Submission to
Victorian Department of Sustainability and Environment

On

Adapting to Climate Change, Enhancing Victoria's Capacity
Consultation Paper

By
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7 September 2004

EXECUTIVE SUMMARY

The issued Consultation Paper 'Adapting to Climate Change – Enhancing Victoria's Capacity' released in July 2004 cannot be classed as an "overview of the existing knowledge of climate change science" and therefore it has failed to provide the public with all the relevant scientific issues on this topic. It has provided one side of the issue, much of which can be discredited with any careful look at the factual data. Therefore undertaking any sort policy initiatives, particularly spending taxpayer dollars on abating CO_2 emissions cannot be justified on any sort rationalisation; eg. Risk Management.

The Consultation Paper does highlight the limited scope of the current research and its bias (blinkered approach) by the omission of other relevant scientific data. It is overly weighted towards modelling and concepts that are not supported by real data. Moreover the "Climate Change Impacts" are not assigned any mathematical probability of actually happening and many of the proposed scenarios are too incredible to be believed!

As a consequence of these deficiencies the Consultation Paper it cannot be used by the public to make rational comments or judgments on how to manage risk of a postulated future climate change. The Consultation Paper takes the stance that Anthropological Global Warming is a fact and has been incontrovertibly measured, even though there is not a single scientific paper published which has shown this to be true.

In this submission I will take issue with the various statements contained in this Consultation Paper to highlight that the contained information is thinly researched, biased, unsubstantiated by actual data, use language that obfuscate uncertainties, and therefore is thoroughly misleading to the public of Victoria. It cannot aid policy making with respect to current and future infrastructure needs and care of the natural environment. Action needs to be taken by the Minister to get an objective view of Climate Science. The Minister should therefore employ a small team of **independent scientists** to review all the relevant published literature on Climate Change. Following this review of ALL available research and factual data, then the Minister can then decide whether any further State Government public funds should spent on "Future Research"! It seems $100 million has been or about to be spent, yet nobody has critically reviewed the freely available data and research. The Federal Government and its Environment Department is just as negligent.

Many research papers have clearly identified and conclusively proven that much of the observed warming over the 20th century is due to Urban Heat Island affects of city/town based ground recording stations. These observed warming-trends are not repeated in remote-area ground based stations or at polar research stations (highest data integrity), the latter being where the Global Circulation Models predict the largest warming. Moreover a high proportion of recording stations were shut down (mainly rural and remote-based) at the end of 1980's which gave a statistic aberration to the climatic record; consequently the record is biased by urban-based thermometers. Over the last twenty five years corresponding Satellite-Microwave Sending Unit (MSU) and Weather Balloon Radiosonde data DO NOT show any warming trend. These instruments measure temperature precisely in the part of atmosphere (near surface to ~8000m; Lower Troposphere) which is predicted to warm by the Enhanced Greenhouse Effect Theory and the GCM's. Unlike the irregular surface measurements, MSU data have an even geographic coverage of the Earth including oceans. Importantly the MSU measurements are very accurate (± 0.01°C). MSU and Weather Balloon Radiosonde measurements are independent of one another in technique and methodology yet show almost the same results. So the predicted warming as espoused by Enhanced Greenhouse Effect (CO_2) Theory and GCM's cannot possibly be valid as the warming predicted hasn't been measured! The at-surface warming is therefore a cultural artifact.

I have included questions posed by Andrei Illarionov (Economic Advisor to Russian President Putin) in October 2003 at the Moscow World Climate Climate Conference to key members of the UN IPCC. Answers to these questions are the caveat placed by Russia to signing the Kyoto Protocol. By 8th July 2004, Mr Illarionov said at a Press Conference regarding the Results of the Climate Change and Kyoto Protocol Seminar in Moscow, that they HAVEN'T RECEIVED ANY RESPONSE AT ALL, even though they had made repeated enquiries. So one can assume that UN IPCC's "evidence" on 20th century global warming and future projection claims CANNOT be substantiated by a thorough scientific analysis, logical argument and/or supporting scientific data! If another government can ask clear and pertinent questions regarding this issue, why can't the Victorian or Australian Governments?

I have included in the Appendix some published papers that clearly highlight and identify problems with the concept of Anthropological Induced Climate Change and the use of Global Circulation Models to project/predict future climate based upon the projected levels of carbon dioxide in the atmosphere.

A substantial amount of research recently published shows that the Sun and its electromagnetic activity have the greatest effect on the Earth's climate. In particular the Sun's activity causing changes to incidence of incoming cosmic rays (flux) colliding with atoms or molecules in Earths upper atmosphere (*cosmic rays are charged particles which are remnants of supernova explosions (collapsing stars) that travel through space at near light speed*). Studies have found that cosmic ray flux is important in the formation/seeding of clouds; hence controlling rainfall and temperature. Consequently when the Sun's magnetic field is strong or is in a violent phase fewer cosmic rays can reach Earth's atmosphere because the rays are swept aside by the Solar Magnetic fields. The research suggests that Earth's Climate was generally cooler during high cosmic ray flux (low solar magnetic activity), and conversely warmer during lower cosmic ray flux (high solar magnetic activity).

Another important adjunct to the Solar influence and ENSO cycles has been recently discovered by the late Theodore Landscheidt, *Schroeter Institute for Research in Cycles of Solar Activity, Nova Scotia, Canada.* This man accurately predicted ahead of time to the month the start and end of the last three El Niño's. All other super-computer powered climate models had failed to do so. Landscheidt has shown that the gravitational affects of the four giant planets Jupiter, Saturn, Uranus and Neptune orbiting around the Sun, regulate the Sun's motion around its Centre of Mass which in turn regulate its eruptive (electromagnetic) activity, which directly correlate to climatic events recorded on the Earth (as discussed above). These planetary-solar activity cycles can be calculated with apparently very high levels of confidence. Before his passing earlier this year, Landscheidt made predictions of the current La Niña from April 2004 to April 2005, while next El Niño from July 2006 until at least May 2007. Our government scientists CSIRO and Bureau of Meteorology would be better employed investigating how Landscheidt undertook his analysis (he was a frequent publisher) than playing around with unrealistic Global Circulation Models.

I believe that climate will vary naturally due to changes in Solar Activities and Celestial factors into the future, therefore one can expect periods of droughts (El Niño's) at intermittent periods into the future. Risk Management can be applied with high confidence as El Niño years can now be accurately predicted by studying Landschiedt methodologies. Consequently water resources for city and country dwellers can be conserved ahead of the next drought period. Farmers can therefore plan ahead their land management practices, crop types, stocking rates and feed requirements into the future El Niño years with confidence.

As the population grows, water will be the most important environmental issue irrespective of any postulated Climate Change facing Australia; availability of fresh potable and mitigating salinity levels in ground waters. If the Victorian government wants to spend money on the environment it would be better spent by piping much of the irrigation channels in northern Victoria; more water available as apparently 95% lost due to seepage and evaporation. Thus by piping irrigation channels we should have 19X more water available for use or for the environment (Murray River). This should also lower salinity levels both in the Murray River and in near-surface groundwaters in the Murray Basin. It is pleasing to see that the government is looking at technologies at recycling effluent, promoting the construction of infrastructure to have recycled water used on public and private gardens in new housing estates.

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STATEMENT:
I am making this submission as a private individual.
I am self employed.
I am not contracted to, or do not represent any private or public organization or lobby group.
Currently I am not a member of any community or business organization or lobby group.

I hold a BSc (Hons) Geology and MSc (Mineral Economics).
I have previously worked in the Mineral Exploration industry.

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VI Theodore Landscheidt papers sourced from www.john-daly.com

1) New ENSO Forecasts Based on Solar Model (22 Dec 2003) 13 pages
2) Solar Activity: A Dominant Factor in Climate Dynamics. 20 pages
3) Solar Activity Controls El Niño and La Niña. 19 pages
4) Top Climatic Events Linked to Solar Motion Cycle. 12 pages
5) El Niño Forecast Revisited (19 Oct 2002). 9 pages
6) Sun's Role in the Satellite-Balloon-Surface Issue (26 Mar 2000). 2 pages
7) Variations in CO_2 Growth Rate Associated with Solar Activity (21 Sept 2003). 5 pages

A. ISSUES WITH CONSULTATION PAPER: Inaccuracies, Unsubstantiated and or Misleading Statements, Omission of Data, And Lack of Real Data

The following discussion is based upon sections nomenclature in the Consultation Paper

FOREWARD by John Thwaites, Minister for Environment
Embarks by saying the recent drought and flash floods are solely due to Climate Change caused by Global Warming. He infers that man-made greenhouse gas emissions contribute to global warming. Moreover that Global Warming IS causing MAJOR changes to weather patterns around the world. He invites us to provide feedback so Victoria can address the impacts of Climate Change.

The reader is confronted by dissertation that infers these things are happening and have been measured.
Unfortunately all the statements by Mr Thwaites cannot be proven as the evidence supporting these statements/conclusions are not provided in the Consultation Paper or References contained within.

INTRODUCTION
The INTRODUCTION (p.6) suggests to the Reader authoritative organizations UN IPCC & CSIRO agree that human-activities has caused Climate Change by emissions of CO_2. It even highlights the words, "Strong evidence now exists that human activities are responsible for climate change."

Close investigation of this claim/statement has shown it to be totally FALSE. It was FABRICATED by UN bureaucrats in the Summary for Policymakers in the three UN IPCC Assessment Reports. There was no evidence at all to support this. Following is taken from De Freitas (2002).

> 'The UN IPCC's voice to the public, press and policy makers regarding climate science is through summaries; in particular, the brief, politically approved "Summaries for Policymakers" (SPM), which have become notorious for their bias, tendency to overstate problems and penchant for simplifying and dramatizing scientific speculation. A classic example is the claim in the 1996 IPCC SPM (Houghton et al., 1996, p. 4): "the balance of evidence suggest that there is a discernible human influence on global climate." The so called "evidence" cited in Chapter 8 of the main report was based on one paper that at the time had not been published in the refereed scientific literature. Moreover, one of the authors of this paper was also the convening lead author of the Chapter 8 that supported the "human influence" claim. A hearing in August 1998 on the subject of global warming before the U.S. House Committee on Small Business, chaired by Republican James Talent, publicized the fact that the 1996 IPCC scientific report (Houghton et al., 1996) was altered to convey the misleading impression to the public that there is a "discernible human influence on global climate" which will lead to catastrophic warming. The background to this is as follows.
>
> The "discernible influence" statement of the IPCC's 1996 report (Houghton et al., 1996) was based on what are called "fingerprinting" studies. A fingerprint study is one in which a geographical pattern of observed climate changes are compared with the patterns of climate changes predicted by numerical simulations of global climate called general circulation models (GCMs). The idea is that by finding a pattern in the observed data that matches the predicted data, a causal connection can be claimed. Following publication of the 1996 IPCC scientific report, and in the wake of mounting criticism of the "discernible influence" claim, a paper by Santer et al. (1996) was published that endeavoured to defend the claim. Subsequently, the results of a re-analysis of the data used in this work were published in an article by Michaels and Knappenberger (1996). It showed that the research on which the IPCC "discernible influence" statement is based had used only a portion of the available atmospheric temperature data. When the full data set was used, the previously identified warming trend disappeared. In light of the widespread use of the "discernible influence" statement to imply that there is proof of global warming, the matter was of great concern (Fig. 1). Not surprisingly, this damaged the credibility of the IPCC.
>
> Neither is the Summary for Policymakers of IPCC 2001 (IPCC, 2001b) a balanced representation of what is contained in the detailed scientific assessment report of IPCC Working Group I (WGI). General "conclusions" are highlighted in the SPM that distorts the actual climate information. For example, the SPM (IPCC, 2001b, p. 10) states: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities." It will be demonstrated later in this review that

a) detailed satellite data show that no warming has been observed,
b) the combined surface weather station data actually show cooling between 1940 and 1975, and
c) data from good quality "de-urbanized" surface stations from around the world show no recent warming trends.

Another "conclusion" of the SPM (IPCC, 2001b, p. 10) is: "Most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gases." But no evidence is presented anywhere that warming is "likely" to have been due to "greenhouse gases'. "Likely" is defined as between 66% and 90% chance, but no probability assessment has been carried out. The statement cannot, therefore, claim that there is actual evidence that the "warming over the last 50 years is likely to have been due to the increase in greenhouse gases." These and other statements made show the SPM (IPCC, 2001b) to be either slanted or misleading. It summarizes the main scientific report selectively in order to claim evidence for a human-caused climate warming.

A true conclusion of "Climate Change 2001", possibly supported by the majority of the scientists involved in the main scientific report, is in Chapter 1 of the IPCC 2001 scientific report itself (IPCC, 2001a, p.97). It reads as follows:

The fact that the global mean temperature has increased since the late 19th Century and that other trends have been observed does not necessarily mean that an anthropogenic effect on the climate system has been identified. Climate has always varied on all time-scales, so the observed change may be natural.

From the above account it appears that the "Summary for Policymakers" is in large part a political document influenced by majority political policies.

Richard Lindzen, lead author of Chapter 7 of the main IPCC scientific report (IPCC, 2001a), has stated that the IPCC use the SPM to misrepresent what scientists say (Lindzen, 2001, p. 18).

The full IPCC report is an admirable description of research activities in climate science, but it is not specifically directed at policy. The "Summary for Policymakers" is, but it is also a very different document. It represents a consensus of government representatives (many of whom are also their nations' Kyoto representatives), rather than of scientists. The resulting document has a strong tendency to disguise uncertainty, and conjures up some scary scenarios for which there is no evidence.'

NOTE: I have included the De Freitas paper '*Are observed changes in the concentration of carbon dioxide in the atmosphere really dangerous?*' in this document as I believe it one of the most complete papers on 'State of Climate Science Knowledge'. The Minister John Thwaites should read it.

It appears that the Victorian Government and CSIRO are perpetuating FALLACIES! CSIRO's publication (Whetton et al, May 2002) *Climate Change in Victoria - High Resolution Regional Assessment of Climate Impacts* unquestioningly emphasize the UN IPCC's misleading statement; '*There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.*' p.1. Didn't CSIRO scientists get to p.97 of the UN IPCC 2001a Report? How can CSIRO agree with UN IPCC? What work was done by CSIRO to verify this statement?

Next the reader is presented with the following statement:
'It is also important that we simultaneously act on climate change information presently available, and begin to adapt when and where appropriate.'
The question is what evidence is available at present? I suggest there isn't any! So what strategic approach can you take or apply if you don't have one single piece of information that is incontrovertible or has some statistical probability of occurring?!

P.7 The Victorian Greenhouse Strategy

You cannot build awareness & understanding unless you provide the public with ALL the scientific information. OTHERWISE it is patently DISHONEST!

The entire discussion paper contains primarily one source of scientific information;

- the CSIRO paper 'Climate change in Victoria – High resolution assessment of climate change impacts' May 2002

This paper is primarily about modelling of Climate by projected changes CO_2 levels. It is heavily weighted to conclusions and prognostications made in IPCC Third Assessment Report SPM or modelling results therein. It

contains NO references to other studies that warming trends may be caused by other man-made (urban heat islands artifacts) or natural phenomena such as Solar and Celestial behaviour. This paper takes it as FACT that CO_2 is the cause of Climate Warming and undertakes studies of modelling from this point of view. The CSIRO should be severely taken to task by omitting the myriad of properly conducted science that provides real data that atmospheric CO_2 (natural or anthropological) is NOT the primary cause of the weak warming (cyclical) observed in the 20th century (discussed later). Again the CSIRO DOES NOT STAND-BY its work (commissioned by Vic Govt), you only need to read the Disclaimer!

> *'This report relates to climate change scenarios based on computer modelling. Models involve simplifications of the real physical processes that are not fully understood. Accordingly, no responsibility will be accepted by CSIRO or the Victorian Department of Natural Resources and Environment (NRE) for the accuracy of projections in this report or actions on reliance of this report.'*

So the subsequent statement points 1) to 4) are weasel words.
The statement…*'In taking a long-term perspective, the Victorian Greenhouse Strategy addresses the **inevitable** and potentially serious economic, social and environmental implications of climate change for Victoria'*…is dishonest as there is no evidence to support this statement!

1. THE ENHANCED GREENHOUSE EFFECT & ITS INFLUENCE ON THE CLIMATE.

§1.1 What is the Enhanced Greenhouse Effect?

It is not stated that the Enhanced Greenhouse Effect is a THEORY.
It just states that CO_2 is responsible for most of the Enhanced Greenhouse Effect

However one reading this could presume that:

- CO_2 levels don't change in the Natural environment, except for man-made influences
- Anthropological influences make a high proportion of CO_2 in the atmosphere

Both of the above are FALSE. CO_2 levels in the atmosphere have changed throughout the Earths geological history (it is currently at very low levels) many cold geological periods such as the Ordovician 438 – 490 M years had much higher levels of CO_2 (2000 ppmv) than is present today (Baliunas, S). CO_2 makes up a very small proportion of "greenhouse gases". Water vapour is the biggest influence in driving climate, it is a naturally non-homogeneous component of the atmosphere and varies from 0 to 40,000ppmv (ie. geographic/seasonal, altitude and time dependant). Importantly water has ~10X the Latent Heat (releases/absorbs 10x more heat changing phase) compared with CO_2. Thus the current level of CO_2 in atmosphere (375ppmv) is equivalent to ~37ppmv water! Alternatively if you agree that CO_2 has risen about 100ppmv since the Industrial Revolution (now seriously questioned, see Jaworowski statement, 2004), it is equivalent to 10ppmv water (this is minute). It is important to understand the majority of CO_2 increase in last 150 years is not due to anthropological means it has been naturally increasing. Anthropological influences are very minor (~3%) to that of nature itself (Mantle-outgassing via Volcanoes aerial and submarine, Oceans, Decaying vegetation etc..) (DeFreitas 2002). Natural variations are High!

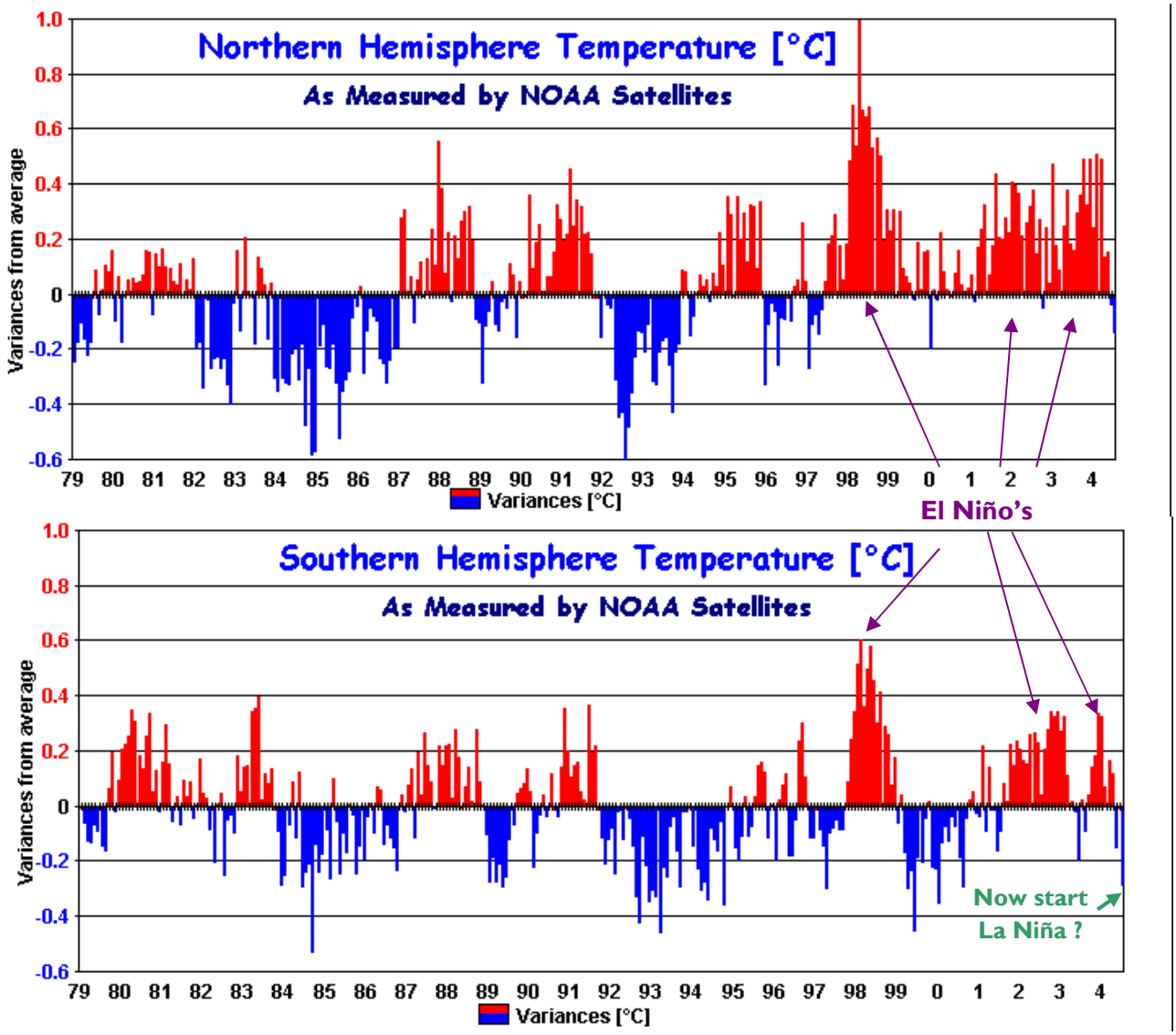
The final paragraph states *'The Earth's climate system is finely balanced. Increased temperatures in the lower atmosphere cause changes to weather and climate worldwide. Consequently, the enhanced greenhouse effect is often referred to as climate change or global warming.'*
This is very interesting statement as it wholly supports what many scientists have been arguing for years (and have been totally ignored and derided as skeptics) that Global Warming has only been measured by city- based (land-based, culturally affected) thermometers (within Stephenson Boxes), since Satellites (Microwave Sending Units – very high level of accuracy ±0.01°C (Christy & Spencer)) and weather balloons radiosondes (both are uninfluenced by cultural features) which specifically measure the Lower Troposphere (near surface to ~8000m) have found NO EVIDENCE of warming over last 25 years albeit in specific El Niño years (See Landscheidt 6). Also see figures below and calculated trends below derived from Global Hydrological Climate Centre, or DeFreitas Figs 12 &13. In fact it could be concluded that there is some cooling taking place in Southern Hemisphere! How does this fit with CSIRO statements?!

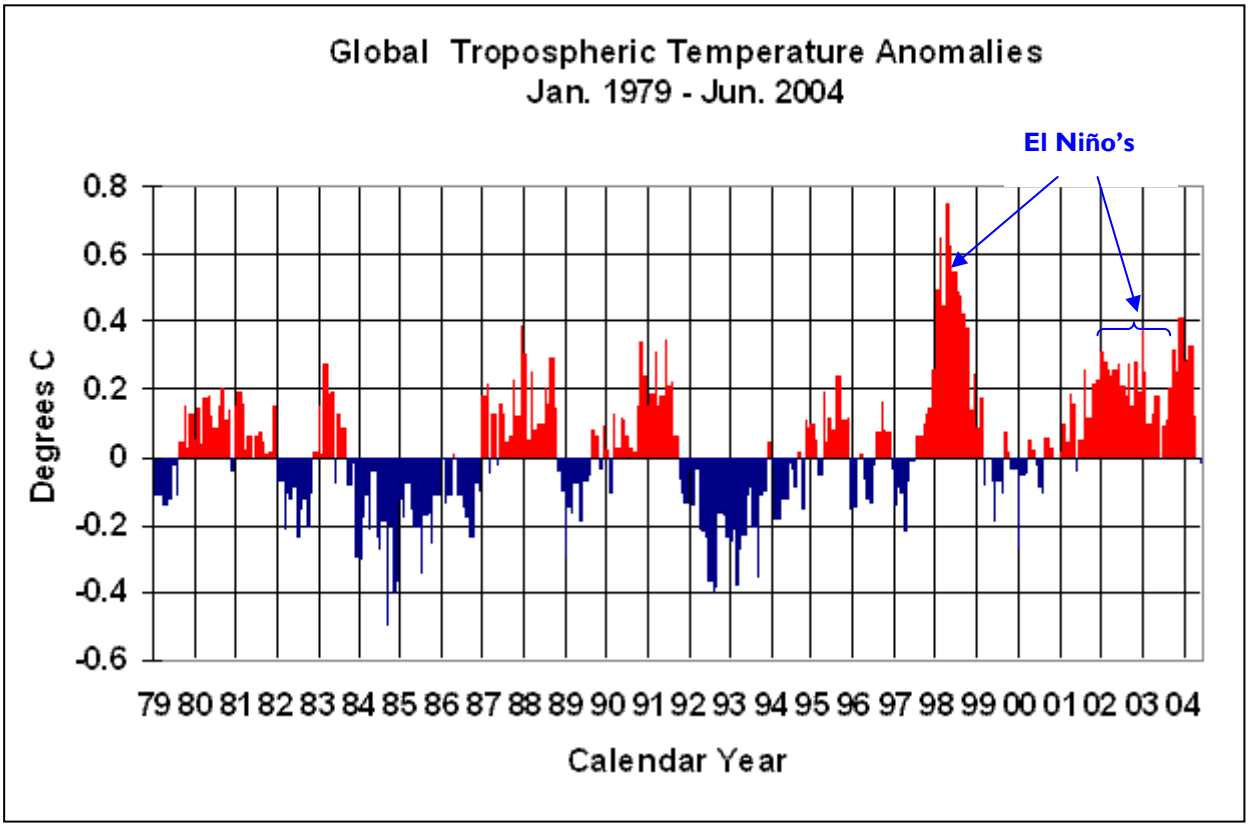
The Lower Troposphere is what and where the Climate Models are trying to model! So any effects on weather and natural climate should be NIL! How come the Models are giving increasing temperature outcomes? So either the Theory (increasing CO2 levels & increasing temperature) is wrong or the culturally-unaffected atmospheric instruments are wrong. Suggest the Theory the enhanced CO_2 –Global Warming Theory and its Models is looking very shaky.

Consequently the Consultation Paper is misleading the general public as they have not been made aware some indisputable facts:

- The theory of Enhanced Greenhouse Effect due to rising CO_2 levels is UNPROVEN!
- The pre-industrial levels of CO_2 as measured within Ice Cores have been corrupted and contaminated by the drilling process and the quantitative CO_2 data is wrong! Also the data has been improperly manipulated. Hence the apparent measured increase in CO_2 since Industrialisation is wrong! Hence CO_2 levels since industrialisation may have only increased ~40ppmv and not ~100ppmv! See Jaworowski 2004
- Levels of CO_2 have varied naturally throughout geological history.
- Studies have found that atmospheric CO_2 levels increase following a warming phase. Not vise versa!
- Anthropological component of CO_2 in the atmosphere is extremely small.
- Evidence from real very precise and highly accurate data (MSU and Radiosondes) DOES NOT SUPPORT the THEORY.
- Consequently using models which are based upon various projections of CO_2 concentrations (using dubious economic modelling) to project temperature and rainfall scenarios is FLAWED as there is NO MEASURED CONNECTION between CO_2 & Temperature precisely in the region of the atmosphere which should be warming according to the Theory!

Figures: Hemispheric Lower Troposphere Mean Temperature Variances
As measured by NOAA satellites MSU – January 1979 through to July 2004
In format originally produced by Dr Roy Spencer (NASA/Marshall SFC) & Dr. John Christy of GHCC UAH
Original Source NOAA & Interpretation by Global Hydrological & Climate Center – Alabama USA
www.ghcc.msfc.nasa.gov/MSU/msusci.html. For Spencer's discussion see www.ghcc.msfc.nasa.gov/MSU/hl_temp_ud.html





Global trend per decade = +0.079°C, (Northern Hemisphere = +0.148°C, Southern Hemisphere = +0.010°C.)
July 2004 Global = -0.213°C, (Northern Hemisphere = -0.140°C, Southern Hemisphere = -0.286°C.)

§1.2 The IPCC's Third Assessment Report

This section is full of distortions and unsupportable claims made under the guise of some international authority to convince the public of impending disaster.

'The IPCC's Third Assessment Report (2001) concluded that global warming has accelerated in recent decades and there is new and stronger evidence that most of the warming over the past 50 years is attributable to the increase in greenhouse gas emissions associated with human activities.'
As mentioned previously this is a bureaucrats summary (the SPM) not a scientific summary. It is FALSE and basically misrepresents what were the real conclusions. There is not a single scientific paper presented or data presented in the Third Assessment Report that actually supports this conclusion! The phrasing used by the UN IPCC is deceptive … "new and stronger evidence"… suggestive of conclusive studies that prove the concept of anthropological CO2 emissions and global warming, when neither has been forwarded. Either you have clear evidence or you have allegations / theories which you cannot prove! So basically the statement is a LIE!

'The 2001 report also noted that even if atmospheric concentrations of carbon dioxide are stabilised within the next century, temperatures will continue to increase for several centuries, and sea level will continue to rise for several millennia. Climate change will adversely affect water resources, agriculture, forestry, fisheries and human settlements, ecological systems and human health in many parts of the world.'
This just shows the absolute extremism in language used. Atmospheric concentrations of CO_2 have never been stable. No evidence is provided that it has been stable in the past. No conclusive proof or unequivocal data at all is supplied that temperatures and sea-levels will continue rising at some presumably unnatural rate, but states everything will be "adversely" affected! No positive benefits at all! Despite the fact that CO_2 is an important factor in efficient plant growth.

'Other key findings from the IPCC's Third Assessment Report include:
• the 1990s was the warmest decade and 1998 the warmest year in the instrumental record since 1861.'
This simply is NOT TRUE and is unsupportable because it is unlikely that the instruments been properly calibrated, systematically read, located in the same position, were not affected by cultural features (in the immediate surrounds of the *Stephenson Box*), and the same amount of recording stations existed for the entire dataset since 1861? Many instruments were decommissioned in late 1980's and 1990's, most of these in rural and remote-areas which gave a statistic aberration to the climatic record; consequently the record is biased by remaining urban-based thermometers. (See below Figure 3 from McKitrick,R., 2003). This highlights a statistical problem, and not a warming problem! Compare with MSU data in early 1990's (shown in figures above).

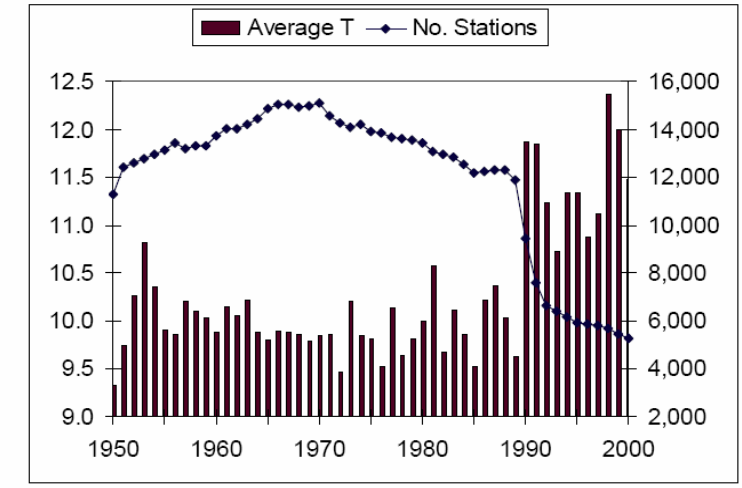


Figure 3. Number of stations in Global Historical Climatological Network (GHCN) collection (diamonds, right axis); Average temperature of annual sample (bars, left axis in °C). Mc Kitrick, R., 2003

So is the dataset comparable? Anyway not all instruments show this over part of the time frame 1979 to now, MSU / Weather Balloons indicate no marked temperature anomaly, especially outside the El Niño years; supposedly the period of greatest "recorded" warming!

'*• globally averaged surface temperatures are projected to increase between 1.4°C and 5.8°C from 1990 to 2100. '*
These aren't facts! Projections are NOT FACTS! These projections are fantasies as the Models cannot replicate last 100 years of actual climate. The economic projections in intensity of use of carbon-based fuels (and hence CO_2 emissions) by human populations as applied by UN IPCC prognostications have been conclusively debunked by Castles & Henderson; *The IPCC Emission Scenarios: An Economic-Statistical Critique* (2003) *published in Energy & Environment.*. Therefore the range in global temperature rise is too far removed from reality, even if the Models could be believed! Moreover the Global Circulation Models do not or cannot mathematically model cloud formation / water vapour or have Solar Cycles / Activities involved; perhaps the biggest factors on climate. So any numerical projections of temperature increase do not have any value of certainty.

• recent regional climate changes, particularly temperature increases, have already affected many physical and biological systems.
No evidence provided! No scientific papers or studies can show this to be true!

• global average sea level has risen and ocean heat content has increased
This is dishonest statement for public discussion as you have not stated what were the natural variations (bounds), or oceanic heat content rises over the 20th Century. Oceans have been rising since last Ice Age. However within the CSIRO paper it states 'the observed sea-level rise over the 20th century has been 1 to 2 cm per decade (after correction for geological effects and data quality); this comes from the IPCC. The quote shows that there is a serious error problem because there is 100% variation in the range of sea-kevel rise. Investigation of this quote suggests that the IPCC data is a construct, based upon a Glacial Rebound model of the North Atlantic not on actual measured data. The model is based upon the estimated rate of rebound of the Earth's Crust in NW Europe/ NE North America, following last Ice Age; the claimed rate is in question consequently apparent mean sea-level changes are also questionable (Daly.J.L). It seems that CSIRO just take the UN IPCC estimate as fact. The quote in the CSIRO paper (p.8) relating to Australia is an apparent construct by Lambeck, 2001. It doesn't match the actual data measured by National Tidal Facility (NTF) based in Adelaide (See below). Why doesn't CSIRO look at the NTF data?

The following is an excerpt from Daly, J.L (*Testing the Waters – A Report on Sea Lea Levels*, published on Greening Earth.org)

'The NTF identifies the following tide gauges as meeting their long-term criteria. NTF calculates the annual sea level change for each location in millimeters per year. Sea level rises are shown in **red (+ve)**, falls in **blue (-ve)**. The stations run counter-clockwise around the Australian continent, beginning with Darwin in the Northern Territory. Compare these results against the IPCC's claimed rate of +1.8 mm/yr.

Location	Years of data	Est. trend (mm per year)
Darwin, NT	34.9	-0.02
Wyndham, WA	26.4	-0.59
Port Hedland, WA	27.7	-1.32
Carnarvon, WA	23.9	+0.24
Geraldton, WA	31.5	-0.95
Fremantle, WA	90.6	+1.38
Bunbury, WA	30.2	+0.04
Albany, WA	31.2	-0.86
Esperance, WA	31.2	-0.45
Thevenard, SA	31.0	+0.02
Port Lincoln, SA	32.3	+0.63
Port Pirie, SA	63.2	-0.19
Port Adelaide - Inner, SA	41.0	+2.06
Port Adelaide - Outer, SA	55.1	+2.08
Victor Harbour, SA	30.8	+0.47
Hobart, TAS	29.3	+0.58
George Town, TAS	28.8	+0.3
Williamstown, VIC	31.8	+0.26
Geelong, VIC	25.0	+0.97
Point Lonsdale, VIC	34.4	-0.63
Fort Denison, NSW	81.8	+0.86
Newcastle, NSW	31.6	+1.18
Brisbane, QLD	23.7	-0.22
Bundaberg, QLD	30.2	-0.03
Mackay, QLD	24.3	+1.24
Townsville, QLD	38.3	+1.12
Cairns, QLD	23.6	-0.02

Eleven of the 27 stations record a *fall* in sea level, while the mean rate of sea level *rise* for all stations combined is a mere 0.3 mm per year. The average record length is 36.4 years. This rise is one-sixth that anticipated by the IPCC. Nor is there an obvious geographical pattern of fall versus rise. Both are distributed along all parts of the coast.

But there's more. As was explained earlier, Adelaide is a prime example of local sea level rise due to urban subsidence [3]. Its two stations (listed above) are the only ones where a sea level rise is greater than the IPCC estimate. The NTF survey points out the Adelaide anomaly and directly attributes it to local subsidence, not sea level rise. NTF reaches its conclusion on grounds that the neighboring stations at Port Lincoln, Port Pirie, and Victor Harbour show only a rise of +0.3 mm/yr between them. If one excludes Adelaide from the list, the average sea level rise for the other 25 stations is only 0.16 mm/yr, *or less than one-tenth the IPCC estimate*.'

NOTE: The Adelaide Basin is sinking primarily due to extraction of groundwater (by market gardeners).

• sea levels are projected to rise between 0.09 and 0.88 metres from 1990 to 2100

Given the real data above, how can anyone take this range seriously! Why such a large discrepancy; low end is ~10X less than high-end estimate?? What are the causes of the rise??? How confident are the people making the projections? What hallucinogens are they taking? Are people so stupid not to question this??? Its 2004, 14 years have passed since this prognostication 12.7% of the time frame has elapsed, have sea-levels risen 11.2cm? (taking high-end scenario; 12.7% x 88cm). Patently these projections are ABSURD and should not be taken seriously! Australia being the most tectonically stable continent on the planet surrounded by 3 big oceans you would suggest that if the sea-levels were rising dramatically we would have measured it by now! So one may conclude based upon the NTF data that within the last 100 years the oceans around Australia have risen on average16mm! Even if you include Adelaide stations brings it to 30mm. That's significantly different to 100 to 200mm for the 20th century estimate given in UN IPCC. Now its going to rise 90 to 880 mm in 95 years OK I still believe in Santa

Claus! Moreover TOPEX satellite data being gathered, is also beginning to show (as more satellite passes increase accuracy of results) negligible rises in ocean levels after removing El-Niño effects (Daly, J.L).

• natural systems are vulnerable to climate change and some will be irreversibly damaged
It's a statement with no evidence!

• water in Australia is likely to be a key issue due to projected drying trends over much of the region and change to a more El Niño-like average state.
This statement is not even supported by text within the discussion of the Consultation Paper! P10
'Rainfall trends are not as clear. While Australia's average annual rainfall increased 6% over the last century, strong regional rainfall variations occurred. Rainfall increased in the north-west but decreased in south-west Western Australia and over much of south-eastern Australia and the east coast. Records since 1910 also indicate a significant increase in the frequency and average intensity of heavy rainfall in many parts of Australia.'

§1.3 Projections of Climate Change (p.10)

Observed Changes in Australia's Climate Observations show that Australia's climate has been changing throughout the 20th century. Australian average temperatures have risen 0.76°C, and the increase has accelerated since 1950.
Why 1950 is the starting date? This was a cold year. Try early 20th century had the Federation Drought and very high recorded temperatures? Why omitted? Maybe the post 1950 acceleration coincides with rapid post-war population and development growth hence is a cultural artifact! Again is the acceleration homogenous over all recording stations? Moreover are all recording stations been properly vetted to verify there have been no cultural-changes around the station, the station has not been moved, and same recording method employed?? Probably not the case as you can see with the statement on night-time temperatures below.

Temperatures during the 1990's were the hottest ever recorded.
Maybe in this time series, what about earlier than 1910? But still there is a problem with vetting of all stations. Suggest many modern ones have been affected by cultural issues (bitumen roads, concrete etc…). Why has a thirty year mean been used? Why not 20, 24, or 15 years? What's so special about thirty years? Does this (hottest ever recorded) correlate with the Satellite MSU and Weather Balloon data over Australia? If not, Why??
Given the MSU data Southern Hemisphere trend shown previously, you can only suggest NO!

Nighttime temperatures have risen faster than daytime temperatures, reducing the diurnal temperature range in most regions.
'Night- time temperatures rising faster than day time temperatures' suggests a big problem with recording station location and cultural influences! Is this differential homogeneous over all recording stations? Are they city based or rural based? Are all recording stations surrounded by the identical cultural features over the time-series? Are the recording locations identical over the time-series? Are ALL the recording locations used throughout the data time-series. If the answer to any of these points is "No", then any conclusions or inferences about future by CSIRO cannot be reasonable! Why hasn't CSIRO investigated the issue of DTR? It took me half an hour on the internet to find many research papers, the best discussion of the reduction of Diurnal Temperature Ranges is given by Hoyt (in www.warwickhughes.com/hoyt/dtr.htm)

> 'A decreasing DTR presents problems for the greenhouse warming theory. In 1995, James Hansen noted: "Models show that daytime warming will be almost as great as nighttime warming" [for a greenhouse gas forcing]. In a 1997 paper in Climate Dynamics, climate modeler Watterton points out that the observed decrease in the range of diurnal temperatures "are not consistent with their being produced by the observed increase in greenhouse gases." No climate model yet devised can fully account for the observed diurnal variations and hence the recent observed warming. Watterton suggests that there are major errors in the way climate models treat clouds. A climate model experiment that comes close to explaining the results is given by Hansen et al. (1995) in Atmospheric Research. Their model experiment implies that a greenhouse gas doubling, accompanied by a 1.2% increase in low level clouds, will reduce the diurnal cycle by 0.21°C compared to an already observed decrease of about 0.5°C. This experiment implies clouds are acting as a strong negative feedback, so that when greenhouse gases double, the global warming will equal 0.67°C. Even this number may be high since they are unable to explain the full 0.5°C change, meaning even more clouds causing more cooling may be required. However, a recent study by Kaiser (1998) shows that cloud cover in China is decreasing along with the decrease in diurnal cycle amplitude. Thus, Hansen's model is not consistent with observations. Neither greenhouse gases nor changing cloud cover can account for the decreasing

diurnal temperature cycle in the surface observations, which is the primary evidence that is used to claim the warming is caused by increased greenhouse gases.

More recently, Stone and Weaver (2003) have looked at the DTR using climate models and find that "the cause of the DTR trend is still poorly understood, as is its relation to anthropogenic forcing." They argue that increasing cloud cover and increasing soil moisture may be the cause of the observed DTR variations. Increasing cloud cover suppresses warming during the day and is thus a negative feedback.

It seems that changes in aerosols, water vapor, or ozone are inadequate to explain the observed DTR trends. Changes in cloud cover are a contender, but if true, it implies clouds are a negative feedback and hence a doubling of carbon dioxide will cause a very modest warming of less than 1°C. Explanations involving Changes in the Land Surface Changes in land surface and the growth of urban heat islands (UHI) can also cause decreases in DTR. As early as 1996, Hughes and Balling showed there were decreases in DTR in urban locals but no change in DTR in adjacent rural locations using stations in South Africa. This study alone gives rather conclusive proof that the DTR changes are caused by UHI and not by any change in the atmosphere, such as clouds, which would be the same for nearby urban and rural stations.

Moreover, if Hansen et al. (1995) and Stone and Weaver (2003) were correct in blaming the decrease in DTR on increasing cloud cover, one would expect the albedo of the Earth to increase rather than decrease as has been shown by the measurements of Palle et al. (2004). Arguments attributing the decrease in DTR to greenhouse warming are simply not tenable.

More recently using stations in China, Zhou (2004; see press release at http://www.zhb.gov.cn/english/news_detail.php3?id=9327) attribute most of the warming and decreases in DTR to UHI and we quote from the press release:

> 'To measure the variations of the DTR, Zhou and his collaborators used observational data of monthly daily maximum and minimum land surface air temperatures at 671 meteorological stations across China from January 1979 to December 1998, collected and processed by the National Meteorological Center of the China Meteorological Administration.'
>
> 'They then focused their study on 13 provinces and cities in southeast China that consist of 194 well distributed observation stations, in the area where most of China's urbanization has occurred.'
>
> 'According to them, this region has the highest meteorological station density; the most uniform station distribution, the minimal non-climatic effects; and most consistent observation data in China.'
>
> 'They found a decline in the DTR at most stations, with the largest decrease in the eastern and southern coastal areas where rapid urbanization has occurred, suggesting a rise in near surface temperature.'
>
> 'The decrease of DTR is greatest in the Yangtze and Pearl River deltas and is generally larger at coastal stations.'
>
> 'They also found the DTR change is generally consistent with several indicators of urbanization such as the number of towns and cities, urban population, and so on.'
>
> 'If urbanization is responsible for the reduction in the DTR, changes should be correlated with factors known to affect urbanization." Zhou says in the paper.'
>
> And we emphasize the statement "the DTR change is generally consistent with several indicators of urbanization". A review of the Zhou paper can be found here.

> On the other hand, Collatz et al. (2000) conclude that changes in land cover cause the decreased DTR. They 'suggest that reported increases in vegetation cover in the Northern Hemisphere during the 1980s could have contributed to the lowered DTR.'
>
> Since land cover changes and UHI are not included in the climate models used by Hansen et al. and Stone et al., it implies that changes in the surface are a strong contender to explain the observed DTR changes. Kaiser showed that changes in cloud cover cannot always explain the observed DTR decrease. In addition, the DTR has a weekly cycle and clouds do not (although fossil fuel burning in cities does have a weekly cycle), providing further evidence that the decreasing DTRs are an effect of changing surface and not an effect of changing atmosphere (Forster et al., 2003).
>
> *What Does it All Mean?*
>
> If changes in the atmosphere are ruled out as a cause for changing DTR, then it implies UHI and land use changes dominate. Since the nighttime temperatures are rising three times as fast as the daytime temperatures (Karl et al., 1993), it implies a non-climatic signal in the nighttime data equal to about one half of the total warming. It implies the reported global warming of 0.6°C in the twentieth century should be reduced to about 0.3°C.'

The number of very warm days also increased during the 1990s, and the frequency of frosts and very cold days has decreased.
Were the "very warm days" in the peak El-Niño Years??

In frost affected areas the number of annual frost days has declined by an average of 5.6 days between 1957 and 1996 and the average frost season shortened by around 10 days.
Is there any reason why CSIRO has not calculated the average frost season to 2001? This paper was written May 2002.

Rainfall trends are not as clear.
This statement indicates no degree of certainty AT ALL! How does this statement fit with statements made on p11 with respect to modelling of rainfall?

While Australia's average annual rainfall increased 6% over the last century, strong regional rainfall variations occurred. Rainfall increased in the north-west but decreased in south-west Western Australia and over much of south-eastern Australia and the east coast. Records since 1910 also indicate a significant increase in the frequency and average intensity of heavy rainfall in many parts of Australia.'
The problem with making a statement of this nature is the baseline date. Was 1910 an "average year in rainfall frequency"? How was this determined? Was this Australia wide?? One could also presume that since there has been an increase in temperature over last 94 years this has also has also led to an increase in recorded rainfall. How does this fit with the forecast drought scenarios, given later in this paper?

P11. ….. *The historical fluctuations in rainfall can be partly explained by the increase in El Niño conditions over recent decades. However, current research suggests that warmer temperatures are increasing the impact of droughts.*
The last sentence is unsupported by evidence presented here or in the CSIRO paper.

Projections of Future Australian Climate Change (p11)

Most of the information presented here are no more than a bunch of random numbers (somehow mimicking ranges presented in UN IPCC TAR Report) which are extremely hard to believe even though they are projections/predictions as they have no statistical confidence bounds.

Can CSIRO Climate models correctly simulate the recorded temperatures, rainfall in Australia or any Victorian regional area over the last 94 years from 1910? Given that we have recorded precise levels of CO2 in the atmosphere particularly from 1960 and probably some physical data over the rest of the time frame. NOTE: There is an obvious problem if you try to re-simulate the historical temperatures due to the UHI affect on the historical record.

According to the CSIRO paper itself, it can't accurately simulate the historical record! The Models used CSIRO GCM (1961-2000) & DARLAM (1961-2000; High Res) simulation run were over only 19 years (1972-91) to

measure average rainfall (mm/day) during summer (p19 CSIRO paper). CSIRO also ran the main models in UN IPCC Report but showed they were nothing better than random event generators see following:

"The model results reveal strong variations from model to model and also from season to season. Model performance is in general poorest in spring and best in winter. No model is clearly best or worst, although the GFDL and ECHAM3 (not shown) simulations are generally poorer. DARLAM125 (not shown) is good in autumn and winter, but shows some unrealistic features in spring and summer. Figure 15 also presents samples of good and poor model performances. The results of this analysis are highly relevant to the assessment of climate model simulations of enhanced greenhouse rainfall change for Victoria. As the model results do vary significantly, they potentially provide a basis for reducing uncertainty through eliminating unrealistic simulations. Since the current results are based on preliminary analyses, further analysis is required to better understand the nature of model success and failure in this new area of model validation."

However this ambiguity of results was not stated in the public Consultation Paper! The omission of these results or findings is DISHONEST.

Yet the public is given the following:
'CSIRO suggest that annual average temperatures will increase between 0.4°C to 2.0°C by 2030'.
Given the uncertainty described above by CSIRO & its models you might wonder! The high-end of the increase is 500% the low-end!! This is totally unacceptable! This is suggestive of problems in the weighting of climate & economic factors within the models themselves!

Slightly less warming is expected in some coastal areas and Tasmania, but greater warming could occur in the north-west.
Weasel words, 'slightly' 'expected'?? How much confidence!

By 2070, average temperatures are expected to increase between 1°C to 6°C.
A 600% difference between low-end scenario to high-end scenario! Right! Any probabilities given??

Warming is likely to be greatest in spring and least in winter. Model results suggest that while trends over the 20th century saw greater observed increases in minima than maxima, future increases in daily maxima and minima will be similar to changes in average temperature.
What does this mean?? Models can't account for this given discussion by Hoyt above!! Night-time being warmer is clearly suggestive of bitumen or concrete re-radiating heat, and or vehicles, buildings emitting heat??

Projections of annual average rainfall indicate a reduction in the south-west and parts of the south-east region, while eastern Australian trends are predicted to range between -10% and +10% by 2030, and between -35% and +35% by 2070.
This is scientific gobbledygook. One can safely assume NO CHANGE in rainfall with predicted range of -10% to +10%, or -35% to +35% (as one could pick zero, it is within the range). Moreover there is no certainty behind the calculation.

In eastern Australia, summer and autumn rainfall is predicted to increase between -5% and +10% by 2030, and between -10% and +35% by 2070.
Comments as above!

In winter and spring less rainfall will tend to occur, with the largest reductions predicted for the south-west of this region.
This is referenced to the AGO. This is a bureaucracy. Is there scientific data to support such a statement? Again unquantifiable weasel words are used "less" & "tend" & "largest reductions predicted". What are the levels of confidence in these predictions mathematically speaking 50%, 100% or 0.00001%!

Climate Change in Victoria (p12)
During 2003, Victorians experienced the reality of what climate change may cause in the future - catastrophic bushfires, violent storms and urban flooding, and greater demand on already limited water supplies. The 2002 drought that contributed to the extent and the intensity of the 2002/2003 bushfires had a more severe impact than any drought since 1950. It was one of the most severe fire seasons in Victoria's 160-year settled history, with more than 80 fires burning 1.3 million hectares.
This statement equates all these disasters to Global Warming, but they cannot show that to be the case.

- Bushfires have happened before in drought / El Niño years. Some were deliberately lit. Some fires could have been ameliorated by backburning in cooler months to reduce fuel loads but some government

departments did not allow this to happen! The government does not have statistics of fire intensity since settlement! Many fires that occurred 100 years ago were never fought and areas they burnt out were never calculated. Therefore how truthful is that Claim??

- Violent Storms; are you telling me there have never been violent storms in Melbourne or suburban flooding! Empirically these storms certainly haven't increased? Are there any studies to show they have???

Projections of Future Climate Change in Victoria

'A Victorian Government-funded report published by CSIRO in 2002, Climate Change in Victoria: High resolution regional assessment of climate change impacts, presented information on global and regional climate change trends, assessed regional capability of climate models, and projected future climates Victorian regions ***will*** *experience'.*

The use of the word "will" suggests 100% certainty. The CSIRO Report does not provide any certainty. One only needs to read the Disclaimer to be certain of that Fact! Some mathematical correlations between models and observed results are presented but clearly there are no perfect results. Most temperature results are out by more than 1°C to ~4°C and Correlation Coefficients vary significantly in Winter (it shows no correlation at all for most Models). Given that these same Models are used to project/predict future climates, one can be skeptical that they will represent reality.

The Victorian Country Towns Predicted Temperatures (Table 1) is beyond any sort of credibility given the ranges stated. I assume the computer generated diagrams are supposed to provide more validity to the results? Words used such as "expected between 15% and 40% more hot summer days…" again no confidence is attached!

The Rainfall dissertation given on p14 also shows CSIRO has absolutely no idea what will happen! Either it's going to be 9% drier or 3% wetter. Thus it may be the same as present! Again more verbose stuff.

The statement about snowfall is just so far removed from reality, quote "*areas which experience at least 60 days of snow cover are predicted to decline between 18% and 60% by 2020, and between 38% and 96% by 2050. The total area with at least one day of snow cover is predicted to decrease between 10% and 39% in 2020 and between 22% and 85% in 2050".* Hasn't anyone twigged 60% decline scenario for 2020 is absurd (15 years to go and max 28 days of cover), given we have had three good snow seasons since 2002. This year already has been the best for 10 years. The snow cover will likely be there till end of September, hence ~120days!

Daily rainfall may become heavier, even where average rainfall declines
Great how did they come up with this concept?

Try and work this out…. '*While extreme events are more difficult to model and characterise than average climates, preliminary research indicates intense low pressure systems are likely to become more frequent. Although the average intensity of low pressure systems decreases, the frequency of intense (storm) systems is projected to increase,'*

and yet within the CSIRO paper they state on p.32 '*Notably, the pressure changes identified here differ significantly from the observed changes in pressure associated with the dry conditions in Victoria since 1994 (see Figure 12). This may indicate that the* ***recent dry spell is unlikely to represent the early effect of greenhouse-related climate change****'……*

'Finally, it should be noted that the discussion above ***assumes*** *that atmospheric circulation and rainfall are realistically simulated in current GCMs. Although, the analysis presented in section 3.2 indicated that this was broadly true, it was also noted that some models showed some unusual features. The realism of the simulated changes in rainfall and associated circulation in current GCMs require further assessment in order to best quantify uncertainties in estimating future climates.'*
No confidence or certainty by CSIRO here. How does this fit with the word "will happen" or "are expected" scattered through the Consultation Paper.

El Niño Southern Oscillation p.15

Climate models do not provide a consistent indication of future changes to ENSO events. However, it is likely global warming will enhance drying and drought conditions associated with El Niño events, and intense rainfall and run-off associated with La Niña events
Again this is a contradictory statement to what was stated on previous pages in this publication, eg. droughts will be worse based upon modelling...NOW 'models do not provide a consistent indication of future changes to ENSO events'. How can the conclusion that 'worse droughts and intense rainfall will happen' be given any sort of credence?

2. *THE IMPACTS OF CLIMATE CHANGE*

§2.2 Victorian Landscapes & the Natural Environment

Coasts

Other potential impacts identified to date include:

• changes in rainfall, tides, wave exposure and water temperature will change the nature of estuary flows. Sediment dumps following heavy rainfall can smother estuarine areas, killing vegetation and reducing breeding habitats.

Changes in tides?? Do you mean regular tides or surge tides? The gravitational-pull of the moon controls tides, not CO_2 levels or air temperature! The stuff about sediment dumps is clutching at straws; this has happened throughout the geological history of Earth.

Many other sub-headings the disasters are regurgitated. Again with no proof or evidence.

Water Quality

Every water quality disaster is mentioned, but the strangest is CO_2 concentrations? How is Water Quality by affected by the dissolving of minor levels of CO_2 from the atmosphere even if it tripled?? Eutrophication is a land management issue, due to phosphate run-off into water-ways. Excessive nutrient loads.

Bushfires

CSIRO has predicted the mean Fire Danger Index will increase 10% if CO_2 concentrations in the atmosphere double. In Victoria this will mean twice as many high and extreme fire danger days each year.

If CO2 were to double...hmm? Currently ~375ppmv, Double = 750ppmv. Rate of growth ~1ppmv /yr. Try around 375years. Why worry! Even using an optimistic cumulative CO_2 growth-rate it would take over 100 years to get to 750ppmv. It is obvious that these sentences are just sensationalist license!

§2.3 People & Communities

Emotive prose designed to frighten the living daylights out of everyone here. First paragraph suggests 'historic climate variability may longer be useful for development planning', although no attempt has been made to explain what has been the normal climate variability since settlement. Then next paragraph puts just every disaster in one sentence, but admit there are Urban Heat Islands; suggest these people can now check their UHI based thermometers!

I'm not sure what Table 5 *Average Annual Costs of damage in Victoria that natural disasters have caused between 1967 and 1999* is trying to convey as we don't know what the numbers mean? Is it Value in Real Terms (2004 dollars) or is it Value per capita insured? In reality it is meaningless as we don't know if the value is increasing over the time-span relative to the people insured. There is a problem with the changing costs of goods some have decreased others increased etc… As people are more affluent they purchase more goods and more take out insurance. Is the number of natural disaster claims exponentially increasing per insured per year since 1967? They should be as global warming apparently started from the Industrial revolution! For me it is used to give the public the idea that insurance costs will blow out due to all the pending disasters (storms flooding etc) that '*will happen*'.

Health

Again some very emotive prose of '*Direct impacts include injuries and death from heat waves, storms and floods. Indirect affects can be caused by declining water quality, water-borne-diseases, infectious diseases and food poisoning (eg. from fish contaminated by toxic algal blooms)*'. These are scenarios that could occur IF the climate in Victoria changed outside normal variability. However one could suggest that we look at Brisbanites, they live in a tropical environment, are they suffering from water-borne or infectious diseases, are people dying in the streets? I suggest not. Alternatively let us look at Perth residents, where the summers ARE hotter and drier than Melbourne, again are they dying in the streets from heat exhaustion or frequent salmonella poisonings? No they are not. However the Swan River does suffer from toxic algal blooms and fish do die on some occasions. People generally don't eat those dead fish. The algal blooms are primarily caused nutrient run-offs from the surrounding areas combined with naturally low fresh water flows during summer. I believe local authorities are dealing with that issue. Therefore if you believe we are in for a hotter, sometimes stormier, sometimes wetter but also sometimes drier future ahead, Australians can adapt easily.

3. *ADAPTING TO CLIMATE CHANGE.*

This is all standard stuff you would think the governmental authorities would be doing as a matter of course even if there was no 'Climate Change'. For example

- Storm Water infrastructure should be updated, renewed and expanded, it should have the capacity now for Flash Flooding.
- Wildlife corridors and maintenance of habitats.

4. VICTORIA'S APPROACH TO ADDRESSING CLIMATE CHANGE IMPACTS AND ADAPTATION.

§4.1 Proposed Goals and Guiding Principles

Comments were invited here.
Firstly climate change impacts can only be undertaken if the climate is conclusively changing from its NORMAL VARIATIONS. Nowhere in this Consultation paper has this been established or let alone proven.

Determination of priorities on the basis of Risk Management.
We are given a good definition of Risk Management in relation to Managing Climate Change Impacts:
'Risk, in this case, is defined as the probability of a particular outcome occurring, weighted by the consequence of that outcome'. However within the Consultation Paper & CSIRO paper all predictions / projections have NO PROBABILITIES attached. Moreover the consequences of outcomes provided again have no probabilities attached. So by definition how can Risk Management be undertaken?

Then another panel in the text re-iterates the definition several times and now emphasizes uncertainties. Then supports the use of Risk Management by the use of an example that more than 20,000 people died and some US$13 billion of economic loss occurred during a heat-wave in Europe in 2003. Even if you believe those figures (could argue that a proportion of those deaths may have occurred anyway, and how was the economic loss calculated?), heat waves have occurred in Europe in the past, what about the deaths and economic damage that occurs during the more frequent cold-snaps in European winters (can't travel or transport goods, or poor people with defective heating freeze to death etc..). So I gather that a Risk Management technique for Europeans would be to provide elderly or susceptible citizens with subsidised Air Conditioning / Heating?

However then the Reader is confronted with the following statement; '*In addition, it is critical to recognise that uncertainty is not an excuse for inaction. A risk management approach can enable appropriate action to be identified and pursued even in the face of uncertainty*'. This is patently an illogical statement, based upon your own definition of Risk Management! Where do you act? How much do act? What are the costs of the acts? What are the benefits of the acts? Uncertainty is a key issue. You cannot spend billions of dollars on systems, infrastructure, or mitigating- practices (eg. reducing Greenhouse Gas Emissions or using public funds subsidising Wind Farms), or other investments which may never have any defined benefit or purpose. I agree improving management of existing infrastructure and resources should happen as a matter of course of continual improvement. New infrastructure should be engineered based upon extremes of known conditions/tolerances within economic cost/benefit analysis.

This problem of going off on the certainty path is given on page 30; '*consider how actions responding to climate change impacts can be pursued in concert with actions designed to abate greenhouse gas emissions (e.g. when considering responses to climate change impacts on the agricultural sector, efficient and effective outcomes are more likely if emissions abatement opportunities are pursued together with efforts to improve understanding of the impacts of climate change and adaptation strategies)*'. I actually don't understand what the statement or example means, but somehow we must spend capital on abating greenhouse gas emissions and this will give us a benefit in understanding the impacts of climate change? What happens if we spend a pile of taxpayer funds in abating greenhouse emissions (mainly CO_2) and it turns out that carbon dioxide or even the statistically minute amounts emitted by human activities plays effectively no measurable role in Climate Change or Variability (this is a 100% probability given the research papers I have looked at). For example if the government mandates some CO_2 emissions level for the privatised LaTrobe Valley power stations and they must geo-sequester the CO_2 or either shut down for periods of time to meet some abstract emissions target (economic damage). The cost of geo-sequestration will be high as there will energy required to compress gasses (or make solids) and pump into geological reservoirs (old oil fields). The final cost will be borne by the public and exporting businesses.

I have read recently that new brown coal processing technology developed by Cooperative Research Centre for Clean Power from Lignite can economically reduce water content of the coal, thereby making the combustion of the coal more efficient (better heat output/per unit tonne of fuel) and as a by-product reducing CO_2 emissions. Here it seems the aim was better combustion, by-product lower CO_2. Research money is best spent on efficiency and not on CO_2 reduction. Efficiency provides a measurable public and economic benefit (lower electricity prices). The problem with the whole CO_2 emissions level issue is that there are no state, or

international boundaries in the atmosphere, Victoria and Australia may spend a small fortune on abatement with increase in economic costs and competitiveness and we will have no measurable benefit, as countries such as India and China will be emitting at increasing rates over time. If you believe anthropological CO_2 affects the Climate it will be global so what is the point!

Consultation and engagement with an informed community
This is the whole point of my Submission, the public is given the following statement:

'A prerequisite for addressing climate change impacts is increasing awareness and understanding in the community of the nature of climate change, its potential impacts, the actions that can be taken to address these impacts, and the benefits, costs and potential risks of these actions.

A partnership approach requires active consultation and engagement with key stakeholders and the community to assess needs and priorities.

Challenges can often be overcome when communities work with researchers to find solutions appropriate to local conditions. Consultation and engagement will also ensure that the community owns the process of identifying vulnerability to climate change impacts, and of determining adaptive responses that 'make sense on the ground'. An effective communication strategy will also be important to ensure key stakeholders and the general community can access reliable information about these issues.'

The nature of climate change has not been fully elucidated as relevant scientific facts have been omitted, uncertainties disguised, probabilities of outcomes not given, so the community cannot make ANY informed decisions on the issue. It seems the science / research relied upon by government is carried out by a few vested / contracted organisations who tend to ignore other studies which have contrary findings. These organisations continually make shrill dubious pronouncements often accompanied by hysterical language. Consequently the general public are indoctrinated that Climate Change is a real phenomenon. The doctrine appears to be akin to some former wartime propaganda minister mantra; "if you repeat something often enough, even though there is no evidence, ….then the people will think it must be true….".

You only need to look at the last round of Public Submissions VGS - Discussion Paper Summary Report p5. No-one questioned the science, the scientific organizations promoted self interest, while the general public and other organizations made submissions in good faith totally based upon flimsy science.

To inform the community you must state ALL scientific opinions and data and explanation of real data. You cannot rely on statistically unconstrained predictions but on actual climate data.

B. RUSSIAN ISSUES WITH UN IPCC CLIMATE CHANGE SCIENCE

The Russian government's scientists and economic advisors have prudently read beyond the IPCC Summary for Policy Makers documents and actually analysed the science. On 1st October 2003 at the Moscow World Climate Climate Conference, Andrei Illarionov (Economic Advisor to Russian President Putin) posed the following ten questions to Bert Bolin a key member of the UN IPCC:

> '1. What was the actual level of carbon dioxide concentration in the atmosphere in 1980-2000?
>
> * The forecast is alarming. What is the basis for it?
>
> 2. What are the parameters of the model of temperature anomalies? And how are they derived? Why are there such fluctuations in anthropogenic forcing observations?
>
> 3. Can we explain the temperature variation by CO2 concentration in the atmosphere in the past 1000 years?
>
> 4. Can we explain the temperature variation by CO2 concentration in the atmosphere in the past 140 years?
>
> 5. Can we explain the temperature variation by CO2 emissions of anthropogenic character?

6. Other factors explaining temperature variation: Volcanic activity? Whether to include in the model?

7. Other factors explaining temperature variation: Long-term cycles? Whether to include in the model?

8. Is the modern "global warming" unique in the last 5,000 years?

9. Can we achieve the Kyoto Protocol targets, providing the share of Annex I countries (including Russia, not including USA and Australia) in the world's CO2 emissions is rapidly falling?

10. And finally: How much does it cost?'

Answers to these questions are the caveat placed by Russia to signing the Kyoto Protocol.

By 8th July 2004, Mr Illarionov said at a Press Conference regarding the Results of the Climate Change and Kyoto Protocol Seminar in Moscow, that they HAVEN'T RECEIVED ANY RESPONSE AT ALL, even though they had made repeated enquiries. So one can assume that UN IPCC's "evidence" on 20th century global warming and future projection claims CANNOT be substantiated by a thorough scientific analysis, logical argument and/or supporting scientific data! If another government can ask clear and pertinent questions regarding this issue, why can't the Victorian or Australian Governments?

The full transcripts of the Press Conferences are in the Appendices of this Submission or click here or here. It is worth a read to see how the British delegation headed by Sir David King tried to bully (unsuccessfully) the Russian organizers to remove "undesirable scientists". This episode highlights how the Global Warming club, try to obfuscate free debate! Sir David King claimed earlier this year that "Global Warming is a bigger threat than terrorism", so you can see the extremism used by proponents to grab attention!

Some key comments by Illarionov are as follows:

> 'Instead of getting replies to our questions, we kept on hearing that replies did not matter. What was important is that whether or not Russia trusts Britain, the European Union and the countries that have ratified the Kyoto Protocol and that have been exerting unprecedented pressure on Russia to ratify it. This is why it was so important for us to arrange a real meeting and a real discussion of real problems with the participation of foreign scientists who have different views ....'

On the scientific basis of Kyoto Protocol, Illarionov commented:

> 'Basically, none of the assertions made in the Kyoto Protocol and the 'scientific' theory on which the Kyoto Protocol is based has been borne out by actual data. We are not seeing any high frequency of emergency situations or events. There has been no increase in the number of floods. Just as there has been no increase in the number of droughts. We can see that the speed of the wind in the hails in some areas is decreasing contrary to the statements made by the people who support the Kyoto Protocol. We are not witnessing a higher incidence of contagious diseases, and if there is a rise, it has nothing to do with climate change. If there is an insignificant increase in the temperature it is not due to anthropogenic factors but to the natural factors related to the planet itself and solar activity. There is no evidence confirming a positive linkage between the level of carbon dioxide and temperature changes. If there is such a linkage, it is a reverse nature. In other words, it is not carbon dioxide that influences the temperature on Earth, but it just the reverse: temperature fluctuations are caused by solar activity influence the concentration of carbon dioxide.'

C. LIKELY CAUSES OF CLIMATE VARIABILITY

A substantial amount of research recently published shows that the Sun and its electromagnetic activity have the greatest effect on the Earth's climate. In particular the Sun's activity causing changes to incidence of incoming cosmic rays (flux) colliding with atoms or molecules in Earths upper atmosphere (*cosmic rays are charged particles which are remnants of supernova explosions (collapsing stars) that travel through space at near light speed*). Studies have found that cosmic ray flux is important in the formation/seeding of clouds; hence controlling rainfall and temperature. Consequently when the Sun's magnetic field is strong or is in a violent phase fewer cosmic rays can reach Earth's atmosphere because the rays are swept aside by the Solar Magnetic Fields. The research suggests

that Earth's Climate was generally cooler during high cosmic ray flux (low solar magnetic activity), and conversely warmer during lower cosmic ray flux (high solar magnetic activity). See discussion in DeFreitas 2002.

Another important adjunct to the Solar influence and ENSO cycles has been recently discovered by the late Theodore Landscheidt, *Schroeter Institute for Research in Cycles of Solar Activity, Nova Scotia, Canada.* This man accurately predicted ahead of time to the month the start and end of the last three El Niño's. All other climate models had failed to do. Landscheidt has shown that the gravitational affects of the four giant planets Jupiter, Saturn, Uranus and Neptune orbiting around the Sun, regulate the Sun's motion around its Centre of Mass which in turn regulate its eruptive (electromagnetic) activity, which directly correlate to climatic events recorded on the Earth (as discussed above). These planetary-solar activity cycles can be calculated with apparently very high levels of confidence. Before his passing earlier this year, Landscheidt made predictions of the current La Niña from April 2004 to April 2005, while next El Niño from July 2006 until at least May 2007. Our government scientists CSIRO and Bureau of Meteorology would be better employed investigating how Landscheidt undertook his analysis (he was a frequent publisher) than playing around with unrealistic Global Circulation Models. Some of Landscheidt's works appears in the Appendix of this Submission.

D. WATER QUANTITY & QUALITY CAN BE RISK MANAGED

I believe that climate will vary naturally due to changes in Solar Activities and Celestial factors into the future, therefore one can expect periods of droughts (El Niño's) at intermittent periods into the future. Risk Management can be applied with high confidence as El Niño years can now be accurately predicted by studying Landschiedt methodologies. Consequently water resources for city and country dwellers can be conserved ahead of the next drought period. Farmers can therefore plan ahead their land management practices, crop types, stocking rates and feed requirements into the future El Niño years with confidence.

As the population grows, water will be the most important environmental issue irrespective of any postulated Climate Change facing Australia. Governments and relevant Water Authorities need to ensure sufficient availability of fresh potable water. The authorities also need to assist in mitigating salinity levels in ground waters, a very serious environmental issue which is real and measurable. Therefore the Victorian government should direct environmental funds towards piping much of the irrigation channels in northern Victoria; more water available as apparently 95% lost due to seepage and evaporation. Thus by piping irrigation channels we should have 19X more water available for public use or for the environment (Murray River). This should also lower salinity levels both in the Murray River and in near-surface groundwaters in the Murray Basin. It is pleasing to see that the government is looking at technologies at recycling effluent, promoting the construction of infrastructure to have recycled water used on public parks and private gardens in new housing estates.

E. CONCLUSIONS

1). Victoria is at no more risk to climate variabilities than it has experienced in last 170 years of settlement. Research (not supplied in the Consultation Paper) has shown NO CAUSAL LINK between CO_2 levels in the atmosphere and climate. The Theory of Global Warming due to Anthropological emissions of CO_2 since Industrialisation has not been demonstrated in any scientific literature! There is enough scientific data at present to show that carbon-dioxide plays an unmeasured role in the Earth's Climate, and man's component is therefore inconsequential. Periodic global warming phases or just general climate variability can be conclusively correlated with Solar Activity. Much of the surface recorded temperature increase can be attributed directly to cultural features in vicinity of ground-level recording stations.

2). The Potential Impacts of Climate Change, economically and socially are clearly nothing to do with any measured climate reality. The economic impacts will accumulate as governments waste taxpayers funds on some crusade to mitigate CO_2 emissions and postulated deleterious affects of global warming based upon flimsy science, when those funds could be used elsewhere for a defined public benefit. Economic waste could take the form of new punitive taxes, hidden subsidies to selected industries, or allowing other industries such as insurance to increase premiums on false probabilities of impending disasters. Moreover it effectively stops the economy functioning in a rational manner. Perpetuating fallacies and public ignorance (by selective educational information) in light of clear scientific evidence that CO_2 content in the atmosphere has no influence on the Earths Lower Troposphere Climate is DISHONEST and UNCONSCIENABLE.

3). Lessons Learnt to date from Research.
The UN IPCC has not provided one shred of evidence to support the concept of Global Warming from Anthropological CO_2 emissions. The UN IPCC Summary for Policymakers document(s) has a consistent history of obfuscating the TRUTH, and deriding messengers of the Truth (the Real Data). The Russian President's scientific and economic advisors have highlighted the deception, Australian governments should take notice. Global Climate models as they currently exist are essentially useless in forecasting climate variability as they are based upon false assumptions with respect to forcings and their weightings. CSIRO have been negligent in providing all scientific data on this issue to the public. I recommend the Minister employ a small team of independent scientists to fully review all available climate studies and data. In the meantime the Minister could start by reading the DeFreitas and McKitrick papers appended.

The 'House of Cards' that has been constructed by UN IPCC, various national governments and proponents of the Anthropological CO_2 Global Warming Theory is about to collapse; based upon the abundance of data conclusively debunking it. Therefore it will only be a matter of time before the mainstream media will get fed up regurgitating the Global Warming scare stories and start to do some in-depth reporting of this issue. There will be inevitable enquiries on why governments and its advisors had not validated the science and wasted so much money on this issue!

4). Our government scientists would be better employed study investigating how Landscheidt undertook his analysis (he was a frequent publisher) with respect to predicting ENSO events than playing around with unrealistic Global Circulation Models.

Climate Change: Incorrect information on pre-industrial CO2

Statement written for the US Senate Committee on Commerce, Science, and Transportation
March 2004

APPENDIX I
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

Statement of Prof. Zbigniew Jaworowski
Chairman, Scientific Council of Central Laboratory for Radiological Protection
Warsaw, Poland

I am a Professor at the Central Laboratory for Radiological Protection (CLOR) in Warsaw, Poland, a governmental institution, involved in environmental studies. CLOR has a "Special Liaison" relationship with the US National Counc on Radiological Protection and Measurements (NCRP). In the past, for about ten years, CLOR closely cooperated wit the US Environmental Protection Agency, in research on the influence of industry and nuclear explosions on pollution of the global environment and population. I published about 280 scientific papers, among them about 20 on climatic problems. I am the representative of Poland in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and in 1980-1982 I was the chairman of this Committee.

For the past 40 years I was involved in glacier studies, using snow and ice as a matrix for reconstruction of history of man-made pollution of the global atmosphere. A part of these studies was related to the climatic issues. Ice core recor of CO2 have been widely used as a proof that, due to man's activity the current atmospheric level of CO2 is about 25% higher than in the pre-industrial period. These records became the basic input parameters in the models of the global carbon cycle and a cornerstone of the man-made climatic warming hypothesis. These records do not represent the atmospheric reality, as I will try to demonstrate in my statement.

Relevant Background

In order to study the history of industrial pollution of the global atmosphere, between 1972 and 1980, I organized 11 glacier expeditions, which measured natural and man-made pollutants in contemporary and ancient precipitation, preserved in 17 glaciers in Arctic, Antarctic, Alaska, Norway, the Alps, the Himalayas, the Ruwenzori Mountains in Uganda, the Peruvian Andes and in Tatra Mountains in Poland. I also measured long-term changes of dust in the troposphere and stratosphere, and the lead content in humans living in Europe and elsewhere during the past 5000 years. In 1968 I published the first paper on lead content in glacier ice[1]. Later I demonstrated that in pre-industrial period the total flux of lead into the global atmosphere was higher than in the 20th century, that the atmospheric conte of lead is dominated by natural sources, and that the lead level in humans in Medieval Ages was 10 to 100 times highe than in the 20th century. In the 1990s I was working in the Norwegian Polar Research Institute in Oslo, and in the Japanese National Institute of Polar Research in Tokyo. In this period I studied the effects of climatic change on polar regions, and the reliability of glacier studies for estimation of CO2 concentration in the ancient atmosphere.

False Low Pre-industrial CO2 in the Atmosphere

Determinations of CO2 in polar ice cores are commonly used for estimations of the pre-industrial CO2 atmospheric levels. Perusal of these determinations convinced me that glaciological studies are not able to provide a reliable reconstruction of CO2 concentrations in the ancient atmosphere. This is because the ice cores do not fulfill the essenti closed system criteria. One of them is a lack of liquid water in ice, which could dramatically change the chemical composition the air bubbles trapped between the ice crystals. This criterion, is not met, as even the coldest Antarctic ic (down to -73°C) contains liquid water[2]. More than 20 physico-chemical processes, mostly related to the presence of liquid water, contribute to the alteration of the original chemical composition of the air inclusions in polar ice[3].

One of these processes is formation of gas hydrates or clathrates. In the highly compressed deep ice all air bubbles disappear, as under the influence of pressure the gases change into the solid clathrates, which are tiny crystals formed by interaction of gas with water molecules. Drilling decompresses cores excavated from deep ice, and contaminates them with the drilling fluid filling the borehole. Decompression leads to dense horizontal cracking of cores, by a well known sheeting process. After decompression of the ice cores, the solid clathrates decompose into a gas form, exploding in the process as if they were microscopic grenades. In the bubble-free ice the explosions form a new gas cavities and new cracks[4]. Through these cracks, and cracks formed by sheeting, a part of gas escapes first into the drilling liquid which fills the borehole, and then at the surface to the atmospheric air. Particular gases, CO2, O2 and N trapped in the deep cold ice start to form clathrates, and leave the air bubbles, at different pressures and depth. At the ice temperature of -15°C dissociation pressure for N2 is about 100 bars, for O2 75 bars, and for CO2 5 bars. Formatio of CO2 clathrates starts in the ice sheets at about 200 meter depth, and that of O2 and N2 at 600 to 1000 meters. This leads to depletion of CO2 in the gas trapped in the ice sheets. This is why the records of CO2 concentration in the gas

inclusions from deep polar ice show the values lower than in the contemporary atmosphere, even for the epochs when the global surface temperature was higher than now.

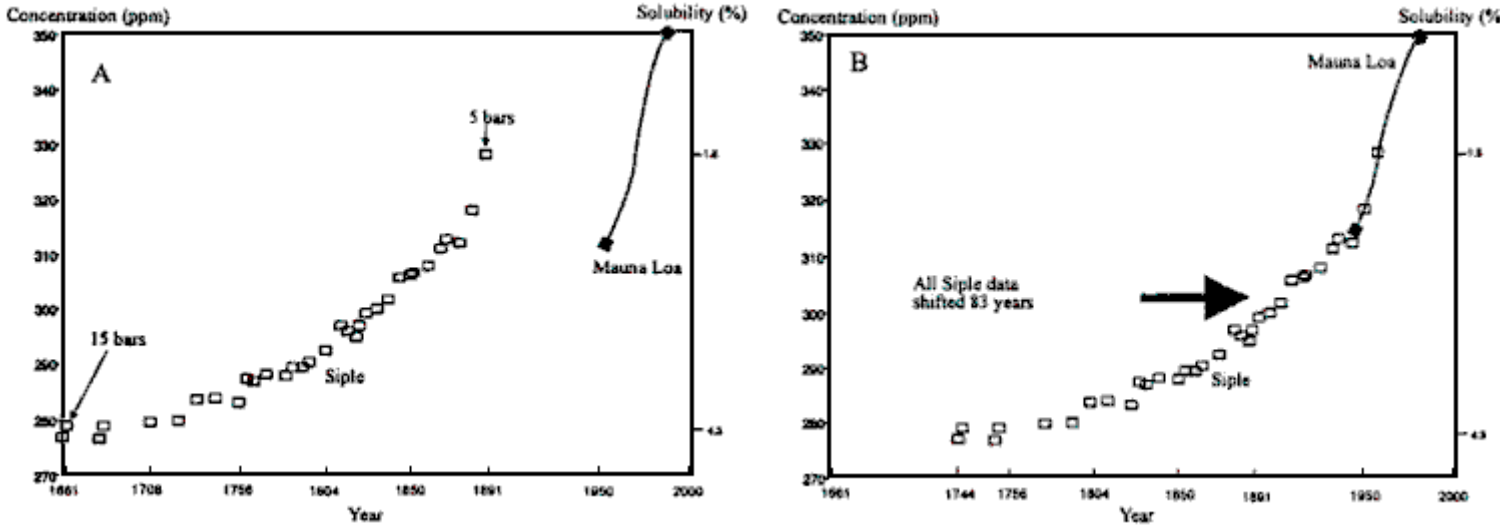


Figure 1 Concentration of CO_2 in air bubbles from the pre-industrial ice from Siple, Antarctica (open squares), and in the 1958-1986 atmosphere at Mauna Loa, Hawaii (solid line): (A) original Siple data without assuming a 83 year younger age of air than the age of the enclosing ice, and (B) the same data after arbitrary "correction" of age of air (Neftel et al., 1985; Friedli et al., 1986; and IPCC, 1990).

The data from shallow ice cores, such as those from Siple, Antarctica[5, 6], are widely used as a proof of man-made increase of CO2 content in the global atmosphere, notably by IPCC[7]. These data show a clear inverse correlation between the decreasing CO2 concentrations, and the load-pressure increasing with depth (Figure 1 A) . The problem with Siple data (and with other shallow cores) is that the CO2 concentration found in pre-industrial ice from a depth of 68 meters (i.e. above the depth of clathrate formation) was "too high". This ice was deposited in 1890 AD, and the CO2 concentration was 328 ppmv, not about 290 ppmv, as needed by man-made warming hypothesis. The CO2 atmospheric concentration of about 328 ppmv was measured at Mauna Loa, Hawaii as later as in 1973[8], i.e. 83 years after the ice was deposited at Siple.

An ad hoc assumption, not supported by any factual evidence[3, 9], solved the problem: the average age of air was arbitrary decreed to be exactly 83 years younger than the ice in which it was trapped. The "corrected" ice data were then smoothly aligned with the Mauna Loa record (Figure 1 B) , and reproduced in countless publications as a famous "Siple curve". Only thirteen years later, in 1993, glaciologists attempted to prove experimentally the "age assumption"[10], but they failed[9].

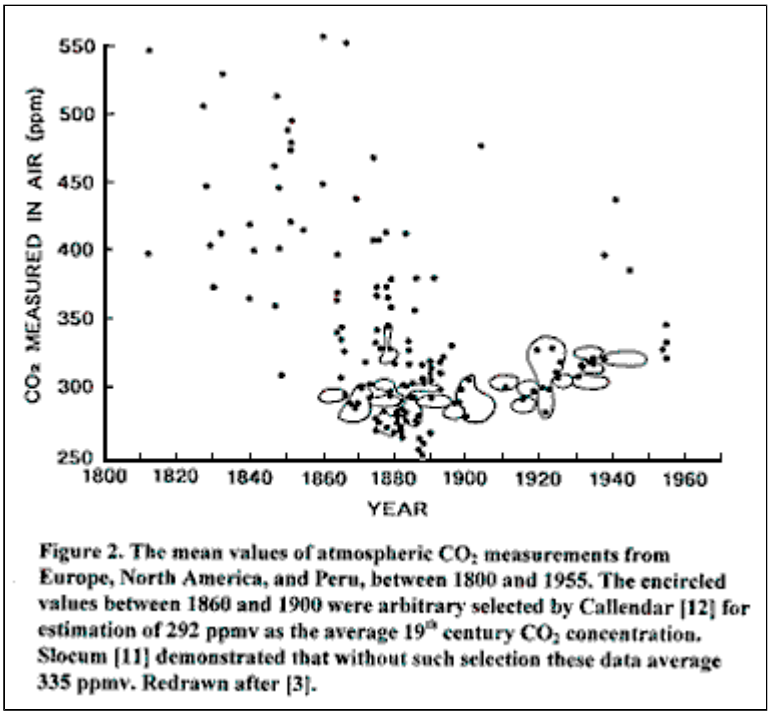


Figure 2. The mean values of atmospheric CO_2 measurements from Europe, North America, and Peru, between 1800 and 1955. The encircled values between 1860 and 1900 were arbitrary selected by Callendar [12] for estimation of 292 ppmv as the average 19th century CO_2 concentration. Slocum [11] demonstrated that without such selection these data average 335 ppmv. Redrawn after [3].

The notion of low pre-industrial CO2 atmospheric level, based on such poor knowledge, became a widely accepted Holy Grail of climate warming models. The modelers ignored the evidence from direct measurements of CO2 in atmospheric air indicating that in 19th century its average concentration was 335 ppmv[11] (Figure 2) . In Figure 2 encircled values show a biased selection of data used to demonstrate that in 19th century atmosphere the CO2 level w 292 ppmv[12]. A study of stomatal frequency in fossil leaves from Holocene lake deposits in Denmark, showing that 9400 years ago CO2 atmospheric level was 333 ppmv, and 9600 years ago 348 ppmv, falsify the concept of stabilized and low CO2 air concentration until the advent of industrial revolution [13].

Improper manipulation of data, and arbitrary rejection of readings that do not fit the pre-conceived idea on man-made global warming is common in many glaciological studies of greenhouse gases. In peer reviewed publications I expose this misuse of science [3, 9]. Unfortunately, such misuse is not limited to individual publications, but also appears in documents of national and international organizations. For example IPCC not only based its reports on a falsified "Sip curve", but also in its 2001 report[14] used as a flagship the "hockey curve" of temperature, showing that there was nc Medieval Warming, and no Little Ice Age, and that the 20th century was unusually warm. The curve was credulously accepted after Mann et al. paper published in NATURE magazine[15]. In a crushing criticism, two independent group of scientists from disciplines other than climatology [16, 17] (i.e. not supported from the annual pool of many billion "climatic" dollars), convincingly blamed the Mann et al. paper for the improper manipulation and arbitrary rejections data. The question arises, how such methodically poor paper, contradicting hundreds of excellent studies that demonstrated existence of global range Medieval Warming and Little Ice Age, could pass peer review for NATURE? And how could it pass the reviewing process at the IPCC? The apparent scientific weaknesses of IPCC and its lack of impartiality, was diagnosed and criticized in the early 1990s in NATURE editorials [18, 19]. The disease, seems to be persistent.

Conclusion

The basis of most of the IPCC conclusions on anthropogenic causes and on projections of climatic change is the assumption of low level of CO2 in the pre-industrial atmosphere. This assumption, based on glaciological studies, is false. Therefore IPCC projections should not be used for national and global economic planning. The climatically inefficient and economically disastrous Kyoto Protocol, based on IPCC projections, was correctly defined by Presider George W. Bush as "fatally flawed". This criticism was recently followed by the President of Russia Vladimir V. Puti I hope that their rational views might save the world from enormous damage that could be induced by implementing recommendations based on distorted science.

References

1. Jaworowski, Z., Stable lead in fossil ice and bones. Nature, 1968. 217: p. 152-153.

2. Mulvaney, R., E.W. Wolff, and K. Oates, Sulpfuric acid at grain boundaries in Antarctic ice. Nature, 1988. 331(247

249).

3. Jaworowski, Z., T.V. Segalstad, and N. Ono, Do glaciers tell a true atmospheric CO2 story? The Science of the Tot Environment, 1992. 114: p. 227-284.

4. Shoji, H. and C.C. Langway Jr., Volume relaxation of air inclusions in a fresh ice core. Journal of Physical Chemistry, 1983. 87: p. 4111-4114.

5. Neftel, A., et al., Evidence from polar ice cores for the increase in atmospheric CO2 in the past two centuries. Natu 1985. 315: p. 45-47.

6. Friedli, H., et al., Ice core record of the 13C/12C ratio of atmospheric CO2 in the past two centuries. Nature, 1986. 324: p. 237-238.

7. IPCC, Climate Change - The IPCC Scientific Assessment. ed. J.T. Houghton et al. 1990, Cambridge University Press: Cambridge, pp. 364.

8. Boden, T.A., P. Kanciruk, and M.P. Farrel, TRENDS '90 - A Compendium of Data on Global Change. 1990, Oak Ridge National Laboratory: Oak Ridge, Tennssee, pp. 257.

9. Jaworowski, Z., Ancient atmosphere - validity of ice records. Environ. Sci. & Pollut. Res., 1994. 1(3): p. 161-171.

10. Schwander, J., et al., The age of the air in the firn and the ice at Summit, Greenland. J. Geophys. Res., 1993. 98 (D2): p. 2831-2838.

11. Slocum, G., Has the amount of carbon dioxide in the atmosphere changed significantly since the beginning of the twentieth century? Month. Weather Rev., 1955(October): p. 225-231.

12. Callendar, G.S., On the amount of carbon dioxide in the atmosphere. Tellus, 1958. 10: p. 243-248.

13. Wagner, F., et al., Century-scale shifts in Early Holocene atmospheric CO2 concentration. Science, 1999. 284: p. 1971-1973.

14. IPCC, Climate Change 2001: The Scientific Basis., ed. J.T. Houton et al. 2001, Cambridge: Cambridge University Press, pp. 892.

15. Mann, M.E., R.S. Bradley, and M.K. Hughes, Global-scale temperature patterns and climate forcing over the past six centuries. Nature, 1998. 392: p. 779-787.

16. Soon, W., et al., Reconstructing Climatic and Environmental Changes of the past 1000 years: A Reappraisal. Energy & Environment, 2003. 14: p. 233-296.

17. McIntyre, S. and R. McKitrick, Corrections to the Mann et al. (1998) proxy data base and Northern hemispheric average temperature series. Energy & Environment, 2003. 14(6): p. 751-771.

18. Editorial, A., IPCC's ritual on global warming. Nature, 1994. 371: p. 269.

19. Maddox, J., Making global warming public property. Nature, 1991. 349: p. 189.

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The following are not part of the above statement, but have been added locally.

At least somewhat related to reference 13,
Rapid atmospheric CO2 changes associated with the 8,200-years-B.P. cooling event
contains additional discussion of stomatal indications of early Holocene atmospheric CO2 concentrations in excess of 280 ppmv.

For additional information regarding reference 17, see McIntyre and McKitrick web pages.

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APPENDIX II
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

Are observed changes in the concentration of carbon dioxide in the atmosphere really dangerous?

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Abstract

Statements made by the United Nations Intergovernmental Panel on Climate Change (IPCC) have been used to put pressure on governments to formulate policies in response to the perceived threat of the climate change resulting from a build up of greenhouse gases in the atmosphere. The Kyoto Protocol proposed by the United Nations calls for industrialized countries to cut greenhouse gas emissions by five percent from 1990 levels by the year 2012. The enormity of the perceived economic consequences of this has led to intense arguments between governments over the appropriateness of reduction targets. But the real reason behind the failure to agree on a global climate treaty is disagreement on tradeoffs between the economic and environmental risks involved.

Contrary to the IPCC predictions, global temperature has not risen appreciably in the last 20 years. Most surface temperature data free from the influence of surrounding buildings and roads show no warming. Data from satellites support this. Sea level has been rising since the end of the last ice age, long before industrialization, but historical records show no acceleration in sea level rise in the twentieth century. Increases in carbon dioxide appear to pose no immediate danger to the planet. The gas is not a pollutant.

An understanding of global warming hinges on the answers to certain key questions. Is global climate warming? If so, what part of that warming is due to human activities? How good is the evidence? What are the risks? The task of answering these questions is hindered by widespread confusion regarding key facets of global warming science. The confusion has given rise to several fallacies or misconceptions. These myths and misconceptions, and how they relate to the above questions, are explained. Although the future state of global climate is uncertain, there is no reason to believe that catastrophic change is underway. The atmosphere may warm due to human activity, but if it does, the expected change is unlikely to be much more than 1 degree Celsius in the next 100 years. Even the climate models promoted by the IPCC do not suggest that catastrophic change is occurring. They suggest that increases in greenhouse gases are likely to give rise to a warmer and wetter climate in most places; in particular, warmer nights and warmer winters. Generally, higher latitudes would warm more than lower latitudes. This means milder winters and, coupled with increased atmospheric carbon dioxide, it means a more robust biosphere with greater availability of forest, crops and vegetative ground cover. This is hardly a major threat. A more likely threat is policies that endanger economic progress. The negative effect of such policies would be far greater than any change caused by global warming. Rather than try to reduce innocuous carbon dioxide emissions, we would do better to focus on air pollution, especially those aspects that are known to damage human health.

Résumé

Des affirmations alarmistes provenant d'un synopsis de l'Intergovernmental Panel on Climate Change (IPCC), destiné aux décideurs politiques, et les communiqués de presse de l'IPCC, ont mis une pression énorme sur les gouvernements, afin d'élaborer des procédures en réponse à la menace perçue du changement climatique résultant d'une augmentation des gaz à effet de serre répandus dans l'atmosphère. Le Protocole de Kyoto, proposé par les Nations Unies, fait appel aux pays de l'OCDE afin qu'ils diminuent de 5% le niveau des émissions de gaz à effet de serre relevés en 1990 d'ici l'année 2012. Compte tenu de l'énormité des conséquences économiques provenant de cette diminution, des discussions très vives ont lieu entre les gouvernements sur l'opportunité des réductions visées. Mais la raison véritable se cachant derrière l'échec d'une politique d'entente sur un traité de climat mondial, porte sur les compromis entre les risques économiques et environnementaux impliqués.

De nombreux scientifiques, qui ont soutenu initialement le réchauffement de la planète, ne sont plus si convaincus. L'une de ces raisons réside dans le fait que la température de la planète n'a pas augmenté de manière appréciable depuis les 20 dernières années, comme l'avait prédit l'IPCC. La plupart des données de températures en surface, sans être influencées par les batiments et les routes, ne révèlent aucun réchauffement. Les données provenant des satellites le confirment. Le niveau de la mer a augmenté depuis la fin de la dernière période glacière bien avant l'industrialisation, mais des rapports historiques ne montrent aucune accélération sur l'augmentation du niveau de la mer au vingtième siècle. L'IPCC et Kyoto nous ont amenés à brandir les armes. L'accroissement en dioxyde de carbone ne semble pas poser de danger immédiat pour la planète. Le gaz n'est même pas un polluant.

La compréhension du réchauffement mondial dépend des réponses à certaines questions-clés. La première repose sur le rôle que les humains jouent dans le cycle du carbone au niveau planétaire. Les questions qui demeurent, portent principalement sur ces conséquences potentielles. La planète se réchauffe-t-elle? Si tel est le cas, quelle part de ce réchauffement provient des activités humaines? Quel est le bien fondé de cette évidence? Quels sont les risques? La tâche de trouver les réponses à ces questions est entravée par la confusion de l'opinion répandue sur les aspects-clés de la science du réchauffement mondial. Cette confusion a répandu de nombreuses erreurs et de méprises. Ces mythes, ces malentendus, et les manières dont ils sont reliés aux questions ci-dessus sont expliquées. Il y a de bonnes raisons de croire qu'il n'est plus nécessaire que les scientifiques continuent à prétendre que les changements observés dans la concentration des gaz à effet de serre dans l'atmosphère, sont dangereux. Plutôt que d'essayer de réduire de manière drastique les émissions de dioxyde de carbone, nous devrions axer notre attention sur la pollution de l'air, particulièrement sur ses aspects reconnus pour être nocifs au bien être humain, tels que les matières à particules, les oxydes d'azote, les monoxydes de carbone et les hydrocarbures.

Traduit par Gabrielle Drivet

Introduction

The global warming issue is as emotionally charged as it is widely misunderstood. Calls for action have put enormous pressure on governments to formulate policies in response to the perceived threat of the human-caused climate change resulting from a build up of greenhouse gases in the atmosphere. The Kyoto Protocol proposed by the United Nations in 1997 calls for OECD countries and former USSR to cut greenhouse gas emissions by 5% from 1990 levels by the year 2012. Despite the political momentum this has generated, there is widespread reluctance to sign on to an international treaty. The main problem is that emission rates are increasing and, given current trends, would be up to 20–30% higher than 1990 levels by 2012. Thus, to meet the requirements of the Kyoto Protocol, many of the industrialized nations of the world must give up one third of their energy use, or find some other way of meeting their commitment. A decrease of this magnitude can only be achieved by severe rationing of oil, coal and natural gas. Because the economic implications — in higher prices for transportation and energy used by industry and households, and for manufacturing — would be immense, the question arises as to whether these harsh measures are justifiable.

Confusion about the global warming science is another reason why progress towards ratifying an international agreement has been slow. This is caused by uncertainty surrounding the science of global warming on the one hand, and public perception of the state of this scientific knowledge on the other. This confusion underlies problems confronting decision makers on how and when to act on greenhouse warming. The Kyoto Protocol aims to implement the United Nations Framework Convention on Climate Change set out in 1992. The global warming science has come a long way since then. The question now arises: Is it still reasonable for scientists to continue to claim that observed changes in concentration of greenhouse gases in the atmosphere are dangerous?

Public perception and factors affecting this perception

There is probably no environmental issue that is as misunderstood as that of global warming. It is now common practice to teach in schools and universities that carbon dioxide is a pollutant that is dramatically warming the Earth's climate with dire consequences such as rising sea levels and severe weather changes. We are lead to believe that the evidence is all around us. The occurrence of cold spells, heat waves, floods, droughts, and increased frequency of storms are often cited as proof of global warming. Global warming has become the scapegoat for climate variability and for prophesies of future catastrophe (de Freitas, 1991, 1994).

Why should this particular view prevail? It is likely the result of a combination of a number of things. First, it fits well with the popular concern for the environment and widespread zeal for environmentalism. The media prefer worse case scenarios, and no matter how outrageous the tale, it becomes the truth if it is told often enough. The view that global warming is both real and dangerous is now deeply entrenched in the minds of the public. Many are reluctant to challenge this, as it is politically incorrect to do so. It would be taken to imply a lack a concern for the environment. Second, politicians are drawn to the topic of global warming by the appeal of tackling something grand — a global environmental issue, as opposed to merely a local one. There is also the allure of the green vote. Believing in global warming is a litmus test for being environmentally conscientious and hence ethically and politically correct. Third, scientists are in effect reinforcing the view by alarmist speculation to propel public concern

about possible dangers of man-made climate change. Heightened concern improves chances of high priority being given to climate change research and ensures an ongoing supply of research funds. Fourth, the issue is confused with the separate matter of conservation of fossil fuels and air quality. The fifth reason is perhaps the most important as it underpins all the others. It is the disproportionate influence of the reports of the United Nations Intergovernmental Panel on Climate Change (IPCC).

The role and impact of the IPCC

The IPCC was established by the World Meteorological Organisation (WMO) and the United Nations Environmental Programme (UNEP) in 1988 to: a) assess available scientific information on climate change, b) assess the environmental and socio-economic impacts of climate change, and c) formulate response strategies. The usefulness of the second and third objectives depends heavily on the conclusions from the first, which makes this the focus of the IPCC's work.

The first IPCC report (FAR) was published in 1990 (Houghton et al., 1990), the second (SAR) in 1996 (Houghton et al., 1996) and the third (TAR) in 2001 (IPCC, 2001a, 2001b). Each report consists of reviews of scientific work on climate, divided into chapters. Each chapter has several lead authors, plus a number of contributors. The TAR Scientific Report (IPCC, 2001a) has, for each chapter, Coordinating Lead Authors, Lead Authors, Contributing Authors, and sometimes Key Contributing Authors and Review Editors. There is an Executive Summary for each chapter. There is also a Policymakers Summary and a Technical Summary for the whole Report. In addition to the three major IPCC Scientific Reports there was a 1992 Supplementary Report often referred to as "Climate Change 92" (Houghton et al., 1992), and "Climate Change 1994; Radiative Forcing of Climate Change, and An Evaluation of the IPCC IS92 Emissions Scenarios" (Houghton et al., 1994).

In compiling each major IPCC Report (FAR, SAR, and TAR), three drafts were produced, which were circulated to "expert reviewers" throughout the world for comment. The TAR had 15 review editors, 124 authors and 397 expert reviewers. It is important to note, however, that comments that were not welcomed by the main authors stood little chance of being considered seriously. A commentary on this by editors of the FAR (Houghton et al., 1990) state: "Whilst every attempt was made by the lead authors to incorporate their comments, in some cases these formed a minority opinion which could not be reconciled with the larger consensus."

The dense 300–400 page IPCC Scientific Assessment Reports are generally good compilations of global warming science. But only experts read them. The UN IPCC's voice to the public, press and policy makers regarding climate science is through summaries; in particular, the brief, politically approved "Summaries for Policymakers" (SPM), which have become notorious for their bias, tendency to overstate problems and penchant for simplifying and dramatizing scientific speculation. A classic example is the claim in the 1996 IPCC SPM (Houghton et al., 1996, p. 4): "the balance of evidence suggest that there is a discernible human influence on global climate." The so called "evidence" cited in Chapter 8 of the main report was based on one paper that at the time had not been published in the refereed scientific literature. Moreover, one of the authors of this paper was also the convening lead author of the Chapter 8 that supported the "human influence" claim. A hearing in August 1998 on the subject of global warming before the U.S. House Committee on Small Business, chaired by Republican James Talent, publicized the fact that the 1996 IPCC scientific report (Houghton et al., 1996) was altered to convey the misleading impression to the public that there is a "discernible human influence on global climate" which will lead to catastrophic warming. The background to this is as follows.

The "discernible influence" statement of the IPCC's 1996 report (Houghton et al., 1996) was based on what are called "fingerprinting" studies. A fingerprint study is one in which a geographical pattern of observed climate changes are compared with the patterns of climate changes predicted by numerical simulations of global climate called general circulation models (GCMs). The idea is that by finding a pattern in the observed data that matches the predicted data, a causal connection can be claimed. Following publication of the 1996 IPCC scientific report, and in the wake of mounting criticism of the "discernible influence" claim, a paper by Santer et al. (1996) was published that endeavoured to defend the claim. Subsequently, the results of a re-analysis of the data used in this work were published in an article by Michaels and Knappenberger (1996). It showed that the research on which the IPCC "discernible influence" statement is based had used only a portion of the available atmospheric temperature data. When the full data set was used, the previously identified warming trend disappeared. In light of the widespread use of the "discernible influence" statement to imply that there is proof of global warming, the matter was of great concern (Fig. 1). Not surprisingly, this damaged the credibility of the IPCC.

Neither is the Summary for Policymakers of IPCC 2001 (IPCC, 2001b) a balanced representation of what is contained in the detailed scientific assessment report of IPCC Working Group I (WGI). General "conclusions" are highlighted in the SPM that distorts the actual climate information. For example, the SPM (IPCC, 2001b, p. 10) states: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities." It will be demonstrated later in this review that a) detailed satellite data show that no warming has been observed, b) the combined surface weather station data actually show cooling between 1940 and 1975, and c) data from good quality "de-urbanized" surface stations from around the world show no recent warming trends.

Another "conclusion" of the SPM (IPCC, 2001b, p. 10) is: "Most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gases." But no evidence is presented anywhere that warming is "likely" to have been due to "greenhouse gases'. "Likely" is defined as between 66% and 90% chance, but no probability assessment has been carried out. The statement cannot, therefore, claim

that there is actual evidence that the "warming over the last 50 years is likely to have been due to the increase in greenhouse gases." These and other statements made show the SPM (IPCC, 2001b) to be either slanted or misleading. It summarizes the main scientific report selectively in order to claim evidence for a human-caused climate warming.

A true conclusion of "Climate Change 2001", possibly supported by the majority of the scientists involved in the main scientific report, is in Chapter 1 of the IPCC 2001 scientific report itself (IPCC, 2001a, p.97). It reads as follows:

> The fact that the global mean temperature has increased since the late 19th Century and that other trends have been observed does not necessarily mean that an anthropogenic effect on the climate system has been identified. Climate has always varied on all time-scales, so the observed change may be natural.

From the above account it appears that the "Summary for Policymakers" is in large part a political document influenced by majority political policies.

Richard Lindzen, lead author of Chapter 7 of the main IPCC scientific report (IPCC, 2001a), has stated that the IPCC use the SPM to misrepresent what scientists say (Lindzen, 2001, p. 18).

> The full IPCC report is an admirable description of research activities in climate science, but it is not specifically directed at policy. The "Summary for Policymakers" is, but it is also a very different document. It represents a consensus of government representatives (many of whom are also their nations' Kyoto representatives), rather than of scientists. The resulting document has a strong tendency to disguise uncertainty, and conjures up some scary scenarios for which there is no evidence.

The process used for producing the SPMs has also been criticized. According to Martin Manning (2001, p.3), who until 2002 was IPCC Vice-Chair of IPCC Working Group II on Impacts, and currently is IPCC Vice-Chair of IPCC Working Group I on the Science of Climate Change:

> The process used to produce the SPM is far from ideal and may be distorting the real messages from the available science. Some government delegates influencing the SPM do not understand the methodologies being used and misinterpret or contradict the lead authors. This may need to be addressed in future through tighter rules of procedure.

By failing to convey a balanced interpretation of the science presented in the detailed reports, the SPMs, along with the IPCC press releases, have become a tool to drive public hysteria. Reinforced by the "official" status given to them, the result has been a distortion of the public's perception of scientific findings.

It may seem a paradox but the IPCC process requires that all the hundreds of participating governments' representatives agree to the text of IPCC summary reports. A statement is rejected from SPMs if only one government objects to it. This results in final reports that are not true representation of the science as a whole. Most participating governments (e.g. all Annex III countries) have pecuniary interest in supporting the United Nations Framework Convention on Climate Change (UNFCCC) objectives (i.e. The 1992 "Rio Treaty"), and the inevitable result is biased Summary reports. This does not imply dishonesty. Exclusion of information can cause more bias than adding information.

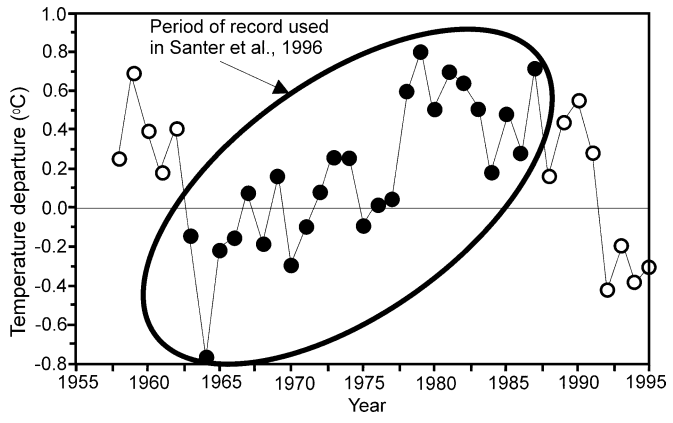

Fig. 1. A critical assessment by Michaels and Knappenburger (1996) of the work of Santer et al. (1996) that set out to provide evidence of a warming from 1963 to 1987 (circled) indicative of a global trend. Michaels and Knappenberger (1996) showed that this research, on which the IPCC "discernible human influence on global climate " statement is based, had used only a portion of the available atmospheric temperature data. When the full data set was used, the previously identified warming trend disappeared (from Michaels and Balling, 2000, p. 98).

Myths and misconceptions surrounding key questions

The scientific debate surrounding global warming hinges on the answers to certain key questions. The first centres on what role humans play in the global carbon cycle. The remaining questions focus on the possible consequences of this. Is global climate warming? If it is, what part of that warming is due to human activities? How good is the evidence? What are the risks? The task of finding answers to these questions is hindered by widespread confusion regarding key facets of global warming science. The confusion has given rise to several fallacies or misconceptions. These myths and misconceptions and the ways they relate to the above questions are the focus of this paper.

Fallacy One: Carbon dioxide in the atmosphere is increasing at alarming rates.

Each year, human activity — primarily the use of coal, oil, natural gas and production of cement — emits about 6.5 Gt of carbon into the atmosphere. Despite this, the annual rate of increase of CO_2 in the atmosphere is highly variable, falling close to zero in some years (for example, in 1992) and declining in others (for example, in 1998). In general, data show that human-caused CO_2 is levelling off, despite increased emissions (Figs. 2, 3). This is believed to be the result of natural stabilizing feedbacks. Carbon dioxide is food for plants. The more there is, the more they use. There are countless studies that

show the effect of an increased concentration of CO_2 in the atmosphere is to increase the growth rates of most plants (Soon et al., 1999). This is especially so in trees but also in grasses (Daepp et al., 2001; Edwards et al., 2001; Lilley et al., 2001a, 2001b; Craine and Reich, 2001; Lee et al., 2001; Reich et al., 2001; Nowak et al., 2001). The results show that elevated CO_2 will produce enhanced growth rates with a higher photosynthesis level and greater water-use efficiency generally, and an increase in leaf longevity for grasses. An additional factor is that plants that need the boost most respond best. Not only do plants generally provide a substantial sink for atmospheric CO_2, but plants under stress from less-than-ideal conditions — a common occurrence in nature — respond more to CO_2 fertilization (Fig. 4).

The significance of all this is that as CO_2 concentration in the atmosphere rises, plants respond positively by providing an increasing sink for atmospheric CO_2. Assuming a doubling of CO_2 release as compared to current emissions, it has been estimated that atmospheric CO_2 levels will rise by about 300 ppm before leveling off (Idso, 1991a). At that level, CO_2 absorption by increased terrestrial biomass may be able to absorb about 10 Gt of carbon per year (Soon et al., 1999). This is over three times the current net annual increase in atmospheric CO_2 from world fossil fuel combustion. These studies indicate that we are anticipating larger CO_2 concentrations in future than will actually occur.

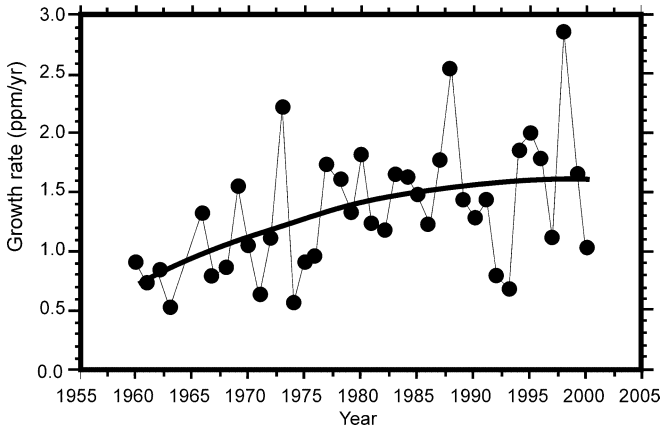

Fig. 2. Trend in growth rates of atmospheric concentrations of carbon dioxide from 1960 to 2000 showing the levelling off in recent times (from World Climate Report, 2001b).

It is noteworthy that each subsequent IPCC report produces new and more numerous greenhouse gas scenarios without explaining what went wrong with the earlier ones. Hansen (2002, p. 437) has commented on this and the general decline in the growth rate of CO_2 (fossil fuel) emissions: "It is noteworthy that the current IPCC (2001) scenarios have a growth rate in the 1990s that is almost double the observed rate … but it is consistent with their failure to emphasize data."

In summary, interaction between sinks and sources of CO_2 are complex and not well understood. Human emissions of CO_2 are a small proportion of natural emissions. The IPCC's argument is that the relatively tiny anthropogenic emissions tip the natural balance and cause a dangerous change in global climate. This neglects the fact that anthropogenic emissions are so small that their role could also be small and get lost in the statistical discrepancy of the measurement of either the natural sources or the natural absorption of CO_2. Moreover, the ocean and biosphere sinks of CO_2 are vast and known to be influenced by a variety of factors that could easily offset anthropogenic emissions.

Fallacy Two: Humans are big players in the global carbon cycle.

Carbon dioxide emissions caused by human use of fossil fuels are small compared to the natural carbon exchange between the atmosphere on the one hand and the terrestrial system and oceans on the other. Anthropogenic CO_2 emissions are only about 3% of the natural carbon cycle and less than 1% of the atmospheric reservoir of carbon of 750 Gt. The vast majority of CO_2 fluxes are natural. The magnitude of the natural reservoirs of carbon between ocean, atmosphere and land and the rates of exchange between them are so large that the role of

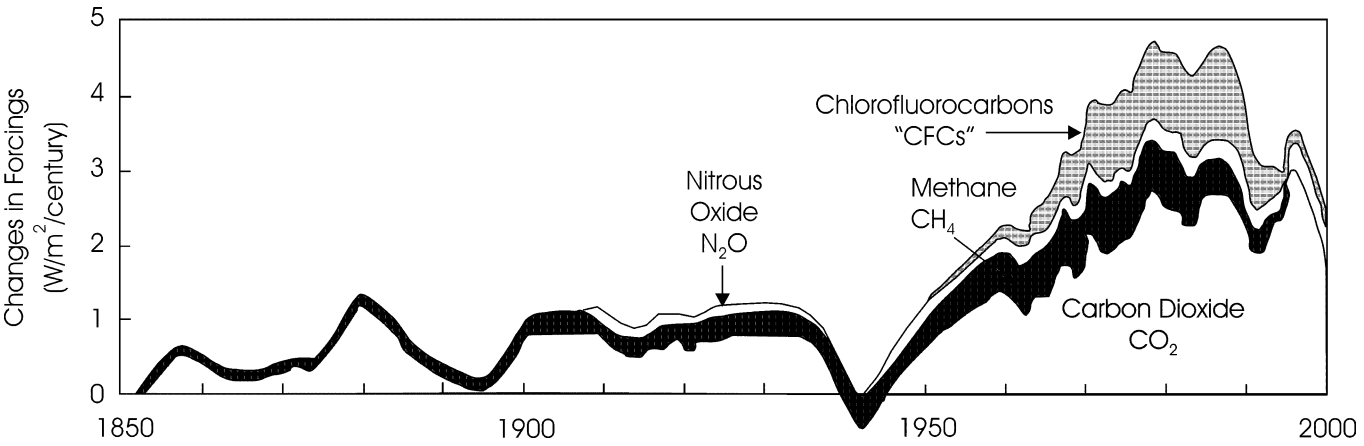

Fig. 3. Growth rates of greenhouse gas forcing showing stabilization of gases, especially carbon dioxide (CO_2) and methane (CH_4) (from Hansen and Sato, 2001).

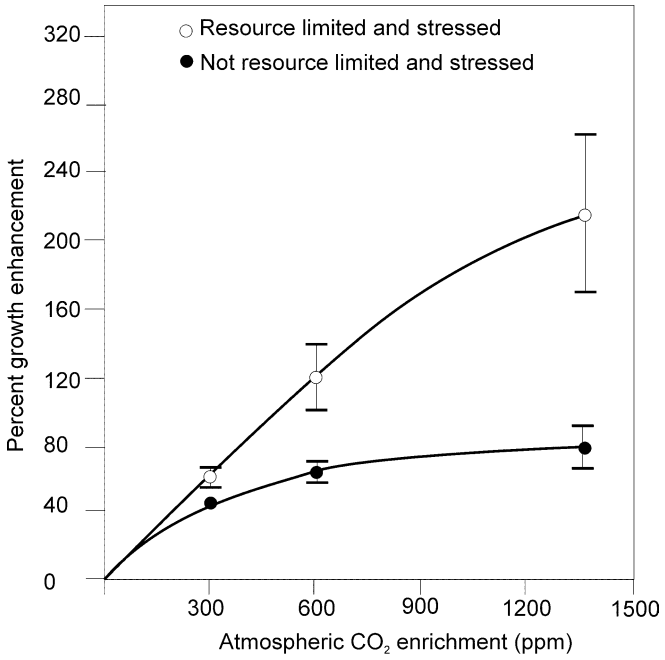

Fig. 4. Summary data from 279 published experiments in which plants of all types were grown under paired stressed and unstressed conditions (Idso & Idso, 1994). Soon et al. (1999, p. 158) explain that "the plant mixture in the 279 studies was slightly biased toward plant types that respond less to CO_2 fertilization than does the actual global mixture and therefore underestimates the expected global response. CO_2 enrichment also allows plants to grow in drier regions, further increasing the expected global response." Source: Soon et al. (1999).

humans in the natural carbon budget is unclear. So great are the difficulties quantifying the natural carbon budget and the uncertainties with which the numbers are estimated that the source of recent rise in atmospheric CO_2 has not been determined with certainty (Keeling et al., 1996; Tans et al., 1990; Adger and Brown, 1995). The fact is that there are no reliable models relating CO_2 emissions to atmospheric concentrations because it is not clear how the two are related.

Atmospheric CO_2 concentrations have varied widely over geologic time, but we are unable to fully explain why. The atmosphere is a result of outgassing of the Earth, and this outgassing was largely accomplished as volcanic activity. The rates of outgassing, however, are highly irregular. Mt. Etna, for example, has emitted well over 25 millions tons of CO_2 into the atmosphere in one year (Gerlach, 1991a; Allard et al., 1991). This equals the output of four 1,000 MW coal-fired power stations. Caldeira and Rampino (1992) have claimed that recent eruptions of Mt. Etna could affect global climate. Geothermal activity at Yellowstone National Park currently emits 10 times the CO_2 of a typical mid-sized coal-fired power plant. The mid-ocean-ridge volcanic system emits 65 million tons of CO_2 annually (Gerlach, 1991a, 1991b).

There are many other factors that influence atmospheric CO_2 concentrations that are not well understood. For example, the current increase in atmospheric CO_2 follows a 300-year warming trend, during which temperatures have been recovering from the global cool period known as the Little Ice Age (Lamb, 1982). The observed increases in CO_2 are of a magnitude that can, for example, be explained by oceans giving off gases naturally as temperatures rise (Dettinger and Ghil, 1998; Segalstad, 1998).

It is known that the equatorial oceans are the dominant oceanic source of atmospheric CO_2. The net flow per year amounts to 0.7 to 1.5 Gt of carbon — about what is emitted in the United States — of which up to 72% emanates from the equatorial Pacific Ocean. The Southern Ocean is modeled as both a source and sink of as much as 1 Gt of carbon per year. Owing to changes in sea surface temperature during the 1991 to 1994 El Niño period, the annual flow of CO_2 was 30 to 80% of normal (Feebly et al., 1999). This has a significant effect on global CO_2 concentrations in the atmosphere.

Fallacy Three: There is a close relationship between changes in atmospheric carbon dioxide and global temperature.

Recent trends in global air temperature are not well correlated with changes in CO_2 concentration in the atmosphere. According to the IPCC, air temperature measurements taken at the surface of the Earth show that the average temperature of the globe has increased by about 0.6 °C over the past century. Most of this rise occurred before 1940 (Fig. 5), but over 80% of the CO_2 entered the atmosphere after 1940. In fact, from the late 1930s to the late 1970s the Earth's atmosphere cooled despite increasing levels of CO_2.

A close association between paleo-temperatures and past CO_2 concentrations has long been used to support global warming predictions. But recent research has challenged this as, for example, in the work of Pearson and Palmer (1999, 2000) and Rothman (2002). CO_2 levels were about five times greater some 200 million years ago than present values. Pearson and Palmer (1999) show that the global cooling since the Eocene was not primarily due to decreases in CO_2 levels, but to changes of ocean circulation resulting from the tectonic opening and closing of oceanic gateways as continents move around.

Atmospheric CO_2 concentration and mean global temperature correlate and cohere such that the CO_2 follows the temperature (both up and down) by some months. This was first observed by Kuo et al. (1990) who did a frequency analysis for the period 1950 to 1990, and has been confirmed by other workers using different data sets (Priem, 1997; Dettinger and Ghil, 1998; Fischer et al., 1999, Indermühle et al., 1999). In other work, reanalysis of the famous Vostok ice core shows CO_2 increases lagging about 600 years behind the temperature increases of the three significant deglaciations (Fischer et al, 1999). Clearly, high CO_2 levels are not the primary cause of temperature rises signaling the end of an ice age. Other research on geological timescales also shows that sometimes temperatures were high when CO_2 concentrations were low, and vice versa (Indermühle et al., 1999, Panagi et al., 1999; Flower, 1999).

More recently, Monnin et al. (2001) examined a record of atmospheric CO_2 and proxy air temperature data obtained from

an ice core drilled at Dome Concordia, Antarctica for the period between 22,000 and 9,000 years before the present. This period covers the transition from the glacial to interglacial climate conditions. The authors express confidence that their record "is an accurate representation of the atmospheric CO_2 concentrations." Close examination of the rise in temperature and atmospheric CO_2 concentration at the end of the last glacial maximum revealed that the increase in temperature took place 17,800 ±300 years ago, while the increase in the CO_2 took place 17,000 ± 200 years ago. The researchers conclude "the start of the CO_2 increase thus lagged the start of the [temperature] increase by 800 ±600 years." (Monnin et al., 2001, p. 113)

Veizer et al. (2000) developed a new reconstruction of tropical sea surface temperatures throughout the Phanerozoic era, which covers a little over half of the past one billion years of Earth's history. This climate reconstruction — which was derived from data obtained from the calcite and aragonite shells of tropical marine fossils using oxygen isotope (delta^{18}O) data — was found to be well correlated with climate variations inferred from other indicators of past climate. This allowed Veizer et al. (2000) to fill in gaps that had existed in the older climate data. However, when the now improved temperature history was compared with temperatures derived from a climate model driven by atmospheric CO_2 concentrations obtained from proxy indicators of CO_2, the model failed to reproduce estimated temperatures. According to Veizer et al. (2000, p. 700) "the simulations based on [the] climate model yield[ed] temperatures that are in serious disagreement with the delta^{18}O-scaled tropical temperatures." The CO_2-driven climate model over-predicted the reconstructed temperatures by as much as 7°C, which is equivalent to predicting a warm interglacial when the earth is actually in the midst of an ice age. The results of these studies do not support the notion that CO_2 is the all-important driver of climate change that some have made it out to be.

Fallacy Four: Global temperature has increased over the past two decades.

The IPCC rely on air temperatures measured at the Earth's surface to reconstruct variations in the Earth's annual mean temperature over the past century. The three authorities that have taken responsibility for the combined surface record are the Climate Research Unit (CRU) of The University of East Anglia (UEA), NASA's Goddard Institute for Space Studies (GISS) and The Global Historical Climate Network (GHCN) run by the United States National Oceanographic and Atmospheric Administration (NOAA). The data come from weather stations unevenly distributed over the Earth's surface, mainly on land, close to towns and cities (Fig. 6). These data show a warming in the range 0.3–0.6 °C over the past century (Fig. 5). The question is whether all or part of this warming can be linked to increases in greenhouse gases or to other factors linked to climate variability and change. For example, the warming may simply reflect the additional heat associated with the growth of towns and cities, or from solar variability or changes in atmospheric transmissivity from volcanic dust or other sources of atmospheric aerosols, natural or anthropogenic.

The science of climate change depends entirely on reliable data, quality controlled and homogenized rigorously, to validate numerical simulation models and to identify fluctuations and trends. Until recently, measurements of global air temperature change were based entirely on measurements taken on the ground. Modification of the surface by human activity can have a significant effect on climate near the ground. The

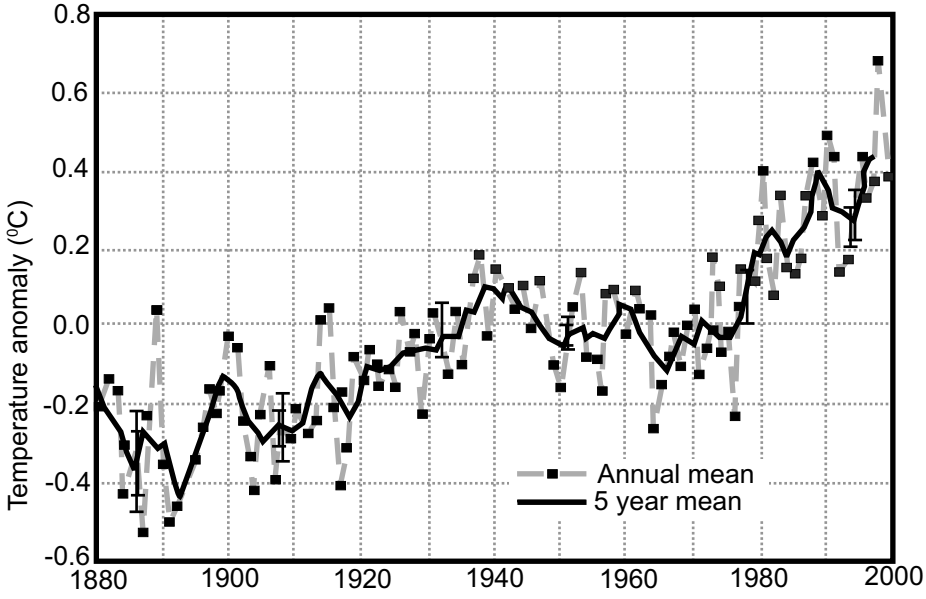

Fig. 5. GISS global annual-mean surface air temperature change derived from the meteorological station network. Uncertainty bars (95% confidence limits) shown for both the annual and 5-year mean. Average temperature of the globe has increased by about 0.6 °C over the past century and most of this rise occurred before 1940.

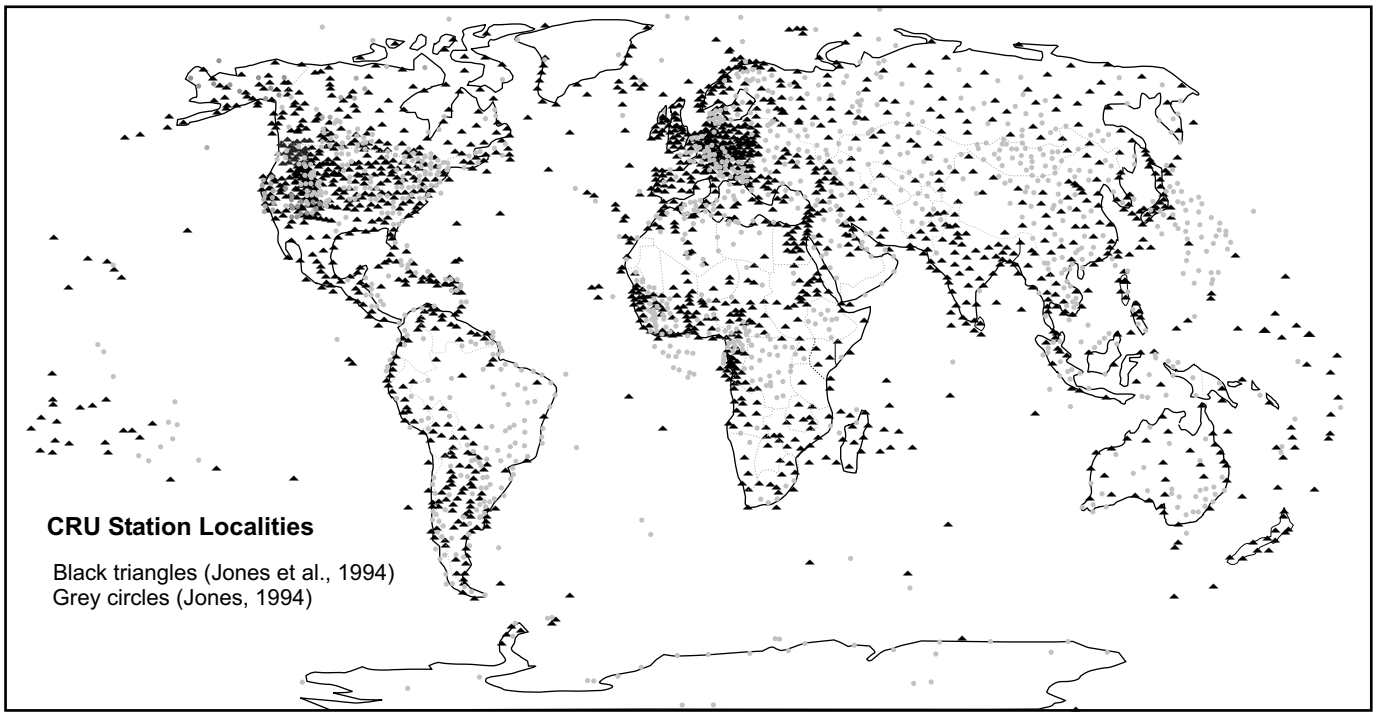

Fig. 6. Location of climate stations that make up the Jones (CRU) surface data used by IPCC.

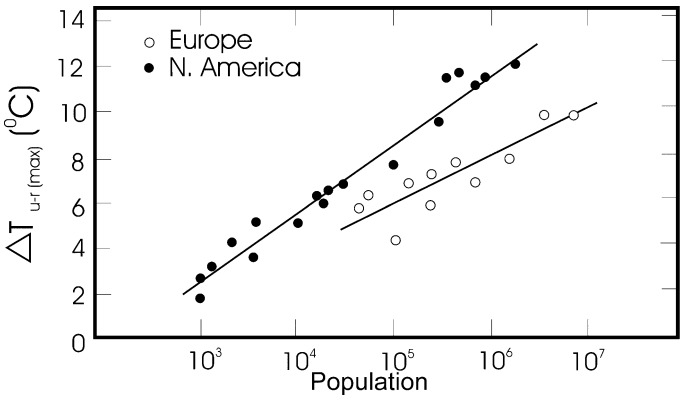

Fig. 7. Relationship between urban population size and maximum urban heating effect in North America and Europe (after Oke, 1987).

best-documented example is the "urban heat island" effect, in which data from urban stations can be influenced by localized warming due to asphalt and concrete replacing grass and trees (Fig. 7). This can account for an urban area being as much as 14 °C warmer than its rural surroundings. The trends in Figure 8 for Phoenix, Arizona, also illustrate the close correlation of city population size with urban heating influence on air temperature.

The IPCC claim that the land-based, surface temperature record it uses is a "de-urbanised" record, but it has been discovered that there is more contamination of the surface temperature record than many climatologists realised (Hansen et al., 1999; Hansen et al., 2001). Hansen et al. (2001, p. 23, 962) comment on NASA's official GISS data: "We find evidence of local human effects (urban warming) even in suburban and small town surface air temperature records." Moreover, rural stations account for only 7% of the Earth's area (Peterson et al., 1999). Balling and Idso (1989) have demonstrated that only very small changes in population are enough to induce a statistically significant local warming. Changnon (1999) used high quality data from central Illinois to evaluate the magnitude of unsuspected heat island effects that may be present in small towns that are typically assumed by the IPCC to be free of urban-induced warming. According to Changnon (1999, p. 535), "both sets of surface air temperature data for Illinois [i.e. small towns with populations less than 2,000 and 6,000, respectively] believed to have the best data quality with little or no urban effects may contain urban influences causing increases of 0.2°C from 1901 to 1950." He warns "this could be significant because the IPCC (1995) indicated that the global mean temperature increased 0.3 °C from 1890 to 1950."

Despite the questionable nature of the surface temperature record as measured by weather stations, IPCC (2001a) only occasionally refers to other methods of global temperature measurement. The fact that satellite and weather balloon measurements of the lower troposphere show little warming for the past 23 years (see Fallacy Five below) strongly suggests that the surface data are influenced by proximity to human habitation, especially concrete and asphalt, rather than by greenhouse warming. Evidence of this is reflected in the fact that many remote weather stations do not show a warming. Where warming occurs it results from a rise in the minimum temperature rather than the maximum, and in cold climates, in winter, and at night, which is consistent with so called "urbanization" effects. Many weather stations are located at airports, which originally were located in rural areas on the outskirts of urban areas. But with rapid population growth airports have made a

transition from "rural" to "heat island", and the national agencies responsible for archiving climate data do not take any precautions against these influences. The problem has been made worse by the fact that two thirds of the weather stations operating in 1975, mainly rural, have been closed down.

Many scientific studies have identified urbanization effects on climate stations, but these have been underestimated, because so called rural stations are assumed to be free of such effects. Also, with time, vegetation growing around stations usually increases, but is rarely reduced. This has a pronounced warming effect. Compilers of surface temperature data sets used so far by the IPCC make inadequate corrections for these and other warming effects. An influence from emissions of greenhouse gases is yet to be established.

Christy (2002) has looked specifically at rural stations in the United States, which were thought to be more reliable than urban stations. His work confirms that data from rural stations can also have many problems and should not be treated as continuous records for climate work. There are other equally persuasive studies that show that the global surface temperature record is contaminated, such as those by Goodridge (1992, 1996) and Christy and Goodridge (1995), the results of which are summarised in Figure 9.

Uneven spatial sampling also contaminates the global surface temperature record. Most climate stations are in the northern hemisphere, in mid-latitude locations and on land (Fig. 6). The problem of the poor spatial coverage is even worse during the early part of the record, particularly in the Southern Hemisphere and Pacific Ocean generally. This further reduces the quality of the record.

Even allowing for the inadequacies of the surface temperature record, there has been no warming globally in tropical and polar regions, and southern temperate regions have cooled slightly. If there is any greenhouse effect surface warming, it appears largely confined to the very cold and very dry high-pressure cells of winter in Siberia and Alaska/Yukon (Michaels et al., 2000). In these harsh regions, winter temperatures remain far below freezing; consequently, the main impact of this regional and seasonal warming is a slightly extended growing-season.

IPCC surface data show temperature inching upwards on a global scale of about 0.005 to 0.01 °C per year, but this rate is exceeded by its standard error. In other words, it is indistinguishable from zero. Moreover, trends and temperature differences justified to one or two decimal places and significant figures are unreliable since the amounts are greater than the accuracy of the data allows, and multiple averaging of measurements do not make it more reliable.

Fallacy Five: Satellite data support IPCC claims on observed and projected global warming.

In order to validate numerical models that attempt to simulate global climate, the science of climate change depends on the availability of a reliable dataset, quality controlled and

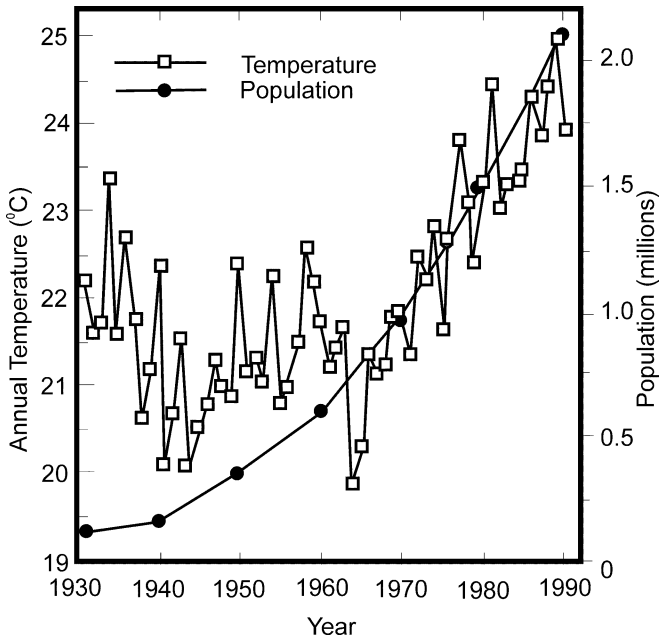

Fig. 8. Mean annual air temperature in Phoenix, Arizona, from 1931 to 1990 and population for the Phoenix metropolitan area. Source: Balling, 1992.

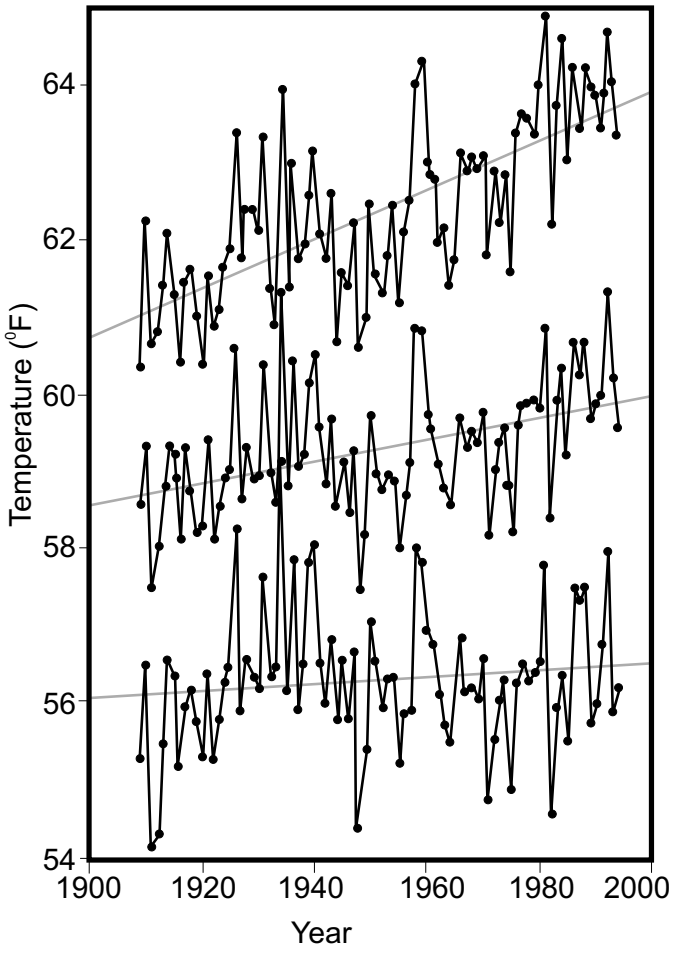

Fig. 9. Average annual air temperatures at 93 California climate stations from 1947 to 1993 stratified by 1990 county population: over 1 million (top); between 1 million and 100,000 (middle); and less than 100,000 (bottom). Source: Goodridge, 1996.

spatially representative of the globe. The IPCC temperature record for the globe is based on thermometers on the ground, usually on the land and in growing urban areas; a system which is not accurate enough to detect changes as small as 0.1 °C.

Since 1979 temperature measurements of the lower troposphere have been made by Tiros-N satellites using microwave radiometry (Microwave Sounding Units - MSU). These are the only precision measurements of global temperature available for direct comparison with temperature predictions from GCMs. The satellites cover the whole earth, measuring and averaging the temperature of the lower troposphere. This is the same region modelled by the GCMs. The accuracy of the radiometer measurements is 0.1 °C, which is considerably better than the accuracy of thermometer measurements made on the surface of the earth.

The satellite (MSU) temperature data set is the only one that is truly global, highly accurate, and uses a completely homogeneous measurement over the entire planet (Spencer and Christy, 1992; Christy and Goodridge, 1995). It also measures the part of the lower atmosphere that, according to the climate models, should be experiencing the greatest warming due to the enhanced greenhouse effect (Bengtsson et al., 1999). But satellite data since 1979 show no significant warming trend (Fig. 10). The IPCC play down the importance of these data because they do not show the recent warming trend suggested by the surface temperature record. Clearly, output from GCMs does not apply to surface temperature changes, and can only be checked by data from the troposphere. The IPCC has been testing its models on the wrong temperature record.

GCMs suffer from an inability to correctly capture the observed behaviour of the lower atmosphere and its relationship to the surface. When run with an increase in greenhouse gases, GCMs predict that the lower atmosphere can be expected to warm at about the same or slightly greater rate than the surface. However, satellite observations reveal just the opposite has happened for at least the last 23 years, which is the time of the greatest greenhouse gas build-up in the atmosphere.

The importance of the satellite data cannot be overestimated. Theory suggests that human-caused greenhouse gas emissions cause warming of the lower atmosphere, and this extra warmth is redistributed towards the Earth's surface. Greenhouse gases cannot warm the surface directly; they warm the atmosphere first. If there is no prior warming of the lower atmosphere, there can be no consequent enhanced greenhouse effect attributable to greenhouse gas emissions. Global climate models estimate temperatures in the lower layer of the atmosphere (rather than the surface itself), which is the area tracked by satellites. In fact, if climate models were correct, the satellite temperatures currently should be higher than surface temperatures. Instead, IPCC claim surface temperatures are going up and lower troposphere temperatures are roughly stable. Thus, the satellite data is direct evidence against the IPCC global warming hypothesis.

The surface temperature record is not global and has not been independently validated. The satellite data covers the entire Earth and has been independently validated by balloon radiosonde data. Moreover, the reliability of the satellite data has been thoroughly critiqued and adjusted for influences such as orbital decay of the satellite, yet the results show that the overall temperature trend is essentially zero (Spencer and Christy, 1992; Christy and Goodridge, 1995; Christy et al., 1998; Christy et al., 2000). It is noteworthy that no mention is made of the satellite data in IPCC's 1995 Summary for Policymakers. The most recent IPCC report (IPCC, 2001a) recognizes and accepts the discrepancy between satellite and the ground station records, but it still relies entirely on the spatially unrepresentative ground stations rather than on the most accurate record based on modern satellite-based instruments. For example, the Summary for Policymakers (IPCC, 2001b) highlights trends in surface temperature records and these data are used exclusively in diagrams to show recent warming.

The natural variability of the satellite record matches changes in the surface record, but no trend is obvious such as the globally averaged surface record shows (Fig. 11). These fluctuations are from 'normal' influences such as El Niño episodes and atmospheric dust from volcanic eruptions, and the temperature returns to 'normal' after each fluctuation. Prior to 1979, when satellite temperature measurements began, the surface record shows no temperature increase since 1940. This indicates that global temperatures have not increased significantly for 60 years.

Global warming is a worldwide effect, thus global rather than regional trends are indicative of its existence. However, spatially averaged hemispheric satellite records show a slight upward (warming) trend in the Northern Hemisphere (Fig. 12) and slightly downward (cooling) trend in the Southern Hemisphere (Fig. 13). The IPCC claim that sulphate aerosols from fossil fuel emissions offset greenhouse gas warming because of their cooling effect on the atmosphere. If this were the case, the hemispheric trends would be reversed as sulphate aerosol concentration is higher in the Northern Hemisphere than in the cleaner, mostly ocean-covered Southern Hemisphere.

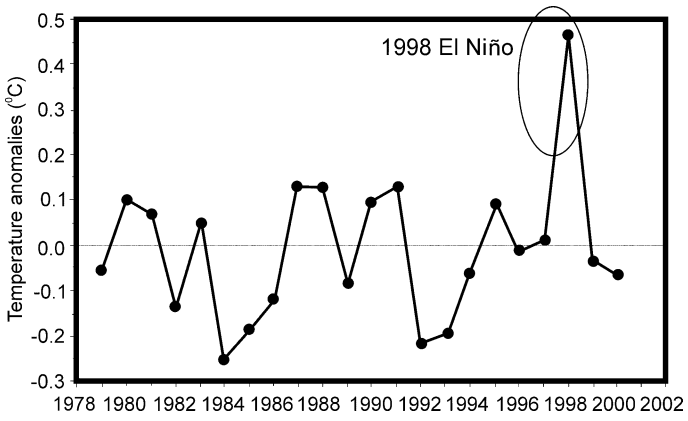

Fig. 10. Mean annual tropospheric temperatures of the globe taken by satellite (MSU) showing the conspicuous effect of the 1998 El Niño and little or no warming trend.

It is interesting that most good quality surface records show little or no warming and therefore agree with the satellite data since 1979. This is the case for the U.S. surface record (Fig. 14), mostly because there is much better coverage than anywhere else, and all of it has been under continuous quality control. Close scrutiny of the recent surface data for the globe indicate little warming, as shown in Figure 15, which is the most recent ten years of data (1991–2001) taken from the longer time series shown in Figure 5. Similarly, data for the world's oceans based on satellite measurements show no rise in sea surface temperatures (Strong et al., 2000).

Fallacy Six: Global climate trends during the past century are very unlike those of the past.

The IPCC 2001 Report has made much of one of the many reconstructions of global temperatures over the past 1000 years using proxy climate data by prominently featuring it in its Summary for Policymakers (IPCC, 2001b). The reconstruction (Fig. 16) is based on the work of Mann et al. (1998, 1999). Figure 16 shows that from about 1000 A.D. to about 1900 there is a slight 900-year cooling. Starting at around 1900 surface temperature data taken from the IPCC instrumental record are tacked on to the proxy data, which shows temperature rising abruptly. The resulting graph resembles a hockey stick. The handle of the 'hockey stick' shows a mean trend of little or no change for 900 years, disregarding the existence of the Medieval Warm Period and the Little Ice Age. The blade of the stick provides a dramatic warming in the twentieth century.

The 'hockey stick' curve challenges the existence of the Medieval Warm Period and subsequent Little Ice Age, which followed the Roman Warm Period and Dark Ages Cold Period (McDermott et al., 2001), and have long been considered to be classic examples of the warm and cold phases of a millennial-scale climate oscillation that occurred throughout glacial and interglacial periods (Oppo et al., 1998; McManus et al., 1999), as well as across the early Pleistocene (Raymo et al., 1998). The interpretation by Mann et al. (1999) implies that the recent warming is anomalous and thus must be linked to increases in greenhouse gases in the atmosphere.

The 'hockey stick' is a compelling image when first seen, and the IPCC 2001 report goes to some lengths to promote it by including it among the few diagrams presented in the Summary for Policymakers (SPM). And, nowhere in the SPM will one discover warnings on interpreting the graph. The IPCC has been severely criticized for this, for four reasons. First, the 'hockey stick' adds 100 years of oranges onto 900 years of apples. The Mann et al. (1999) 900-year run of data for the handle of the 'hockey stick' is mostly tree ring proxies from high altitudes or high latitudes, and their 100-year blade is full-year thermometer measurements from climate stations. These thermometers are recording mainly Northern Hemisphere urban-influenced warming, which is mostly in winter and in early spring. Tree rings are not necessarily reliable indicators of annual mean temperature as they are primarily responses to growth in the spring and early summer, so indicate temperatures for this time of year. Tree rings are also highly dependent on soil moisture availability in the growing season and solar variability that affects photosynthesis and thus growth rates of trees. The work by Mann et al. (1999) would have been more convincing if it had contrasted 900 years of tree ring proxies with like proxies for the past 100 years — i.e. apples plus apples. But even here, it is not safe to assume tree rings will provide a homogeneous record because of recent CO_2 fertilization.

Second, error estimates for the Mann et al. (1999) data, which are shown as the shaded light grey curve in Figure 16,

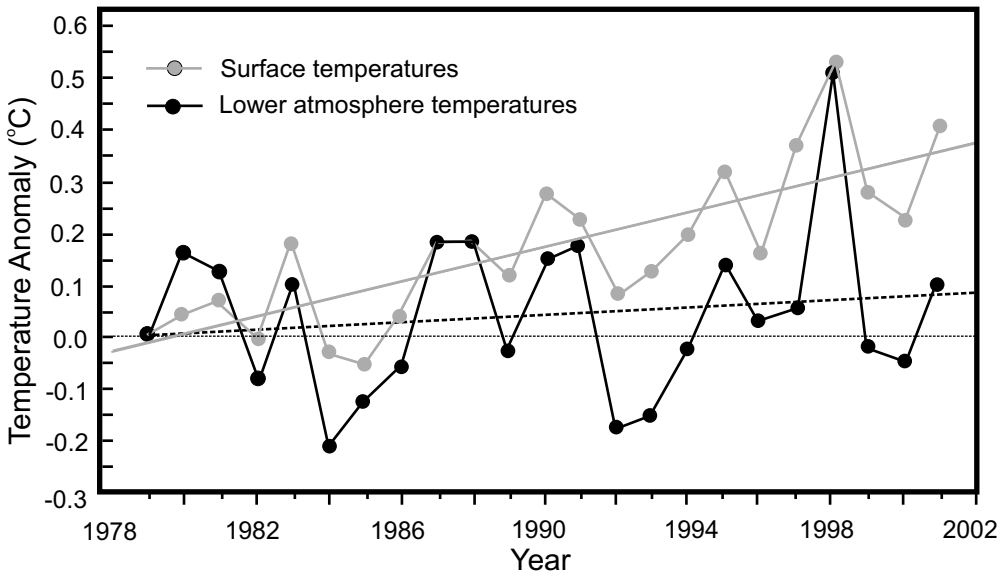

Fig. 11. Surface and lower atmosphere (satellite MSU) global temperature data for the period 1979-2001. Source: World Climate Report, 2001c.

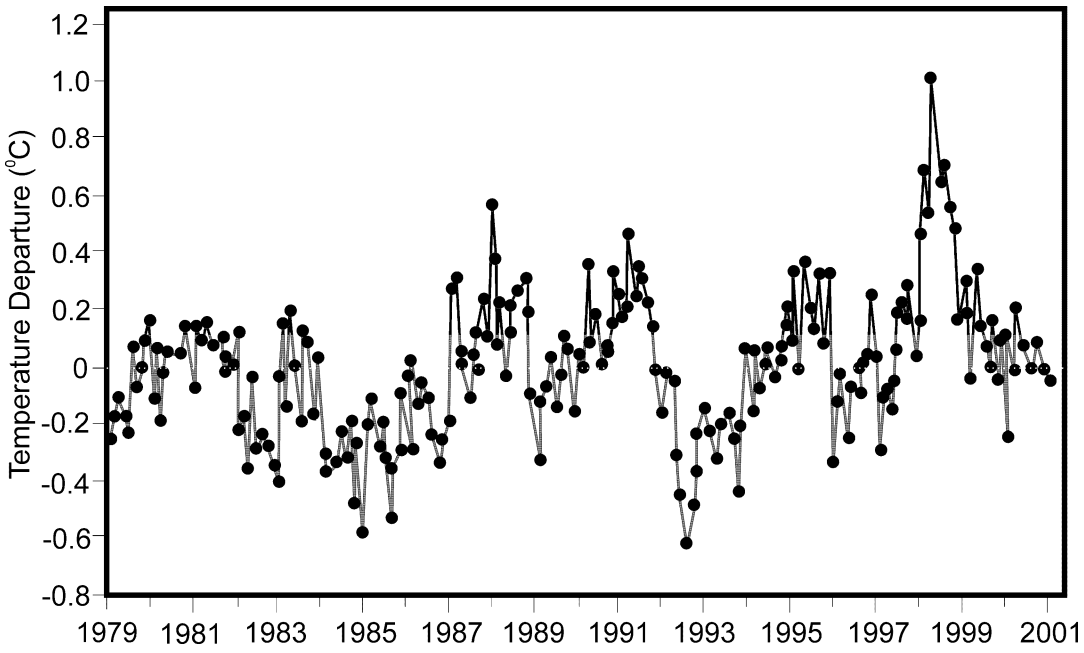

Fig. 12. Satellite (MSU) global temperature data for the period 1979-2001 for the Northern Hemisphere. Source: World Climate Report, 2001c.

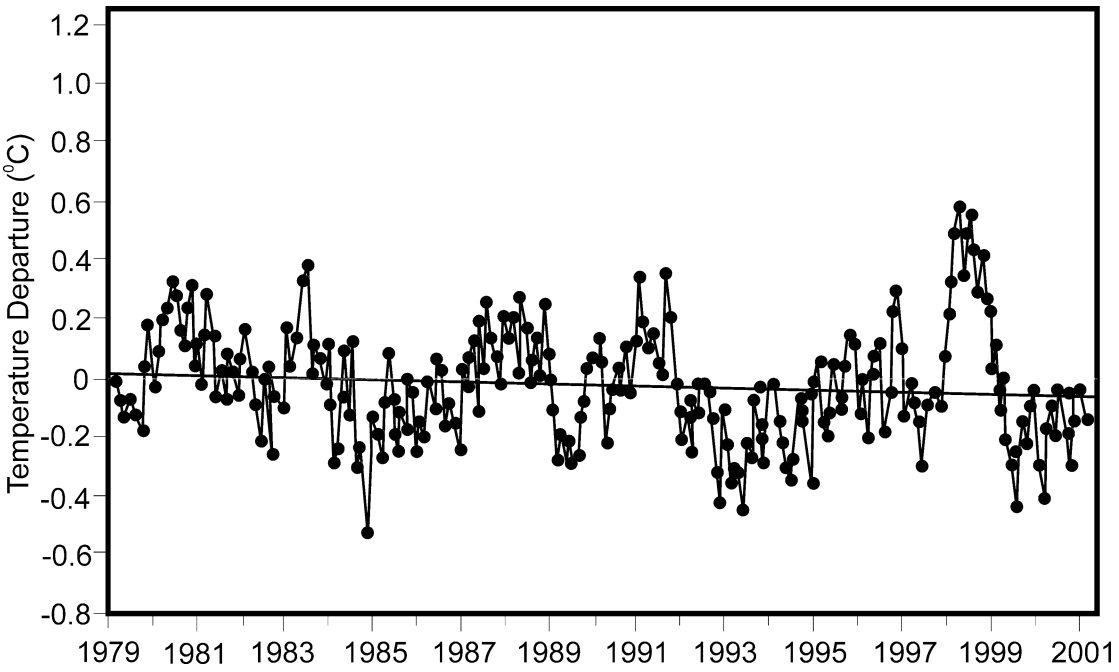

Fig. 13. Satellite (MSU) global temperature data for the period 1979-2001 for the Southern Hemisphere. Source: World Climate Report, 2001c.

are played down. The range of the error bars exceeds even the late twentieth century rise in surface temperatures. Third, tree rings and other proxies show substantial warming from about 1850 to 1940, but not since. The curve presented by Mann et al. (Fig. 16) shows proxy records only until 1980, with no temperature greater than in 1940, but does not show data since 1980, which show no warming. Fourth, the Mann curve fails to show several well-known climate events, namely, the Medieval Warm period (from about 800–1200 A.D.) followed by the Little Ice Age. Mann et al. (1999) claim that those events were not global, but rather regional temperature changes. They say this is a result of too much emphasis being placed on records from Western Europe where there is readily available historical documentation. However, the validity of this assumption has

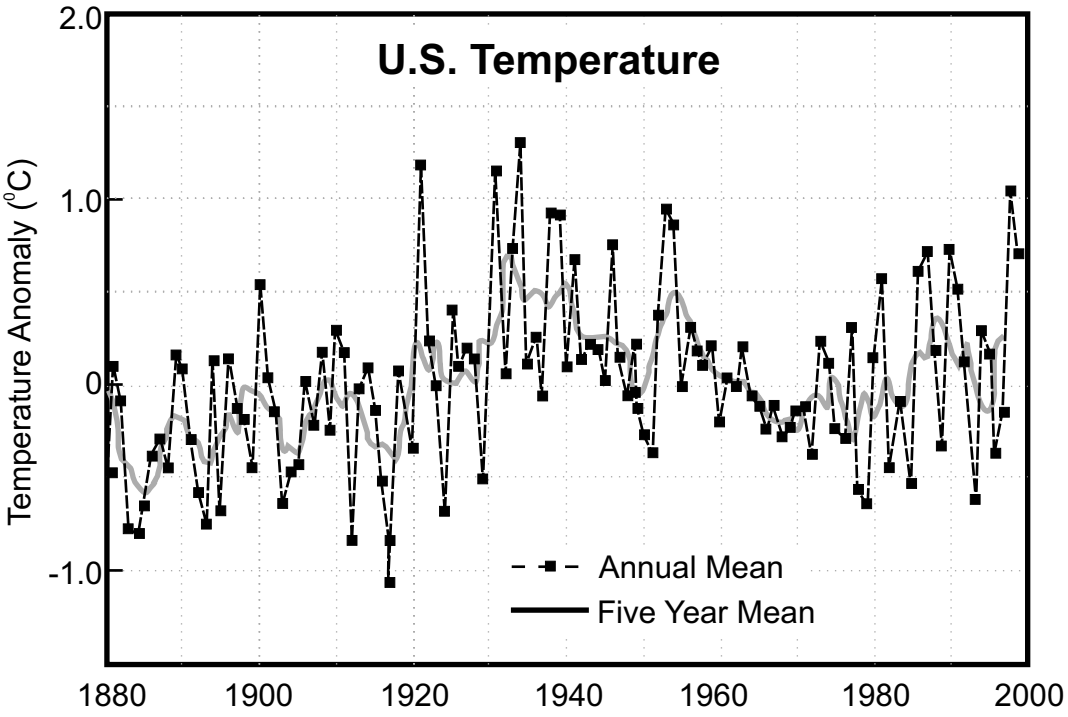

Fig. 14. GISS surface air temperature record for the United States.

been soundly challenged and sufficient evidence now exists to disprove it. A summary of this follows.

Wilson et al. (1979) provide data for far off New Zealand which, being located in the Southern Hemisphere, is meteorologically unrelated to Europe. Using $^{18}O/^{16}O$ dating profiles through a stalagmite, they found "the temperature curve for New Zealand to be broadly similar to England and such climatic fluctuations as the Medieval Warm Period and Little Ice Age are not just a local European phenomenon" (Wilson et al., 1979, p. 316). Tyson et al. (2000) gathered similar data from a stalagmite from Cold Air Cave, located 30 km southwest of Pietersburg, South Africa. Broecker (2001) cites several high-quality data sets as evidence to prove that the Medieval Warm Period and the Little Ice Age are a global phenomenon. Calkin et al. (2001) reviewed detailed research of Holocene glaciation along the northernmost Gulf of Alaska between the Kenai

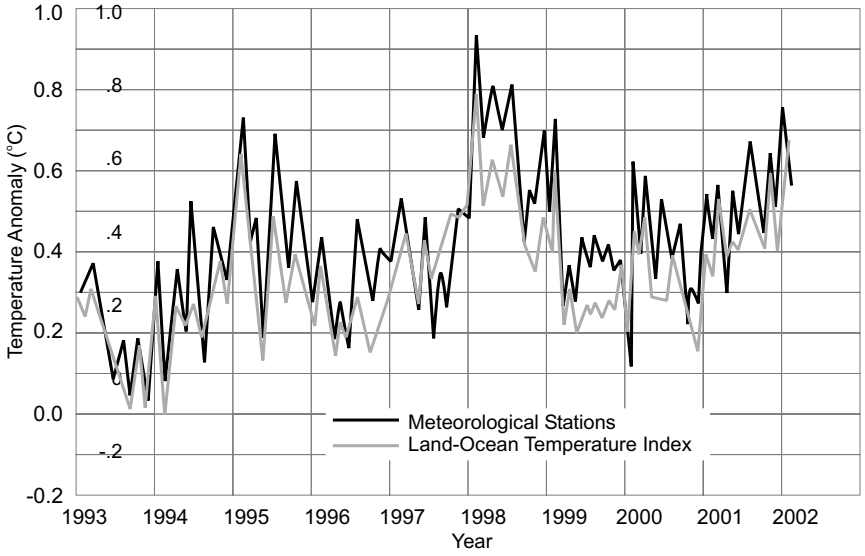

Fig. 15. GISS monthly mean global surface temperature derived from meteorological stations alone and the monthly mean land-ocean temperature index. This is the last 10 years of data shown in Fig. 5.

Peninsula and Yakutat Bay. They found that there is clear evidence of the existence of a Medieval Warm Period and a Little Ice Age in Alaska. Glaciers there reached their maximum Holocene extensions during the Little Ice Age. Given that Alaskan temperatures reached their Holocene minimum during Little Ice Age, from this time to the present, temperatures have been rising in a natural recovery from the coldest period of the Holocene.

A great deal of recent research has demonstrated that the Little Ice Age was evident even in Australia and reaffirms that it really did happen on a global scale. For example, work by Hendy et al. (2002) and Linsley et al. (2000) shows largely synchronous temperature trends of the South Pacific Ocean over the past 400 years support the view that the Little Ice Age was a truly global phenomenon and not a minor regional anomaly of lands in the vicinity of the North Atlantic Ocean. In addition, the data of Hendy et al. (2002) and Linsley et al. (2000) show temperatures in the South Pacific during the mid-18th century as being as warm as, or even warmer than, the present day. This is in contrast to the 'hockey stick' temperature history of Mann et al. (1999), which portrays the last two decades of the 20th century as the warmest of the past millennium. Other supporting evidence from around the world is provided by Le Roy Ladurie (1971), MacCracken et al. (1990), Grove and Switsur (1994), Leavitt (1994), Luckman (1994), Villalba (1994), Zhang (1994), Huffman (1996), Keigwin (1996a, 1996b), Huang et al. (1997), Dahl-Jensen et al. (1998), Cioccale (1999), de Menocal et al. (2000), Hong et al. (2000), Naurzbaev and Vaganov (2000), Winter et al. (2000), Verschuren at al. (2000), Broecker (2001), Haug et al. (2001), Holmgren et al. (2001), Johnson et al. (2001), Nicholson and Yin (2001) and Schilman et al. (2001).

In a particularly interesting study, Majorowicz et al. (1999) present proxy temperature records for the past 300 years. Data were extracted from borehole temperature-depth logs obtained at ten sites scattered throughout southern Saskatchewan, Canada. Data from the latter portion of the record were compared to observed surface temperature measurements over the last 100 years. The researchers found that the temperature proxies indicate the existence of a relatively cool period throughout most of the 18th and 19th centuries. Then, from about 1820 to

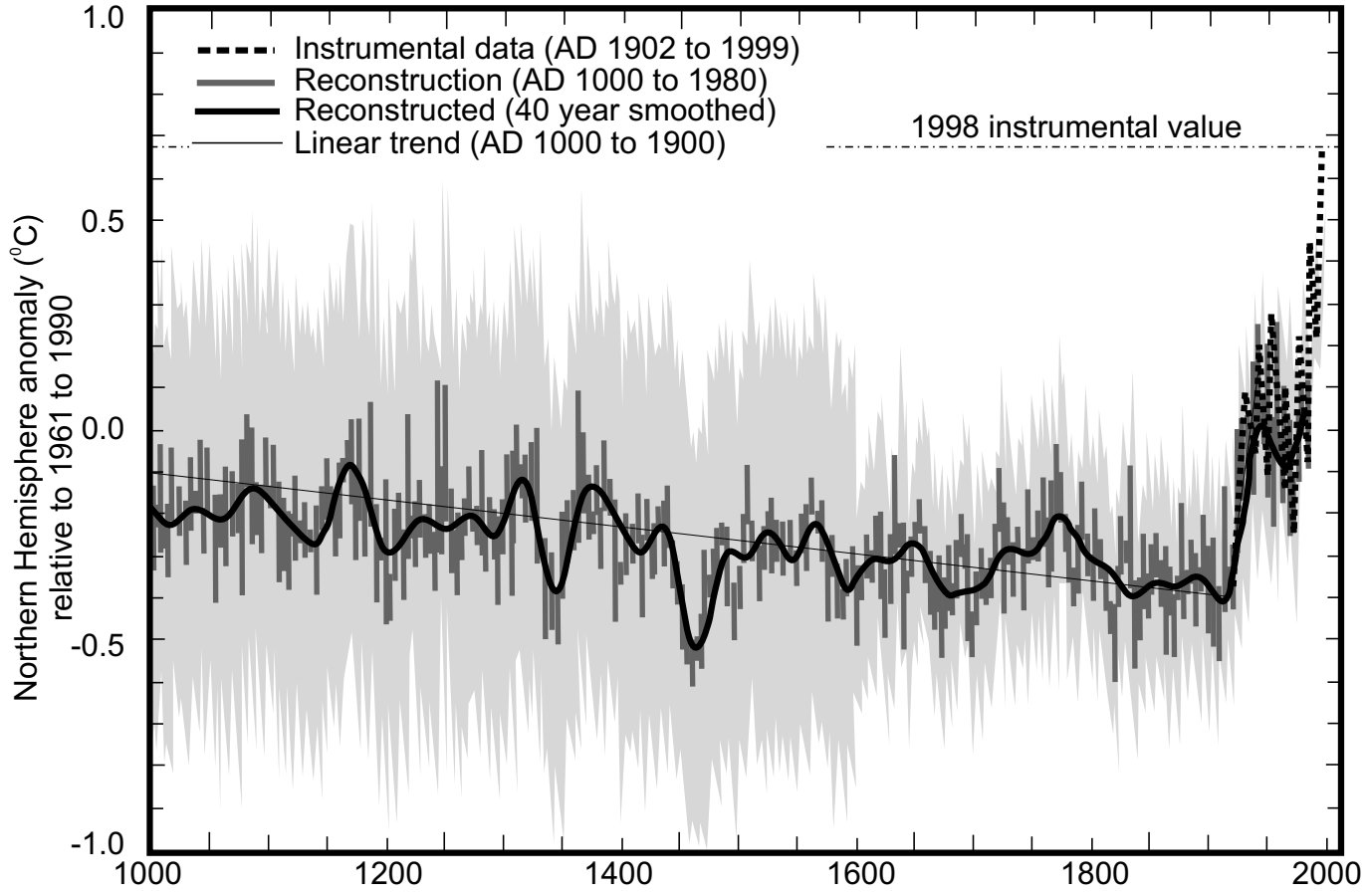

Fig. 16. Reconstruction of past Northern Hemisphere surface temperatures based on the work of Mann et al. (1999) prominently featured in IPCC (2001a). The smoothed inner curve (black line) is the 50 year average, the next curve (dark grey) is the year by year average and the outer curve (light grey) is the 95% confidence range of the annual data. The graph resembles a hockey stick. The handle of the hockey stick shows a mean trend of little change for 900 years, disregarding the existence of the Medieval Warm Period and the Little Ice Age. The blade of the stick provides a dramatic warming in the twentieth century likely linked to temperature rise from proximity of weather stations to rapid growing urban areas. Note error bars match the recent temperature peak caused by the 1998 El Niño event.

present, temperatures rose between 2.5 and 3.0°C, suggesting "the last major warming event [which is still going on] began in the 18th–19th century" (Majorowicz et al., 1999, p. 240). According to the authors, "the significance of this record is that it suggests almost half of the warming occurred prior to 1900, before the dramatic buildup of atmospheric greenhouse gases." Thus, according to a review of the article Center for the Study of Carbon Dioxide and Global Change (1999, p. 1) "if something other than greenhouse gases caused the first half of the most recent global warming event (in which we are still imbedded), something other than greenhouse gases may be responsible for the second half of the warming as well."

Recent work by Naurzbaev and Vaganov (2000) and Esper et al. (2002) appear to have finally put paid to the 'hockey stick' curve by emphasizing that most temperature reconstructions using proxy data results do not support the 'hockey stick' curve. Figure 17 from Naurzbaev and Vaganov (2000) shows tree ring data from Northern Siberia that, in contrast to the Mann et al. (1999) 'hockey stick', shows the Medieval Warm Period, 900 to 1100, and the Little Ice Age in the early 1800s, so well recognized elsewhere. The large peak in the 1940s, visible in the surface temperature data, can also be seen (Fig. 17). Esper et al. (2002) analyzed over 1200 tree-ring series derived from 14 different locations scattered over the extra tropical region of the Northern Hemisphere (Fig. 18). Their data indicate a temperature rise similar in form to most recent trends, but without any matching rise in greenhouse gases. In reviewing this and similar work, Briffa and Osborn (2002, p. 2227) note that the record of Esper et al. (2002) clearly shows that the warming of the 20th century was actually "a continuation of a trend that began at the start of the 19th century."

In conclusion, it is clear that the Mann et al. (1999) 'hockey stick' is nothing more than a mathematical construct vigorously promoted in the IPCC's 2001 report to affirm the notion that temperature changes of the twentieth century were unprecedented. The validity of this has been soundly challenged and sufficient evidence exists to disprove it.

Fallacy Seven: There are reliable forecasts of future climate.

General circulation models (GCMs) are computer simulations of global climate. The scientists that construct these models accept that they do not adequately handle key aspects of the climate system, such as the feedback effect of clouds and aspects of heat transfer in ocean circulation (Cess et al., 1995; Charlock and Alberta, 1996; Lindzen, 1997). Water vapour dominates the greenhouse effect. Because of this, half of the IPCC-predicted global warming depends on how water vapour responds to increased CO_2. But climate science is not yet capable of predicting how water vapour will respond. Earlier on, some scientists argued that better models might actually show more warming. The opposite has proved to be the case. From their inception, global climate models have been predicting spuriously high values of global temperatures. As the models have improved over the last decade, the IPCC's "best estimates" of global warming by the year 2100 are becoming smaller: 3.3 °C in 1990, 2.8 °C in 1992, and 2 °C in 1996, and perhaps even less in 2001(Fig. 19). One is led to wonder: if the climate models cannot accurately predict change a mere ten years on, what chance do they have for 100 years? Perhaps to counter this trend of decreasing warmth in "best estimates" projections, the IPCC avoided these in its most recent report (IPCC, 2001a) and introduced the concept of "storylines" instead. Storylines are constructed to depict future states, replacing 'scenarios' used in the SAR (Houghton et al., 1996), which in turn replaced 'predictions' and 'projections' used even earlier. Some see it as a means of keeping global warming

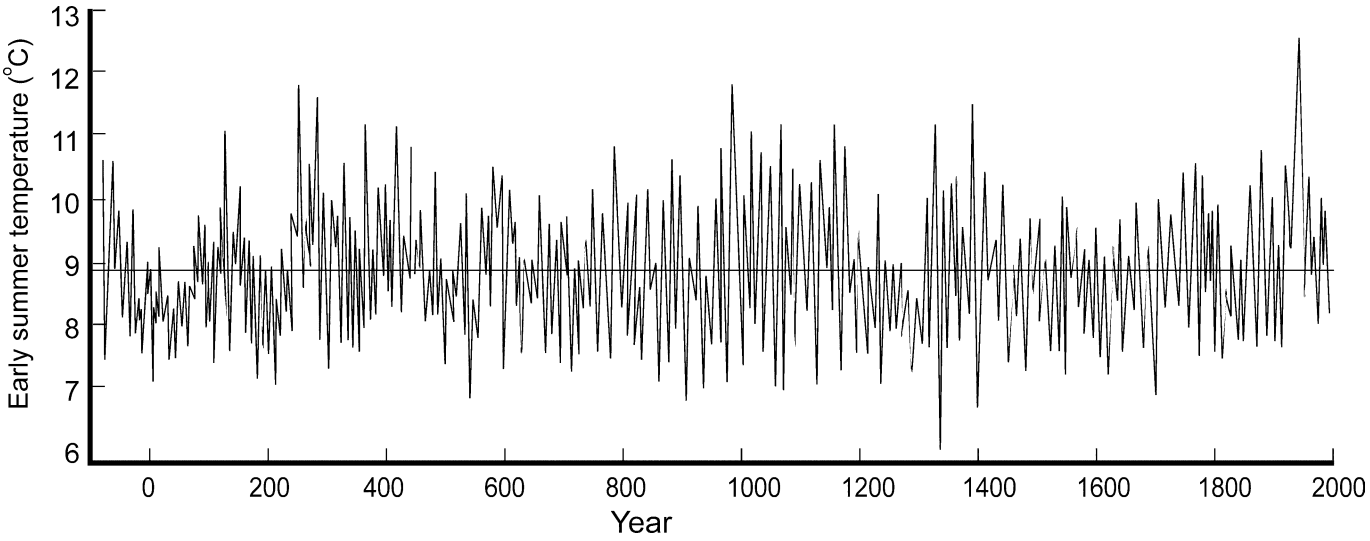

Fig. 17. Proxy early summer temperatures from tree rings in Northern Siberia (from Naurzbaev and Vaganov, 2000). In contrast to the Mann et al. (1999) Hockey Stick (Fig. 16) this shows no dramatic twentieth century warming, but it does show the Medieval Warm Period, 900 to 1100, and the Little Ice Age in the early 1800s, so well recognized elsewhere.

in the limelight and in the forefront of environmental concerns. Other approaches have also been used.

Just prior to the United States Presidential election of 7 November 2000, in which candidates Al Gore and George W. Bush were at odds on the global warming issue, a leak from the IPCC appeared in the New York Times and elsewhere, which showed the IPCC's renewed determination to promote its version of climate-change science. An editorial in *Science* of 10 November 2000 (v. 290 p. 1091) under the title "New Climate News" covered the leak as follows:

> The preface of the latest draft report from the Intergovernmental Panel on Climate Change was leaked last week and was widely reported in the press. Here are the surprises. The first is that the global warming estimate itself — at least its upper bound — has received an upward adjustment. The last IPCC estimates, in 1995, put the average global temperature increase by the end of this century at 1.5 to 4.0 °C. This newest estimate is 1.5 to 6.0 °C. The second surprise is that a firmer association between human activities and climate has emerged. Even the most sceptical climatologist in the IPCC group now concedes that warming bears an anthropogenic handprint.

And

> Even without an unpleasant surprise, the new IPCC report raises the prospect of serious risk to a new level. And it's about time: Right now, climate change has drifted off the radar screen, warranting scarcely a glance in this season of electoral politics.

The results from global climate models are of little value until the reliability of their performance can be verified. A

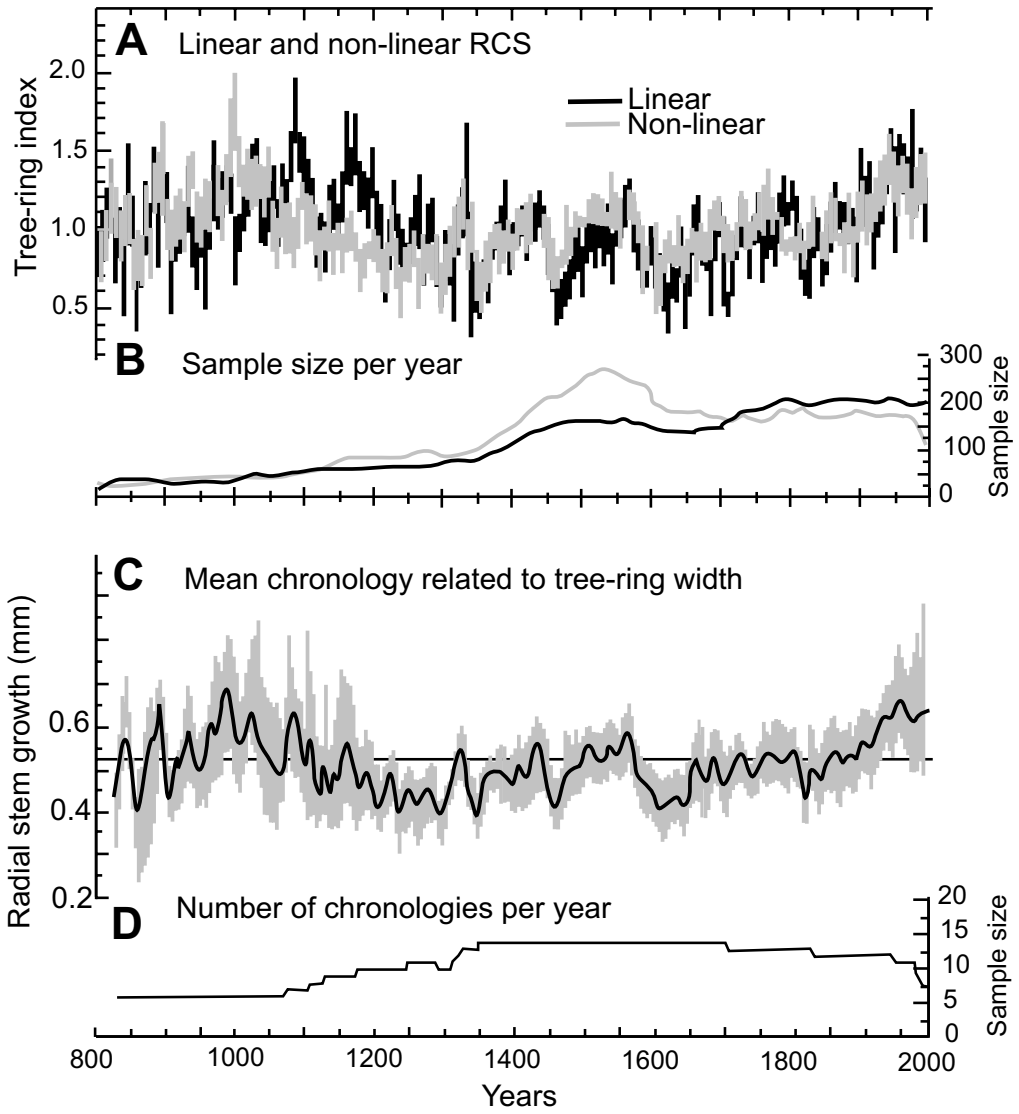

Fig. 18. Proxy summer temperatures from over 1200 tree-ring series derived from 14 different locations scattered over the extratropical region of the Northern Hemisphere (from Esper et al., 2002). In contrast to the Mann et al. (1999) Hockey Stick (Fig. 16) this shows no dramatic twentieth century warming, but it does show equally significant cycles of warming in the past.

GCM is just a hypothesis until there is supporting evidence for it. There has been widespread criticism of the use of GCMs (Soon et al., 2001). In a good deal of the literature on global warming the research content is based solely on model results that are treated as real data. This is far removed from reality.

According to Richard Lindzen (Lindzen, 1992, p.124) who is the lead author of Chapter 7 of IPCC 2001, Working Group I, The Scientific Basis: "The GCM models are just experimental tools, and now these tools are forced to make predictions that they are not able to..." and "There is nothing wrong with GCM modelers, they do the best job they are able to. The problem is, that too many people believe in the unreliable predictions. This problem is thus not scientific, it is political."

According to Singer (1996, p. 581): "The gap between the satellite observations and existing theory is so large that it throws serious doubt on all computer-modelled predictions of future warming. Yet this discrepancy is never mentioned in the IPCC report's Summary [SPM] — nor does the SPM [Houghton et al., 1996] even admit the existence of satellites."

All GCMs consistently predict greater increase in temperature with increasing distance from the equator. Thus, if IPCC models are correct, we should see the poles warming relative to the tropics. But temperatures in polar regions show no net change over the past four decades (Khal et al., 1993; Dowdeswell et al., 1997; Comiso, 2000; Przybylak, 2000; Venegas and Mysak, 2000). In fact, recent data have shown that Antarctica has cooled significantly (Doran et al., 2002).

Hanna (2001), using satellite analysis of Antarctic sea-ice cover (extent and area) based on Special Sensor Microwave/Imager data for the period October 1987 to September 1999, shows an ongoing slight but significant hemispheric increase of 3.7(±0.3)% in ice extent and 6.6(±1.5)% in area. Hanna comments that this is "entirely "consistent with cooling over Antarctica from 1979–98." Trends in Antarctic sea ice over a longer period have been examined by Yuan and Martinson (2000) using satellite data over 18 years leading up to 2000. They found that the mean Antarctic sea ice edge has expanded equatorward by 0.011 degree of latitude per year. They infer from this that it is likely that the global extent of sea ice is also on the rise. Watkins and Simmonds (2000) have analysed trends in a number of southern ocean sea ice parameters using satellite data. They found statistically significant increases in sea ice area and total sea ice extent between 1978 and 1996. In addition, the results indicate that there was an increase in the length of the sea ice season during the 1990s. The most recent measurements indicate that the movement of the glacial Ross ice streams is slowing, allowing the ice in West Antarctica to thicken, and demonstrating that the behaviour of Antarctic ice is unrelated to temperature *per se* (Joughin and Tulaczyk, 2002).

Reports on otherwise bland scientific information on climate change often distort the facts or the intended message, presumably to shock us. An example is the news item that appears in *Nature* of 2 November 2000 (v. 408, p. 10) under the headline "Global warming happening faster than predicted":

> Global warming could be happening more rapidly than previously estimated, leading to an average temperature increase of as much as 6 °C over the next century, according to the latest assessment by the Intergovernmental Panel on Climate Change (IPCC). The Report, which was leaked in advance of its expected completion in January next year, predicts that global warming will be greater than the IPCC's earlier assessments in 1990 and 1995. The panel had previously estimated the maximum likely temperature increase at around 3 degrees C.

In reply, the World Climate Report (2000, p. 1) remarks:

> But the document the IPCC sent out for scientific peer review contained no such number. Indeed, after the scientists reviewed it, the maximum value was 4.8 degrees C… In a sad repetition of a 1995 fiasco in which the key phrase "the balance of evidence suggests a discernible human influence on global climate" was inserted after the document had circulated among scientific reviewers, the IPCC has changed its report's most crucial conclusion at the 11th hour, after the scientific peer review process had concluded.

And

> After the scientific review process, the IPCC document undergoes a 'Government Review.' It was at this stage that the 6 degrees C figure was inserted.

Rather than dramatic change, expectations of future climate are for current temperature trends to continue (Michaels and Balling, 2000). For example, Bunde et al. (2001) compared the output of several GCMs against real-world characteristics of climatic trends and persistence. They used newly-developed, sophisticated methods derived from mathematical physics called wavelet techniques and detrended fluctuation analysis. They found that "the models tend to underestimate persistence while overestimating trends", implying, in their words, "that the models exaggerate the expected global warming of the atmosphere," and that it therefore "cannot be excluded that the

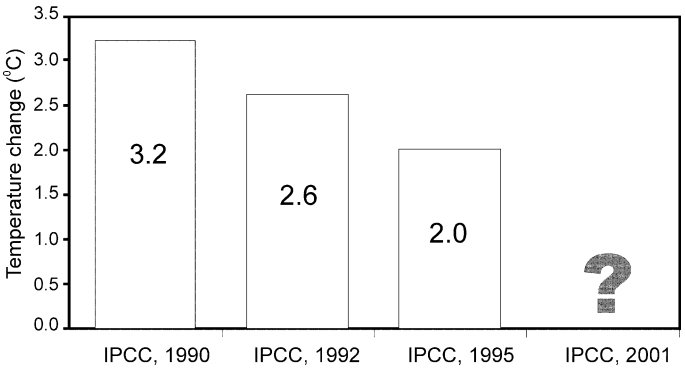

Fig. 19. Some scientists argued that better climate models might actually show more warming, but the opposite has proved to be the case. The figure shows changes in IPCC "best estimate" projections of global temperature rise to the year 2100 caused by increases in greenhouse gas concentrations in the atmosphere. IPCC 2001 breaks the tradition of giving up dated best estimate, as it did in all its previous reports. Instead, it uses "storylines" to speculate about warming as high as 5.8°C in 2100.

global warming in the next 100 yr will be less pronounced than predicted by the models." (Bunde et al., 2001, p. 264)

Because of the impossibility of testing climate models successfully on past climate sequences, the only way a climate model could achieve any sort of credibility is if it were successful in predicting future climate. Climate modelling began in earnest in the 1980s. Now we have 20 years of data to decide whether these models are capable of predicting future climate. All have failed badly. The Earth's atmosphere has warmed only about 10 per cent as much as climate models forecast, averaged over the last 30 years. The main reason for this is that there are very large uncertainties associated with most model parameters. Figure 20 from the 2001 IPCC SPM (IPCC, 2001b) graphically illustrates this. It is clear that there is only a low to very low level of scientific understanding (LSU) of the various factors that cause climate change. Amazingly, however, IPCC 2001 SPM claims a high level of confidence in projected changes in climate. Table 1 shows that estimates of confidence in projected changes in extreme weather and climate events during the twenty-first century is very high, despite a very high range of uncertainty as a result of a "low" and "very low" level of scientific understanding as to the inputs shown in Figure 19. Assuming a large warming, in spite of "very low" confidence as to its cause (LSU), has done nothing for the IPCC's credibility.

Fallacy Eight: Significant anthropogenic global warming is underway.

Climate is naturally variable and always changing. The notion of constant climate is misleading. Climate is always either warming or cooling. Over the past 100 years, all changes in climate have been well within the range of the climate's natural variations (Mahlman, 1997).

Climate can change as result of two categories of factors: 1) natural changes and 2) human-induced changes. The latter can be divided into two groups of causes: a) changes due to increases in greenhouse gas concentrations in the atmosphere and b) changes from other human activities, such as urbanization, change in reflectivity of the land surface due to agriculture and other forms of land use, and particulate emissions into the atmosphere. The IPCC (2001b, p. 2), however, states: "Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity." In this way, the IPCC lumps together all types of climate change, at the same time, readily attributing any observed change in global climate to changes in greenhouse gases concentration.

Even if twentieth century surface temperature data were taken as evidence of warming, it would indicate that forcing from greenhouse gases is lower than expected. According to

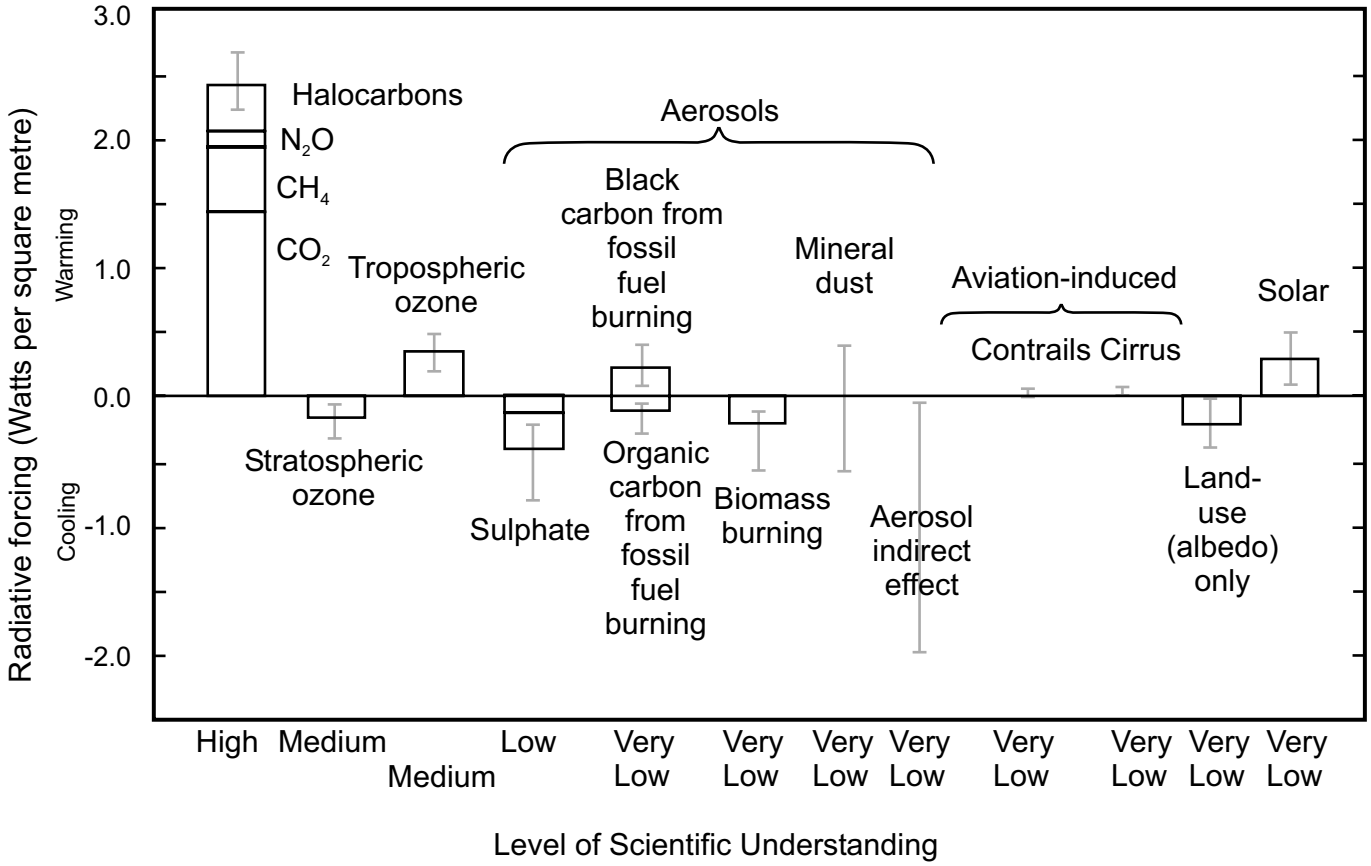

Fig. 20. Mean global radiative forcing of the climate system for the year 2000, relative to 1750. Fig. 3 in Summary for Policymakers, WG1 (IPCC, 2001b).

Table 1. Estimates of confidence in observed and projected changes in extreme weather and climate events. Table 1 in Summary for Policymakers, WG1 (IPCC, 2001b). Note that estimates of confidence in projected changes in extreme weather and climate events during the 21st century is very high, despite a very high range of uncertainty due to a low level of scientific understanding of the inputs, as shown in Fig. 20.

Confidence in observed changes (latter half of the 20th century)	Changes in phenomenon	Confidence in projected changes (during the 21st century)
Likely	Higher maximum temperatures and more hot days over nearly all land areas	Very likely
Very likely	Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely
Very likely	Reduced diurnal temperature range over most land areas	Very likely
Likely over many areas	Increase of heat index over land areas	Very likely over most areas
Likely over many Northern Hemisphere mid- to high-latitude land areas	More intense precipitation events	Very likely over many areas
Likely in a few areas	Increased summer continental drying and associated risk of drought	Likely over most mid-latitude continental interiors (lack of consistent projections in other areas)
Not observed in the few analyses available	Intense tropical cyclone peak wind intensities	Likely over some areas
Insufficient data for assessment	Increase in tropical cyclone mean and peak precipitation intensities	Likely over some areas

North and Wu (2001), a possible explanation for the weak CO_2 signal is global temperature is less sensitive to greenhouse gas increases than previously thought. This supports the conclusions of Michaels and Balling (2000) who have shown how the climate models have greater sensitivity to CO_2 increases than the real atmosphere, and that the likely warming by the year 2100 is significantly lower than most GCMs forecast.

Lindzen et al. (2001) have discovered further compelling evidence of reduced sensitivity. Their research showed that, over the Pacific, when the ocean is warm, there are fewer cirrus clouds than when the ocean is cold. Since cirrus clouds act like a blanket and keep longwave radiation from escaping to space, there is a negative feedback loop, which the researchers call an "adaptive infrared iris". Lindzen et al. (2001) postulate that if this effect is common all over the Earth (rather than limited to the region in the tropical Pacific they studied), the impact of a greenhouse effect increase would be much smaller than that anticipated by the climate models. Applying the effects of this process to IPCC model runs, Lindzen et al. (2001) found that it greatly reduces output sensitivity. The net warming effect of increased greenhouse gases on global temperature was found to be 0.64 to 1.6 °C, compared to the IPCC range of 1.7 to 4.2 °C (Fig. 21). The "iris" hypothesis is yet to be confirmed (Hartman and Michelsen, 2002; Lin et al., 2002) but the seminal work of Lindzen et al. (2001) demonstrates both the role and importance of negative feedback processes.

Added to this are the results of other recent research that show there are mechanisms affecting global climate that dwarf the potential effects of CO_2 (Goode et al., 2001; Jacobson, 2001) Goode et al. (2001) developed a new technique of accurately measuring the Earth's reflectivity using the moon. Every new moon, when the sun illuminates it from behind, light is reflected from the Earth onto the otherwise dark side of the moon. The glow that is seen on the dark part of the new moon results from earthshine, that is, sunlight reflected from the Earth and reflected back from the moon. The amount of earthshine is a measure of how much of the sun's incoming radiation is reflected away by the Earth. Previously, the most accurate measure of the Earth's albedo was obtained from satellites. These view only small parts of the Earth's surface for short periods, which then must be added and averaged for global estimates of reflectivity. Using this new, highly accurate photometric technique Goode et al. (2001) show that Earth's reflectivity varies by over 2% on the scale of nearly a decade, which is the climate equivalent of doubling atmospheric CO_2.

There is also a great deal of research on the theory relating the sun's variability to climate change (Friis-Cristensen and Lassen, 1991; Lassen and Friis-Cristensen, 1995; Soon et al., 1996; Svensmark and Friis-Cristensen, 1997; Bjorck et al., 2001; Yu, 2002). Although the work is in its early stages, the results show a close correlation with observed global temperature trends (Fig. 22). What is most interesting is that prior to the work of Svensmark and Friis-Cristensen (1997), research to include solar variations in climate modelling had focused on variations in radiation from the sun, often referred to as total solar irradiance (TSI). But since it varied only about 0.14% over a sunspot cycle, it was dismissed as being too small a variation to contribute significantly to global temperature variations. However, Svensmark and Friss-Christensen (1997) and Yu (2002) show that global cloud cover varies in response to the solar cycle which would amplify the heating effect of the small variation in total solar irradiance. The reasoning is that changes in the sun's magnetic field alter the amount of cosmic rays that strike Earth, which in turn affects cloud formation.

High, thin clouds typically warm the planet by trapping outgoing heat in the sky. But thick, umbrella-like low clouds have a net cooling effect. When the sun's magnetic field, or solar wind, is stronger — as it is, for example, during high sunspot activity — it deflects more cosmic rays, preventing them from hitting air molecules. Cosmic rays collide with air molecules to produce secondary particles that seed the cloud types that act to cool the Earth. Low clouds increase and decrease as cosmic rays from deep space increase and decrease. Increased solar activity means fewer cosmic rays, fewer clouds, and more warming. The cosmic rays are modulated by the sun's solar wind, so that when the solar wind is strong (as during a solar maximum) the cosmic rays are partially blocked out. When the solar wind is weak (as during a solar minimum) the cosmic rays increase, adding to cloudiness. Although the process is as yet unproven, many scientists are convinced that the high correlation (0.98) between global temperatures and the solar cycle length over the past 150 years is no coincidence. This and related work has been critically assessed by Soon et al. (2000).

It may be appropriate to conclude discussion of Fallacy Eight with an emphatic reminder that even the IPCC admits

that recent variations in climate could be natural. In the Section headed "Detection and Attribution" IPCC (2001a, Chapter 7, p. 97) the authors state:

> The fact that the global mean [surface] temperature has increased since the late 19th century and that other trends have been observed does not necessarily mean that an anthropogenic effect on the climate system has been identified. Climate has always varied on all time-scales, so the observed change may be natural. A more detailed analysis is required to provide evidence of a human impact.

Fallacy Nine: Global warming will produce a rise in sea level.

Reasonable scenarios of sea level change are based on calculations that rely on scientifically sound assumptions. Over the short term, climate warming could cause sea level to rise mainly by the thermal expansion of the oceans. Melting of polar ice caps is not involved since this is a long-term response. As only the surface water is affected, response times can be rapid but sea level changes are small, amounting to only a few millimetres (Warrick and Farmer, 1989). Other factors cause changes of sea level of far greater magnitude but sensitivity of coastal systems seems to be reasonably low. For instance, the large 1982–83 El Niño event raised sea levels 35 cm above average along parts of the west coast of the United States, as the failure of the prevailing easterly winds caused water in the west Pacific to surge back eastward across the ocean (Wyrtki, 1982; Harrison and Cane, 1984; Komar, 1986).

Supporters of worst-case scenarios of global warming point to evidence of sea level rising. But changes in sea level are often relative changes that vary from one region to another. Currently, sea level is rising in many places and is falling in many others, such as along very large areas of coastline in Western North America, Western Europe and Eastern Asia (Bryant, 1987).

Sea level measurements are subject to a number of biases, usually upwards, from removal of ground water and oil, erection of buildings, roads and airports, subsidence of the measuring equipment, surface movement due to earthquakes, or as a result of large depositional features such as river deltas.

Cabanes et al. (2001) have analyzed highly accurate global sea level observations by precise instruments carried aboard satellites. These researchers explain that the rate of sea level rise over the course of the twentieth century has likely been overestimated by a factor of two. In other words, instead of a global average sea level rise of 15 cm during the past 100 years, the true value is likely to be closer to 7 cm. The authors attribute the overestimate to the fact that historical sea level measurements have been primarily made from a rather sparse network of tide gauges located at coastal margins, which are often geologically unstable places, rather than a uniform sampling across the world's oceans. Corrected data for a large part of the globe show 1.8 mm/yr for 1900 to 1980 (Trupin and Wahr, 1990), which is roughly consistent with long-term values from corals and other proxies for the past 3000 yrs. It is noteworthy that historical records show no acceleration in sea level rise in the twentieth century (Douglas, 1992).

In light of IPCC scenarios of rapidly rising seas, the wellbeing of the populations low lying atolls in the tropical Pacific has been the subject of much speculation. As a result, it is alleged that the government of Tuvalu was ready to sue the United States and Australia because they had not signed the Kyoto Protocol. The Tuvalu government believes that most of its country, which at its highest is only five meters above sea level, will have disappeared into the ocean within 50 years. The New Zealand government too, by all accounts, believes this. It

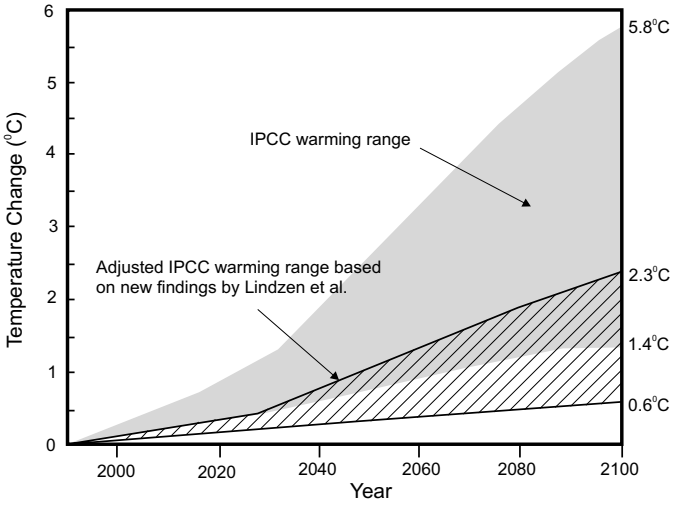

Fig. 21. Future global temperature ranges based on IPCC (2001) compared with the same models adjusted according to findings by Lindzen et al. (2001) of reduced atmospheric sensitivity from negative feedback loop caused by high level clouds (from World Climate Report, 2001a).

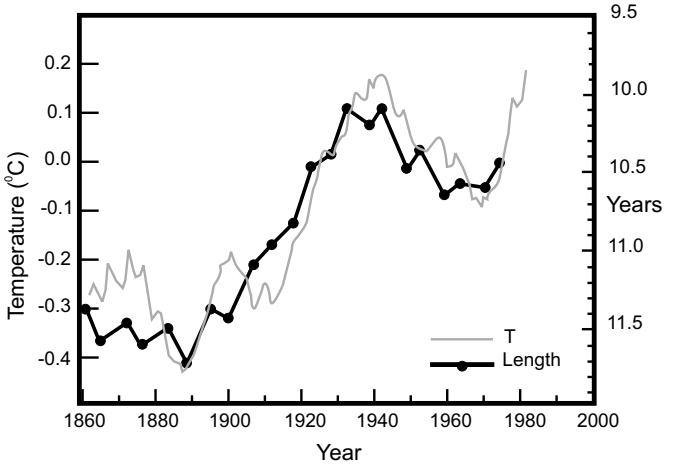

Fig. 22. Eleven-year running means of solar activity, in terms of the sunspot cycle length (years), compared with global temperature (T) based on the work of Friis-Cristensen and Lassen (1991). The global temperature is the same as that used by IPCC (Jones, 1988; Jones et al., 1986).

recently improved immigration procedures for Tuvalu residents after a false claim that the ocean level is rising, presumably to cater to "environmental refugees" wishing to re-settle in New Zealand. In fact, detailed measurements at the main Tuvalu island of Funafuti have shown no dramatic rise in ocean level over the past 30 years (Fig. 23).

It is important to keep in mind that greenhouse gas induced climate change can also act to substantially lower sea level. There is now a substantive body of research reported in the peer reviewed scientific journal literature that suggests that sea levels, which have been rising since the end of the last ice age (long before industrialization), are likely to stabilize or fall in a greenhouse-warmed world. This is because empirical evidence indicates that a modest warming of the Earth could lower sea level by increasing evaporation from the oceans. The result is increased deposition and accumulation of snow on the polar ice caps, principally in the Antarctic, thereby transferring large amounts of water from the oceans to the ice sheets (Oerlemans, 1982; Zwally, 1989; Bromwich, 1995; Thompson and Pollard, 1995; Ohmura et al., 1996; Ye and Mather, 1997; Meese et al., 1994; Hogan and Gow, 1997). The reasoning is that if the Antarctic air were to warm, it would still be below freezing, but its water holding capacity would increase as it warms. With more moisture in the atmosphere over the Antarctic, snowfall would increase and ice sheets would grow, locking up water that would otherwise be in the sea. The result would be thicker ice caps, especially in Antarctica. In this context, it is significant that during the strong warming episode of 1920-40, sea level rise did not accelerate but actually stopped (Singer, 1997). According to Singer (1997, p.19): "All these findings point to the conclusion that future warming will slow down rather than accelerate the ongoing rise in sea levels."

Fallacy Ten: Global warming will result in more extreme weather events.

It is common to see media reports of how floods, droughts, or increased frequency of hurricanes are proof of global warming. The problem is that no matter how outrageous the tale, it becomes the truth if it is told often enough. According to the 1996 IPCC report (Houghton et al., 1996, p. 173): "Overall, there is no evidence that extreme weather events, or climate variability, has increased, in a global sense, through the 20th century…" The 2001 IPCC Report (IPCC, 2001b, p. 5) states that "no systematic changes in the frequency of tornadoes, thunder days, or hail are evident..." The increasing dollar cost of storm and other weather related events could be accounted for by a rise in the value of development and number of properties, especially in tropical cyclone prone areas (Changnon et al., 1997; Pielke and Lansea, 1998; Kunkel et al., 1999). In the Atlantic region, the number of intense hurricanes declined during the 1970s and 1980s, and the period 1991-1994 experienced the smallest number of hurricanes of any four years over the last half century (Idso et al., 1990; Murphy and Mitchell, 1995; Landsea et al., 1996; Bengtsson et al., 1996; Serreze et al., 1997; Zhang and Wang 1997).

There is also evidence from Europe to support these observations. For the period 1896-1995, Bielec (2001, p. 162) analyzed thunderstorm data obtained at Cracow, Poland, which is "one of the few continuous records in Europe with an intact single place of observation and duration of over 100 years." From 1930 onward the trend is negative, revealing a linear decrease of 1.1 storms per year from 1930 to 1996. Bielec (2001) also reports there has been a decrease in the annual number of thunderstorms with hail over the period of record, and there has been a decrease in the frequency of storms producing precipitation greater than 20 mm.

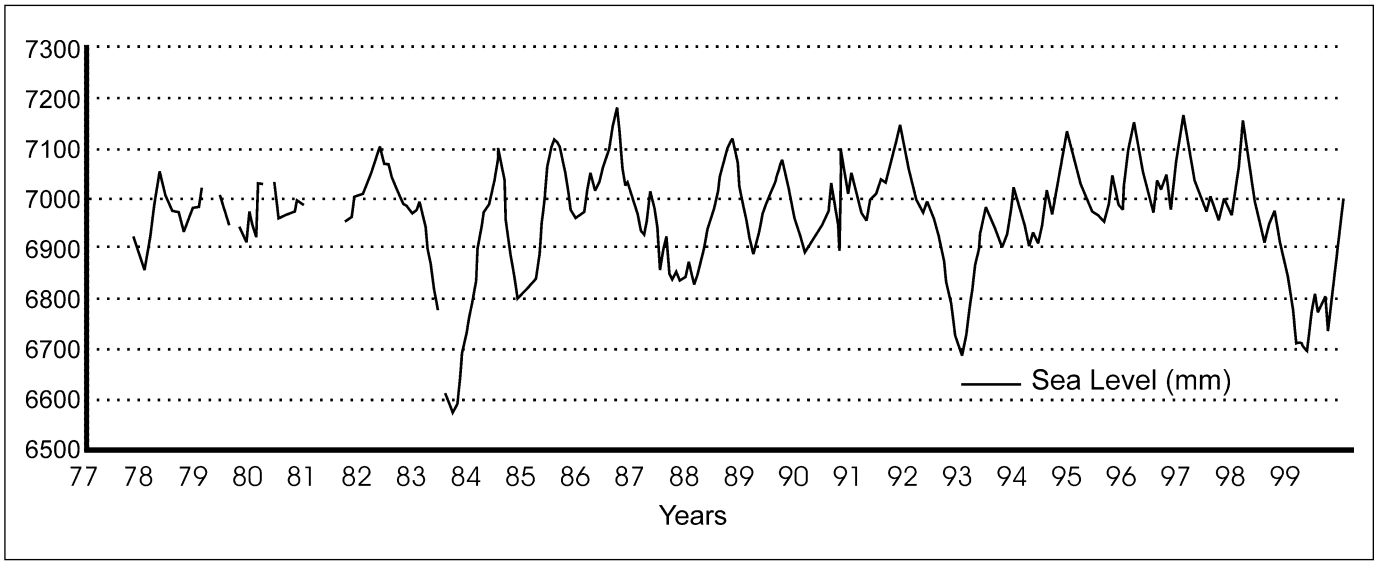

Fig. 23. Monthly mean sea level for the period 1977–1998 for Tuvalu's main atoll, Funafuti, in the tropical Pacific Data is from the Permanent Service for Mean Sea Level (PSMSL). PSMSL has been responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges. It is based at the Proudman Oceanographic Laboratory (POL), Bidston Observatory that is a component of the UK Natural Environment Research Council (NERC).

Nguyen and Walsh (2001) simulated the occurrence of hurricanes in the Australia region using a GCM that assumes a tripling of CO_2. The results showed that the numbers of hurricanes declined in a greenhouse-warmed world and that the decline is statistically significant. In a study of Atlantic hurricanes, Goldenberg et al. (2001) show that they occur in distinct multidecadal cycles and are linked to sea-surface temperature anomalies in the Atlantic Ocean's main hurricane development region. Warm anomalies are associated with increased major hurricane activity; cold anomalies, with suppressed activity. Goldenberg et al. (2001) suggest that increases in the frequency of big Atlantic hurricanes are due to the natural variations in hurricane frequency and intensity rather than global warming.

The media seems to want the storms, extremes of heat and cold, floods and droughts to be caused by global warming. Unfortunately, there is no evidence that they are. In fact, there is research that more warmth means a more stable climate. Karl et al. (1995) point out that an increase in CO_2 should decrease temperature variability. Balling (1998) examined changes in the spatial variability of mean monthly and daily temperatures that have occurred during the historical climate record. His research showed that, overall, the spatial variability in temperature anomalies has declined, and that the interannual variability in temperature anomalies is negatively correlated to mean hemispheric temperatures. Balling et al. (1998) and Michaels et al. (1998) both show that as the atmosphere warms, the month-to-month variability also declines (Fig. 24). Clearly, there is little support for the popular perception that temperatures have become more variable.

There is even a case for reduced climate variability accompanying global warming. The results of a study by Andrus et al. (2002) confirm the results of several other studies that indicate the mid-Holocene was significantly warmer than the present time. Andrus et al (2002) show a situation where a considerably warmer climate than that of the present was apparently unable to sustain significant El Niño activity. This demonstrates that future global warming may lead to fewer and less intense El Niños, which contradicts the predictions of climate dismalists who claim the opposite.

Fallacy Eleven: IPCC's predictions are reasonable.

The IPCC's treatment of emission scenarios has been criticized as merely the personal opinions of their creators who seem uninterested in procedures for checking whether any of the scenarios agree with past or future trends (Gray, 1998). In particular, recent unwelcome changes in greenhouse gases are ignored. Carbon dioxide emissions from combustion of fossil fuels have fallen for the years 1997 and 1998. Over half the models listed in Chapter 9 of IPCC 2001 (IPCC, 2001a), which deals with emissions, assume that carbon dioxide in the atmosphere is increasing at the rate of about 1% a year, when the measured rate of increase, for the past 33 years, has been half this. The effect of this is to boost future projections of warming.

It is also noteworthy that the rate of increase of the only other important greenhouse trace gas, atmospheric methane, has fallen steadily for the past 17 years and, since 1998, there has been a fall in atmospheric concentration (Figs. 3, 25). Unlike CO_2, methane in the atmosphere decomposes rapidly — within about 10 years — so that the atmospheric concentration depends on a constant source of supply. Clearly, methane's importance as a greenhouse gas is decreasing, despite the emphasis placed on it by the IPCC and by Kyoto Protocol negotiators.

In any analysis of CO_2 it is important to differentiate between three quantities: 1) CO_2 emissions, 2) atmospheric CO_2 concentrations, and 3) greenhouse gas radiative forcing due to atmospheric CO_2. As for the first, between 1980 and 2000 global CO_2 emissions increased from 5.5 Gt C to about 6.5 Gt C, which amounts to an average annual increase of just over 1%. As regards the second, between 1980 and 2000 atmospheric CO_2 concentrations increased by about 0.4 per cent per year. Concerning the third, between 1980 and 2000 greenhouse gas forcing increase due to CO_2 has been about 0.25 W m^{-2} per decade (Hansen, 2000). Because of the logarithmic relationship between CO_2 concentration and greenhouse gas forcing, even an exponential increase of atmospheric CO_2 concentration translates into linear forcing and temperature increase; or, as CO_2 gets higher, a constant annual increase of say 1.5 ppm has less and less effect on radiative forcing, as shown in Figure 3. Leaving aside for the moment the satellite temperature data and using the surface data set, between 1980 and 2000 there has been this linear increase of both CO_2 greenhouse gas forcing and temperature. If one extrapolates the rate of observed atmospheric CO_2 increase into the future, the observed atmospheric CO_2 increase would only lead to a concentration of about 560 ppm in 2100, about double the concentration of the late 1800's. That assumes a continuing increase in the CO_2 emission rate of about 1% per year, and a carbon cycle leading to atmospheric concentrations observed in the past. If one assumes, in addition, that the increase of surface temperatures in the last 20 years

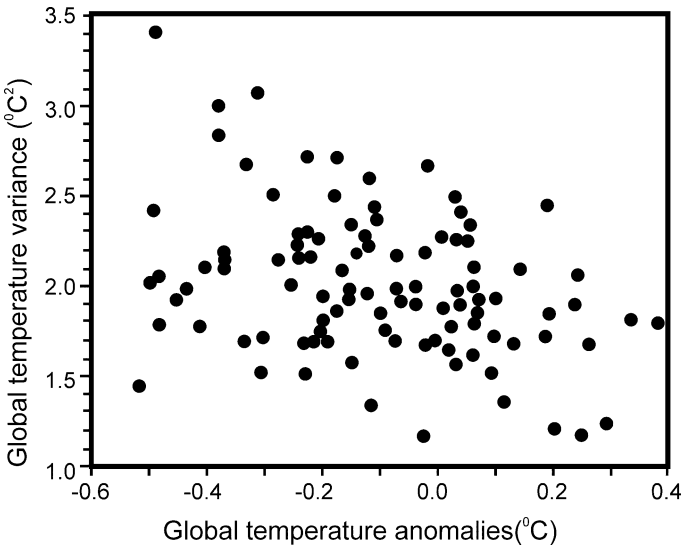

Fig. 24. Inter-annual surface temperature variability vs. global temperature anomalies for the 1897-1997 time series showing the warmer the surface temperature, the less variable climate becomes. Source: Michaels et al. (1998).

(about 0.3 °C) is entirely due to the increase in greenhouse gas forcing of all greenhouse gas, not just CO_2, that would translate into a temperature increase of about 1.5 °C (or approximately 0.15 °C per decade). Using the satellite data, the temperature increase is correspondingly lower. Based on this, the temperature increase over the next 100 years might be less than 1.5 °C, as proposed in Figure 19.

The IPCC (2001a) estimates that the direct warming contribution of a doubling of CO_2 is about 1.2 °C. Given that the 560 ppm CO_2 concentration for 2100 would be about double the concentration of the late 1800's, there would be a direct warming of 1.2 °C over late 1800's temperatures. That amounts to about 0.06 °C per decade, which is close to warming trends for the Northern Hemisphere from the satellite data. Additional warming forecast by the IPCC comes from the much higher emissions and concentration growth assumed by the IPCC SRES scenarios and amplifying feedbacks in the models that appear to be based on the assumption that the atmosphere is more sensitive to greenhouse gas induced climate change than is the case (Lindzen et al., 2001). Thus, by matching observed warming to observed forcing, anticipated warming can be more than about 0.7 °C in the next 50 years (Michaels and Balling, 2000; Allen et al., 2000; Hansen, 2002). Such a modest global temperature change would undermine the widespread concern generated so far by the exaggerated claims and hyperbole of the IPCC and the green lobby groups.

Microscopic airborne particles called aerosols can have a significant effect on global climate because they tend to cool the surface. If included in climate models, the UN IPCC 100 year prediction would include the possibility of less warming or even cooling. IPCC 2001a (p. 334) states in Chapter 5 on "Aerosols, Their Direct and Indirect Effects": "The largest estimates of negative forcing due to the warm-cloud effect may approach or even exceed the positive forcing due to long-lived greenhouse gases." But the SPM has suppressed the significance of the negative radiative forcing that can arise from an increase in some types of aerosols. Characterization of these climate forcing agents and their changes over time is required to project what climate changes could lie ahead. Figure 3 in the IPCC 2001 WG1 SPM (IPCC, 2001b) shows current estimates of the radiative forcing due to increased concentrations of atmospheric constituents and other mechanisms. Figure 3 illustrates the considerable effect of aerosols on radiative forcing and the text plainly states that an ability to predict future climate requires an understanding of the effect of these aerosols on radiative forcing. Nevertheless, the IPCC excludes them from the projections of future climate. This is a major omission.

Figure 3 in IPCC (2001b) shows estimated forcings for five classes of aerosols (Fig. 20). For four of these classes there is also a vertical error bar which the legend explains "indicates a range of estimates, guided by the spread in the published values of the forcings and physical understanding." In addition, each class is labelled with a "Level of Scientific Understanding." One class is labelled "Low" and the other four are labelled "Very Low." No explanation of these uncertainty levels is provided. Wojick (2001) points out that, in the UN IPCC's 1995 Second Assessment Report (Houghton et al., 1996, p. 117), an earlier version of this same figure appears as Figure 2.16. Here, it is explained that the levels "low" and "very low" are "our subjective confidence that the actual forcing lies within this error bar." In fact, the levels are called "levels of confidence" not "levels of understanding." Wojick (2001, p. 12) states:

> In plain language, this means that the chances that the aerosol forcings actually lie within the error bars are very low in most cases. Conversely, it is very likely that the actual forcings lie outside these error bars. What then is the likely range for these forcings? We are not told, in fact the very issue, which was at least alluded to in the IPCC SAR, has now been entirely omitted.
>
> The truth is that the possible range of forcings is very large, much larger than the error bars show. Therefore the range of aerosol forcings is much larger than the ranges for the greenhouse gases, which are shown to have a "high" level of understanding. If the correct error bars for aerosols were shown — bars that display the likely range of forcings — they would be seen to overwhelm the greenhouse gas forcings.
>
> In short we simply do not understand aerosol forcing. In fact a recent paper, Charlson et al. (2001), claims that the range of possible forcings is as much as twice the very large range that is not shown in the TAR.

The IPCC deals with this lack of understanding of aerosols forcing in a curious fashion. It states (IPCC, 2001b, p. 13 and Footnote 11): "The globally averaged surface temperature is projected to increase by 1.4 to 5.8°C over the period 1990 to

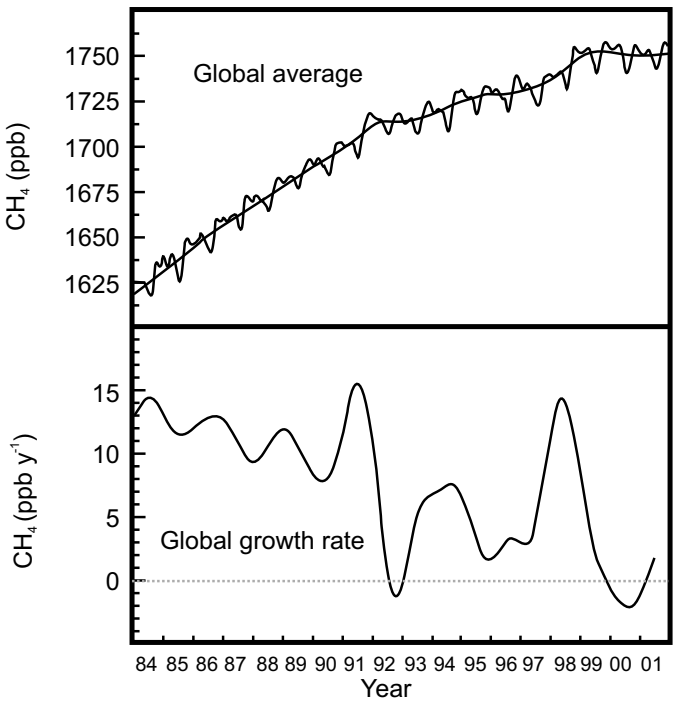

Fig. 25. Global average atmospheric methane (top) and global average growth rate (bottom). Source: The National Oceanic and Atmospheric Administration (NOAA), Climate Monitoring and Diagnostics Laboratory (CMDL).

2100. These results are for the full range of 35 SRES scenarios, based on a number of climate models." And, Footnote 11 states: "This range does not include uncertainties in the modelling of radiative forcing, e.g. aerosol forcing uncertainties." Thus, the IPCC has simply ignored the large aerosol uncertainties, and no reason is given. Clearly, if they were included, predicted warming rates might be considerably lower, or non existent. According to Wojick (2001, p. 13): "It is hard not to see this as scientific fraud."

In summary, CO_2 is increasing in concentration linearly at the rate of 0.4% a year, and as a result, agricultural and forestry yields are increasing. There are no established harmful effects of this increase. The rate of increase of the only other important greenhouse gas, methane, has fallen steadily for the past 17 years and the concentration is currently falling. Computer climate models are based on the incorrect belief that changes in the greenhouse effect are the only influences on the climate, and the role of aerosols has been omitted. There are huge uncertainties in the model outputs which are unrecognized and unmeasured. They are so large that adjustment of model parameters can give model results which fit any climate, including one with no warming, and one that cools. No model has ever successfully predicted any future climate sequence. Despite this, future "projections" for as far ahead as several hundred years have been presented by the IPCC as plausible future trends, based on hypothetical and, some say, largely distorted "storylines", combined with untested models. The IPCC has provided a wealth of scientific information on the climate, but has not established a case that increases in CO_2 are causing any harmful effects**.** Model uncertainties are so great that the models are quite unsuitable for any form of future projection.

Fallacy Twelve: Observed temperature trends are those predicted by climate models.

The inadequacies of the climate models were recognized early on (Houghton et al., 1990, p. 321): "If the atmosphere and the upper-ocean alone were responding to the increase in greenhouse heating and the cloud-radiation feedbacks operated according to current knowledge, then the surface of the earth would already be 1 to 2 degrees C warmer than the temperatures of the nineteenth century." So far, the climate models are, in effect, unproven hypotheses, since observations of the past 100 years are not consistent with model's calculations. The shortcomings of the models call attention to the need for research into discrepancies between observations and GCM theories: to explain why increased radiative forcing by CO_2 has not produced the expected global temperature rise, and in particular, why the highly accurate satellite data show no global warming.

The most likely explanations lie in negative feedback processes that counteract warming from increase concentrations of greenhouse gases, or solar effects that offset or are mistaken for an enhanced greenhouse effect. The most obvious negative feedback would come from increased cloudiness.

Orthodox greenhouse theory says CO_2 warms the oceans, which causes more evaporation, which puts more water vapour (the dominant greenhouse gas) into the atmosphere, and this leads to more warming and so on until the final warming becomes several times larger than the initial CO_2 warming which triggered it. Without this positive feedback built into most climate models, the calculated temperature increase due to, say a doubling of CO_2, would be only in the vicinity of 1 °C. Initially the IPCC dismissed this and any research that suggested anything to the contrary, as illustrated by this statement in IPCC 1990 (Houghton et al., 1990, p. 78): "The best understood feedback mechanism is water vapour feedback, and this is intuitively easy to understand." With time, views slowly changed, and this is reflected in the 1996 IPCC report: "Feedback from the redistribution of water vapour remains a substantial uncertainty in climate models…" (Houghton et al., 1996, p. 201). Recent work (Chen et al., 2002; Wielicki et al., 2002) supports the scale and significance of the negative feedback mechanism advocated in 1984 by Ellsaesser (1984), and later by Lindzen (1990), that has been used to explain why observed global warming is so much less than predicted by conventional climate models. Both show that the process starts with increased convective activity in the tropics leading to an intensification of the Hadley circulation. This in turn leads to increased subsidence in the return flows in the extra-tropical zones. Drying of the upper troposphere leads to increased longwave emission into space from the water vapour in the warm boundary layer. This produces negative feedback, reducing the warming effects of increased CO_2 and therefore the sensitivity of global climate to changes in CO_2 (Singer, 1997, p. 52; see also Hartmann, 2002). The resulting sensitivity is considerably lower than that suggested by the IPCC (Fig. 21). Thus, there is now persuasive evidence that errors inherent in the climate models cause over-prediction of the rate of future global warming.

Fallacy Thirteen: There is a consensus that greenhouse induced climate change is a major threat.

Scientific issues are not decided by ballot. They are resolved by observations that support a theory or hypothesis. In 1990, the IPCC claimed their report represented the "consensus" view of science, and this was used by some as an excuse for discouraging debate. Consensus, however, is like models. Neither are evidence, or proof, of global warming claims. The views of scientists who objected to the IPCC stand were dismissed as those of a "fringe group". However, the increasingly large number of critics and the presence of their opposing views in the peer reviewed scientific literature led the IPCC and environmental groups to abandon the "consensus" claim.

The study of climate change is a relatively new science. It is both complex and inter-disciplinary and its methods are still crude. Most important, its analyses suffer from a paucity of long-running observational data. Despite this, the work published by the IPCC has never displayed signs of the contention and debate on which the advancement of scientific understanding necessarily depends. Scientists are a well-educated, diverse and ill-disciplined assortment of freethinkers. And yet, consensus has been paramount in the workings of the IPCC. One

wonders where the dissidents are among the IPCC scientists, especially those who contribute to the SPMs.

FALLACY FOURTEEN: THE THREAT OF HUMAN-CAUSED CLIMATE CHANGE JUSTIFIES TAKING THE ACTION PROPOSED IN THE UNFCCC AND KYOTO PROTOCOL.

The United Nations Framework Convention on Climate Change (UNFCCC) is a product of the 1980s, following the First World Climate Conference in Villach, Austria. But research, science, our knowledge and understanding is increasing and improving constantly and at an accelerated pace. According to recent findings, human-caused CO_2 growth rates are levelling off (Table 2, Figs. 2, 3), despite increased emissions (Hansen and Sato, 2001). Human influence on global climate is less than previously thought, probably because climate is not so sensitive to greenhouse gases as earlier believed. Most important, there is no evidence of catastrophic man-made global warming, thus throwing doubt on the IPCC predictions.

The Kyoto Protocol, although economically costly, would be ineffective in reducing the calculated temperature increase. Wigley (1998) shows that the 1997 Kyoto Protocol (calling for an average cut in greenhouse gas emissions of 5.2% from 1990 levels by industrialized nations by the year 2010) is not sufficient to significantly reduce the growth of greenhouse gases in the atmosphere; therefore, its effect on temperature would be imperceptible (Fig. 26). The required emission cuts by OECD countries would, according to the climate models, reduce warming by as little as 0.07°C by 2050. Reductions of this size would be lost in the noise of natural climate variability. So, in addition to being ineffective, costly, and unfair to industrialized nations, the Kyoto Protocol is also unnecessary.

CONCLUSION

Climate change science is a relatively new area of study. Over the past two decades progress has been rapid, but the findings are uncertain and are likely to remain so into the foreseeable future because of the complexity of climate and the inadequacy of scientific understanding. The controversy surrounding global warming comes not from the uncertainty of scientific findings, but from attempts by ideologues and interests to promote their own viewpoint or advantage. Scientists, like any one, can be biased, politically motivated and ideologically driven. There is a difference between scientific findings and speculation by scientists. Often the public is not told which is which.

The concepts of scientific 'proof', 'evidence' and 'truth' are also open to manipulation. Consider the issue of temperature record (i.e. use of measurements from thermometers a few feet above the ground versus those from satellites), which has been discussed here in some detail. The IPCC chose to use the surface temperature record rather than the more accurate satellite record. Sceptics wonder why. Taking into account the error limits on the surface record, the two records show a high degree of correlation, and although the trends differ slightly, the IPCC opted for the more dramatic one. To take one record as the 'truth' and ignore the other is non-scientific. Clearly, it is necessary to resist the temptation to select only data that support a hypothesis and ignore other available data.

Table 2.
Emissions of CO_2, atmospheric increase of CO_2 and percentage CO_2 uptake compared for the periods 1980-1989 and 1990-1999. According to IPCC SPM (IPPC, 2001b, p. 12): "As the CO_2 concentration of the atmosphere increases, ocean and land will take up a decreasing fraction of anthropogenic emissions". But information from Table 3.1 on page 190 of the WG1, IPCC 2001 main report (IPCC 2001a) shows an increase in CO_2 uptake. The net effect is less CO_2 in the atmosphere despite increasing emissions (see Fig. 2).

	1980-1989	1990-1999
Emissions (Gt/yr)	5.4	6.3
Atmospheric increase (Gt/yr)	3.3	3.2
CO_2 uptake (%)	39	49

Global warming involves a scientifically realistic mechanism that links climate change to the concentration of greenhouse gases in the atmosphere. Beyond this, scientists must be careful what they say in 'summary' statements to the public. It is extremely important to make it clear that there is debate rather than a consensus of opinion on the subject. Criticism for the failure to emphasize this is being directed at reports by governmental climate panels and some environmental groups claiming to speak on behalf of scientists. The content of the IPPC's Summaries for Policymakers epitomizes this. The SPMs are cleverly biased reports on climate change science. A SPM clearly based of scientific knowledge would be more credible, and more useful for ideologues of all persuasions.

A balanced summary would include the following statement. Although the future state of global climate is uncertain, there is no reason to believe that catastrophic change is underway. The Earth's surface has warmed slightly, but floods, droughts, hurricanes and tornadoes have not changed for the worse. The atmosphere may warm because of human activity, but if it does, the expected change is unlikely to be much more than 1 °C, and probably less, in the next 100 years.

A lot of very complex work has been done on general circulation models (GCMs) over the past 20 years; of which none has been verified by evidence. Satellites provide the best evidence and this does not show the warming trend predicted by the GCMs. Even the climate models promoted by the IPCC do not suggest that catastrophic change is underway. They suggest that increases in greenhouse gases are likely to give rise to a warmer and wetter climate in most places, in particular, warmer nights and warmer winters. Generally higher latitudes would warm more than lower (equatorial) latitudes. This means milder arctic winters and, coupled with increased atmospheric CO_2, it also means a more robust biosphere with more forest, crops and ground cover for more animals and people. This is

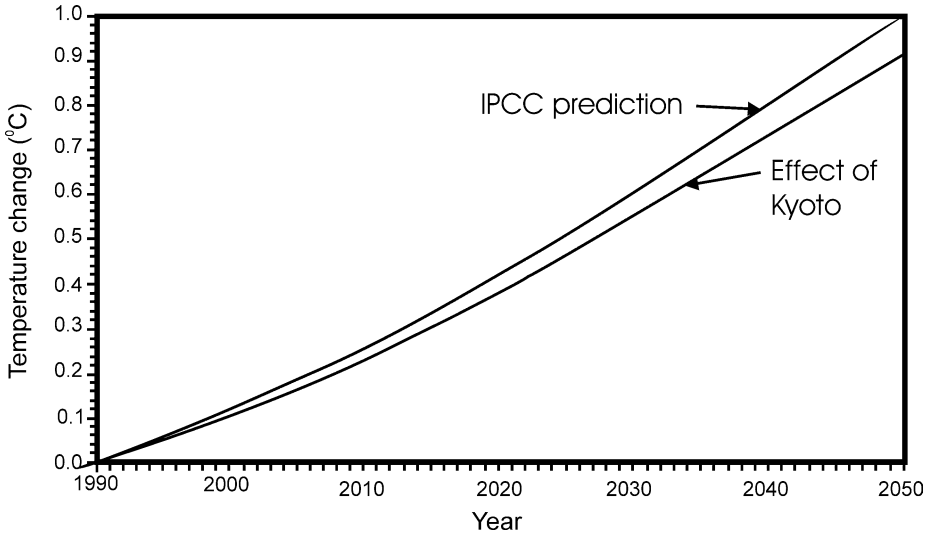

Fig. 26. The effect on global temperature rise of cuts in greenhouse gas emissions proposed by the Kyoto Protocol (Wigley, 1998). Upper line is the projected temperature rise based on IPCC projections of what would occur if greenhouse gases were to continue to increase into the next century; labelled the "IS92e" scenario. The lower line is the temperature rise that would occur if emissions were stabilized at 1990 levels, as proposed by the Kyoto Protocol; labelled the "IS92d" scenario. The figure shows that by 2050 the Kyoto stabilization emission policy would have reduced temperature rises by less than 0.1 °C, and would be even less under the modified "New Kyoto" proposal shown in Fig. 27.

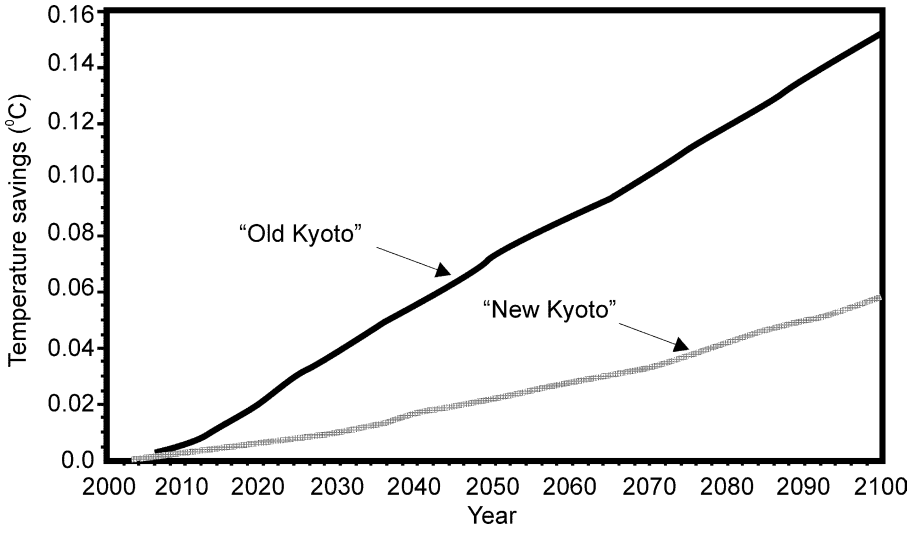

Fig. 27. The effect on global temperature rise of cuts in greenhouse gas emissions proposed by the "Old" Kyoto Protocol drafted in 1997 and the "New" Kyoto agreement drafted in July 2001. The Old Kyoto required that the major industrialized nations reduce their emissions of carbon dioxide to 5.2% below 1990 levels beginning in 2008. The New Kyoto requires 1.8% below 1990 levels at the same time. Assuming global temperature rises by 2.5 oC for a doubling of atmospheric carbon dioxide, which is the standard IPCC assumption, the Old Kyoto produces a world, in 2100, whose surface temperature is 0.15°C lower than it would be if no one did anything; the New Kyoto, a temperature that is 0.06°C lower. The effect on global climate change of either one would be imperceptible. Expressed in another way, the New Kyoto delays the 2.5°C warming by 288 days. Source: World Climate Report, 2001c.

hardly a major threat. Warming, from whatever cause, is more likely to produce economic benefits than economic losses. A more likely threat is policies that endanger economic progress. For many countries, the negative impact of such policies would be far greater than any change caused by global warming.

REFERENCES

Allen, M.R., Stott, P.A., Mitchell, J.F.B., Schnur, R. and Delworth,T.L. 2000. Quantifying the uncertainty forecasts of anthropogenic climate change. Nature, v. 407, p. 617-620.

Adger, W. Neil and Brown, K. 1995. Policy implications of the missing global carbon sink. Area, v. 24, no.4, p. 311-317.

Allard, P., Carbonelle, J., Dajlevic, D., Le Bronec, J., Morel, P., Robe, M.C., Maurenas, J.M., Faivre-Pierret, R., Martin, D., Sabrouk, J.C., and Zeltwoag, P. 1991. Eruptive and diffuse emissions of CO_2 from Mount Etna. Nature, v. 351, p. 387-391.

Andrus, C.F.T., Crowe, D.E. Sandweiss, D.H., Reitz, E.J. and Romanek, C.S. 2002: Otolith ó^{18}O record of mid-Holocene sea surface temperatures in Peru. Science, v. 295, p. 1508-1511.

Balling, R.C. Jr. 1992. The Heated Debate: Greenhouse Predictions Versus Climate Reality. San Francisco: Pacific Research Institute for Public Policy, 195 p.

_____ 1998. Analysis of daily and monthly spatial variance componenets in historical temperature records. Physical Geography, v. 18, p. 544-552.

_____, Michaels, P.J. and Knappenberger, P.C. 1998. Analysis of winter and summer warming rates in gridded temperature time series. Climate Research, v. 9, p. 175-181.

_____ 2001. Pumped-up pastures. World Climate Report, v. 6, no. 22.

_____ and Idso, S.B. 1989. Historical temperature trends in the United States and the effect of urban population growth. Journal of Geophysical Research, v. 94, p. 3359-3363.

Barnett, T.P., Pierce, D.W. and Schnur R. 2001. Detection of anthropogenic climate change in the world's oceans, Science, v. 292, p. 270–274.

Bengtsson, L., Botzet, M. and Esch, M. 1996. Will greenhouse gas-induced warming over the next 50 years lead to a higher frequency and greater intensity of hurricanes? Tellus, v. 48A, p. 57-73.

_____, Roeckner, E. and Stendel, M. 1999. Why is the global warming proceeding much slower than expected? Journal of Geophysical Research, v. 104, p. 3865.

Bielec, Z. 2001. Long-term variability of thunderstorms and thunderstorm precipitation occurrence in Cracow, Poland, in the period 1896-1995. Atmospheric Research, v. 56, p. 161-170.

Bjorck, S., Muscheler, R., Kromer, B., Andresen, C.S., Heinemeier, J., Johnsen, S.J., Conley, D., Koc, N., Spurk, M. and Veski, S. 2001. High-resolution analyses of an early Holocene climate event may imply decreased solar forcing as an important climate rigger. Geology , v. 29, p. 1107-1110.

Briffa, K.R. and Osborn, T.J. 2002. Blowing hot and cold. Science, v. 295, p. 2227-2228.

Broecker, W.S. 2001. Was the Medieval Warm Period Global? Science, v. 291, p.1497-1499.

Bromwich, D. 1995. Ice sheets and sea level. Nature, v. 373, p. 18.

Bryant E., 1987. CO_2-warming, rising sea-level and retreating coasts: review and critique. Australian Geographer, v. 18, p. 101-113.

Bunde, A., Havlin, S., Koscielny-Bunde, E. and Schellnhuber, H. J. 2001. Long term persistence in the atmosphere: global laws and tests of climate models. Physica A, v. 302, p. 255-267.

Cabanes, C., Cazenave, A. and Le Provost, C. 2001. Sea level rise during the past 40 years determined from satellite and in situ observations. Science, v. 294, p. 840–842.

Caldeira, K. and Rampino, M.R. 1992. Mount Etna CO_2 May Affect Climate. Nature, v. 355, p. 401-402.

Calkin, P.E., Wiles, G.C. and Barclay, D.J. 2001. Holocene coastal glaciation of Alaska. Quaternary Science Reviews. v. 20, p. 449-461.

Center for the Study of Carbon Dioxide and Global Change, 1999. Three Centuries of Ground Surface Temperature Change in Southern Canada. Review of Majorowicz, J.A., Safanda, J., Harris, R.N. and Skinner, W.R. 1999: Large ground surface temperature changes of the last three centuries inferred from borehole temperatures in the Southern Canadian Prairies, Saskatchewan. Global and Planetary Change 20: 227-241. Reviewed 1 September 1999 (www.co2science.org).

Cess, R.D., Stephens, G.L., Zhang, M.H., Pilewskie, P. and Valeroet, F.P.J. 1995. Absorption of solar radiation by clouds: Observations versus models. Science, v. 276, p. 496.

Changnon, S. A., Changnon, D., Fosse, E.R., Hoganson, D.C., Roth, R.J. and Totsch, J.M. 1997. Effects of recent weather extremes on the insurance industry: Major implications for the atmospheric sciences. Bulletin of the American Meteorological Society, v. 78, p. 425.

_____ 1999. A rare long record of deep soil temperatures defines temporal temperature changes and an urban heat island. Climatic Change, v. 42, p. 531-538.

Charlock, T. P. and Alberta, T.L. 1996. The CERES/ARM/GEWEX Experiment (CAGEX) for the retrieval of radiative fluxes with satellite data. Bulletin of the American Meteorological Society, v. 77, p. 2673.

Charlson, R.J., Seinfeld, J.H., Nenes, A., Kulmala, M., Laaksonen, A. and Facchini, M.C. 2001. Reshaping the Theory of Cloud Formation. Science, v. 292, no. 5524, p. 2025-2026.

Chen, J, Carlson, B.E. and Del Genio, A.D. 2002. Evidence for strengthening of the Tropical general circulation in the 1990s. Science, v. 295, no. 5556, p. 838-841.

Christy, J.R. 2002. When was the hottest summer? A state climatologist struggles for an answer. Bulletin of the American Meteorological Society, v. 83 (5), p. 723-734.

_____ and Goodridge J.D. 1995. Precision global temperatures from satellites and urban warming effects from non-satellite data. Atmospheric Environment, 29, 1957-1961.

_____., D.E. Parker, Brown, S.J., Macadam, I., Stendel, M. and Norris, W.B. 2001. Differential trends in tropical sea surface and atmospheric temperatures since 1979. Geophysical Research Letters, v. 28, no. 1, p.183-186.

_____, J.R., Spencer, R.W.and Braswell, W.D. 2000. MSU tropospheric temperatures: dataset construction and radiosonde comparisons. Journal of Atmospheric and Ocean Technology, Journal of Atmospheric and Oceanic Technology, v. 17, p. 1153-1170.

_____, _____ and Lobl, E.S. 1998. Analysis of the merging procedure for the MSU daily temperature time series. Journal of Climate, v. 11, p. 2016.

Comiso, J.C. 2000. Variability and trends in Antarctic surface temperatures from in situ and satellite infrared measurements. Journal of Climate, v. 13, p.1674-1696.

Cioccale, M.A. 1999. Climatic fluctuations in the Central Region of Argentina in the last 1000 years. Quaternary International, v. 62, p. 35-47.

Craine, J.M., and Reich, P.B. 2001. Elevated CO_2 and nitrogen supply alter leaf longevity of grassland species. New Phytologist, v. 150, p. 397–403.

_____, Wedin, D.A. and Reich, P.B. 2001. Grassland species effects on soil CO2 flux track the effects of elevated CO2 and nitrogen. New Phytologist, v. 150, p. 425–434.

Daepp, M., Nösberger, J. and Lüscher, A. 2001. Nitrogen fertilization and developmental stage alter the response of *Lolium perenne* to elevated CO_2. New Phytologist, v. 150, p. 347–358.

Dahl-Jensen, D., Mosegaard, K., Gundestrup, N., Clow, G.D., Johnsen, S.J., Hansen, A.W. and Balling, N. 1998. Past temperatures directly from the Greenland Ice Sheet. Science, v. 282, p. 268-271.

de Freitas, C.R. 1991. The greenhouse crisis: myths and misconceptions. Area (Institute of British Geographers), v. 23, no.1, p. 11-19.

_____ 1994. A critical appraisal of the global warming debate. New Zealand Geographer, v. 50, no.1, p. 30-33.

de Menocal, P., Ortiz, J., Guilders, T. and Sarnthein, M. 2000. Coherent High- and Low-Latitude Climate Variability During the Holocene Warm Period, Science, v. 288, p. 2198-2202.

Dettinger, D.M. and Ghil, M. 1998. Seasonal and interannual variations of atmospheric CO_2 and climate. Tellus, v. 50B, p. 1-24.

Dlugocencky, E.J, Masurie, K.A., Lang, P.M. and Tans, P.P. 1998. Continuing decline in the growth rate of the atmospheric methane burden. Nature, v. 393, p. 447-450.

_____, Walter, B.P., Masurie, K.A., Lang, P.M. and Kasischke, E.S. 2001. Measurements of an anomalous global methane increase during 1998. Geophysical Research Letters, v. 28, p. 499-502.

Doran, P.T., Priscu, J.C., Lyons, W.B., Walsh, J.E., Fountain, A.G., McKnight, D.M., Moorhead, D.L., Virginia, R.A., Wall, D.H., Clow, G.D., Fritsen, C.H., McKay, C.P. and Parsons, A.N. 2002. Antarctic climate cooling and terrestrial ecosystem response. Nature, v. 415, p. 517-520.

Douglas, B.C. 1992. Global sea level acceleration. Journal of Geophysical Research, v. 97, p. 12699-12706.

Dowdeswell, J.A., Hagen, J.O., Bjornsson, H., Glazovsky, A.F., Harrison, W.D., Holmlund, P. Jania, J., Koerner, R.M., Lefauconnier, B., Ommanney, C.S.L. and Thomas, R.H. 1997. The mass balance of circum-Arctic glaciers and recent climate change. Quaternary Research, v. 48, p. 1-14.

Edwards, G.R., Clark, H. and Newton, P.C.D. 2001. Seedling performance of pasture species under elevated CO2. New Phytologist, v. 150, p. 359-369.

Ellsaesser, H.W. 1984. The Climatic Effect of CO_2. A Different View. Atmospheric Environment, v. 18 no.2, p. 431-434, 1984.

Esper, J., Cook, E.R. and Schweingruber, F.H. 2002. Low-frequency signals in long tree-ring chronologies for reconstructing past temperature variability. Science, v. 295, p. 2250-2253.

Feebly, R., Wanninkhof, R., Takahashi, T. and Trans, P. 1999. Influence of El Niño on the equatorial Pacific contribution to atmospheric CO_2 accumulation. Nature, v. 398, p. 597-600.

Fischer, H., Wahlen, M., Smith, J., Mastroianni, D. and Deck, B. 1999. Ice core records of atmospheric CO_2 around the last three glacial terminations. Science, v. 283, p. 1712-1714.

Flower, B.P. 1999. Warming without high CO_2? Nature, v. 399, p. 313-314.

Friis-Cristensen, E. and Lassen, K. 1991. Length of solar cycle: an indicator of solar activity closely associated with climate. Science, v. 254, p. 698-700.

Gerlach, T. 1991a. Etna's greenhouse pump. Nature, v. 351, p. 352-353.

_____ 1991b. Present-day CO_2 emissions from volcanoes. Eos, Transactions of the American Geophysical Union, v. 72, no. 23, p. 254-255.

Goldenberg, S., Landsea, C.W., Mestas-Nuñez, A.M. and Gray, W.M. 2001. The recent increase in Atlantic hurricane activity: Causes and implications, Science, v. 293, p. 474-479.

Goode, P.R., Qui, J., Yurchyshyn, V., Hickey, J., Chu, M-C., Kolbe, E., Brown, C.T. and . Koonin, S.E. 2001 Earthshine observations of the earth's reflectance, Geophysical Research Letters, v. 28, p.1671-1674.

Goodridge J.D. 1992. Urban bias influences on long-term California air temperature trends. Atmospheric Environment, v. 26B, no. 1, p. 1-7.

_____ 1996. Comments on "Regional Simulations of Greenhouse Warming including Natural Variability". Bulletin of the American Meteorological Society, v. 77, p. 3-4.

Gubler, D. J. 1998. Resurgent vector-borne diseases as a global health problem. Emerging Infectious Diseases, v. 4, p. 442.

Gray, V. 1998. The IPCC future projections: are they plausible? Climate Research, v. 10, p. 155-162.

Grove, J.M. and Switsur, R. 1994. Glacial geological evidence for the medieval warm period. Climatic Change, v. 26, p.143-169.

Hanna, E. 2001. Anomalous peak in Antarctic sea-ice area, winter 1998, coincident with ENSO. Geophysical Research Letters, v. 28, p. 1595-1598.

Hansen, J.E. Sato, M., Glascoe, J. and Ruedy, R. 1998. A common-sense climate index: Is climate changing noticeably? Proceedings of the National Academy of Sciences, v. 95, p. 4113-4120.

_____, Ruedy, R., J. Glascoe and Sato, M. 1999. GISS analysis of surface temperature change. J. Geophys. Research, v. 104, p. 30,997-30,022.

_____ 2000. Global warming in the 21st century: An alternative scenario. Proceedings of the National Academy of Sciences, v. 97, p. 9875-9880.

_____ 2001. Climate forcings in the industrial Era. NASA Goddard Institute for Space Studies Research [http://www.giss.nasa.gov/research/intro/hansen.05/]. Update of Hansen (1998).

_____ 2002. A brighter future. Climatic Change, v. 52, p. 435-440.

_____, Sato, M., Lacis, A., Ruedy, R., Tegen, I. and Matthews, E. 1998. Perspective: Climate forcings in the industrial era. Proceedings of the National Academy of Sciences, v. 22, p.12753-12758.

_____, Ruedy, R., Sato, M., Imhoff, M., Lawrence, W., Easterling, D., Peterson T. and Karl, T. 2001. A closer look at United States and global surface temperature change. Journal of Geophysical Research, v. 106, no. D20, p. 23,947-23,963.

_____ and Sato, M. 2001. Trends of measured climate forcing agents. Proceedings of the National Academy of Sciences, v. 98, no. 26, p. 14778–14783.

Harrison D.E. and Cane, M.A. 1984. Changes in the Pacific during the 1982-83 El Nino event. Oceanus, v. 27, p. 21-28.

Hartman, D.L. 2002. Tropical Surprises. Science, v. 295, p. 811-812.

_____ and Michelsen, M.L. 2002. No evidence for Iris. Bulletin of the American Meteorological Society, v. 83, p. 249-254.

Haug, G.H., Hughen, K.A., Sigman, D.M., Peterson, L.C. and Rohl, U. 2001. Southward migration of the intertropical convergence zone through the Holocene. Science, v. 293, p. 1304-1308.

Hendy, E.J., Gagan, M.K., Alibert, C.A., McCulloch, M.T., Lough, J.M. and Isdale, P.J. 2002. Abrupt Decrease in Tropical Pacific Sea Surface Salinity at End of Little Ice Age. Science, v. 295, p. 1511-1514.

Hogan, A. W. and Gow, A.J. 1997. Occurrence frequency of thickness of annual snow accumulation layers at South Pole. Journal of Geophysical Research, v. 102, p. 14, 021-14, 027.

Holmgren, K., Tyson, P.D., Moberg, A. and Svanered, O. 2001. A preliminary 3000-year regional temperature reconstruction for South Africa. South African Journal of Science, v. 97, p. 49-51.

Hong, Y.T., Jiang, H.B., Liu, T.S., Zhou, L.P., Beer, J., Li, H.D., Leng, X.T., Hong, B. and Qin, X.G. 2000. Response of climate to solar forcing recorded in a 6000-year delta 18 time-series of Chinese peat cellulose. The Holocene, v.10, p. 1-7.

Houghton, J. T., Callander, B.A. and Varny, S.K. (eds.). 1992. Climate Change 1992, the Supplementary report to the IPCC Scientific Assessment. Cambridge University Press, New York, NY, 200 p.

_____, Jenkins, G.J. and J.J. Ephraums, J.J. (eds.). 1990. Climate Change: the IPCC Scientific Assessment. Cambridge University Press, New York, N.Y. 359 p.

_____, Meira Filho,L.G., Bruce, J., Lee, H., Callander, B.A., Haites, E., Harris, N. and Maskell, K. (eds.). 1994. Climate Change 1994: Radiative Forcing of Climate Change, and An Evaluation of the IPCC IS92 Emission Scenarios. Cambridge University Press, New York, NY., 292 p.

_____, _____, Callander, B.A., Harris, N., Katenberg, A. and K. Maskell (eds.). 1996. Climate Change 1995: the Science of Climate Change, Contribution to Working Group 1 to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York, NY, 572 p.

Huang, S., Pollack, H.N. and Shen, P.Y. 1997. Late Quaternary temperature changes seen in world-wide continental heat flow measurements. Geophysical Research Letters, v. 24, p. 1947-1950.

Huffman, T.N. 1996. Archaeological evidence for climatic change during the last 2000 years in southern Africa. Quaternary International, v. 33. p. 55-60.

Hurrell, J. W., Brown, S.J., Trenberth, K.E. and Christy, J.R. 2000. Comparison of Tropospheric Temperatures from Radiosondes and Satellites: 1979-98. Bulletin of the American Meteorological Society, v. 81, no. 9, p. 2165–2178.

Idso, S.B. 1991a. The aerial fertilisation effect of CO_2 and its implications for global carbon cycling and maximum greenhouse warming. Bulletin of the American Meteorological Society, v. 72, p. 962-965.

_____ 1991b. Reply to comments of L.D. Danny Harvey, B. Bolin and P. Lehmann. Bulletin of the American Meteorological Society, v. 72, p. 1910-1914.

_____, Balling, R.C. and Cerveny, R.S. 1990. Carbon Dioxide and Hurricanes: Implications of Northern Hemispheric Warming for Atlantic/Caribbean storms. Meteorology and Atmospheric Physics, v. 42, p. 259-263.

_____, and K.E. Idso, 1994. Plant responses to atmospheric CO_2 enrichment in the face of environmental constraints. Agricultural and Forest Meteorology, v. 69, p. 153-203.

_____, and _____ 2001. Effects of atmospheric CO_2 enrichment on plant constituents related to animal and human health. Agricultural and Forest Meteorology, v. 45, p. 179-199.

Intergovernmental Panel on Climate Change (IPCC), 2001a. Climate Change 2001: The Scientific Basis. Houghton, J.T., Ding, Y., Griggs, D.J., Noguer,

M., van der Linden. P.J. and Xiaosu, D. (eds.). Cambridge University Press, New York, NY, 752 p.

_____ 2001b. Summary for Policymakers, Third Assessment Report. Climate Change 2001: The Scientific Basis, J.T.Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J. and Xiaosu, D. Cambridge University Press, New York, NY, 20 p.

Indermühle, A., Stocker, T.F, Joos, F., Fischer, H., Smith, H.J., Wahlen, M., Deck, B., Mastroianni, D., Tschumi, J., Blunier, T., Meyer, R. and Stauffe, B. 1999. Holocene carbon-cycle dynamics based on CO_2 trapped in ice at Taylor Dome, Antarctica. Nature, v. 398, p.121-126.

Jacobson, M. 2001. Strong radiative heating due to the mixing state of black carbon in atmospheric aerosols. Nature, v. 409, p. 695-697.

Johnson, T.C., Barry, S., Chan, Y. and Wilkinson, P. 2001. Decadal record of climate variability spanning the past 700 yr in the Southern Tropics of East Africa. Geology, v. 29, p. 83-86.

Jones, H.G., Davies, T.D., Ohmura, A. and Morris, E.M. 1994. Snow and Ice Covers; Interactions with the Atmosphere and Ecosystems. International Association of Hydrological Sciences, publ. no. 223, Wallingford, U.K. 340 p.

Jones, P.D. 1994. Recent warming in global temperature series. Geophysical Research Letters, v. 21, p. 1149-1152.

Jones, P. D., Raper, S.C.B., Riley, R.S., Diaz, H.F., Kelly, P.M. and Wrigley, T.M.L. 1986. Northern hemisphere surface air temperature variations: 1851-1984. Journal of Applied Meteorology, v. 25, p. 161-179.

_____ 1988. Hemispheric temperature variations: Recent trends and an update to 1987. Journal of Climate, v. 1, p. 654-660.

Joughin, I. and Tulaczyk, S. 2002. Positive Mass Balance of the Ross Ice Streams, West Antarctica. Science, v. 295, no. 5554, p. 476-480.

Kahl J.D., Martinez, D.A. and Zaitseva, N.A. 1993. Absence of evidence for greenhouse warming over the Arctic Ocean in the last 40 years. Nature, v. 361, p. 335-337.

Karl, T.R., Knight, R.W. and Plummer, N. 1995. Trends in high frequency climate variability in the twentieth century. Nature, v. 377, p. 217-320.

Keeling, R.F, Piper. S.C. and Heimann, M. 1996. Global and hemispheric CO_2 sinks deduced from changes in atmospheric CO_2 concentration. Nature, v. 381, p. 1504-1508.

Keigwin, L.D. 1996a. Sedimentary record yields several centuries of data. Oceanus, v. 39, no.2, p. 16-18.

_____ 1996b. The little ice age and the medieval warm period in the Sargasso Sea. Science, v. 274, p. 1504-1508.

Komar P.D. 1986. The 1982-83 El Niño and erosion on the coast of Oregon. Shore and Beach, v. 54, p. 3-12.

Kunkel, K.E., Pielke, R.A. and Changnon, S.A. 1999. Temporal fluctuations in weather and climate extremes that cause economic and human health impacts: A review. Bulletin of the American Meteorological Society, v. 80, p. 1077.

Kuo, C., Lindberg, C.R. and Thomson, D.J. 1990. Coherence established between atmospheric carbon dioxide and global temperature. Nature, v. 343, p. 709-714.

Lamb, H.H. 1982. Climate, History and the Modern World. Methuen, 387 p.

Landsea, C.W., Nicholls, N., Gray. W.M. and Avila, L.A. 1996. Downward trends in the frequency of intense Atlantic hurricanes during the past five decades. Geophysical Research Letters, v. 23, p. 1697-1700.

Lassen K. and Friis-Cristensen, E. 1995. Variability of the solar cycle length during the past five centuries and the apparent association with terrestrial climate. Journal of Atmospheric and Terrestrial Physics, v. 57, no. 8, p. 835-845.

Le Roy Ladurie, E. 1971. Times of Feast, Times of Famine. A History of Climate Since the Year 1000. Doubleday, New York, NY, 426 p.

Lee, T.D., Tjoelker, M.G., Ellsworth, D.S. and Reich, P.B. 2001. Leaf gas exchange responses of 13 prairie grassland species to elevated CO_2 and increased nitrogen supply. New Phytologist, v. 150, p. 405-418.

Leavitt, S.W. 1994. Major wet interval in White Mountains medieval warm period evidenced in delta13 of bristlecone pine tree rings. Climatic Change, v. 26, p. 299-307.

Lilley, J.M., Bolger, T.P. and Gifford, R.M. 2001a. Productivity of *Trifolium subterraneum* and *Phalaris aquatica* under warmer, high CO_2 conditions. Climatic Change, v. 26, p. 371-383.

_____, _____ and _____ 2001b. Nutritive value and the nitrogen dynamics of *Trifolium subterraneum* and *Phalaris aquatica* under warmer, high CO_2 conditions. Climatic Change, v. 26, p. 385–395.

Lin, B., Wielicki, B.A., Chambers, L.H., Hu, Y., Xu, K.M. 2002. The Iris Hypothesis: A negative or positive cloud feedback? Journal of Climate, v. 15, p. 3-7.

Lindzen, R.S. 1992. The Origin and Nature of the Alleged Scientific Consensus. Energy and Environment. Special Issue: Proceedings of the OPEC Seminar on the Environment 1992, Vienna, 13-15 April 1992, p.122-137.

_____ 1997. Can increasing carbon dioxide cause climate change? Proceedings of the National Academy of Sciences USA, v. 94, p. 8335.

_____ 2001. U.S. scientists' report doesn't support the Kyoto treaty. National Post, June 16, 2001. Reprinted from The Wall Street Journal.

_____, Chou, M.-D. and Hou, A.Y. 2001. Does the earth have an adaptive infrared iris? Bulletin of the American Meteorological Society, v. 82, p. 417-432.

Linsley, B.K., Wellington, G.M. and Schrag, D.P. 2000. Decadal sea surface temperature variability in the subtropical South Pacific from 1726 to 1997 A.D. Science, v. 290, p. 1145-1148.

Luckman, B.H. 1994. Evidence for climatic conditions between ca. 900-1300 A.D. in the southern Canadian Rockies. Climatic Change, v. 26, p. 171-182.

Mahlman, J.D. 1997. Uncertainties in projections of human-caused climate warming. Science, v. 278, p. 1416.

Mann, M.E., Bradley, R.S. and Hughes, M.K. 1998. Global-scale temperature patterns and climate forcing over the past six centuries. Nature, v. 392, p. 779-787.

_____, _____ and _____ 1999. Northern hemisphere temperature during the past millennium: Inferences, uncertainties and limitations. Geophysical Research Letters, v. 26, p. 759-762.

Manning, M. 2001. Report on IPCC Working Group II 6th Plenary Session. Geneva, 13-16 February 2001. National Institute of Water and Atmospheric Research Ltd., Wellington, New Zealand, 8p.

Majorowicz, J.A., Safanda, J., Harris, R.N. and Skinner, W.R. 1999. Large ground surface temperature changes of the last three centuries inferred from borehole temperatures in the Southern Canadian Prairies, Saskatchewan. Global and Planetary Change, v. 20, p. 227-241.

MacCracken, M.C., Budyko, M.I., Hecht, A.D. and Izrael, Y.A. (eds.). 1990. Prospects for Future Climate. A Special US/USSR Report on Climate and Climate Change. Lewis Publishers, Chelsea, MI.

McDermott, F., Mattey, D.P. and Hawkesworth, C. 2001. Centennial-scale Holocene climate variability revealed by a high-resolution speleotherm ó18O record from SW Ireland. Science, v. 294, p. 1328-1331.

McManus, J.F., Oppo, D.W. and Cullen, J.L. 1999. A 0.5-million-year record of millennial-scale climate variability in the North Atlantic. Science, v. 283, p. 971-974.

Meese, D.A., Gow, A.J., Grootes, P., Mayewski, P.A., Ram, M., Stuiver, M., Taylor, K.C., Waddington, E.D. and Zielinski, G.A. 1994. The Accumulation Record from the GISP2 Core as an indicator of Climate Change throughout the Holocene. Science, v. 266, p. 1680-1682.

Michaels, P.J. and Knappenburger, P.C. 1996. Human effect on global climate. Nature, v. 384, p. 522-523.

_____, Balling, R.C., Vose, R.S. and Knappenburger, P.C. 1998. Analysis of trends in the variability of daily and monthly historical temperature measurements. Climate Research, v. 10, p. 27-33.

_____ and Balling, R.C. 2000. The Satanic Gases. Cato Institute, Washington, D.C. 235 p.

_____ and Knappenburger, P.C., Balling Jr., R.C. and Davis, R.E. 2000. Observed Warming in Cold Anticyclones. Climate Research, v. 14, p. 1-6.

Mitchell, W., Chittleborough, J., Ronai, B. and Lennon, G.W. 2000. Sea Level Rise in Australia and the Pacific. Proceedings of the Pacific Islands Conference on climate change, climate variability and sea level change. Rarotonga Cook Islands, 3-7 April.

Monnin, E., Indermühle, A., Dällenbach, A., Flückiger, J., Stauffer, B., Stocker, T.F., Raynaud, D. and Barnola, J.-M. 2001. Atmospheric CO_2 concentrations over the last glacial termination. Nature, v. 291, p. 112-114.

Murphy, J.M. and Mitchell, J.F.B. 1995. Transient response of the Hadley Centre coupled ocean-atmosphere model to increasing carbon dioxide. Part II: Spatial and temporal structure of response. Journal of Climate, v. 8, p. 57-80.

National Research Council. 2001. Under the Weather: Exploring the Linkages among Climate, Ecosystems, and Infectious Disease. Committee on Climate, Ecosystems, Infectious Diseases, and Human Health, Board on Atmospheric Sciences and Climate, National Research Council Washington, D.C., National Academy Press, 125p.

Naurzbaev, M.M. and Vaganov, E.A. 2000. Variation of early summer and annual temperature in east Taymir and Putoran (Siberia) over the last two millennia inferred from tree rings. Journal of Geophysical Research, v. 105, p. 7317-7326.

Nguyen, K.C., and Walsh, K.J.E. 2001. Interannual, Decadal, and Transient Greenhouse Simulation of Tropical Cyclone-like Vortices in a Regional Climate Model of the South Pacific. Journal of Climate, v. 14, p. 3043-3054.

Nicholson, S.E. and Yin, X.. 2001. Rainfall conditions in equatorial East Africa during the Nineteenth Century as inferred from the record of Lake Victoria. Climatic Change, v. 48, p. 387-398.

North, G.R. and Wu, Q. 2001. Detecting climate signals using space-time EOFs, Journal of Climate, v. 14, p. 1839-1863.

Nowak, R.S., Jordan, D.N., DeFalco, L.A., Wilcox, C.S., Coleman, J.S., Seemann, J.R. and Smith, S.D. 2001. Leaf conductance decreased under free-air CO_2 enrichment (FACE) for three perennials in the Nevada desert. New Phytologist, v. 150, p. 449-458.

Oerlemans, J. 1982. Response of the Antarctic ice sheet to climate warming. J. Climatol., v. 2**,** p.1-12.

Ohmura, A., Wild, M. and Bengtsson, L. 1996. A Possible Change in Mass Balance of Greenland and Antarctic Ice Sheets in the Coming Century. Journal of Climate, v. 9, p. 2124-2135.

Oke, T.R. 1987. Boundary Layer Climates. (2nd ed), Methuen, London, England, 435 p

Oppo, D.W., McManus, J.F. and Cullen, J.L. 1998. Abrupt climate events 500,000 to 340,000 years ago: evidence from subpolar North Atlantic sediments. Science, v. 279, p. 1335-1338.

Panagi, M., Arthur, M.A. and Freeman, K.H. 1999. Miocene evolution of atmospheric carbon dioxide. Paleoceanography, v. 14, p. 273-292.

Pearson, P., and Palmer, M. 1999. Middle Eocene seawater pH and atmospheric carbon dioxide concentrations. Science, v. 284, p. 1824.

_____ and _____ 2000. Atmospheric carbon dioxide concentrations over the past 60 million years. Nature, v. 406, p. 695-699.

Perry, C.A. 1994. Solar-irradiance variations and regional precipitation fluctuations in the western United States. International Journal of Climatology, v. 14, November 1994, p. 969-983.

_____ 1995. Association between solar-irradiance variations and hydroclimatology of selected regions of the USA. In: Proceedings of 6th International Meeting on Statistical Climatology, Galway, Ireland, June 19-23, 1995. Steering Committee for International Meetings on Statistican Climatology, p. 239-242.

_____ 2000. A regression model for annual streamflow in the upper Mississippi River Basin based on solar irradiance. In: West, G.J., and Buffaloe, L. (eds.). Proceedings of the Sixteenth Annual Pacific Climate Workshop, Santa Catalina Island, California, May 24-27, 1999, Interagency Ecological Program for Sacramento-San Joanquin Delta Technical Report 65, p. 161-170.

_____ and Hsu, K.J. 2000. Geophysical, archaeological, and historical evidence support a solar-output model for climate change. Proceedings of National Academy of Science, v. 97, no. 23, p. 1244-1248.

Peterson, T.C., Gallo, K.P., Lawrimore, J., Owen, T.W., Huang, A. and McKittrick, D.A. 1999. Global rural temperature trends, Geophysical Research Letters, v. 26, p. 329-332.

Pielke, R. A. and Landsea, C.W. 1998. Normalized hurricane damages in the United States 1925-1995. Weather Forecasting, v. 13, p. 621.

Priem, H.A. 1997. CO_2 and climate: a geologist's view. Space Sciences Review, v. 81, p. 173-198.

Przybylak, R. 2000. Temporal and spatial variation of surface air temperature over the period of instrumental observations in the Arctic. International Journal of Climatology, v. 20, p. 587-614.

Raymo, M.E., Ganley, K., Carter, S., Oppo, D.W. and McManus, J. 1998. Millennial-scale climate instability during the early Pleistocene epoch. Nature, v. 392, p. 699-702.

Reich, P.B., Tilman, D., Craine, J., Ellsworth, D., Tjoelker, M.G., Knops, J., Wedin, D., Naeem, S., Bahauddin, D., Goth, J., Bengtson, W. and Lee, T.A. 2001. Do species and functional groups differ in acquisition and use of C, N and water under varying atmospheric CO_2 and N availability regimes? A field test with 16 grassland species. New Phytologist, v. 150, p. 435-448.

Reiter, P. 1998. Global warming and vector borne disease in temperate regions and at high latitude. Lancet, 351, 839.

_____ 2000. From Shakespeare to Defoe: Malaria in England in the Little Ice Age. Emerging Infectious Diseases, 6.

Rothman, D.H. 2002. Atmospheric carbon dioxide levels for the last 500 million years. Proceedings of the National Academy of Sciences USA, v. 99, p. 4167-4171.

Santer, B.D., Taylor, K.E., Wigley, T.M.L., Johns, T.C., Jones, P.D., Karoly, D.J., Mitchell, J.F.B., Oort, A.H., Penner, J.E., Ramaswamy, V., Schwarzkopf, M.D., Stouffer, R.J. and Tett, S. 1996. A search for human influences on the thermal structure of the atmosphere. Nature, v. 382, p. 39-46.

Schilman, B., Bar-Matthews, M., Almogi-Labin, A. and Luz, B. 2001. Global climate instability reflected by Eastern Mediterranean marine records during the late Holocene. Palaeogeography, Palaeoclimatology, Palaeoecology, v. 176, p. 157-176.

Segalstad, T.V. 1998. Carbon cycle modelling and the residence time of natural and anthropogenic atmospheric CO_2, on the construction of "greenhouse effect global warming" dogma. In: Bate, R. (ed.). Global Warming the Continuing Debate. Cambridge, UK. European Science and Environmental Forum, p. 184-218.

Serreze, M.C., Carse, F., Barry, R.G. and Rogers, J.C. 1997. Icelandic Low cyclonic activity: Climatological features, linkages with NAO, and relationships with recent changes in the Northern Hemisphere circulation. Journal of Climate, v. 20, p. 453-464.

Singer, S.F. 1996. Climate change and consensus. Science, v. 271, p. 581.

_____ 1997. Hot Talk, Cold Science: Global Warming's Unfinished Debate. The Independent Institute, Oakland, CA., 110 p.

_____ 1999. Hot Talk, Cold Science: Global Warming's Unfinished Debate (2nd edition). The Independent Institute, Oakland, CA., 110 p.

Soon, W.H., Baliunas, S.L., Robinson, A.B. and Robinson, Z.W. 1999. Environmental effects of increased atmospheric carbon dioxide. Climate Research, v. 13, no. 2, p. 149-164.

_____, Postmentier, E.S. and Baliunas, S.L. 1996. Inference of solar irradiance variability from terrestrial temperature changes, 1880-1993: an astrophysical application of the sun-climate connection. Astrophysical Journal, v. 472, p. 891.

_____, Baliunas, S.L., Postmentier, E.S. and Okeke, P. 2000. Variations of solar coronal hole area and terrestrial lower tropospheric air temperature from 1979 to mid-1998: Astronomical forcings of change in Earth's climate? New Astronomy, v. 4, p. 563-579.

_____, _____, Idso, S.B**.**, Kondratyev, K.Y. and Postmentier, E.S. 2001. Modeling climatic effects of anthropogenic CO_2 emissions: Unknowns and uncertainties. Climate Research, v. 18, p. 259-257.

Spencer, R.W. and Christy, J.R. 1990. Precise monitoring of global temperature trends from satellites. Science, v. 247, p.1558-1562.

_____ and _____ 1992. Precision and radiosonde validation of satellite gridpoint temperature anomalies. Part I: MSU channel 2 and Part II: a tropospheric retrieval and trends during 1979-1990. Journal of Climatology, v. 5, p. 847-866.

_____, Christy, J.R. and Grody, N.C. 1990. Global atmospheric temperature monitoring with satellite microwave measurements: methods and results 1979-1984. Journal of Climate, v. 3, p. 1111-1128.

Strong, A.E., Kearns, E.J., Gjovig, K.K. 2000. Sea Surface Temperature Signals from Satellites - An Update. Geophysical Research Letters, v. 27, p. 1667-1670.

Svensmark, H. and Friis-Cristensen, E. 1997. Variation in cosmic ray flux and global cloud coverage - a missing link in solar-climate relationships. Journal of Atmospheric and Terrestrial Physics, v. 59, no. 11, p. 1225-1232.

Tans, P.P., Fung, I.Y. and Takahashi, T. 1990. Observational constraints on the global atmospheric CO_2 budget. Science, v. 247, p. 1431-1438.

Thompson, S. L., and Pollard, D. 1995. Greenland and Antarctic Mass Balances for Present and Doubled Atmospheric CO_2 from the GENESIS

Version-2 Global Climate Model. Eos (Trans. AGU) v. 76, no. 46, Supplement (meeting abstracts). Also: 1997, Journal of Climatology, v. 10, p. 871-900.

Trupin, A. and Wahr, J. 1990. Spectroscopic analysis of global tide gauge sea level data. Geophysical Journal International, v. 100, p. 441-453.

Tyson, P.D., Karlen, W., Holmgren, K. and Heiss, G.A. 2000. The Little Ice Age and medieval warming in South Africa. South African Journal of Science, v. 96, p. 121-126.

Veizer, J., Godderis, Y. and Francois, L.M. 2000. Evidence for decoupling of atmospheric CO_2 and global climate during the Phanerozoic era. Nature, v. 408, p. 698-701.

Venegas, S.A. and Mysak, L.A. 2000. Is there a dominant timescale of natural climate variability in the Arctic? Journal of Climate, v. 13, p. 3412-3434.

Verschuren, D., Laird, K.R. and Cumming, B.F. 2000. Rainfall and drought in equatorial east Africa during the past 1,100 years. Nature, v. 403, p. 410-414.

Villalba, R. 1994. Tree-ring and glacial evidence for the medieval warm epoch and the little ice age in southern South America. Climatic Change, v. 26, p. 183-197.

Warrick R. and Farmer, G. 1989. The greenhouse effect, climatic change and rising sea level: implications for development. Transactions of the Institute of British Geographers, v. 15, p. 5-20.

Watkins, A.B. and Simmonds, I. 2000. Current trends in Antarctic sea ice: The 1990s impact on a short climatology. Journal of Climate, v. 13, p. 4441-4451.

Wielicki, B., Wong, A.T., Allan, R.P., Slingo, A., Kiehl, J.T., Soden, B.J., Gordon, C.T., Miller, A.J., Yang, S.-K., Randall, D.A., Robertson, F., Susskind, J. and Jacobowitz, H. 2002. Evidence for large decadal variability in the tropical mean radiative energy budget. Science, v. 295, no. 5556, p. 841-844.

Wigley, T.M.L. 1998. The Kyoto Protocol: CO_2, CH_4 and climate implications. Geophysical Research Letters, v. 25 no.13, p. 2285-2288.

Wilson, A.T., Hendy, C.H. and Reynolds, C.P. 1979. Short-term climate change and New Zealand temperatures during the last millennium. Nature, v. 279, p. 315-317.

Winter, A., Ishioroshi, H., Watanabe, T., Oba, T. and Christy, J. 2000. Caribbean Sea Surface Temperatures: Two-to-Three Degrees Cooler than Present During the Little Ice Age. Geophysical Research Letters, v. 27, n. 20, p. 3365-3369.

Wojick, D. E. 2001. The UN IPCC's artful bias: Glaring omissions, false confidence, and misleading statistics in the Summary for Policymakers. Climatechangedebate.org.

World Climate Report. 1998. Global warming moderates nail extremists eight ways. World Climate Report, v. 3, no. 23, p. 1.

_____ 2000. The IPCC does it again. World Climate Report, v. 6, no. 4, p. 1-2.

_____ 2001a. IPCC's crumbling foundation. World Climate Report, v. 6, no. 13, p. 1-2.

_____ 2001b. The technological fix is in. World Climate Report, v. 6, no. 24, p. 3.

_____ 2001c. New Kyoto: 1 Winner, 178 Losers. World Climate Report, v. 6, no. 23, p. 1-2.

Wyrtki K. 1982. The Southern Oscillation, ocean-atmosphere interaction and El Niño. Journal Marine Technology Society, v. 16, p. 3-10.

Ye, H. and Mather, J.R. 1997. Polar snow cover changes and global warming. International Journal of Climatology, v. 17, p. 155-162.

Yu, Fangqun. In press. Altitude variations of cosmic ray induced production of aerosols: Implications for global cloudiness and climate. J. Geophys. Res., v. 107.

Yuan, X. and Martinson, J. 2000. Antarctic sea ice extent variability and its global connectivity. Journal of Climate, v. 13, p. 1697-1717.

Zhang, D. 1994. Evidence for the existence of the medieval warm period in China. Climatic Change, v. 26, p. 289-297.

Zhang Y. and Wang, W.C. 1997. Model simulated northern winter cyclone and anticyclone activity under a greenhouse warming scenario. Journal of Climate, v. 10, p. 1616-1634.

Zwally, H.J. 1989. Growth of Greenland ice sheet: Interpretation. Science, v. 246, p. 1589.

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APPENDIX III
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

An Economist's Perspective on Climate Change and the Kyoto Protocol

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An Economist's Perspective on Climate Change and the Kyoto Protocol

Ross McKitrick

0. Introduction

I have spent many years trying to figure out what is the optimal climate change policy for Canada. I believe the answer is, roughly, "keep studying the basics, don't try to stop it and learn to adapt." But one does not come to this view with reference to economics alone. So in my discussion today I will try to give a snapshot of some of the range of technical issues that I have tried to think through in pursuit of an optimal climate policy.

There are no intellectual shortcuts on this issue. Even a simple question like "what is the cost of Kyoto" turns out to be maddeningly difficult to answer. Kyoto is, at best, a target: the costs are attached to the specific policies that will be used to reach that target, and to date no one knows what those policies will be for Canada. Broadening the issue to ask "what is the cost of climate change for Canada?" only piles up the ambiguity. There is no formal definition of "climate," only traditional rules based on rather ad hoc averages of geophysical data, the sampling of which is often very unsystematic. There is even less agreement on what constitutes "change," which is why every time a forest burns or an iceberg calves someone asks: "Is this a sign of global warming?" Witness the apocalyptic thrill as seers and sages scan the skies for signs, omens and portents of global warming; but climate change is an elusive concept, and no one is sure what the thing would look like, even if it was already happening.

This ambiguity is reflected in the two key documents that govern much of the thinking on this issue. The 1992 UN Framework Convention on Climate Change (UNFCCC) defined "climate change" as follows:

> "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
>
> (http://unfccc.int/index.html)

The recent Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) defined it differently (http://www.ipcc.ch/):

> [1] *Climate change* in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity.

This is a very important difference: The IPCC is looking for signs of any change, whereas the policy instruments prescribed by the UNFCCC are not triggered unless it is a particular kind of change: that attributable to human activity. When IPCC officials declare that "climate change" is for real, this is about as informative as announcing that the passage of time is for real. Of course the climate changes: if it didn't Winnipeg would still be under a glacier. But the fact that the last ice age ended doesn't imply that the policy mechanisms of the UNFCCC should kick in. That's the problem with the ambiguity over the term "climate change"—and it seems to trip up a lot of people—accepting the reality of "climate change"

does not mean accepting the need for policy interventions. And denying that global warming is a problem requiring costly policy measures is not the same as denying "climate change."

This purported link between two fundamentally different concepts was written into those pamphlets Environment Canada sent out two years ago. They began, ominously, "Our Climate is Changing" and concluded with the stuff on the back about the importance of turning down your thermostat and doing the laundry in cold water. It's always comforting when big, complicated issues turn out to have such simple solutions, so perhaps we should take our cue from this line of thinking.

Therefore, rather than start with one of the complicated, ambiguous questions posed above I will organize my presentation around the practical question, "Does the possibility of climate change imply that I should wash my socks in cold water?" The affirmative answer offered by the Government of Canada arises from a long chain of assertions like this:

1. The "climate" is a well-defined thing, the mean state of which is measured with precision.

2. The equations of motion of the climate are sufficiently-well understood that the full range of natural variability is quantified and future climate states can be predicted.

3. By adding to the stock of atmospheric CO_2 humans have an affect on the climate which necessarily involves a general warming of the Earth's surface.

4. The present state of the climate can only be explained by invoking this mechanism.

5. Continued use of fossil fuels, by adding CO_2 to the air, will cause unprecedented changes to the future climate.

6. These changes will be generally deleterious.

7. We ought to reduce emissions of CO_2.

8. The best mechanism to accomplish this is through the Kyoto Protocol.

9. The best way for Canada to comply with Kyoto is to pursue a package of measures as outlined in the Canadian Climate Change Plan, which includes encouraging Canadians to do their laundry in cold water.

To the extent time permits I will grapple with each of these assertions. Notwithstanding the simplicity of the solution proffered in #9 I find the chain of thinking problematic at each step.

1. The "climate" is a well-defined thing, the mean state of which is measured with precision.

"It's sunny out" is a statement about the weather. "Palm trees do not grow in Winnipeg" is a statement about the climate. *Climate* is a rather abstract concept that stands behind the weather. Dictionaries define it with phrases like "prevailing conditions" and "averages over some period of time" and so forth. Linacre (1992) surveyed 16 published definitions and reduced them to the following:

> "Climate is the synthesis of atmospheric conditions characteristic of a particular place in the long-term. It is expressed by means of averages of the various elements of weather, and also by the probabilities of other conditions, including extreme values."

Note the ambiguities: Does 'long-term' in a geophysical setting mean 5 years? 30 years? 300 years? What are the 'various elements' and how do they average together? For example how would one average warm and wet, then compare it to the average of cold and dry?

Very well, it's vague: so is 'the economy.' We don't need to have a precise definition of 'economy' to study it, so we shouldn't impose undue burdens on other fields. We can work with averages and aggregates in economics without doing too much violence to theoretical consistency (usually). But in the case of thermodynamic phenomena there is a catch, which as far as I know has not been discussed in the context of climate change before Chris Essex and I wrote *Taken By Storm*.

The catch does not involve a novel, contentious or obscure theory; it involves an old, standard, well-known definition from introductory thermodynamics. Indeed it seems to have been overlooked precisely because it is so elementary. The main problem in the debate over what the Global Temperature is doing is that there is no such thing as a Global Temperature. Temperature is a continuous *field*, not a scalar, and there is no physics to guide reducing this field to a scalar, by averaging or any other method. Consequently the common practice of climate measurement is an ad hoc approximation of a non-existent quantity. Figure 1 shows NASA's version of this simulacrum.

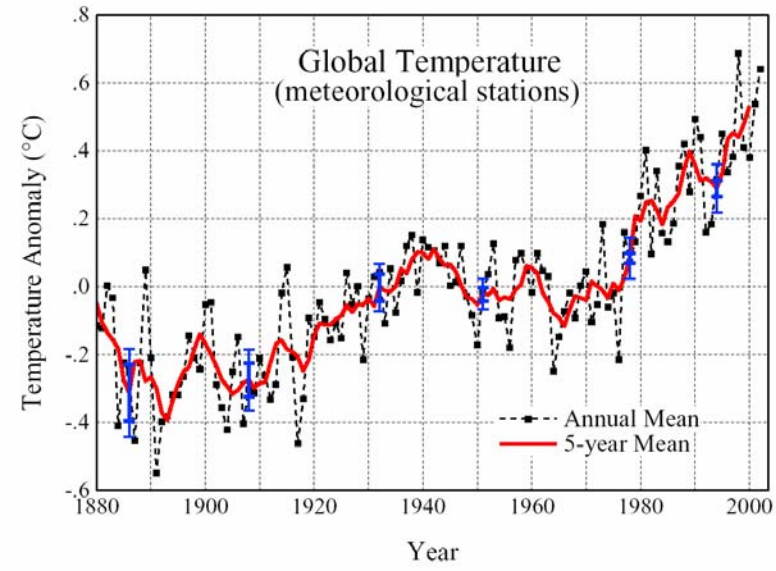

Figure 1. The "Global Temperature" from http://www.giss.nasa.gov/data/update/gistemp/graphs/.

Even if climate scientists were willing to use one arbitrary average and call it the "Global Temperature," they also face the acute problem of sampling. Meteorological services use a 30-year interval to define "normals" for temperature. These are not "normal" temperatures, the name notwithstanding, they are just

averages. On a geological scale the "normal" for Winnipeg would be that of the interior of a glacier. Why don't we use, say, 300 years? The answer is the data do not exist. But this does not provide scientific justification for defining 'climate' as a 30-year average.

Equally problematic is the collapse that occurred around 1990 in the number of climate monitoring stations around the world. Figure 2 (Peterson and Vose 1997) shows the numbers for the Global Historical Climatology Network (GHCN), graphed in terms of the number of stations with at least 10 years of reliable data (a) and the corresponding geographical coverage (b). In the early 1990s, the collapse of the Soviet Union and the budget cuts in many OECD economies led to a sudden sharp drop in the number of active weather stations.

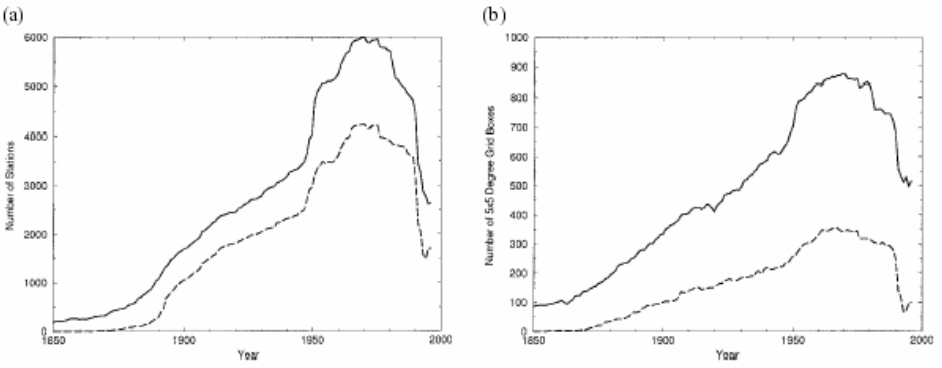

FIG. 2. Time series of the number of stations (a) and the number of 5° × 5° boxes (b) for mean temperature (solid) and maximum and minimum temperature (dashed). The graphs start in 1850, but the earliest mean temperature datum is for January 1701 from Berlin, Germany, and the earliest mean maximum and minimum temperature data in GHCN are for March 1840 from Toronto, Canada. The reasons why the number of stations in GHCN drop off in recent years are because some of GHCN's source datasets are retroactive data compilations (e.g., World Weather Records) and other data sources were created or exchanged years ago. Only three data sources are available in near-real time. The rise in maximum and minimum temperature stations and grid boxes in 1995 and 1996 is due to the World Meteorological Organization's initiation of international exchange of monthly CLIMAT maximum and minimum temperature data over the Global Telecommunications System in November 1994.

Figure 2: From Peterson and Vose (1997).

Figure 3 shows the total number of stations in the GHCN and the raw (arithmetic) average of temperatures for those stations. Notice that at the same time as the number of stations takes a dive (around 1990) the average temperature (red bars) jumps. This is due, at least in part, to the disproportionate loss of stations in remote and rural locations, as opposed to places like airports and urban areas where it gets warmer over time because of the build-up of the urban environment.

This poses a problem for users of the data. Someone has to come up with an algorithm for deciding how much of the change in average temperature post-1990 is due to an actual change in the climate and how much is due to the change in the sample. When we hear over and over about records being set after 1990 in observed "global temperatures" this might mean the climate has changed, or it means an inadequate adjustment is being used, and there is no formal way to decide between these.

Nevertheless, confident assertions are routinely made about 'changes in the global temperature' on the order of tenths of a degree C per decade. The confidence masks pervasive uncertainty in the underlying concepts and data quality.

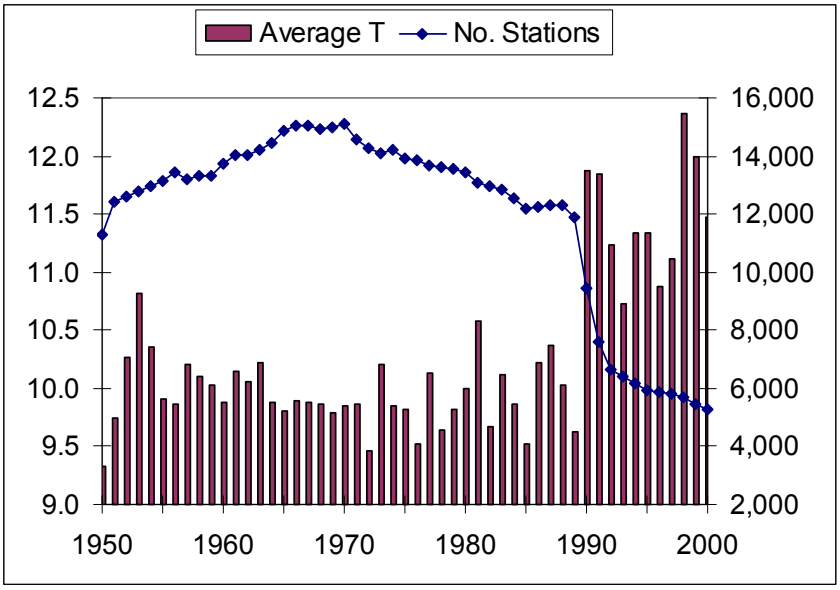

Figure 3. Number of stations in GHCN collection (diamonds, right axis); Average temperature of annual sample (bars, left axis in C). Source: see *Taken By Storm* chapter 4.

This discussion only looked at temperature. If we look at precipitation, humidity, air pressure and so forth the situation only gets worse. Ad hoc averaging rules, inconsistent sampling and a lack of theoretical guidance as to how to define and interpret the basic quantities pervade the topic and consequently I am very skeptical about our ability to define and measure "climate" of the Earth with the sort of precision we expect in a medical thermometer.

2. The equations of motion of the climate are sufficiently-well understood that the full range of natural variability is quantified and future climate states can be predicted.

There is no theory of climate. This is an overlooked but elementary point Chris Essex and I tried to reinsert into the climate discussion. By 'theory' I mean a set of known equations representing laws of nature. There is a theory of how atoms and molecules behave: that is, there are differential equations that can be written down and used for predicting things. Average up from them to the everyday level we experience and you find a theory also exists for describing the behaviour of fluids (it's called Navier-Stokes theory). The theory can be derived by the averaging-up process, but conveniently it was already known before this approach was undertaken, so the path was well-marked. Also, experimental data are available to guide the theorizing. So this aspect of the scientific work went ahead with the intellectual odds in its favour, and nonetheless it was very hard.

Now think about the next step: averaging up to a theory that describes air and water motions on the scale of climate—time scales of decades or centuries and spatial scales of regions and continents. We are used to seeing numbers like "annual average temperature." But remember, we *compute* these things, we do not *observe* them. Nature does not work with annual averages. Nature integrates temperature over time, but in different ways in different materials, over different time scales. The growth and decline of glaciers represents a local "averaging" of temperature and precipitation, as does the migration of the northern tree

line in a particular region. The appropriate time scale, be it annual, decadal or some other, is up to nature herself, and is not determined by what we find convenient for organizing our data.

If we make the heroic assumption that we can define climate as a 30-year average of local temperatures, we can then ask: what are the equations of motion that describe the evolution of this average over, say, the open ocean or the Rocky Mountains? The answer is no one knows. In principle they are deterministic but it is unlikely we will live to see them derived. The base equations (Navier-Stokes) for the climb to a climate theory are insoluble. They cannot be rearranged into a form useable for direct numerical computations nor can they be solved into a form useable for the kind of averaging needed to analyze on the climate scale. So when contemplating the derivation of a theory of climate, all the advantages that got us to a theory of fluids are lost. The end point is not known. Experiments are impossible. And the base equations are insoluble.

It gets worse. The study of fluid dynamics in meteorology gave rise to the rich and remarkable field of chaos theory. Most of us by now have a basic understanding of chaotic systems, including the property that they are bounded yet sensitive to arbitrarily small changes in initial conditions. Chaotic systems can be algebraically very simple. For instance, the logistic map, $X_t = aX_{t-1}(1 - X_{t-1})$, is chaotic for initial values of X between 0 and 1, and values of a around 3.8. Introduce chaos into a mathematical system and predictability quickly vanishes. This is true even in deterministic chaotic systems. It is why weather forecasts will never get much more reliable than they are now, regardless of how big or fast our computers get: because the weather is chaotic.

Is the climate chaotic? You would think this would be a question of great interest to the Intergovernental Panel on Climate Change, for it defines the limits to their useful prediction horizon. And indeed they have expressed a view. They accept that the climate *is* chaotic and consequently future climate states cannot be predicted:

> In climate research and modeling, we should recognize that we are dealing with a coupled non-linear chaotic system, and therefore that the long-term prediction of future climate states is not possible. The most we can expect to achieve is the prediction of the probability distribution of the system's future possible states by the generation of ensembles of model solutions.
>
> IPCC Third Assessment Report, Chapter 14.2.2.2

This is a remarkable admission. It is typical of the IPCC that it gets buried in the back of a thousand page report, while the hubristic declarations of confidence in model forecasts are all over the Executive Summary.

Chaos draws a veil of unknowability across the future, as does the phenomenon of random walks, something that economists have learned (though not, perhaps, those in business schools?). In the case of temperature the situation is even worse than in economics, since the climate is chaotic *and* the famous average temperature statistics appear to be random walks (Essex 1987, Kärner 2003, 1996; Tsonis *et. al.* 1998).

The IPCC does not use the term 'prediction' to describe its divination of future climates. Instead it refers to "projections" based on "scenarios." This is a tacit admission of the reality that no one can predict the climate of the future, though the wording is weasely because they turn around and sell their predictions to unsuspecting cabinet ministers anyway.

Since experiments in climate are impossible and there is no theory of the system's evolution, scientists are limited to studying sparse observations, working up ad hoc statistics and using parameterized models. It is reminiscent of macroeconomics in the 1960s and 1970s. Climate modelers will probably go through their own Lucas critique, and it will probably be as tumultuous for them as it was for macroeconomists.

Meanwhile, inability to predict the behaviour of the climate, combined with a lack of an observational base implies incomplete understanding of it. The physical behaviour of climate is an open research question. It is contradictory to acknowledge that we cannot predict its behaviour nor can we measure its mean state precisely, then say we can characterize its natural variability so precisely that comparatively minuscule changes can be attributed to anthropogenic factors. For more on this I refer you to Chapters 6 and 7 of *Taken By Storm*.

3. By adding to the stock of atmospheric CO_2 humans have an affect on the climate which necessarily involves a general warming of the Earth's surface.

The problem with this assertion is the word "necessarily." It ain't necessarily so. What the 'certainty' crowd have in mind is the radiation mechanism in a greenhouse. That is, by any reckoning, simple, settled and certain. Calling the atmosphere a "Greenhouse" (as, among many others, Environment Canada does, see http://www.climatechange.gc.ca/english/workroom/students/greenhouse.shtml) hides all the complexities of fluid dynamics and thereby sweeps aside what makes the issue complicated. Chris and I treat these topics in detail in Chapter 3 of TBS, but here's a sketch.

Figure 4 shows a stylized picture of solar radiation coming down, then the offsetting energy flow from the Earth's surface. There are two principal mechanism for energy transport back to space: radiation and fluid dynamics. Radiation means the low-frequency infrared shine that comes off the land and water. Fluid dynamics refers to the convection of air and water in the atmosphere that constitutes our weather. They each drain about half the energy from the surface, though the proportions change with altitude. The amount of convection decreases through the stratosphere and at the top of the atmosphere all energy drain is radiative.

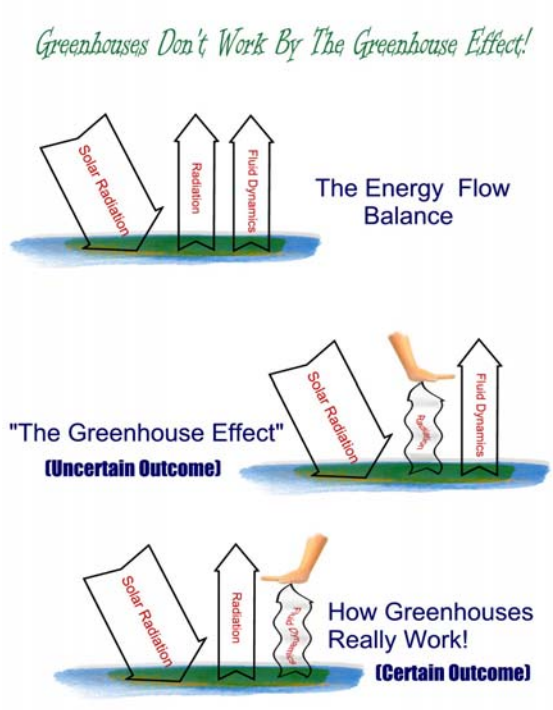

Figure 4: Radiative and Convective Energy Transport.

A greenhouse works according to the bottom picture. By putting up glass or plastic the fluid dynamics (i.e. air currents) are blocked, so the radiation has to intensify to maintain an equivalent energy drain. The radiative transfer equation is a linear ordinary differential equation in which temperature appears as an absolute level. The solution can be computed and it is known unambiguously that the greenhouse has to warm up. This can be confirmed experimentally too, of course.

The so-called "Greenhouse effect" works according to the middle picture. CO_2 filters infrared light in a narrow band around 15 microns. Water vapour does almost all the infrared absorption in the atmosphere, but CO_2 does a little. So adding CO_2 to the air slows the radiative energy drain. The fluid dynamic has to intensify to accommodate. But this process is governed by a nonlinear vector partial differential equation, which has no known solution and cannot be directly computed. Temperature does not appear as an absolute quantity in those equations, only as a gradient. It is impossible to predict what temperature will do in this context. Essex (1992) showed that within the known range of variability of key climate model parameters it is possible to predict CO_2-induced cooling at the surface, without violating the laws of physics. The fact that models predict (sorry, 'project') warming only reflects the fact that they are parameterized to do so.

The role of CO_2 in warming the atmosphere is very minor. On its own CO_2 could not generate a climate change. Everything depends on the water vapour feedback, since H_2O is the main 'greenhouse' gas, absorbing across most of the infrared spectrum. So a major scientific challenge for climate modelers has been to characterize the way water vapour in the atmosphere adjusts to the minuscule changes arising from CO_2 enrichment. But this involves all the fatal complexities of fluid dynamics, including chaos and the unsolved problem of turbulence. The uncertainties are important and fundamental and will not be resolved any time soon.

4. The present state of the climate can only be explained by invoking this mechanism.

At some point in the past, the state of the climate—however measured—could be entirely explained by natural causes. But it is now routinely asserted that the present state can only be explained by invoking the influence of infrared-absorbing gases. The draft report of the Intergovernmental Panel on Climate Change released at the end of scientific review (April 2000) hinted at this:

17
18 • *From the body of evidence since IPCC (1996), we conclude that there has been a discernible human influence on*
19 *global climate*. Studies are beginning to separate the contributions to observed climate change attributable to
20 individual external influences, both anthropogenic and natural. This work suggests that anthropogenic greenhouse
21 gases are a substantial contributor to the observed warming, especially over the past 30 years. However, the accuracy
22 of these estimates continues to be limited by uncertainties in estimates of internal variability, natural and
23 anthropogenic forcing, and the climate response to external forcing.
24

However the final version published 9 months later (IPCC 2001) was much more definitive:

> In the light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely[7] to have been due to the increase in greenhouse gas concentrations.

There was no great advance of science in those 9 months to justify this change in wording: some officials (never identified) simply wanted to make a stronger statement. The whole business of detecting an anthropogenic influence merits scrutiny, but I'll just reiterate some points already made and refer you to TBS chapter 6 for details.

The state of the climate cannot be measured in precise, quantitative units. The natural mechanisms of change have not been characterized above a low-level of understanding, and to the extent that we understand them they appear chaotic and formally unpredictable. The effect of CO_2 on the atmosphere is not predictable, even in principle. In this context, the claim that some climate modelers have unambiguously detected the influence of man on the global climate strikes me as nonsensical.

A more formal evaluation of the role of CO_2 was published recently in the *Journal of Geophysical Research* by Olavi Kärner (2003), a statistician at the Tartü Observatory in Estonia. Kärner's insight was that if CO_2 is the dominant forcing mechanism on atmospheric temperatures (as the IPCC has asserted), and the CO_2 concentration is monotonically increasing, there should be a spectral signature in temperature data called "persistency." Persistency means that if a series departs in one direction over a particular time span it tends to move in that same direction over subsequent periods of the same scale. Antipersistency means that a departure in one direction over some scale is followed by a move in the opposite direction over the subsequent period of the same scale. Persistency can be quantified by looking at the power spectrum of a series, an in particular by looking at the Hurst exponent of a power function. If the Hurst exponent is between 0 and 0.5 the series displays antipersistency and if it is between 0.5 and 1 the series displays persistency.

Kärner had run a spectral analysis on the daily solar irradiance series from space-based radiometers and found the Hurst exponent was between 0.22 and 0.35, implying antipersistency. This gave rise to a rather neat hypothesis test. If solar irradiance dominates the climate mechanism the temperature data will have a Hurst exponent below 0.5; but if CO_2 is dominant the exponent will be over 0.5. So he looked at 22 years' worth of daily temperature readings from NASA's polar-orbiting weather satellites and found their Hurst exponent is between 0.26 and 0.36: closely matching the solar pattern and contradicting the CO_2-forcing mechanism. His conclusion was:

> "[The] solar forcing variability is actually the governing one among other existing (random or not) forcings in the Earth climate system…The revealed antipersistence in the lower tropospheric temperature increments does not support the science of global warming developed by IPCC… Dominating negative feedback also shows that the period for CO_2 induced climate change has not started during the last 22 years. Increasing concentration of greenhouse gases in the Earth atmosphere appeared to produce too weak forcing to dominate in the Earth climate system."

The only comment I would add here is that it is highly unlikely Kärner's work will influence the IPCC. It has been observed by others that from report to report the evidence changes but never the conclusions. The conclusions of the next one, the Fourth Assessment Report, are foregone from the outset. This sort of finding will, at best, be grudgingly acknowledged in a footnote somewhere, buried amidst pages of full-colour graphics of model-generated warming projections.

5. Continued use of fossil fuels, by adding CO_2 to the air, will cause unprecedented changes to the future climate.

We have so little capacity to measure the state of the climate today, it is even less likely we can measure the state of the climate as at Thursday October 23, 1503. Pretending that the job gets easier if all you are interested in are vague averages 'round about' 1503-ish runs into the problem mentioned above that there is no physical rule for averaging the temperature field. Nonetheless there are people going around today claiming that a 'robust scientific consensus' (to use the words of one group's statement) exists that the climate is changing today in ways unprecedented since the end of the last ice age, and that Global Temperatures are higher today than they have been for the past thousand years, or more.

I have an unexpected familiarity with Mann's work now, having misspent my fall sabbatical on a research project with Steve McIntyre on the subject (McIntyre and McKitrick 2003). It began as an audit of Mann's paleoclimate proxy data base and ended up being shown around the US Senate as part of a debate on the McCain-Lieberman climate bill.

Mann and his coauthors (1998) published a famous graph (Figure 5, top) which suggests that the late 20th century climate is unusually 'warm' compared to that of the previous 600 years. In subsequent work he went on to extend the claim back to AD1000 and most recently to 0 AD.

Steven McIntyre obtained Mann's data from him in late 2002 and undertook what was apparently the first due diligence audit. In the end he and I found nine types of errors in the data. Some were careless collation errors, others involved using incomplete or obsolete versions of source data, and some were computational errors involving principal component series. We constructed a new data base using Mann's

specified sources and repeated his statistical analysis method on it. Simply correcting his data errors ended up radically-overturning his results.

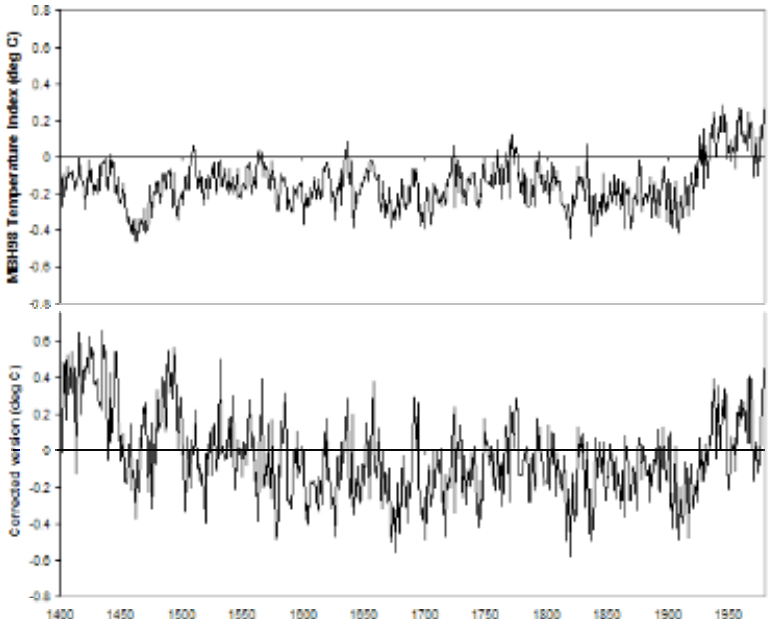

Figure 5. The Northern Hemisphere Temperature Index: original (top) and corrected (bottom)
Source: McIntyre and McKitrick 2003.

As shown in Figure 5, if the height of the graph is interpreted in the common way, as an index of the "warmth" of the northern hemisphere climate, then the hockey stick-shaped IPCC version (top) is merely an artifact of substandard data management and miscalculated principal components. The corrected version (bottom) shows that the late 20th century exhibits neither unusual mean values nor variability.

This is important since the 20th century has been a period of apparently unusual build-up of CO_2 in the atmosphere. I say "apparently" since there is good evidence from the examination of tree leaves preserved in northern European bogs that CO_2 levels in the air went through rapid growth and decline after the end of the last ice age (see *Taken By Storm* chapter 7). But most of the recent build-up happened after 1950, where the temperature lines in Figure 5 go flat, and certainly did not occur in the 15th century to coincide with the rapid swings in that portion of the graph.

Evidence of substantial climate variability in the past millennium (see survey in Soon and Baliunas 2003), the fact that attribution of climate change to CO_2 is done using a method that presupposes the veracity of general circulation models (see *Taken By Storm* chapter 6), and the intrinsic uncertainties of the climate problem as discussed above, make assertion No. 5 unlikely to be true.

Its credibility is further diminished by the egregious exaggeration of future CO_2 emission trends in the IPCC's Third Assessment Report. Figure 6 shows the globally-averaged per-person emissions of carbon dioxide in tonnes per capita (tC) since 1960. The average grew steadily from about 0.8 tC to 1.2 tC from 1960 to the early 1970s, and fell thereafter to about 1.15 tC. Since 1970 the average has been just below 1.14.

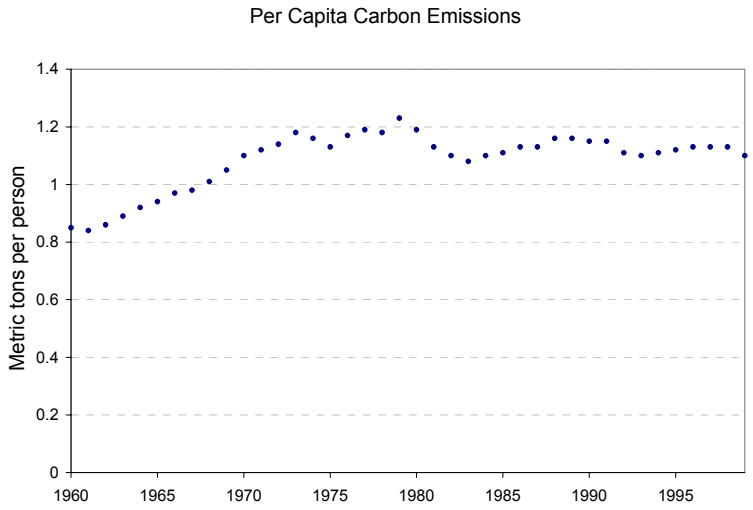

Figure 6: CO_2 emissions in tonnes carbon equivalent (tC) per capita Source: Marland et. al. (2002).

The steadiness of this average during the interval from 1970-1999 is striking in the context of considerable, albeit uneven global per capita income growth during this period. Brazil's per capita income rose 80 percent while Nigeria experienced no real growth at all. In the developed countries there was widespread increase in real per capita income: 60 percent in the US, 74 percent in the UK, 77 percent in Canada, 112 percent in Japan, etc. (Easterly and Sewadeh 2001). Nonetheless carbon dioxide emissions per capita did not rise for the world as a whole.

This lead me to suspect that a long-run equilibrium relationship exists that constrains global CO_2 emissions through the rationing mechanism of global fossil fuel markets. A way to test this would be to examine if per capita emissions are cointegrated across markets. That is, if per capita emissions have unit roots within a country, but across regions or trading blocks they are jointly stationary, then the time series interpretation would be that CO_2 emissions per capita are cointegrated. That, in turn, would imply that the global emissions per person are stationary around a stable mean of just over 1.1 tonnes carbon equivalent (tC) per person. Growth in emissions (per capita) in one region will induce reductions in emissions elsewhere, via the long-run equilibrating mechanism.

I suggested this possibility to Jennifer Orr, a Master's student at Queen's last summer, who did the analysis for her MA research essay. She found evidence (Orr 2003) that per capita CO_2 emissions are indeed I(1) at the country level, but across groups of countries defined by trading intensity cointegrating relationships emerge. More empirical work is needed to fully characterize the phenomena (though because of the short time series, low power will remain a problem). But at this point I think it likely that global per capita CO_2 emissions are pretty invariant to economic growth, at least at a globally-averaged level. We could likely rule out, for instance, the possibility that emissions will exceed 2 tC per capita in the next few decades.

Currently there are about 6.1 billion people in the world. The United Nations projects world population will reach about 9.3 billion persons by 2050 (UN 2002). If CO_2 emissions per capita average 1.14 tC for the next 50 years that would imply total global emissions of 10.6 billion tC by 2050. If emissions per capita range from 1.09 tC to 1.31 by 2050 tC the total emissions range will be 10.2 to 12.2 billion tC.

The IPCC emission scenarios project that by 2020 the average annual emissions per person will be, at a *minimum*, 1.2 tC from fossil fuel consumption. By 2050, the SRES is projecting total emissions of 11 to 23 gigatonnes, implying emissions per capita of between 1.2 and 2.5 tonnes per person (see McKitrick 2003 for more details). This would require a sharp departure from what has been observed historically. If the pattern over the previous decades persists, emissions will fall in the range 10.3 to 12.1 gigatonnes, hovering at the low end of the IPCC scenarios. The standard global warming projections at the low end of the emission scenarios are not the ones people worry about.

6. These changes will be generally deleterious.

If we don't know what changes are likely to happen, and if we have no way of recognizing at a local level if such changes as are happening would not have happened naturally anyway, then this claim is groundless. Climate changes can be good, bad or indifferent. But if anything, warming is better than the alternative.

> "Given the choice, I imagine nobody would opt for a world without any greenhouse, that is, a world with a mean temperature of about 259K [-14 C]. And probably few would opt for an ice-age world with a mean temperature of 275K to 280K [2-7 C]. To this point the greenhouse is seen as good. Further still, a majority clearly continues to see the greenhouse as good up to the present-day mean of about 290K. But, at the next 1.5K a drastic change of opinion sets in: the greenhouse suddenly becomes the sworn enemy of environmental groups, world-wide, to the extent that they rush off to Rio and elsewhere, and make a great deal of noise about it. I find it difficult to understand why. If I am told that computer calculations show immensely deleterious consequences would ensue, then I have a good laugh about it."
>
> Sir Fred Hoyle (1996).

The economic impact depends on the adaptations people undertake. In North America (where the best long term data exist) deaths due to hurricanes and tropical storms are negligible today compared to the period up to the mid-1900's, despite the large increase in population located on the storm-prone southeastern US coastline. The US National Hurricane Centre lists 259 Atlantic cyclones as making landfall in the US over the past 5 centuries (http://www.nhc.noaa.gov/pastdeadlya1.html). The deadliest 39 storms each caused more than 1000 deaths, but they occurred long ago. The deadliest storm after 1981 was hurricane Joan (October 1988) which was 95th most severe with 216 deaths. The deadliest entry since 1995 is Hurricane Opal (October 1995), which is the 182nd most severe, with 59 deaths. Despite the buildup of population in the path of storm tracks, the death rate is dropping. This reflects improved adaptation to climate—a luxury confined to wealthy countries.

Even if we take the worst-case scenario about climate change seriously, the release of CO_2 into the atmosphere represents a trade-off between a climate change and an improvement in economic circumstances. There is good reason to believe the trade-off would be beneficial even if the climate change were costly, but there is also good reason to believe the climate change will not be costly.

Recently Reinsborough (2003) and Adamowicz and Weber (2003) independently conducted Ricardian analyses of Canadian agriculture under conventional climate warming scenarios. Each team used a regression model to relate changes in land values to changes in past local climatological conditions, then used the coefficients to project future land value changes from the regional effects projected by the Canadian Climate Model. Reinsborough found a very small positive effect overall, while Adamowicz and

Weber found a large positive impact, about $500 per acre under the central scenario. The benefits are spread widely over the whole agricultural area of Canada.

These findings mirror those of other teams that project net global gains in agriculture (Mendelsohn *et. al.* 1999, 2000) and forestry (Sohngen and Mendelsohn 1998). Beyond these sectors most economic activity (manufacturing, services, etc) takes place indoors and is not affected by the weather.

As for climate extremes and severe weather, a recent review prepared for the Alberta government by a retired Environment Canada meteorologist (Khandekar 2002) concluded that there is no evidence of an increasing trend in extreme weather events anywhere in Canada. Other studies have likewise concluded that there is no upward trend in the frequency of storms, nor is there any upward trend in the severity of storms (Landsea *et. al.* 1996, Zhang *et. al.* 2000). If so much global warming has happened in the 20th century, it follows that it does not induce more storm activity.

7. We ought to reduce emissions of CO_2.

Now we get to the normative issue, and here the conventional tools of economic reasoning are very pertinent. The standard graphical tool of environmental economics shows the marginal damages of emissions and the marginal abatement cost associated with reducing emissions. This latter curve is equivalent to the marginal benefits of the activity generating the emissions.

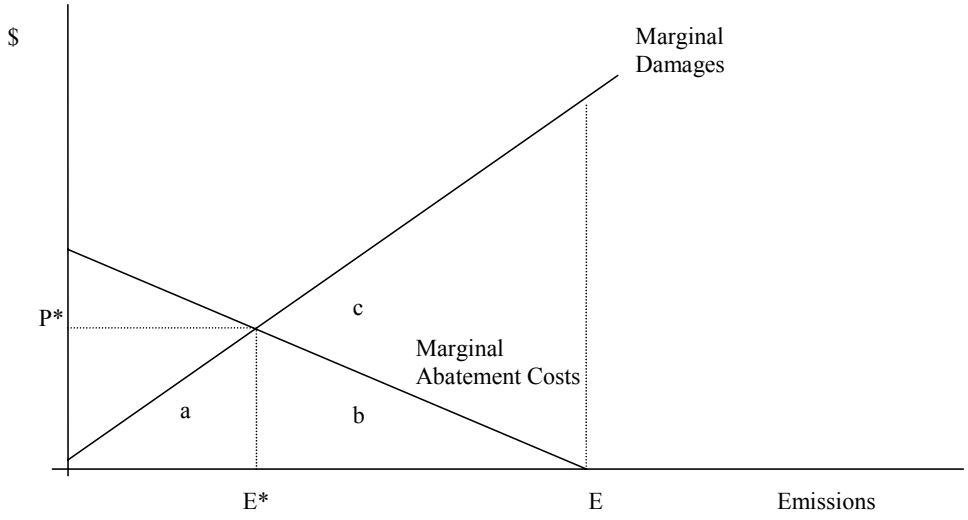

Figure 7: The Optimal Emissions Level.

If emissions are initially at point E, the total social damages equals the area under the marginal damages curve, which is a+b+c. If emissions are reduced from E to E*, the costs of doing so is represented by the area under the Marginal Abatement Cost function between E and E*, which is b. The gain to society is the reduction in damages, equal to the area b+c. Consequently, the net gain of reducing emissions is area c. If emissions were reduced further, the marginal cost of doing so (shown along the MAC curve) would exceed the marginal reduction in damages (shown along the MD curve), so such a move would be welfare-reducing. And if emissions were not reduced as far as E*, the foregone benefits of emission reduction would exceed the cost savings. Consequently, at the optimal emissions level E*, the net social gain (=c) of pollution reduction is maximized.

The above story applies when we are beginning from a position of zero regulation, which is not quite true for CO_2 since there are regulations on fuel use and fuel efficiency and so forth, but it's a close enough approximation. If we start at the unregulated emissions level *and the optimum is an interior point* then we ought to reduce emissions. If instead the diagram looks like Figure 8, there is no reason to reduce emissions below the unregulated level, even if there is some level at which emissions are acknowledged to be damaging.

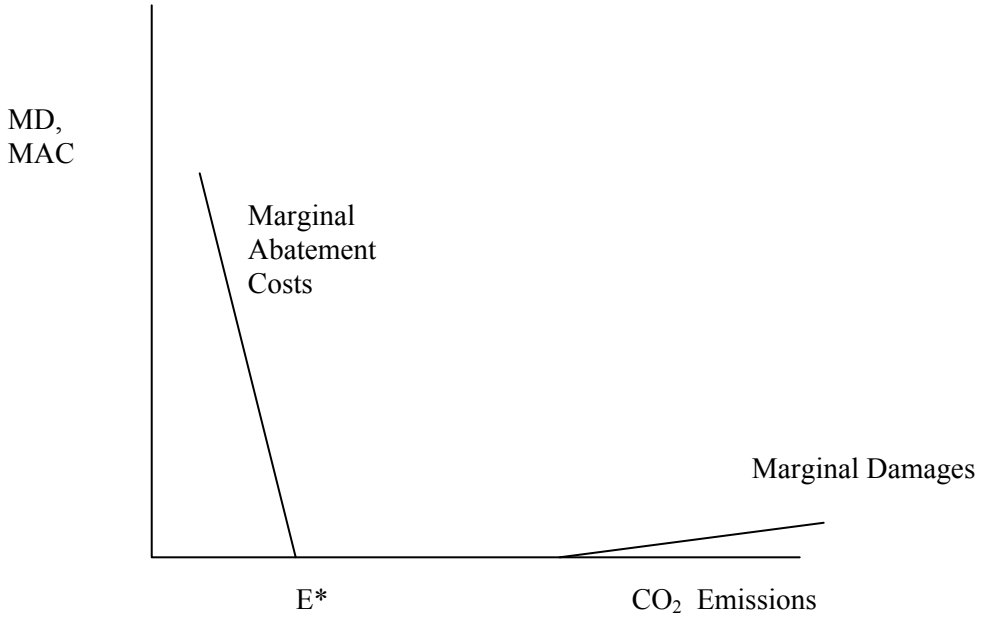

Figure 8. The Marginal Damages and Marginal Abatement Costs for Global CO_2 Emissions

This, I submit, is the situation the world is in. It is certainly the situation for Canada individually. Reducing emissions generates costs which go up with the triangular area under the MAC, but generate no offsetting benefits since the area under the MD curve does not change. Invoking benefits due to "energy efficiency" is no help since the MAC is drawn on the assumption that these are fully already realized. If they are not, the public policy issue is energy efficiency, not emission reductions. But energy efficiency is like labour productivity: governments always want it to increase, but it is easy to spend a lot of money without getting the desired result. Energy efficiency does improve over time but if there was a magic formula for accelerating the process I think we'd know it by now.

At this point it is also important to remind ourselves that CO_2 is not a pollutant. Noxious air contaminants like SO_2, NO_x, ozone, smoke particles, etc. cause direct damages to health and utility. CO_2 is harmless, odourless, colourless and is a naturally occurring part of our atmosphere and respiration. No one would be concerned about regulating it except for its possible role in the climate. But emissions themselves do not cause damage, only (in principle) the atmospheric concentration does, and this changes very slowly in response to large variations in emissions. That's why the MD line is so flat in Figure 8: any potential damages due to CO_2 emissions are constant over large ranges of feasible emission levels, since the gas is well-mixed on a global level.

8. The best mechanism to accomplish this is through the Kyoto Protocol.

A further point to be gleaned from Figures 7 and 8 is that, if the volume of abatement is denoted *A* (the difference between observed emissions and E*) then the total abatement costs go up with the square of *A*, while the total benefits rise at a declining rate. This matters because some proponents of Kyoto argue that while Kyoto will do nothing for the world atmosphere it is just the first of what will be many more ambitious agreements. It is tempting to invoke the *benefits* of those agreements, but the *costs* must also be invoked. And if Kyoto fails the benefit-cost test the subsequent agreements will as well, since the net benefits decline.

Treaty participants are divided into Annex B and non-Annex B countries. The distinction refers to whether the country has accepted an emissions reduction target. Non-Annex B countries, such as India, China and other developing countries, can join and ratify the treaty, though they are not required to cut emissions.

Annex B countries include the industrialized west and some former Soviet Bloc members. The treaty will enter into force if it is ratified by 55 countries, including enough Annex B members to account for 55 percent of the Annex B emissions. As of October 2003, 119 countries had ratified the Protocol, including 32 Annex B members accounting for 44.2 percent of Annex B emissions. The US accounts for 36.1 percent and the Russian Federation accounts for 17.4 percent of Annex B emissions. Neither of these countries has ratified. The US has indicated that it has no intention of doing so, while Russia is still considering the matter. Australia, which has 2.1 percent of Annex B emissions, has also indicated it will not ratify.

The European Union ratified jointly,as is permitted under Article 4, but must secure internal agreement on the sharing of the emission reduction requirements among themselves. Japan ratified the treaty, though the government proposed only voluntary measures and plans to revisit the issue in several years. Japan's ratification does not seem to involve imminent formal implementation plans.

Canada's Annex B share is only 3.3 percent, so our decision on its own is not particularly influential in the larger scheme of events. However, if the Russian Federation ratifies, the treaty enters into force. Likewise if they do not, the treaty dies. That is why there has been such intense interest in Russia's views lately: and the hints at this point are that the Russians are unlikely to ratify. If they do ratify, because of the economic collapse in the early 1990s Russia's emissions are below their target level. This gives them credits that they can sell to other countries. The large block of Russian credits is often referred to as "hot air."

For the purpose of the policy discussions, emissions are measured in "Megatonnes (metric tons) carbon dioxide equivalent", or MT. Canada's emissions as of 2010 are projected to be 809 MT, while the Kyoto target is 571 MT. This creates a gap of about 240 MT, about 30 percent. One reason this is so much more daunting than controlling SO_2 or particulates is that CO_2 cannot be "scrubbed." If you burn fuel you release it, regardless of how efficiently you burn and filter the smoke. The only large-scale way to reduce emissions is to reduce fuel consumption.

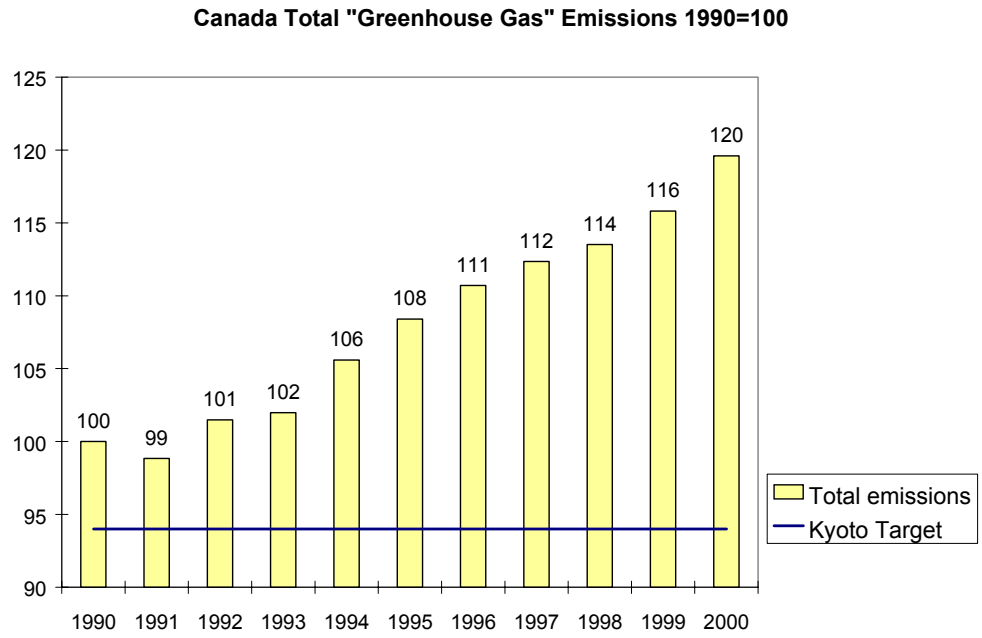

Figure 9: Canada's Greenhouse Gas Emissions and the Kyoto Target.
Source: Environment Canada State of the Environment Infobase
http://www.ec.gc.ca/soer-ree/English/indicator_series/techs.cfm?tech_id=15&issue_id=4&supp=1#data

The treaty requires compliance, on average, over the period 2008 to 2012 and treaty members must submit evidence of having made "substantial progress" towards meeting their goals by 2005. The treaty does not specify what happens after 2012, though plans are being made for a subsequent treaty that would tighten the targets further. There are no financial penalties for non-attainment of one's target, however a proposed rule would require deeper cuts in subsequent periods by parties failing to meet their goals in the current compliance period.

Following the signing of the original treaty, negotiations at Bonn and Marrakech in 2001 authorized the use of "sinks" credits. Under this arrangement, Canada, Japan, Russia and other countries are allowed to claim credits for the fact that forest and plant growth within their boundaries draws CO_2 from the air. In Canada's case the original target was relaxed by 10 percent (we can claim 24 MT worth of sinks from existing plant and forest growth).

Since then, Canada unsuccessfully sought 70 MT worth of credits for so-called 'clean energy exports.' Under this proposal, if another country, for example, Japan, reduces its emissions by switching from coal to natural gas from Canada (which emits less CO_2 per joule), Ottawa wants to claim the reduction in the other country's emissions as reductions for Canada. The accounting rules for Kyoto do not allow this except by prior agreement under something called the Joint Implementation plan. The idea is incoherent anyway. Canada would not have accepted the obvious corollary, which is that if a country buys coal from Canada but *could have* bought natural gas, we should be penalized for the extra emissions.

The original form of Kyoto required countries responsible for about half the world's CO_2 emissions to reduce them to just under five percent below 1990 levels. Because of economic growth, by 2010 emissions among participating countries could be at least 30 percent above their aggregate target.

Consequently the original Kyoto would have led to a nominal target amounting to a 15 percent cut in global emissions as of that date (half of 30 percent).

However, there is the leakage effect to consider. Reduction in fossil fuel consumption in Kyoto participants (Annex B countries) would lower the world price of fuels and induce higher consumption in non-Annex B countries. That development, as well as migration of energy-intensive capital, would cause emissions to increase in non-Annex B countries, partly offsetting the original emission reductions. The process is known as the "leakage effect." Global economic simulations have found the leakage rate to be anywhere from below 10 to almost 50 percent (see, e.g., Oliviera-Martins *et. al*, 1992, Smith 1994). If the leakage rate is 30 percent, then the emission cuts in Annex B countries will induce emission increases elsewhere that offset 30 percent of the cuts. Under the original terms of Kyoto a 30-percent leakage rate would imply total global emissions would fall by about 11 percent (15 times 70 percent).

The US withdrawal from Kyoto reduced the impact of the treaty further, because the United States is responsible for over one-third of Annex B emissions. While the United States proposed some unilateral initiatives, the country's withdrawal means about two-thirds of the world's emissions are not covered by Kyoto. If the remaining participants reduce their emissions by 30 percent, this amounts to a 10 percent cut in global emissions (one-third of 30 percent) as of 2010. But if the leakage rate is 30 percent, global emissions will only be reduced by about seven percent against 2010 levels. Once we add in the credits for land "sinks" given to the remaining participants we get an expected global emissions reduction of about six percent of 2010 emissions.

Kyoto's climate impact was analyzed in a simulation model by Wigley (1998). The original form of the treaty, under the assumption that additional accords are developed subsequently to keep emissions from going back up to business-as-usual levels after 2012, only slowed the accumulation of CO_2 in the atmosphere by a small amount. The concentration of CO_2 reached at 2100 under business-as-usual would be reached about five years later under Kyoto-plus-subsequent treaties. With 60 percent of the original emission reductions undone, this small delay shrinks as well. Consequently Kyoto can, at best, only delay by a few years whatever would happen as a result of increasing CO_2 in the atmosphere, unless the Protocol's targets are later tightened.

Consequently, at the global level, the Kyoto treaty is already a dead letter. This was confirmed in a recent article in the CJE by Bohringer and Vogt (2003), who compiled the exemptions and loopholes and showed that upon implementation, Russia's hot air would more than cover the existing demand for emission credits, making the overall emission reduction as a result of implementing Kyoto roughly zero.

As for the costs, Randy Wigle and I surveyed them in a C.D. Howe Commentary last year (McKitrick and Wigle 2002). The difficulty of coming up with cost estimates is that there is no coherent implementation plan. It is disingenuous for the federal cabinet to cite cost estimates that apply to efficient pricing mechanisms (like CO_2 taxes) and present them as if they apply to any and all schemes for compliance. There is a narrow range of policy types that can achieve cost-effectiveness, as I'll discuss shortly.

I thought I had a pessimistic view of Canada's ability to comply with Kyoto, but then I participated in a panel at Queen's with Chris Green of McGill. Professor Green does not dispute the IPCC view of the science as I do, but he goes further than me in warning about the costs. I have published estimates that it will shave about 2.5 percent off our national income: Chris thinks 8-10 percent is more realistic (Green 2003).

His analysis is beguilingly simple. There is a simple identity to describe total emissions of CO_2:

$$E \equiv \frac{E}{Y} \times \frac{Y}{P} \times P$$

where E denotes emissions, Y denotes GDP, and P denotes population. Denote emissions intensity of output as e and income per capita as y. Then taking logs and time derivatives we have

$$\%\Delta E \equiv \%\Delta e + \%\Delta y + \%\Delta P$$

where the $\%\Delta$ denotes annual percent change. This expression is called the Kaya identity. Greenhouse emissions are now about 25 percent above the Kyoto target. To get them down to the target between now and 2010, which is required to achieve Kyoto, emissions will have to decline by just over 3 percent annually. Population grows by about one percent per year. Emissions intensity in Canada fell by about 2 percent per year during the oil price shocks of the 1970s, but since 1990 the decline has been only about 0.6 percent per year. Since we require

$$\%\Delta e + \%\Delta y + \%\Delta P = -3$$

and current data suggest

$$\%\Delta e + \%\Delta P = 1 - 0.6 = +0.4 ,$$

we need to ensure

$$\%\Delta y = -3.4$$

for the rest of the decade. In other words we need Canadians to accept a reduction in real per capita income of about 3.4% per year from now until 2010. After that per capita income cannot grow by more than $\%\Delta e - \%\Delta P$ annually, which by historical standards is about -0.4%. Not a happy prospect.

9. The best way for Canada to comply with Kyoto is to pursue a package of measures as outlined in the Canadian Climate Change Plan (CCCP), which includes encouraging Canadians to do their laundry in cold water.

Figure 9. CCCP

When talking about the "best" way to implement a policy target we should focus on cost-effectiveness. In economics this means minimizing the cost of getting the job done. In policy settings the term seems to mean "less than infinite cost" but we can try for a bit more rigour than that.

The key to cost-efficient pollution policy is that marginal abatement costs across all polluters must be equal. This is called the 'equimarginal' principle. To prove it, first note that we are assuming emissions mix uniformly in the environment, so all polluters face a common marginal damages curve. Each polluter *i* gets (decreasing marginal) benefits from generating emissions e_i so its profits can be written as a function of emissions, $\pi^i(e_i)$, and its marginal benefits of emissions, a.k.a. its marginal abatement cost curve, can be written $\frac{\partial \pi^i}{\partial e_i}$.

The regulator wants to achieve some overall emissions level $E = \sum_i e_i$. The policy challenge is to do this in such a way as to minimize the economic costs, or equivalently, to maximize the economic benefits from the allowed total emission levels *E*:

$$\max w.r.t.\{e_i\} \sum_i \pi^i(e_i) \text{ subject to } \sum_i e_i = E .$$

The Lagrangian function for this constrained optimization problem is:

$$L = \sum_i \pi^i(e_i) - \lambda\left[\sum_i e_i - E\right].$$

The first order conditions, with respect to the e_i's are each written

$$\frac{\partial L}{\partial e_i} = \frac{\partial \pi^i(e_i)}{\partial e_i} - \lambda = 0$$

and since the λ's are constant this implies that

$$\frac{\partial \pi^i(e_i)}{\partial e_i} = \frac{\partial \pi^j(e_j)}{\partial e_j}$$

for any pair of polluters *i,j*; or in other words, the MAC's across all pollution sources should be equal.

To see the intuition of this result, suppose that as a result of a pollution control policy, two firms must reduce their emissions a certain amount each. The last unit of emissions reduction cost firm A $1200, and the last unit of emission reduction cost firm B $200. If A had paid firm B, say, $300, to cut its emissions by one more unit, and A had cut its emissions one less unit, A would save (1200-300)=900, while B would earn 300 for an action that cost it 200, for a net gain of 100. Consequently, while the overall emissions would have been identical, both firms would have been better off. As long as MAC's differ at the margin, the possibility for a mutually-advantageous rearrangement of abatement activity exists. That is why equimarginality is a necessary condition for cost-efficiency. Moreover, cost-efficiency is a necessary condition for optimality, since if the MAC's differ at the margin, they cannot all have abated to the point where marginal damages equal marginal abatement costs, which defines the optimal level of emissions for each source.

Policies to achieve equimarginal costs must be price-based. To equate marginal costs across decentralized consumers they must supply a price signal, either through a market for permits or a tax on emissions. The optimal tax, as shown in Figure 8, is zero. So we have, at present, the optimal economic instrument for CO_2 emissions already in place. A variant on the optimal policy would be to freely distribute emission permits until the trading price is zero.

Unfortunately the CCCP goes in a different direction. Following consultations over the summer of 2002 a plan was released in November 2002 (OK, it's actually called the "Climate Change Plan for Canada" or CCPC). It assumes that pre-existing programs will achieve 80 MT emission reductions. New measures were proposed that will achieve about 100 MT cuts, and a future phase will identify another 60 MT reductions.

The actions described by this Plan were those that came out of the earlier "Issues Tables" process. The language describing them is extremely vague, lacking clear timetables, mechanisms and cost measures. For instance, one plan is to retrofit a fifth of the national building stock. It is explained in the Plan as follows:

Energy efficiency retrofit of 20 percent of housing by 2010 (1.5 MT)

This Plan proposes the goal of energy efficiency retrofits for 20 percent of housing by 2010. Cost shared audits and information for homeowners under the Energuide for Houses initiative will be expanded. Financial incentives for retrofits will also be explored.

Energy efficiency retrofit of 20 percent of buildings by 2010 (1.2 MT)

This Plan proposes the goal of retrofitting 20 percent of the commercial and institutional buildings stock to higher energy efficiency levels by 2010. This could be achieved through collaboration between provincial/territorial governments, municipalities, Aboriginal people, non-governmental organizations, trade associations and the private sector. Commercial and institutional building owners would be consulted on how to encourage retrofits. They can contribute, for example, through the formation of buyers groups to reduce price and risk in the acquisition of new technologies and products.

(http://www.climatechange.gc.ca/plan_for_canada/plan/chap_3_2.html)

Note that these ambitious undertakings would yield only 2.7 MT emissions cuts, or about 1% of the estimated Kyoto target.

Households are challenged to reduce emissions by one tonne per person, through measures such as:

On the Road
Transportation accounts for half of individual greenhouse gas emissions. The kind of vehicle and the number of kilometres driven can have a huge impact on greenhouse gas emissions. Canadians can take many actions to reduce emissions from transportation.

* Buy a fuel-efficient vehicle – A 25 percent more fuel-efficient vehicle could reduce emissions by more than one tonne per year and save $360 on an average annual gasoline bill of $1440.
* Use ethanol blend gasoline – Current vehicles can use up to 10 percent ethanol blended gasoline without any adjustment to or effect on the engine.
* Use the car less – Driving 10 percent less, by walking, cycling, carpooling, or taking public transit, can reduce greenhouse gas emissions by 0.2 to 0.8 tonnes per year, depending on the vehicle.
* Reduce idling – If every Canadian motorist avoided idling their vehicles for just five minutes a day, all year, more than 1.6 million tonnes of carbon dioxide, along with other toxic substances, would not enter the air.

(http://www.climatechange.gc.ca/plan_for_canada/plan/chap_4.html#a)

The Plan, so-called, is long on expenditure, short on tangible detail, and anything remotely resembling the concept of cost-efficiency is missing, even though the term is used throughout. The question to be asked of a program like subsidies for retrofitting houses is: how much would this cost per tonne of emission reductions? The long, discouraging experience with programs like the old CHIP grants ought to have taught governments that "energy efficiency" subsidies deliver little measurable value, for all their costs. Subsidies mainly end up paying people to do something they were going to do anyway, and where the subsidy might induce, say, adding extra insulation in the Jones' attic, it is very expensive to go back and audit if the developer or homeowner actually did the work they promised to do when they took the money.

The implementation of Kyoto is also submerged in the usual political soup. The auto industry, of such political importance in Ontario, was quietly exempted in November of last year. The oil and gas sector has been promised it won't have to spend more than $15 per tonne of abatement, even though at that price (according to the simulations done for the federal government by Informetrica last year) for the nation as a whole only about 25 MT of emission reductions altogether would occur, and the price effect on oil will only be a few cents per barrel: not enough to change anyone's behaviour. The Ontario power sector has been operating under a rate freeze (NB: it seems to have been scrapped today—October 31, 2003—and will be replaced with a pricing board) that undermines any plans to reduce electricity consumption. And Alberta has introduced Bill 37, which forbids the Alberta government from entering into any federal-provincial emissions control deal that is inconsistent with the Alberta government's plan.

In all, the Canadian plan for implementing Kyoto is in ruins, and it is inconceivable that we will meet the target. It is looking unlikely we will even hit the business-as-usual target of 810 MT at the current rate of emissions growth. Following through with the CCPC, such as by washing clothes in cold water, will have no bearing on whether Canada achieves the Kyoto target. To the extent that doing a cold-water wash is a private cost, it is a cost with no offsetting benefit. If hot water is better for your laundry, use hot water.

11. Conclusions

My conclusions can be briefly stated as the opposites of the assertions made in the introduction.

1. The "climate" is not subject to precise definition, and its mean state cannot be measured with precision.

2. The equations of motion of the climate are unknown. The full range of natural variability is not well-known and future climate states cannot be predicted.

3. By adding to the stock of atmospheric CO_2 humans have an affect on the climate which may involve a general warming, cooling or some combination of both, at the Earth's surface, but it is unpredictable.

4. The present state of the climate reflects primarily natural causes, and if infrared-absorption plays a role it seems very minor.

5. Continued use of fossil fuels following any reasonable trajectory, by adding CO_2 to the air, may at most cause small and barely noticeable changes to the future climate.

6. These changes will be impossible to detect in any location, but on balance they will probably be beneficial.

7. The optimal emissions of CO_2 corresponds with the unconstrained level.

8. The Kyoto Protocol is a costly initiative that yields no environmental benefit.

9. There is no reason for Canada to comply with Kyoto, so Canadians should be left alone to do their laundry in whatever water they find works best.

References.

Böhringer, Christoph and Carsten Vogt (2003). "Economic and Environmental Impacts of the Kyoto Protocol." *Canadian Journal of Economics* 36(2) pp. 475—494.

Easterly W, Sewadeh M (2001) Web site http://www.worldbank.org/research/growth/GDNdata.htm. World Bank Global Development Network Growth Data Base.

Essex, C. and R. McKitrick (2002). *Taken By Storm: The Troubled Science, Policy and Politics of Global Warming.* Toronto: Key Porter

Essex, Chris (1991). "What Do Climate Models Teach Us about Global Warming?" *Pure and Applied Geophysics* 135(1) 125-133.

Essex, Chris, Turab Lookman and M.A.H. Nerenberg (1987). "The Climate Attractor over Short Timescales." *Nature* 326 pp. 64—66.

Green, Chris (2003). "Canada's Kyoto Commitment: Fiscal and "Real" Aspects." Presentation to the John Deutsch Institute 2003 Federal Budget Conference, Kingston, April 2003.

Hoyle, Sir Fred (1996). "The Great Greenhouse Controversy." In Emsley, J. (ed)., *The Global Warming Debate*, London: ESEF, 179—190.

Intergovernmental Panel on Climate Change (2001) *Climate Change 2001: The Scientific Basis*. Cambridge: CUP

Kärner, Olavi (1996) "Global temperature deviations as a random walk." *Journal of Climate* 9 656—658.

Kärner, Olavi (2003) "On nonstationarity and antipersistency in global temperature series" *Journal of Geophysical Research* (v107 D20, pp ACL 1-1 to 1-11).

Khandekar, Madhav L. (2002). "Trends and Changes in Extreme Weather Events: An Assessment with Focus on Alberta and Canadian Prairies." Technical Report to Alberta Environment, Edmonton AB.

Landsea, C.W., N. Nicholls, Gray, W.M. and L.A. Avila (1996). "Downward Trends in The Frequency of Intense Atlantic Hurricanes During the Past Five Decades." *Geophysical Research Letters* 23(13):1697-170.

Linacre, Edward (1992). *Climate Data and Resources: A Reference and Guide*. London: Routledge.

Mann, M.E., Bradley, R.S. & Hughes, M.K. (1998) Global-Scale Temperature Patterns and Climate Forcing Over the Past Six Centuries, *Nature*, **392**, 779-787, 1998

Marland, G., T.A. Boden, R. J. Andres, A. L. Brenkert, and C. Johnston. (2002). "Global, Regional, and National CO_2 Emissions." In *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

McIntyre, Steven and Ross McKitrick (2003). "Corrections to the Mann et. al. (1998) Proxy data Base and Northern Hemispheric Average Temperature Series." *Energy and Environment* 14(6) pp. 751—771.

McKitrick, Ross R. (2002) “Emission Scenarios and Recent Global Warming Projections.” *Fraser Forum*, January 2003

McKitrick, Ross R. and Randall M. Wigle (2002). “The Kyoto Protocol: Canada’s Risky Rush to Judgment.” C.D. Howe Institute Commentary, October 2002.

Mendelsohn, Robert and J. E. Neumann, eds. (1999) *The Impact of Climate Change on the United States Economy*. Cambridge: Cambridge University Press.

Mendelsohn, Robert, Wendy Morrison, Michael E. Schlesinger and Natalia Andronova (2000). “Country-Specific Market Impacts of Climate Change.” *Climate Change* 45, 553-569.

Oliviera-Martins, Joaquim, Jean-Marc Burniaux and John P. Martin. “Trade and the Effectiveness of Unilateral CO2-Abatement Policies: Evidence from GREEN.” *OECD Economic Studies* 19, pp. 123—140.

Orr, Jennifer L. (2003). “Projecting Future Trends in Carbon Dioxide Emissions: A New Approach.” MA Research Paper, Department of Economics, Queen’s University, Kingston Ontario.

Peterson TC, Vose RS (1997) An overview of the global historical climatology network temperature database. *Bull Am Meteor Soc* 78:2837—2849.

Reinsborough, Michelle J. (2003) “A Ricardian model of climate change in Canada” *Canadian Journal of Economics* **36**(1), February 2003, pp. 21-40.

Smith, Clare (1994). “Modelling Carbon Leakage in Incomplete CO_2 Abatement Treaties.” Centre for Economic Forecasting, London Business School, Discussion Paper DP 26-94.

Sohngen, Brent and Robert Mendelsohn (1998). “Valuing the Impact of Large-Scale Ecological Change in a Market: The Effect of Climate Change on U.S. Timber.” *American Economic Review* 88(4) pp. 686-710.

Soon, Willie and Sallie Baliunas (2003). “Proxy Climatic and Environmental Changes of the Past 1000 Years.” *Climate Research* 23:89—100.

Tsonis, A. A., P.J. Roebber and J.B. Elsner (1998). “A Characteristic Time Scale in the Global Temperature Record.” *Geophysical Research Letters* 25(15) 2821-2823.

United Nations Population Information Bureau (2002). Web site http://www.un.org/popin/

Weber, Marian and Wictor Adamowicz (2003). “Climate Change Impacts on Canadian Agriculture: A Spatial Ricardian Approach.” Presentation at the University of Guelph Department of Agricultural Economics, February 2003.

Wigley, T.M.L. (1998). “The Kyoto Protocol: CO_2, CH_4 and climate implications.” *Geophysical Research Letters* 25(13), 2285-2288.

Zhang, K., B.C. Douglas and S.P. Leatherman (2000). “Twentieth Century Storm Activity Along the US East Coast.” *Journal of Climate* 13:1748-1761.

PRESS CONFERENCE WITH

PRESIDENTIAL ECONOMIC ADVISER ANDREI ILLARIONOV

APPENDIX IV
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

Moscow World Climate Change Conference

[ALEXANDER HOUSE, Friday, OCTOBER 3, 2003]

Moderator: Good day, ladies and gentlemen. Today we---by we I mean the Kremlin.org network---are holding a press conference with Andrei Nikolayevich Illarionov, an economic adviser to the President. The topic of our press conference is "Russia and the Kyoto Protocol: What Is to Be Done?"

This question interests us very much because, and I am afraid I will express almost everybody's view, everything we read about this, that has been said or written by supporters and opponents, and especially by supporters, because with opponents everything is simply they only have to maintain the status quo, so all this offers very vague arguments.

Usually we are offered different explanations of why we should sign the Kyoto Protocol. And all these explanations are so enticing, one can't help asking why there are so many of them. Just yesterday a very respected person who works in a very respected energy company tried to explain to me why it was so important for Russia to join the Kyoto Protocol, that it was an international club of very important countries. Is it a club, is it a way to save mankind, or is it a way for Russia to earn? What it is? I hope we will find this out today.

Illarionov: Thank you, Gleb Olegovich for your introduction. Before we start talking about the content of our meeting, I would like to make a few introductory remarks. First of all, as it turned out, the topic of the Kyoto Protocol, the topic of ratification by Russia of the Kyoto Protocol or the topic of non-ratification of the Kyoto Protocol or the topic of postponement by Russia of the Kyoto Protocol ratification has become so politicized lately that frankly speaking I can't think of any other topic recently that would have stirred such intensive and emotional debates.

Just two days ago I was at one of the press conferences devoted to the ratification of the protocol and I witnessed so much emotion on the part of the people who attended that I hadn't seen since the end of the 1980s or at least since October 1993. It's not quite usual for such a calm life, political and economic and intellectual, we have had over the last few years. Relatively calm, of course, at least compared to the emotions that I could see several days ago.

So my first wish in our meeting today is that this meeting should not have a nature of political statements. We do not pursue any goals here. The only task we are facing is to have a calm and balanced discussion of problems that are confronting the country, the choice that has been offered to the country, the choice that has been the subject of very intensive intellectual and political fighting. Despite all this, I will try to have as calm and balanced a discussion as possible in order to try to figure out what is happening.

Just a few very general words about the Kyoto Protocol, although I am sure the people in this room know this. The Kyoto Protocol was prepared and signed in December 1997 in the city of Kyoto. This is why it is called the Kyoto Protocol. I have here this small book called "The Kyoto Protocol: the Convention on Climate Change." The Convention on Climate Change was adopted by the United Nations.

But it is not the convention that is a legally binding document but the Kyoto Protocol. The essence of the protocol is that---of course, it's a legal document that is based on a certain theory, on a certain concept.

According to this concept, the global climate warming that has been happening over the last few decades and maybe even centuries is caused primarily, if not entirely, by human activities, mainly by industrial and agricultural activities, as a result of which a considerable amount of carbon dioxide is discharged into the atmosphere. Carbon dioxide accumulates in the atmosphere and increases the greenhouse effect that has always existed or at least it has existed for the last several hundred million years, but carbon dioxide has increased this effect. As a result, the temperature rises, the climate changes. This leads to serious cataclysms, both short-lived and long-lasting, such as the melting of snow, ice, the rise of the Ocean, severe draughts in one place and devastating floods in another place, and so on.

In order to prevent such scenarios, it was proposed to restrict the discharge of carbon dioxide obtained through human activities. Certain quotas were introduced for countries that are members of the so-called Appendix 1 to the Convention on Climate Change. Here is the text of the Convention both in English and Russian. And there is Annex 1 that lists these countries. As a result of different negotiations, these countries arrived at a decision that, using the year 1990 as the basis, the emission of carbon dioxide and several other gases that are called greenhouse gases and that account for a relatively small share of all greenhouse gases, including methane, lower nitrogen oxide, should be reduced for about 5 percent for all Kyoto Protocol member-states as a whole. These quotas differed for other members of Appendix 1.

The European community countries and the European community as a whole decided to reduce greenhouse emissions by 8 percent. Japan, if I am not mistaken, decided to reduce them by 6 percent, Russia by about 100 percent of the 1990 level, Iceland by 101 percent, Australia by 110 percent. That is, the quota for each country was negotiated separately. This list included most but not all industrialized countries and several, but not all, countries that used to be called and are still called economies in transition. The overwhelming majority of countries in the world are not parties to Appendix 1 and therefore they have not undertaken to reduce greenhouse gas emissions or to reduce carbon dioxide emissions.

In accordance with the provisions of the protocol, the protocol may enter into force only after it has been signed by not less than 55 countries that are jointly responsible for the emission of not less than 55 percent of greenhouse gases, the countries that are included in Appendix 1. Such a provision can be found in many international documents. By now if the information is correct that I have received on September 29, naturally the protocol was signed or rather was opened for signature in 1998, it was signed in 1997 and it was opened for ratification in 1998.

Since then, I think on September 29, the treaty was ratified by 105 states and it follows from this that not all countries have ratified the instrument and correspondingly, out of those have ratified the agreement, there are countries that assume certain commitments to restrict and limit the emissions of carbon dioxide, there are also countries that do not pledge themselves to such restrictions and which remain without any restriction, without any ceilings. They can increase their emission of hothouse gases in whatever way they please to.

Now about ten countries or maybe more have yet to ratify the agreement. 2.5 years ago, in March 2001, the United States through the lips of President Bush declared that the United States would not ratify the protocol and they go out of it. A little later a similar statement was released by the government of Australia. And considering that the share of the United States in the aggregate emission of hothouse gases according to data of 1990 was quite substantial, over 36 percent, then correspondingly, the US exit from the protocol put the entire construction into question---can the agreement take effect?

A situation developed as a result of which the protocol could take effect only if, considering the countries that have already ratified and those who have not ratified and quit it, the agreement may enter into force, rather the protocol may enter into force only when it is ratified by Russia. And only Russia and no other country---even if all other countries which would like to ratify the protocol have done it, but it is not done by Russia, then under this document the agreement may not be able to enter into force.

The fact that Russia from March 2001 has found itself in such a role, the role of the keeper of the key to the Kyoto Protocol, in the past 2.5 years a big part of the discussion devoted to the Kyoto Protocol has this way or the other been related to Russia. Will Russia ratify the agreement? Won't Russia ratify the agreement? When will it ratify? And so on.

Considering that the discussion about the Kyoto Protocol and its ratification was extremely acute, was acute between, on the one hand, the Europeans, Japanese and Canadians and, on the other, the United States, as a result of that discussion which among other things was happening in the city of Genoa at the meeting of the heads of state of the Eight in June 2001, the Russian President Putin who was present at that meeting submitted a proposal after two hours of intensive discussion on these issues when the parties were exchanging opinions about the pluses and minuses, the pros and cons of ratifying the protocol---after that Vladimir Putin made a proposal to try to resolve the outstanding issues that existed at a special conference, a world conference on climate change.

The proposal was supported by all the participants of the Eight and this position was registered in the final document. And now 2.5 years later, in September this year, there began in Moscow and is now into its fifth day to be closed today---the world conference on climate change. Without Articles of Association doubt it is quite an outstanding phenomenon. It is just a third world conference on climate change. The previous ones were held as follows: the first

one took place 24 years ago, the second---13 years ago and now the third. And it is naturally the first that the conference is being held in Moscow.

Also for the first time, and also on a proposal of our President, the conference is attended not only by scientists but also by officials from governments, statesmen, businessmen, representatives of informal or nongovernmental entities. This was done on purpose, so that everybody has the opportunity to hear out any viewpoints and that everybody would have an opportunity to express one's own point of view to see which position is considered to be the most reasonable.

So, in the course of five days such a conference is happening and today it is being completed. As you know, on Monday, at the opening of the conference our President addressed the conference and although the conference is devoted to questions of climate change, this topic is much more broader than the topic of the Kyoto Protocol, nevertheless, as was to be expected, but not to that extent, very many among the conference participants for some reason waited for the opening statement of the President to announce that Russia will ratify the Kyoto Protocol or this has already been done or is being done, something like that.

Putin Announcement

As you know, the President decided not to do this. He did not do it and he said a different thing. He said that we are being urged to ratify the Kyoto Protocol and it is already not the first day they do it and they insistently urge us to do it, we are hearing the arguments in favor of ratifying the Kyoto Protocol. We also hear other arguments. We would like to attentively analyze all information. The Russian government is engaged in analyzing the protocol and the possible consequences of the ratification. And when the analysis is completed, then the decision will be taken in accordance with Russia's national interests.

One must say that among a part of the participants in the conference the statement caused a sense of regret, to put it mildly, and several delegates intervened in the sense that a magnificent opportunity was lost to ratify the Kyoto Protocol. Why wasn't the opportunity used? To tell you honestly, this is a somewhat strange approach.

It is necessary to make such a preface because I think over the past two months our mass media and in the public area there was an intensive and heated discussion of the question related to ratifying the Kyoto Protocol.

I would also like to make my small contribution to this discussion and to formulate several questions and several positions which in my opinion represent a broad public interest. I will say more: two days ago, at the same world conference on climate change I had been given the floor and I intervened and some of these questions were asked there. **Ten questions were asked concerning the scientific foundation of the Kyoto Protocol.**

Questions posed to Bert Bolin by Andrei Illarionov

Moscow World Climate Change Conference

October 1, 2003

1. What was the actual level of carbon dioxide concentration in the atmosphere in 1980-2000?

* The forecast is alarming. What is the basis for it?

2. What are the parameters of the model of temperature anomalies? And how are they derived? Why are there such fluctuations in anthropogenic forcing observations?

3. Can we explain the temperature variation by CO2 concentration in the atmosphere in the past 1000 years?

4. Can we explain the temperature variation by CO2 concentration in the atmosphere in the past 140 years?

5. Can we explain the temperature variation by CO2 emissions of anthropogenic character?

6. Other factors explaining temperature variation: Volcanic activity? Whether to include in the model?

7. Other factors explaining temperature variation: Long-term cycles? Whether to include in the model?

8. Is the modern "global warming" unique in the last 5,000 years?

9. Can we achieve the Kyoto Protocol targets, providing the share of Annex 1 countries (including Russia, not including USA and Australia) in the world's CO2 emissions is rapidly falling?

10. And finally: How much does it cost?

Colleagues from the international panel of experts on climate change---the English abbreviation is IPCC---well known to specialists, got together and jointly they drafted answers to those ten questions and this morning one of the IPCC leaders, Professor Bolin from Sweden acquainted the participants of the conference with answers to those ten questions.

I just want to show you a book. It's a sort of a synthesis report that was prepared by the Intergovernmental Panel on Climate Change, which is the intergovernmental group of experts on climate change. The book summarizes the main conclusions on climate change made by scientists. The research makes three volumes of special studies. This is just a brief overview. And there is a special chapter for those who do not understand complex calculations, that is for those who make political decisions. It explains why the problem of global warming exists, what role human activities play in this process. And I would say it makes an attempt to provide a scientific basis for the Kyoto Protocol.

Ten Questions to Bolin: No Answers

Professor Bolin is one of the leaders in this team of authors, he also spoke and gave answers to these questions. I can tell you that unfortunately none of the formulated questions was answered. One of the reasons for that may be that there was not enough time and there was not enough information at hand. However the questions that were formulated were not raised yesterday. They have been on the agenda for at least the last 20 years at all such conferences, meetings and seminars of climate scientists and economists who discussed global warming and the role of human activities in this warming and climate changes.

The fact that there are no answers to these questions does not mean that these questions will not be answered tomorrow or the day after tomorrow.

We hope, and we reached such an agreement, that our honorable colleagues will try to prepare appropriate answers and make them known not only to us but to the world and the international scientific community to make this knowledge public domain so that everyone could study and analyze it and make his own conclusions.

What I am going to offer you after such a long introduction is only part of the questions that were formulated one more time in the last 20 years two days ago, some of the questions and observations that were formulated today, and some additional information. In order to draw a picture, and I think that climate experts will find it extremely simplified, and they may be true, but for those who do not deal with climate changes every day, it will give them a rough idea of how the mechanism of climate changes works.

In the last several years when the attention of the people was riveted mainly to the human impact on climate, but the problem of climate changes is much broader and much bigger. **Roughly speaking, if we focus on climate changes, by which we mean the change of temperature and mainly precipitation, we can single out a group of factors that affect climate and that can be divided into two big groups. These are natural factors, of which the most important are solar radiation and changes in solar radiation, the reflecting ability of the surface of Earth, for which there is this serious scientific word albedo and which changes depending on the nature of the surface, whether it is covered with woods or it is ploughland, or it is barren rocks , ice or ocean**.

Each of these surfaces has its own reflecting capability. The change of the surface changes the reflecting ability, the albedo, and therefore the amount of solar radiation that Earth received from the Sun and then reflects back into the outer space. And the third, very important, element is the concentration of carbon dioxide in the atmosphere, which serves as a cushion that causes the greenhouse effect. There are several sources of carbon dioxide emissions. Carbon dioxide is generated by Earth's mantle regularly and constantly. This is the main source. Carbon dioxide is discharged by volcanoes and oceans. Carbon dioxide is produced by decomposing organic substances and by animals when they breathe. People also contribute to the concentration of carbon dioxide especially by burning fossil fuel for the generation of electricity and heat, and in industry. Cement production produces a lot of carbon dioxide. And of course, carbon dioxide is produced by breathing. So, these are human factors. All these factors cause climate changes. Climate changes affect the lithosphere, the cryosphere, the atmosphere, the hydrosphere and the biosphere and everything that is called human society: economy, social relations, politics. There is a well-known example when riots, revolutions, uprisings occurred in lean years, people died and so on.

There is a lot to discuss, and very much has been written about this. In the discussion on the Kyoto Protocol,---**the Kyoto Protocol addresses only one group of factors that are called human factors. It does not deal with the breathing of people yet but it deals with restrictions on the emission of carbon dioxide generated by burning of fossil fuel and industrial activities, and how this affects the climate. It is a general approach. The impact of other factors is left outside, on the periphery. And I think it shouldn't be because the study of relevant literature showed that the share of carbon dioxide emissions caused by human activities in the overall carbon dioxide emission caused by both natural and human factors is growing and reached 8 percent at the end of the 20th century. In other words, this means that if we take a step back, we will see that these two factors account for 8 percent. Carbon dioxide emissions caused by natural factors make up 92 percent of the total. But these are not addressed by the Kyoto Protocol. But natural factors also play a role in this process---among these three key factors: solar radiation, the reflecting ability of Earth, or albedo, and---so, if we try to build a climate model and assign a certain share to a certain factor, human factors should get their share. Bit they cannot account for more than 8 percent. They will be actually smaller than that because each of these factors has its share. You may ask me, what are the shares of other factors? I addressed this question many times to climate scientists, and different people gave me different answers. This is a subject of a broad discussion. But I did not get a single answer although such an answer probably exists.**

But I would like to draw your attention to the following. At least we must have in mind that although the emission of carbon dioxide of antropogenic nature exists, and is growing, it indeed increases the concentration of carbon dioxide in the atmosphere and its contribution is roughly like this.

Further on, we area passing over to the basic essence of the concept, the theory under which the temperature in the recent period, especially falling on the 20th century, I mean the rise in temperature, cannot be explained by anything else except man-made activities. Strictly speaking, this is the basis of the theory and all these data are taken from this book and there are indications as to where the data were taken.

Like any person who looks at this picture, one immediately gets to ask several questions: these changes in the temperature or even the basic changes on the planet, and mind you, in Northern Hemisphere---it is not coincidental that here we have the Northern Hemisphere and if we trace here such a trend, more or less constant, here we will get a big growth.

If we take a look at data on the Northern and the Southern hemispheres, we don't get such a picture, and there is also a trend of rising temperature, but it is much less expressed. If you take a look at the data about the trend of temperature of the ocean that have been obtained in recent time, the trend shows a strictly horizontal straight line, there is not even a hint of an increase. If one analyzes data on temperature measurements in the near-Earth atmosphere at the level of 1.5-2 kilometers---received from satellites---they indicate a weak tendency toward lower temperature.

Now we kind of leave this side with different measurements, and we take only one part---the part used in this report---a certain increase in temperature in Northern Hemisphere. But if it is there, then the question arises: so they say this is connected with human activity. Then naturally, this question arises: the other temperature fluctuations over the past thousand years have also been connected with anthropogenic activity the bulk of which is the burning of organic fuel---meaning coal, oil, gas and so on. And we have discovered quite a number of examples over the past thousand years which, by the angle inclination and by scale are comparable with the period we had in the 20th century. But honestly, it is quite difficult to say how the active anthropogenic activity of burning organic fuel was noted.

Moreover, it is not difficult to see that after a period of higher temperature there were observed quite notable sharp reductions in temperature. It was apparently assumed that at that period the anthropogenic factory ceased to operate and then for 30, 40, 50 and sometimes even 100 years mankind ceased to burn organic fuel.

This is obviously causing very big doubts, I mean such an interpretation, and this interpretation gets more profound if another graph is super imposed on this one, taken again from that book. It is shown by dots here.

It is a graph showing concentration of carbon dioxide in the atmosphere obtained with different methods also over the past 1,000 years. So when the graphs are examined separately and incidentally they are given in this and in other books, then the question of the extent to which they match each other just does not arise.

If however, one still tries to super impose one graph on the other, then naturally the question arises as to what extent these two graphs are correlated. To what extent it is possible to say that the changes of this indicator are to some extent the functions of the change of this factor.

Anyone who engaged in correlations or regression analysis, even in their simplest form, will naturally express some minor doubts about whether it is possible to draw such a conclusion. Naturally, quite a number of scientists in climatology are also expressing doubts over the possibility of this kind of interpretation of the data.

We can take a shorter period---140 years. This is how this was done in this book which also says that over the past hundred years, namely during the 20th century, the temperature on the planet increased by 0.6 degrees and then it is added in brackets---plus- minus 0.2 degrees. Considering that the accuracy of measurement may change. And they say that 0.6 degrees rise in temperature in a hundred years is so colossal, so dramatic that there can be only one explanation---the impact of anthropogenic activity, the impact of carbon dioxide which is man-made. If you take this period of the 20th century and try to analyze it not from 1990 to 2000 but try to divide it into three sections that differ by their trends. Actually we can do it a little later. And let us put on this graph the same line of concentration of carbon dioxide in the atmosphere and let us take a look at the extent to which these lines correlate with one another and what can one say about the strength of such a statistical link.

IPCC Hockey Stick

An additional problem is one that is shown here in the appearance of a trend line, indicated in blue here. The fact is that in this book there are no data on carbon dioxide concentrations over the past 20 years---from 1980 to 2000. Instead of such dots that indicate the actual observations, instead of the dots there is the traced line of the trend, relying on about the last 10-12 points and it plays a role sort of representing the existing observations of the concentrations of carbon-dioxide in the atmosphere.

This question appears to be all the more strange because on all other gases, methane, nitrogen-oxide, there are some detailed actual data of observations over the past 20 years. However, for some reason there are no data concerning carbon dioxide. All participants in these discussions, the authors of the report asset that there are such data and in general it is hard to imagine that such data do not exist. But for some reason the data were not included in the book and instead of the data by traced the a line of the trend, a straight line of the trend, thanks to which it is possible to say that at this section between the end of the 1960s and the end of 1970s and 1980s there exists a certain likeness between this trend line and the temperature line.

However, there is no confidence that everything has been accurately done from the viewpoint of science and many scientists asked questions. Finally, we can take the same graph make out trends by individual sections of the 20th century. Let us take the section of 1970s; from mid-1970s to 2000; from the mid-1940s to the mid-1970s and say from the 1910s of the 20th century to the middle of the 1940s.

It is not hard to see that in principle these three lines of the trend reflect three different types of behavior, or three different characters and if on this same graph we super impose a graph of the emission of anthropogenic carbon-dioxide, then the question of how much these lines correlate emerges with special acuity.

While up to this period of time---from the mid-1970s to 2000---it was possible speak about some link between the emission of anthropogenic carbon-dioxide with a rise in temperature; here there seems to be a certain similarity observed although one cannot say whether there is a link or not, if there is a cause-effect connection or not. At least

we can't say what causes what.

As for the period from the middle of the 1940s to the middle of the 1970s, it remains a big mystery because anyone who knows the history of mankind since the middle of the 20th century knows that it was a period, that it was a golden period, a golden era of economic growth, when the highest rate of economic growth was achieved by most countries and it was a period of the highest economic growth of the world economy, it was an era of cheap oil, when oil, coal and gas were extracted and burned at an incredible rate. During these 30 years the extraction and consumption of oil increased six-fold. And we can only imagine how much carbon dioxide emissions increased.

But what is happening to the atmosphere? The temperature of the atmosphere is not rising. Moreover, there is a clear trend, which has been around for 30 years, and over these 30 years the temperature at the surface of Earth dropped by 0.2 degrees, which is quite a lot. Therefore, not for a year or two, but for 30 years diametrically opposite tendencies developed: carbon dioxide emissions caused by human factors continued to increase considerably, as we can see on this curve, and at the same time the climate was cooling off and the temperature was decreasing. How can this be explained? No explanations have been produced in the last 20 years in any discussion or at the latest conference.

And finally, this period. We see a rather considerable increase in temperature that is comparable in terms of speed and angle of inclination with what we have been seeing in the last 25 years. At the same time, in the period from 1913 to 1944-1945, a period when two world wars, the Great Depression, several global economic crises occurred, a period when the biggest portion of the world economy was stagnating, carbon dioxide emissions caused by human factors increased very slowly. At the same time, now the temperature is growing as fast as it did in the last 25 years. How can it be explained that carbon dioxide emissions grow rapidly in the period of slow economic development and economic stagnation, and decrease in the period of rapid economic development and growth? Unfortunately, we have so far not got any answer to this question.

And this raises several more questions. For example, climatology has come up with a rather decent connection between volcano activities and the concentration of carbon dioxide. It's quite decent for our level of knowledge and for our limited scope of knowledge and measurements. In fact, when volcanoes erupt, they discharge a large amount of carbon dioxide into the atmosphere, its concentration increases, and this results in an increase in the temperature of the air. These curves are based on data covering a period of more than 100 million years. It's a rather long period of monitoring. It's not 20 or 25 years, as we saw in the previous charts. And here, too, we see a rough semblance. **There is a number of studies that show that volcanoes are one of the main source of carbon dioxide emissions into the atmosphere.**

Concerns about Models

However, this factor was not included in the climate model that was represented here. As a result, one of the most important factors, which has been recognized by all climatologists, was not incorporated into the model which provides the basis for the Kyoto Protocol. The question is why? Unfortunately, no answer was given to this question either.

Historical Data

Now, there are even more interesting factors. For example, this chart represents changes in temperature at the surface of Earth over a rather long period of time. Not millions of years but for more than 400,000 years. What is so good about this period of time? It is good because it is a period of time when people were already around. According to the latest studies, people appeared about four million years ago, at least the first signs of human presence date back to that time, and 400,000 years ago people existed in large groups, and there already began to appear the first signs of human society. By the end of this period the first protohuman societies came into existence.

So, what do we see here? We see that temperature changed considerably during this period from the peak of minus 8 and minus 10 and even minus 12 degrees, the relative average for the period, to plus 2 and plus 3. In other words, the fluctuation amounted to 12--15 degrees. Over what period did this occur? It's a period of about 1,000 years. If we

extrapolate these numbers into our times, we will see that---the amplitude of fluctuations shows that they by far exceed the fluctuations we have seen in recent years. As far as the rate of temperature increase or decrease is concerned, they considerably---they certainly don't differ from what has been happening in recent years. Moreover, the climate has never been constant either and will never be constant. It changes all the time.

It is obvious that during this period of time fossil fuel was not burnt in more or less considerable amounts. And this means that these fluctuations were caused by other factors that are not related to human activities. The question is what are these factors? And if there are any cycles, whether they are connected with solar radiation or something else, it is necessary to understand which factors affect the situation and why, and can't they be included in the model. **Unfortunately, this book, The Climate Model, on which the Kyoto Protocol is based, does not include these factors either.**

And the last thing. It is necessary to say that at the moment we are in the upward part of this curve. This may to some extent explain why the temperature on the planet is rather high or is said to be rather high. And yet, the temperature is lower than the peaks registered in the previous era. It needs to be said that people already existed during this entire period, they survived at high temperatures and they surely survived at the temperatures that are marked here as peaks. This is interesting information for discussion on whether humankind will be able to survive an increase in temperature by one degree or several degrees.

We gradually reduce the period. At first we had 100 million years, then we reduced it to 400,000 years, and now let's see what happened in the last 5,000 years. This point here represents the year 2000 A.D. And this point here is the year 3000 B.C. It's easy to see that the current increase in temperature, it is marked here, does not really differ much from increases that occurred around 800th or 900th years A.D., or 200th and 100th years B.C., around the year 1300 B.C. It's easy to see that these peaks were much higher than the ones we have now. And this is a period when people not just existed but when rather developed human societies existed.

Suffice it to say that this is a period when the Ancient World had reached its highest point. Everything we know about that period happened then, when the temperature of air at the surface of Earth was higher than it is now.

Reports say that grapes were harvested in England in ancient times, and then around 800th or 900th years B.C. when Eric the Red discovered Greenland, it was all green and that is why it was called that way and there is nothing of this kind today.

This is fertile ground for reflections, food for thought. And the question is: what factors, evidently no longer anthropogenic in nature because in this time nothing was observed similar to what is emitted by mankind into the atmosphere today. Nevertheless, the temperature was much higher.

These questions were also perennially put, but so far there are no answers. Further on, there emerge a number of questions related to a not so distant history or rather the current history: it is what is happening today or maybe over the past 40 years. These are data of the World Bank and we see that in absolute volume the emission of carbon dioxide at least from the middle of the 1990s is stabilizing and probably shows a weak tendency toward reduction. Now it is difficult to say but at least the data related to highly developed countries or countries of average development---register a weak indication of reduction.

If we take a look at the indicator of the emission of carbon dioxide per capita we will see that on the whole in the world the indicator has stabilized roughly from the middle of the 1970s. In highly developed countries it begins to diminish from the mid-1990s. I beg your pardon, I find it a little difficult to speak ... In the weakly- and average-developed countries the tendency also indicates a certain reduction.

If one talks about the specific "load" of carbon dioxide per one dollar GDP produced, at least over the entire period of observation for which there are the appropriate rows of statistical data based on the information of the World Bank, one observes a sufficiently sustainable tendency of reduced emission of carbon dioxide for the entire world economy. And even steeper tendency is for highly developed countries.

As regards the weak- and average-developed countries, there was a rising tendency which continued roughly from the middle of the 1980s, and from the mid-1980s the tendency attested already to a drop.

We then pass over directly to the document for which we have gathered here, namely the Kyoto Protocol. It

transpires that the document is not universal, it does not embrace all the countries of the world, it imposes no restrictions on the emission of carbon dioxide for all countries of the world. And we see how a change occurred between the two groups of countries. The countries of Annex 1, which undertook the commitments and ratified the agreement, took the commitment and abide by them, and the rest of the world.

In 1990s the countries of Annex 1 produced 7.5 billion tons of carbon dioxide while the rest of the world---12.8. In 1999 the Annex 1 countries produced less carbon dioxide and indeed they are doing some work to reduce the discharges of carbon dioxide while other countries, not committed to the obligations of the Kyoto Protocol, are increasing it. As a result the gap between those who undertook the commitment and those who did not take commitments, has notably increased.

This can be seen, among other things, also on the graph here that shows the specific weight in emission of carbon dioxide of Annex 1 countries in the world emission. In 1968 those countries were responsible roughly for half of the world emission of carbon dioxide; in 1990---on the order of 37 percent; and finally, in late 1990s it was slightly less than 31 percent of the world emission of gas---this is if you count it with Russia; and if you count it without Russia then the indicators will be slightly lower, of the order of 24 percent at the present time.

It is clear that this has nothing in common with 55 percent and naturally the question arises to what extent such a protocol and such international law can be effective in attaining even the goals that were proclaimed. If countries which are responsible only for less than one-third of world emission do everything possible and even impossible to cut on the emission, while the countries responsible for 70 percent of discharges will not do it and will continue to increase the emission, it is not hard to see that in this case the goals of the Kyoto Protocol in principle cannot be attained because these countries are not bound by anything and one must say that they do not intend to be bound by these restrictions.

Long Term Reductions Required to Meet True Kyoto Agenda

The next question that was also actively discussed---related to the price of the activities in order to meet the demands stemming from the Kyoto Protocol at later stages of development---for the economies of different countries of the world and for the entire world economy. This graph is somewhat complicated but I will try to explain it. You can see here slightly pale posts---this is the cumulative emission of carbon dioxide between the years 1990 and 2100, which means for 110 years. On condition that the carbon dioxide concentration in the first case will not exceed 450 ppm---meaning 450 particles per one million in a molecule, or molecule per million molecules of atmospheric air. Here it is 550 ppm, which means 550 particles of carbon dioxide per million of molecules of atmospheric air, correspondingly 650 ppm and 750 ppm.

And here we have different variants of reducing the emission, different variants of technological decision. And I would like to draw your attention not so much to that vertical axis indicating maximum volumes of carbon dioxide emission, measured in gigatons of carbon and more for that vertical axis which contains the indication of the price of activities, measured in trillions---and for those who might make mistakes with zeros, we have a "crutch"---ten to the power of 12---dollars in prices of 1990.

If we take a look at this scale, we will see that this variant is near the figure of 1,800 which means one quadrillion 800 trillions of dollars in 1990 prices. For those who deal with such figures not quite regularly, I will simply give you one figure for comparison. The figure is the world gross domestic product of 2002, i.e., of last year measured in 1990 prices. The whole world, including the US, China, Germany, Japan---generally the whole world, all those six billion odd people produced the GDP worth 32 trillion dollars per year. This is to say that if we put this post here, it would be a very small post. This is what produced by the entire world economy during the year. And here---marked with a pole---is the spending to take measures under the Kyoto Protocol on this particular project with these conditions. Of course, with other conditions and on other variants, the expenditure may be even less. **But even in the most conservative estimate, it is a figure on the order of 100 trillion dollars. This is to say that it is three times more than the current world gross domestic product. Each can make a conclusion as to whether or not such activities are expensive or cheap and to what extent such measures are practicable and realistic.**

There is one more aspect which as a rule is not discussed intensively because it is regarded not to be quite decent to discuss. And not all of us engage in the studies of climate and we don't have any restraining factors and we can engage in discussing this part which may be regarded as not quite correct in political terms. And this part is called

Emission of Carbon Dioxide---it is an inevitable product of civilization at the current stage of development. We will not say that carbon dioxide is a product of human life. But it we stop producing carbon dioxide, we will simply cease to exist. But the present economic civilization is based on hydrocarbons. Like it or not, effective or ineffective, but humankind burned and is burning wood, coal, oil, gas, fossil fuel, people are generating energy which they use in their life.

This chart here shows a connection between average annual increase in carbon dioxide emissions in the last 40 years and the average annual increase in GDP over the same period. It's easy to see that there is a rather high correlation between the two in about 150 countries. It's easy to see that all countries that had high economic growth rates are in the right-hand upper corner of the chart. This means that these countries had rather large average emissions of carbon dioxides. At the same time, the countries that had no increase in carbon dioxide emissions during this period had either low or negative economic growth rates. **Since our country has been busy the last six months discussing how to double GDP, we couldn't help looking at this picture from this point of view.**

Impact on Russia; Plan to Double GDP by 2010

If we are to double GDP within the next 10 years, this will require an average economic growth rate of 7.2 percent. It's a horizontal line here. We see the first point on this line or above it, draw a vertical line through this point and this tells us that these countries that had sufficient economic growth rates for doubling GDP within 10 years or even higher rates, these countries increased their carbon dioxide emissions by 7 percent or even more every year. No country in the world can double its GDP with a lower increase in carbon dioxide emissions or with no increase at all.

If we apply to this picture the requirements that the Kyoto Protocol applies to Russia, we will see the following: since the Kyoto Protocol says that the 1990s levels may not be changed, in other words, it sets the limit, we may actually say the zero point---we use this zero point to draw a vertical line until it meets the last point here and continue it to the left toward axis Y. And this leads us to the point of 4.5 percent. This means that the best rate that has ever been achieved in the world economic history in the last 40 years, that this is the best one can achieve without increasing the emission of carbon dioxide and with the maximum economic growth rate of 4.5 percent. All other observations are below that. At least 4.5 percent is the maximum that one can achieve. There has been nothing higher. This is the highest rate that one can achieve. If we take the average, the growth rate will be lower.

Impact of Kyoto: Reduce Emissions to 58% below 1990 by 2050!

Lastly, if we look at the criterion that simply does not exist in official documents, but that has been actively discussed, for Russia it is 42 percent of the 1998 level, which the country is supposed to achieve by 2050. And this means that we will have to reduce greenhouse gas emissions every year by about 3.5 percent. So, we take this rate of 3.5 percent and go up every year until we meet the last point that is consistent with this criterion. And this takes us to about 2.5 percent.

In other words, the maximum rate of economic growth that may be possible if this criterion is to be met and that has been achieved in the last 40 years is 2.5 percent of GDP growth a year. Everything else will be below that. This chart may not be politically correct. But it shows the nature of connections between carbon dioxide emissions and economic development at the present stage of human civilization. Like it or not, people will survive because they have to inhale oxygen and exhale carbon dioxide. The economy is a living creature and it has to consume energy. In the 1930s there was a motto that read "Coal is the bread of industry." So, we can say that oil is the blood of industry and so on. But there is logic to this because this is something that gives us energy that powers our industrial and economic development. **Since there is such a strong connection between carbon dioxide emissions and economic growth, the implementation of the Kyoto Protocol or even preparations for its implementation, which will be more correct to say, will curb economic growth considerably.**

This column here includes all countries listed in Appendix 1, that is the countries that are parties to the Convention on Climate Change and that have ratified the Kyoto Protocol. Some of them have worked to reduce carbon dioxide emissions with more success, others with less success in order to meet the criteria established for them in 2008-2012. It turned out that the average increase in GDP in 1997-2002 was chosen because the Kyoto Protocol was signed in

1997. These are the years when authorities had to meet the criteria determined by the Kyoto Protocol. And the rate of growth was 2.1 percent a year.

The rest of the world that was not bound by any obligations, irrespective of whether a country has ratified the Kyoto Protocol or not and whether it is a party to the Kyoto Protocol or not, they did not assume any obligations. And they developed almost twice as fast as the countries that had assumed such obligations and fulfilled them. As we can see, some of the countries, especially EU countries and Japan, took their obligations very seriously and have reduced emissions. For these countries and regions of the world that have undertaken to reduce emissions, the rate of growth was negative in the last 1990s. Other countries did not reduce emissions and actually increased them. How did this affect economic growth in these countries? While the European Union still had economic growth, although quite modest in the last few years, Japan was basically stagnating, but the countries that did not reduce emissions showed very impressive economic growth rates. This allowed them to obtain additional financial resources to improve the life of their citizens, including the poor part of the population, particularly in such a country as India where more than one billion people live, as well as Iran and Mexico.

If we further narrow down the topic, we will approach the relationship between Russia and the Kyoto Protocol and we will see a rather noticeable phenomenon which can hardly be described in any other way but discrimination against Russia. In fact, if we take the absolute volumes of carbon dioxide emissions, these are the latest data that have been available for a whole number of countries, Russia has produced 1.7 billion tons of carbon dioxide. But there are countries that produce more carbon dioxide than Russia. The biggest of them are the US and China.

However, these countries have not imposed any restrictions on emissions and they have no plans to assume any obligations. If we taka a look at the per capita figure of carbon dioxide emission in Russia, it is quite a big indicator---about 10 tons per one person. But it turns out that there are tens of countries in the world where the emission is higher than in Russia. And in some countries the emission is tens of times higher than it is in Russia and those countries do not commit themselves to any restrictions. If we take a look at the specific GDP "load" in regard to carbon dioxide emission, it is quite big---1.6 kilograms per one dollar of the GDP produced in accordance with purchasing power parity in prices of 1999. However, it turns out that tens of countries in the world where carbon dioxide emission per one Dollar of GDP produced is higher than in Russia but they are not restricted in any way. Our country possesses a certain amount of financial resources, conditioned by the size of the GDP but nevertheless, we are not the largest economy in the world. There are economies that have not smaller but much bigger financial resources, including for the pursuit of different activities in order to meet the requirements of the Kyoto Protocol but emission is not limited in those countries. Finally, per capita GDP in this country is about 7.5 thousand dollars per capita---it is a country with an average development but we can see that there is quite a number of countries which have much higher indicators of per capita GDP incomes and they undertake no restrictions on carbon dioxide emission.

Sale of Russian "Hot Air"

Finally, one of the most hotly debated questions is the following: given all the deficiencies and unclear points of the Kyoto Protocol, it has one substantial advantage---the Kyoto Protocol enables Russia to trade in its quotas per superfluous ones, say pure air. Russia can sell the air to countries that need it. It is because those other countries will exceed the limits of hothouse gas emission.

Alas, regrettably, this statement does not square with reality, it is illusory. It has its roots in the reflections of those who established the Kyoto Protocol in 1990s. Then indeed there were three major potential buyers of free quotas in the world---the United States of America, the European Union and Japan. Based on the projections of economic growth in those countries it was expected that they will be net buyers of available quotas. However, quite a lot of interesting things happened over the period. The United States left the Kyoto Protocol and is not going to ratify it while the European Union and Japan, on the one hand, carry out large programs to introduce technologies reducing the discharges of hothouse gases; and on the other they have lower rates of economic growth, actually being in a stage of stagnation.

As a result of this, one can say with a high degree of probability that the European Union and Japan will on the whole reach the required levels of hothouse gas emission in 2008-2012. And that is why no demand will appear on their side for free and clear air. Essentially, there is no buyer for European quotas. At least there is no high degree of probability.

But let us also say that the European Union will most likely meet those criteria. But different countries meet the criteria in different ways and it is likely that some countries may not be able to reach that level---that is true. But then these countries will not be able to buy free quotas from other EU countries---which is attested to by the appropriate EU directive approved two months ago.

Finally, if the number of such countries turns out to be slightly bigger and it will not be possible to reduce the carbon dioxide emission to the degree one would like to over the period, **then there are 10 countries of Eastern Europe which in the spring of 2004 will become EU members and thus they will be the first natural participants in that line. They will become the sellers of the quotas that they have. Russia will in any case be the last in that list.**

Finally, even if you imagine a hypothetical situation that buyers will still be found for some Russian quotas, that situation will exist for a very brief period. Between the year 2008 when the appropriate market mechanism may begin to operate, and up to 2012, 2014, 2016 the dependence on the rates of growth of the Russian economy **when we will reach those restrictions on discharges that are established either under the first stage of the Kyoto Protocol or under the next one which is now beginning to be discussed.**

And then after crossing that point Russia finds itself not as a seller but a buyer of pure air quotas. And if we are not going to restrict ourselves in economic growth, in economic development in 2012, 2014 or 2016, that in principle they are not of great importance, we will then be forced to buy additional technologies and equipment in order to better meet the stringent standards and on the other hand, to buy additional quotas in order to be able to improve our production.

One can imagine this tradeoff---this matching of pluses and minuses of the solution. In principle, the situation in regard to the Kyoto Protocol may be illustrated with us a slightly simplified picture compared with man. Considering that human organism in this sense differs little from the economy. Let us say we can imagine the US economy as a grown up person, with 180 centimeters in stature, weighing 80 kilograms, aged 20 and such a man exhales bout 249 kilograms of carbon dioxide a year. We take the average parameters of man, not an athlete, not big, not small, about an average man.

Compared with such a man, we Russia, as an economy would look like a child aged five and a half years, weighing 20 kilograms, being 110 centimeters in stature and the results of our life and work would be exhaled as roughly 88 kilograms of carbon dioxide a year. If we ratify the Kyoto Protocol, then we will at most reach the level that corresponds to what we had in 1990---it is about 159 kilograms of carbon dioxide. Such volume, a mass of carbon dioxide corresponds to a teenager aged 12 and weighing 40 kilograms. We simply cannot develop any further. Of course we would like to grow and inhale more oxygen and eat more of something, but we have that boundary in the form of a red plank, beyond which we cannot grow.

Moreover, there enters into force the second phase of the Kyoto Protocol under which the emission permitted to us must not exceed 48 percent from the 1998 level when, in terms of emission per man per year will reach 30 kilograms which roughly corresponds to an infant aged two and a half months and weighing about 6 kilograms.

Of course, this is clearly a simplification. Nevertheless, this simplification gives one an idea of the challenges and problems we may face if we decide to go down that road. At least if we take that road we have to clearly see what tasks we will have to resolve in addition to other problems we are also grappling with.

And finally, naturally, one more argument arises which can repeatedly be heard and you surely heard it---the argument to the effect that with such an economy, with such an energy effective economy, with an economy that consumes so much carbon dioxide, such goals cannot be accomplished. It is necessary to switch to new technologies. We need to move on to a higher level of development. And we can only agree with this. There is no doubt that this must be done. But the big question is when and how we can move on to these new technologies.

In order to get some idea about other technologies, let's take a look at this picture. Global power generation looks as follows: 6.8 percent of energy, and not only energy, is generated by nuclear power plants, 2.3 percent by hydropower plants, 0.5 percent by geothermal power plants, and 90.4 percent by hydrocarbons that are burnt to heat our houses, to cook food, to power our cars, planes and ships.

This is why when some say that it is necessary to move on to another stage of technological development, there are no objections to that. But the question is what exactly is meant. If you stop using hydrocarbons, what stage are you

going to move on to? Geothermal? And then the question is where are the sources and when can you do this? Or, are you going to move on to the stage of hydropower generation. But most of the world's hydropower resources have already been used and what is left is located in a few localities in different parts of the world, and this will not solve global problems. And this leaves the last option---nuclear power engineering. Therefore, we must understand that those who say that---after all, we are people and we are not fantasizing here. And this means that if we give up fossil fuel as the main source of energy and the main element of our civilization and modern economy, we will have to move on to nuclear power engineering and to replace fossil fuel with nuclear power generation.

The supporters, those who call themselves environmentalists, the supporters of the Green movement who support the Kyoto protocol and who object to the development of nuclear power engineering, they may find it interesting to know that there is a discovery many of them are not even aware of when they call for the ratification of the Kyoto Protocol. It is quite possible that nuclear power engineering is the safest way to generate energy, as those who work in this field say. I may not know this.

But even if there is a certain period of time during which humankind may change one energy generation technology for another, the ratio would be 4.9 to 6.8. It's not hard to figure out how much time and investment we will need, what structural changes will have to occur in our life and society and safety in order to do this. And whether this can be done by 2008, 2012, 2014 or 2016.

So, from this point of view, it is very interesting how justified is a seemingly illusory belief in such technological operations. Basically, this allows us to formulate 10 conclusions. Sometimes they may be formulated in a somewhat harsh or categorical way.

Conclusions

Nevertheless, we don't have answers to the questions that were formulated and to the many other questions that were not expressed today but which are constantly heard over the past 20 years. They may be formulated as follows. So far the Kyoto Protocol does not have a scientific substantiation. That model of climate which is proposed, has many deficiencies and fails to accommodate many factors, and what has been presented so far lacks conviction. The Kyoto Protocol has significantly exaggerated the speed of the real increase in carbon dioxide emission especially in recent years. The Kyoto Protocol is not universal. It does not include all the countries of the world and it does not impose limitations on all countries of the world.

By its mechanism, the Kyoto Protocol is not effective, it cannot attain even the goals that it proclaims. The Kyoto Protocol is unacceptably expensive. The costs given in the calculations in this book are of course beyond the boundary of the reality.

The Kyoto Protocol or rather compliance with the Kyoto Protocol conditions is obviously holding up economic growth and today this was again admitted at the world conference on climate change, in the statement by IPCC co-chairman Professor Bolin who clearly said in his statement that yes, indeed, meeting the Kyoto Protocol provisions reduces the pace of economic growth by one percent a year according to his estimate.

One can argue whether it's one or two percent, this is immaterial. The important thing is that nobody, including the supporters of Kyoto Protocol ratification, takes issue with the fact that the pursuit of the Kyoto Protocol requirements and the economic growth are opposed directions. They are incompatible.

Kyoto Protocol would cripple Russian Economy

The concrete text of the Kyoto Protocol and the requirements that Russia is expected to meet, are discriminatory. The Kyoto Protocol is dooming Russia not to the role of the seller, but to the role of a buyer of quotas for hothouse gas emission. Considering that the Kyoto Protocol is restricting economic growth, we must say it straight that it means dooming the country to poverty, backwardness and weakness.

And finally and lastly, this concerns not only Russia but also the entire world and in this case we can speak about the interests of not only and not solely of Russia but rather of the interests of the world. The Kyoto Protocol relies of

course on technological illusions. Replacing the technological base of hydrocarbon energy sector, which took 1,000 years to establish and which is now in a state of development in which it has been during several years, is a great illusion.

That would be it. Now I am prepared to answer your questions.

(Further Mr. Illarionov answered journalists' questions.)

REMARKS AT A PRESS CONFERENCE WITH

PRESIDENTIAL ECONOMIC ADVISER ANDREI ILLARIONOV

On the Results of the Climate Change and Kyoto Protocol Seminar in Moscow

[ALEXANDER HOUSE, JULY 8, 2004]

For remarks made at a previous Press Conference (October 2003) which include the "10 questions" referred to below, click **here**

Illarionov: We have a few minutes left and I would like to tell you about the impressions on the two-day seminar that has just ended.

Yuri Antonovich and I have mentioned the fact that this is the first seminar of its kind that we have managed to arrange and it was accidental. Over almost a year we have repeatedly asked our foreign partners who advocate the Kyoto Protocol and who insist that Russia should ratify the Kyoto Protocol, and we have invited them to meet and discuss these issues, present arguments and counter-arguments and discuss them jointly. But we have not received any reply for a year. These people persistently refused to take part in any discussion.

Nine months ago, at an international climate change conference in Moscow, ten questions concerning the essence of the Kyoto Protocol and its underlying theory were submitted to the IPCC. We were told that the reply would be given within several days. Nine months have passed since then but there has been no reply, even though we have repeated our inquiries on these and the growing number of other related questions.

Instead of getting replies to our questions, we kept on hearing that replies did not matter. What was important is that whether or not Russia trusts Britain, the European Union and the countries that have ratified the Kyoto Protocol and that have been exerting unprecedented pressure on Russia to ratify it. This is why it was so important for us to arrange a real meeting and a real discussion of real problems with the participation of foreign scientists who have different views in order not to stew in one's own juice, as Yuri Antonovich put it, but to hear the arguments not only of our Russian scientists but also the arguments and counter-arguments from scientists in other countries.

We did get such an opportunity and over the past two days we heard more than 20 reports, we held detailed discussions, and now we can say that a considerable number of the questions we formulated and raised have been somewhat clarified, just as some other questions have.

I would sum up my conclusions in six points. The first one concerns the nature and the contents of the Kyoto Protocol. This is one of the biggest, if not the biggest, international adventure of all times and nations. Frankly speaking, it's hard to recall something like this of the same scale and of the same consequences, just as the lack of any grounds for action in field.

Basically, none of the assertions made in the Kyoto Protocol and the "scientific" theory on which the Kyoto Protocol is based been borne out by actual data. We are not seeing any high frequency of emergency situations or events. There has been no increase in the number of floods. Just as there has been no increase in the number of droughts. We can see that the speed of the wind in the hails in some areas is decreasing contrary to the statements made by the people who support the Kyoto Protocol. We are not witnessing a higher incidence of contagious diseases, and if there is a rise, it has nothing to do with climate change.

If there is an insignificant increase in the temperature it is not due to anthropogenic factors but to the natural factors related to the planet itself and solar activity. There is no evidence confirming a positive linkage between the level of carbon dioxide and temperature changes. If there is such a linkage, it is a reverse nature. In other words, it is not carbon dioxide that influences the temperature on Earth, but it just the reverse: temperature fluctuations are caused by solar activity influence the concentration of carbon dioxide.

The statistical data underpinning these documents and issued in millions of copies are often considerably distorted if

not falsified. The most vivid example of that is the so-called "ice hockey stick", or the curve of temperature changes on the planet over the past 1000 years. It is alleged that there were insignificant temperature fluctuations for 900 years but there was a sharp rise in temperature in the 20th century.

A number of scientific works published lately show that in order to produce this "ice hockey stick", nine intentional or unintentional, I don't really know, mistakes were made that led to distortions in initial data and final results. Using the words of famous poet Vladimir Vysotsky, everything is not the way it should be.

Second, in respect to the presentation made by representatives of the so-called official team of the British government and the official British climate science, or at least how they introduced themselves at the seminar. I personally was surprised by the exceptionally poor content of the papers presented. During the past two years I took part in many international meetings, seminars, conferences and congresses on these issues both in Russia and in many of the countries, including the seminar that we had today and yesterday. Honestly, these papers and presentations differed dramatically from what is usually offered at international congresses and conferences.

Simultaneously, they revealed an absolute---and I stress, absolute inability to answer questions concerning the alleged professional activities of the authors of these papers. Not only the ten questions that were published nine months ago, but not a single question asked during this two-day seminar by participants in the seminar, both Russian and foreign, were answered.

When it became clear that they could not provide a substantive answer to a question, three devices were used. And I have to say it now although has not direct bearing on the Kyoto Protocol and the content of the extremely interesting presentations made during the past two days. The British participants insisted on introducing censorship during the holding of this seminar. The chief science adviser to the British government, Mr. King, demanded in the form of an ultimatum at the beginning of yesterday that the program of the seminar be changed and he presented an ultimatum demanding that about two-third of the participants not be given the floor.

The participants in the seminar who had been invited by the Russian Academy of Sciences, they have been invited by the president of the Academy of Sciences Yuri Sergeyevich Osipov. Mr. King spoke about "undesirable" scientists and undesirable participants in the seminar. He declared that if the old program is preserved, he would not take part in the seminar and walk out taking along with him all the other British participants.

He has prepared his own program which he proposed, it is available here and my colleagues can simply distribute Mr. King's hand-written program to change the program prepared by the Russian Academy of Sciences and sent out in advance to all the participants in the seminar.

A comparison of the real program prepared by the Academy of Science and the program proposed as an ultimatum by Mr. King will give us an idea of what scientists, from the viewpoint of the chief scientific adviser to the British government, are undesirable. In the course of negotiations on this issue Mr. King said that he had contacted the British Foreign Secretary Mr. Straw who was in Moscow at the time and with the office of the British Prime Minister, Blair, so that the corresponding executives in Britain should contact the corresponding officials in Russia to bring pressure on the Russian Academy of Sciences and the President of the Russian Academy of Sciences to change the seminar's program.

When the attempt to introduce censorship at the Russian Academy of Sciences failed, other attempts were made to disrupt the seminar. At least four times during the course of the seminar ugly scenes were staged that prevented the seminar from proceeding normally. As a result we lost at least four hours of working time in order to try to solve these problems.

During these events Mr. King cited his conversations with the office of the British Prime Minister and had got clearance for such actions.

And thirdly, when the more or less normal work of the seminar was restored and when the opportunity for discussion presented itself, when questions on professional topics were asked, and being unable to answer these questions, Mr. King and other members of the delegation, turned to flight, as happened this morning when Mr. King, in an unprecedented incident, cut short his answer to a question in mid sentence realizing that he was unable to answer it and left the seminar room. It is not for us to give an assessment to what happened, but in our opinion the reputation of British science, the reputation of the British government and the reputation of the title "Sir" has sustained heavy damage.

The next point brings us directly to the Kyoto Protocol, or more specifically, to the ideological and philosophical basis on which it is built. That ideological base can be juxtaposed and compared, as Professor Reiter has done just now, with man-hating totalitarian ideology with which we had the bad fortune to deal during the 20th century, such as National Socialism, Marxism, Eugenics, Lysenkovism and so on. All methods of distorting information existing in the world have been committed to prove the alleged validity of these theories. Misinformation, falsification, fabrication, mythology, propaganda. Because what is offered cannot be qualified in any other way than myth, nonsense and absurdity.

Finally, my last point is why it happens and how the whole thing can be described. When we see one of the biggest, if not the biggest international adventures based on man-hating totalitarian ideology which, incidentally, manifests itself in totalitarian actions and concrete events, particularly academic discussions, and which tries to defend itself using disinformation and falsified facts. It's hard to think of any other word but "war" to describe this.

To our great regret, this is a war, and this is a war against the whole world. But in this particular case the first to happen to be on this path is our country. It's unpleasant to say but I am afraid it's undeclared war against Russia, against the entire country, against the left and the right, against the liberals and the conservatives, against business and the Federal Security Service, against the young and the old who live in Moscow or in provinces. This is a total war against our country, a war that uses all kinds of means.

The main prize in this war for those who have started it and who are waging is the ratification by Russian authorities of the Kyoto Protocol. There is only one conclusion to be made from what we have seen, heard and researched: Russia has no material reasons to ratify this document. Moreover, such a ratification would mean only one thing: complete capitulation to the dangerous and harmful ideology and practice that are being imposed upon us with the help of international diplomacy.

This is not a simple war. Like any war it cannot be easy and simple. Regrettably like any war it has its losses and victims, and we must understand that. The main thing is that we have now obvious evidence that we have got over the past two days, although we had some hints before that time, and it was the approach to Russia practiced by some people attending the seminar, an approach to Russia as a kind of banana republic, an approach to a country that is not a colony yet but about to become it as soon as it ratifies the document. At least we now know how people in colony feel towards other people who are trying to make them a colony.

And maybe the last touch. During the discussion of the economic impact of the ratification of the Kyoto Protocol and of when Russia will achieve the 1990 emission level, one of the representatives of this official British team of scientists and government officials said quite bluntly: Russia cannot expect an increase in the population, on the contrary, the population will decrease. And as long as you reduce your population, you can meet the Kyoto Protocol requirements.

Thank you for your attention. The remaining small team is ready to answer your questions.

Izrael: Just a couple of words to add. The Kyoto Protocol aims to impoverish our country, and not only us but our children and grandchildren, I'd like to emphasize that, because the more time passes the more we will have to invest to meet the requirements of the Kyoto Protocol.

Illarionov: And maybe the very last point. Indeed Russia has found itself in the forefront of this war. We haven't chosen it. We did not want and do not want to war. This war has been imposed on us. The fate of our country, the fate of our children, as Yuri Antonovich has just said, and the fate of the entire world will depend on the outcome of this war.

There have been examples in our fairly recent history of how a considerable portion of Europe was flooded with the brown Nazi ideology, the red Commie ideology that caused severe casualties and consequences for Europe and the entire world. Now there is a big likelihood that a considerable part of Europe has been flooded with another type, another color of ideology but with very similar implications for European societies and human societies the world over. And now we in Russia are facing a historical opportunity: are we going to let the genie out of the bottle as the previous generations let the Nazi and Communist genies out of the bottles or not?

Question: My question is to the representative from Australia. Unfortunately I did not get his name...

Illarionov: William Kinenmos. [Note]

Question: As far as I know Australia has refused to ratify the Kyoto Protocol. Can you tell us if Great Britain and the European Union exerted the same kind of pressure on Australia when it was thinking about whether or not it should ratify the Kyoto Protocol? And how can you explain what is now happening to Russia?

And a question to Andrei Illarionov...

Kinenmos: Getting to the Australian situation, very early after Kyoto, the Australian government and the Prime Minister said that Australia was not going to ratify the Kyoto Protocol because of the impact on the economic conditions in Australia. It would mean the loss of jobs and the export of jobs because Australia is essentially a country that has a lot of energy-intensive industries, and their growth would be on energy-intensive industries. So the Prime Minister was very categorical, and he has been since that time that Australia would not ratify the Kyoto Protocol.

Question: Was there any pressure on Australia to ratify?

Kinenmos: I cannot answer whether in the government area there was pressure or not. There certainly was not pressure as is experienced here in Russia, but Australia very early, the Prime Minister said that Australia was not going to ratify for the reasons that I gave.

Question: My second question is for Andrei Nikolayevich. Doesn't the Academy of Sciences have security guards so that you wouldn't have to lose four hours and wouldn't have your seminars disrupted?

Illarionov: Before I answer your question I've just been asked that here is a package of materials distributed at the seminar and is available at the exit. You will be able to get the hand out.

As for the guards, I have seen them. But I understand that the question was that Russian participants tried to do all they could in order that the seminar's work were normal. And unfortunately, from this two-day experience, I have made it clear for myself that different participants in the seminar pursued different goals. For some participants the main goal was the search for the truth, understanding of real processes. Other people had the task of disrupting the seminar, so that other people who were seeking the truth could not do so. And this, probably, accounts to what was taking here over the past two days.

Izrael: I will add something because Andrei Nikolayevich has already said that Sir David King, adviser to the British government---he had brought several scientists along with him and he insisted that the program should include among the speakers only those scientists and no other. So, he came over, selected scientists at his discretion, scientists who were to be given the floor in his opinion and scientists who were to be denied an opportunity to speak. He even said that you are in the minority and we are not going to listen to you.

Question: Japanese paper Mainichi. I have a question to Mr. Illarionov. Last month when Foreign Minister of Japan came to Moscow she met with high-ranking officials of the Russian government and one of them told her that Russia will soon be ready to get the answer about the Kyoto Protocol ratification issue and he also told her that the answer will be in favor of Japan. Pretty much indicating that Russia will be ratifying the protocol pretty soon. Do you think that will happen and has Mr. Putin made the decision about ratifying or not ratifying the protocol?

Illarionov: I'll try to answer each part of your question. The first part is, you said that the decision would be taken in favor of Japan. As you understand, a decision in favor of Japan means a refusal to ratify the Kyoto Protocol. Because the ratification of the Kyoto Protocol will hit hardest at those countries which had been careless enough to assume obligations to cut carbon dioxide emissions, and Japan was one of such countries.

In February a large international seminar was held in Moscow on the issues of the Kyoto Protocol and climate change which was attended among others by representatives of Japan, including representatives of Japanese business and the government of Japan. I remember the presentation by a Japanese representative who described how Japan was already doing everything possible to comply with the terms of the Kyoto Protocol. That gentleman said that Japan was doing everything to reduce economic activities in Japan, including the movement of production outside Japan thus aggravating the economic crisis in which Japan has been for the last 14 years.

It is known that in the last 14 years Japan has been lagging far behind other developed states and instead of bridging

the gap between itself and the United States and even Europe, it was increasing the gap. So, the introduction of the Kyoto Protocol through ratification, for instance, possible ratification by Russia would mean that Japan would quickly start to move back to the state in which it was a decade ago, it would be weak, poor and backward. I don't think it would be in the interests of Japan.

As for the reference to the remarks by you Foreign Minister who had met with an unidentified Russian officials who allegedly promised your Minister early ratification of the Kyoto Protocol by the Russian side, you understand that in wartime, and we re aware that it is a war, there is always room for the fifth column. You know what the fifth column is. And the people in the fifth column are working actively because they want Russia to pass such a decision as quickly as possible and they use every trick in the book starting from bribery and ending with intimidation, threats and blackmail.

So, you as a close observer of events in Russia has a unique chance to see, identify and even interview some of the representatives of the fifth column.

And finally, regarding the last part of your last question. If the Russian Federation ever decides to ratify the Kyoto Protocol such a decision will have been taken not only the basis of substantive analysis, not for substantive, but for some other reasons. We cannot fully rule that out just as we cannot fully predict climate change on the planet. But in any case, if such a decision is taken, it would deal, I repeat, a very serious blow to Russia, Japan, the European Union and Canada, the countries and regions which were rash enough to assume such obligations.

And it would deal a powerful blow on the whole humanity similar to the one humanity experienced when Nazism and communism flourished.

Question: The Japanese Information Agency. Mr. Illarionov, a very simple question. Why don't you go along with the words of your boss, President Putin, who said quite clearly: "We are in favor of the Kyoto Protocol"?

Illarionov: I will permit myself to remind you of the words said by President Putin. President Putin has never said that he supported the Kyoto Protocol. President Putin said on May 24, 2004 that he supported the Kyoto process. So, I am sorry, but you can't say that I do not support President Putin on this issue.

Note: Mr Illarionov's reference here is really to **Bill Kininmonth**, former director of the Australian National Climate Centre. [back to text]

New ENSO Forecasts Based on Solar Model

APPENDIX VI (1)
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath
7 Sept 2004

by **Dr Theodor Landscheidt** (22 Dec 2003)

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1. Introduction

Anomalous warming (El Niño) or cooling (La Niña) of surface water in the eastern equatorial Pacific occurs at irregular intervals (2 to 7 years) in conjunction with the Southern Oscillation (SO), a massive seesawing of atmospheric pressure between the south-eastern and the western tropical Pacific. The coordinated El Niño/Southern Oscillation phenomenon (ENSO), also including La Niña, is the strongest source of natural variability in the global climate system. Anomalies in the global temperature (positive or negative deviations from a defined mean temperature) are primarily driven by ENSO events **(Peixoto and Oort, 1992)**.

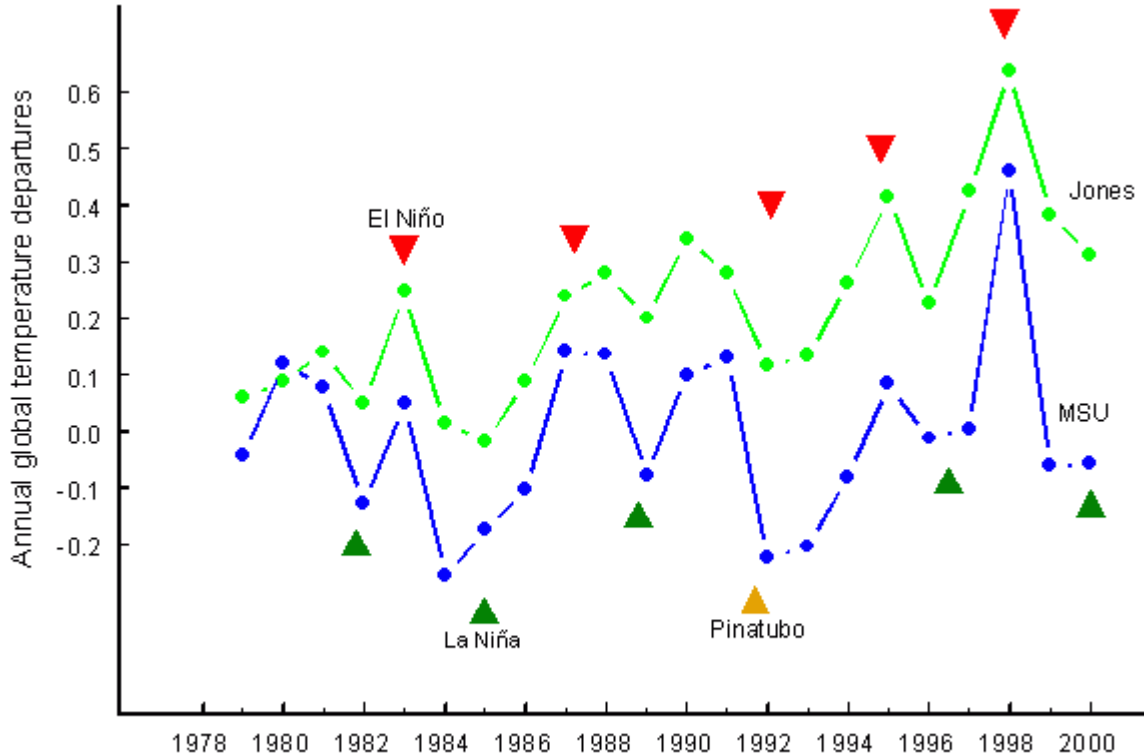

Figure 1

Figure 1 shows this clearly. The green curve presents global temperature anomalies based on surface observations (Jones) while the blue curve is based on satellite data (MSU). Though the amplitudes of the two curves are quite different, they reach peaks and troughs at nearly the same time. Red triangles mark El Niño events and green triangles La Niña episodes. El Niños consistently coincide with peaks in global temperature and La Niñas with troughs. There is only one exception around the Pinatubo eruption indicated by a yellow triangle. When explosive volcanic activity intervenes, global temperature is modulated by its cooling effect.

The importance of ENSO activity for global climate has recently been corroborated by an investigation which shows that the variability of the Pacific Decadal Oscillation (PDO) is subjected to direct forcing by El Niños and La Niñas, not vice versa, so that predicting the PDO may be directly related to the skill of forecasting ENSO **(Newman et al., 2003)**.

So it is plausible that there are strong links between ENSO events and the seasonal course of weather in other world regions. As this might be the key to long-range seasonal forecasts, there is strong interest in precursors that could make it possible to predict ENSO events. Daily observations of changes in sea surface temperature (SST), surface wind, upper ocean thermal structure, and ocean currents enable researchers to develop models that can be tested by experimental forecasts. It seems to be very difficult, however, to design models that extend the limit of several months set by the observation of precursors. Zane and Zebiak of the Lamont-Doherty Earth Observatory made the first successful forecast of an El Niño in early 1986, one year ahead of the event, but their model did not predict the strong El Niño in 1997.

At present, there exist no physical or statistical models that can skilfully predict ENSO events at lead times longer than 12 months **(Neelin and Latif, 1998)**. Landsea and Knaff **(2000)**, who employed a statistical tool to evaluate the skill of twelve state-of–the-art climate models in real time predictions of the development of the 1997-1998 El Niño, have shown that the models exhibited essentially no skill in forecasting the event at lead times ranging from zero to eight months.

According to Neelin and Latif **(1998)** weather noise and deterministic chaos, representing the internal variability of the climate system, set the fundamental limits to the lead time. This emphasis on the exclusively internal character of ENSO events is in accordance with the tenet of climatology that ENSO phenomena are the most spectacular example of a free internal oscillation of the climate system not subjected to external forcing **(Peixoto and Oort, 1992)**. It has been shown that this tenet is not tenable because there is external forcing exerted by solar activity to such a degree that long-range ENSO forecasts can be based on it. I correctly predicted the last three El Niños, years before the respective events, and also the course of the last La Niña **(Landscheidt, 2002)**, though the forecast was exclusively based on the Sun's variable eruptive activity. **(See special note by John L. Daly re. this claim)**. Meanwhile, I have been working on this solar model to improve it. The advanced version is presented here together with new detailed ENSO forecasts.

2. Maximum of solar eruptions in the 11-year sunspot cycle

The sunspot maximum of the 11-year cycle is a well known feature. In the literature, the length of the sunspot cycle is not only measured from minimum to minimum, but also from maximum to maximum. Yet it is scarcely known that there is also a maximum of the Sun's eruptional activity (flares, coronal mass ejections, and eruptive prominences) within the 11-year cycle. It is shown here that it can be defined in a precise way. Consecutive maxima of eruptions (EM) form cycles of their own - from EM to EM - which also have a mean length of 11 years. They are of special import as they are closely linked to ENSO activity.

The 11-year sunspot cycle is not symmetric. Reliable observations available since 1750 show that the mean rise to the sunspot maximum (4.3 years) is considerably steeper than the decline to the sunspot minimum (6.7 years). In the mean cycle normalized to 1, the ratio of the rising part to the whole cycle is 0.39 and of the descending part to the complete cycle 0.61. This is close to the proportion of the golden section which divides a frame structure like a line segment, a surface, a cycle, or any other delimited feature so that the ratio of the smaller part (minor) to the larger part (major) equals the ratio of the larger part to the whole. When the whole is set equal to 1, we get

$$0.3819 \ldots : 0.618 \ldots = 0.618 \ldots : 1.$$

To find the approximate major of the length of a cycle, it has to be multiplied by 0.618. Multiplication by 0.382 yields the minor. This makes it easy to see that according to observations going back to 1750 the sunspot maximum falls nearly exactly at the minor of the golden section when the cycle is measured from minimum to minimum.

This is not merely a queer coincidence. It is well known that the golden section has not only astounding mathematical qualities, but also orchestrates the growth of plants and regulates neuron stability **(Kappraff, 1991)**. Yet even scientists are often not aware of physical functions of the golden section, especially in celestial dynamics. There is mathematical proof that the golden number G =

0.618 … is the most irrational number in all classes of numbers. This quality links it to the stability of the solar system as the mathematicians and physicists Siegel **(1942)**, Kolmogorov **(1979)**, Arnol'd **(1963)** and Moser **(1973)** have shown. This is crucial, as a 100-million year integration of the solar system **(Sussman and Wisdom (1992)** provides evidence that all planetary orbits are chaotic with a time scale for exponential divergence of about 4 million years. In my paper *"The Cosmic Function of the Golden Section"* **(Landscheidt, 1995)** I have shown how the golden section as a stability parameter has kept the solar system stable for 4.6 billion years in spite of chaos in all planetary orbits. The stabilizing function of the golden section is not confined to macroscopic dynamical systems. Child **(1993)** and Mackay, Meiss and Percival **(1987)** have provided evidence that it governs the inner dynamics of molecules at energies approaching the ionization threshold. The fact that the ascending part of the 11-year sunspot cycle equals the minor and the descending part the major of the golden section contributes to the stabilization of solar activity which is characterized by phenomena generated by instability.

In this light, it makes sense that first investigations indicate that the maximum of eruptions EM falls at 0.618 of the unit cycle. It establishes symmetry within the 11-year cycle as sunspot maximum (SM) and EM at 0.382 and 0.618 show bilateral symmetry with respect to 0.5 at the middle of the cycle. The interval from EP to EP turns out to be a cycle (EMC) which as well as its second harmonic (EMC/2) is closely connected with ENSO events.

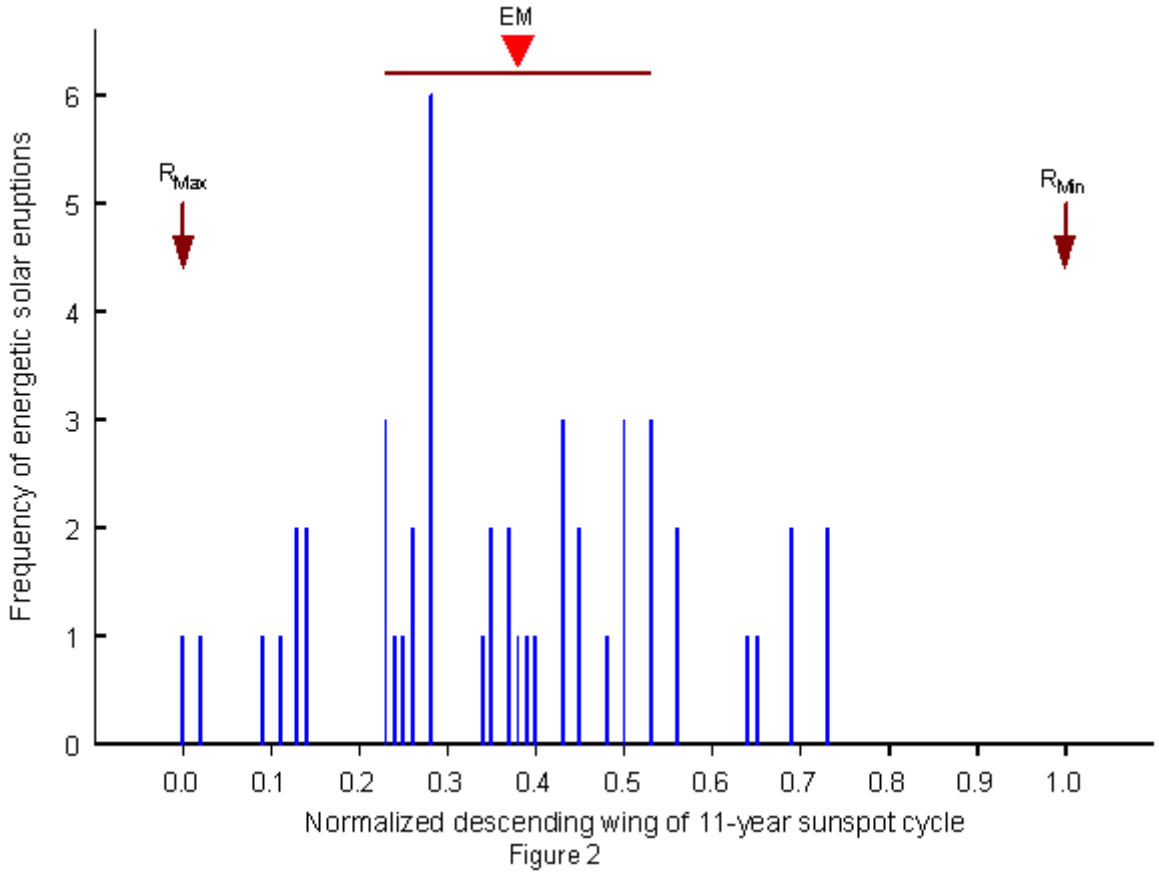

Figure 2

Figure 2 presents a first assessment of the position of EM checking the working hypothesis that EM falls at 0.618 of the unit cycle. It shows the frequency distribution of energetic solar eruptions within the descending part of the 11-year sunspot cycle from maximum to minimum as indicated by arrows. The sample covers all energetic flares X => 6 observed by satellites from 1970 to present. These data are available at the National Geophysical Data Center, Boulder. Intense X-ray flares, nearly always accompanied by heavy coronal mass ejections, are geophysically more effective than flares categorized into classes of optical brightness. Before 1970, there were no continuous satellite observations of X-ray flares. This is why all highly energetic cosmic ray flares observed between 1942 and 1970 were included as listed by Sakurai **(1974)** and Smith and Smith **(1963)**. The total sample comprises 49 extremely energetic eruptions. The descending wings of the sunspot cycles between 1942 and present were normalized to have equal unit length to make it easy to recognize identical phases of events in different cycles.

The hypothetical position of EM at 0.618 of the 11-year cycle normalized to 1 is marked in Figure 2 by a red triangle. A range of ±0.15 around EM is indicated by a horizontal bar. As expected, the energetic eruptions accumulate in this region close to EM. As many as 33 of the 49 eruptions fall at this range. The recent spectacular eruptions covered by media reports, too, are to be found in this region. Close to the sunspot maximum RMax, however, only a few eruptions were observed.

In a statistical evaluation based on traditional expectations it would have seemed reasonable to assume a maximum of eruptions around RMax and a descending frequency parallel to the course of the diminishing sunspot activity. This expected frequency, however, would be exposed to objections. As can be seen from Figure 2, beyond 0.75 of the scale there are no longer any strong eruptions observed as this is too close to the minimum of the cycle. Moreover, it seems more objective to expect an equal distribution in the whole area covered by eruptions from 0 to .75 on the scale so that any predilections are avoided. A Pearson-test on this basis with two classes, one ±0.15 around EM and the other one comprising the rest of the scale up to 0.75, yields $Chi^2 = 15.3$ for 1 degree of freedom and $P < 0.0001$. Re-sampling confirms this result. As EM falls just at the center of the most frequent eruptions, the hypothesis that the mean position of EM is identical with the major of the golden section at 0.618 of the scale cannot be rejected.

This is corroborated by an additional result. As Figure 2 shows only the frequency distribution in the descending wing of the cycle normalized to 1, the position 0.618 in the whole cycle is identical with 0.382 on the scale in Figure 2. The weighted mean of the observed frequency distribution in Figure 2 is equal to 0.37. This is rather close to the hypothetical position of EM at 0.382.

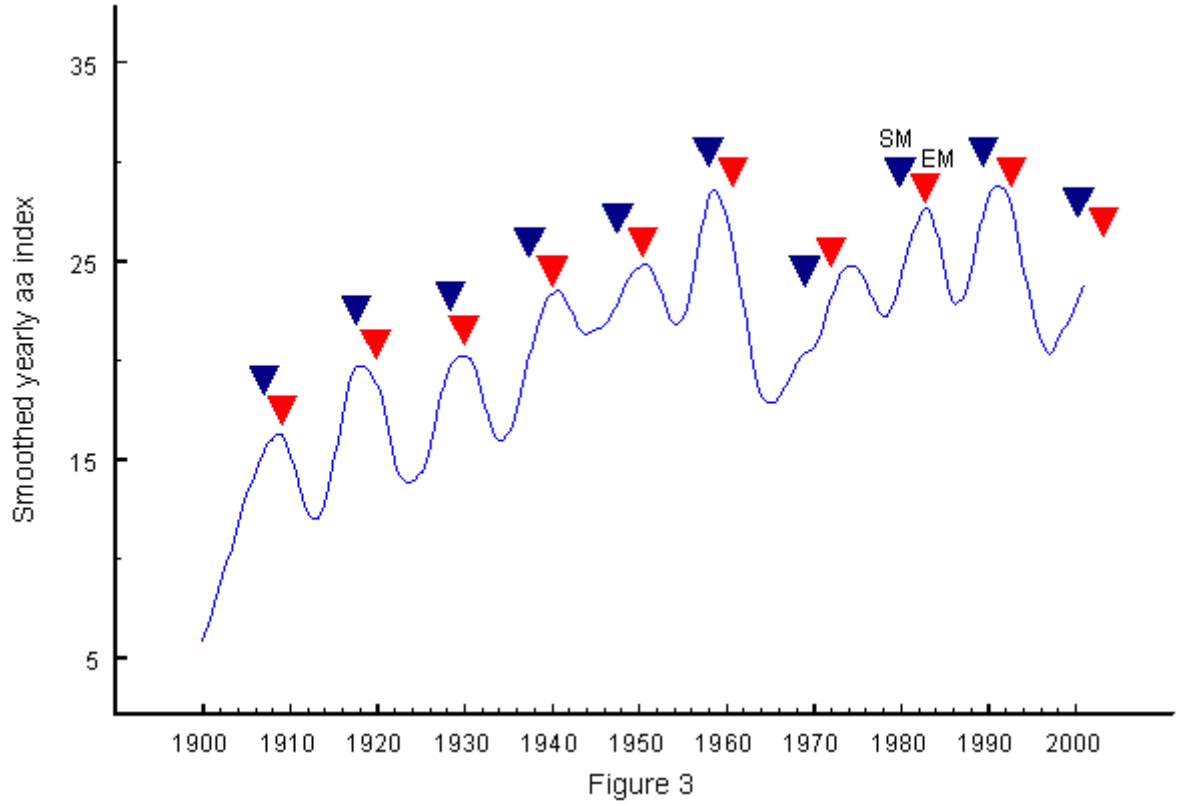

Figure 3

The investigation of energetic eruptions covers only the sunspot cycles from 1970 on. Figure 3 extends the assessment of EM back to 1900. The geomagnetic aa index **(Solar-Geophysical-Data, 2003)** measures the effect of solar eruptions near Earth. The blue curve in Figure 3 shows the smoothed aa index from 1900 to 2000. Hypothetical EM positions at 0.618 are marked by red triangles and the sunspot maxima (SM) by blue triangles. It can clearly be seen that the position of EM nearly always coincides with the aa maxima indicating phases of strong eruptional activity on the sun. There are only two exceptions: the aa maxima around 1958 and 1990 occurring within exceptionally short and intense sunspot cycles. In such cases the aa maximum seems to develop earlier than hypothesized. Obviously, the SM is a bad indicator of the most eruptive phase in the sunspot cycle.

3. El Niño and La Niña linked to cycles based on EM and SM

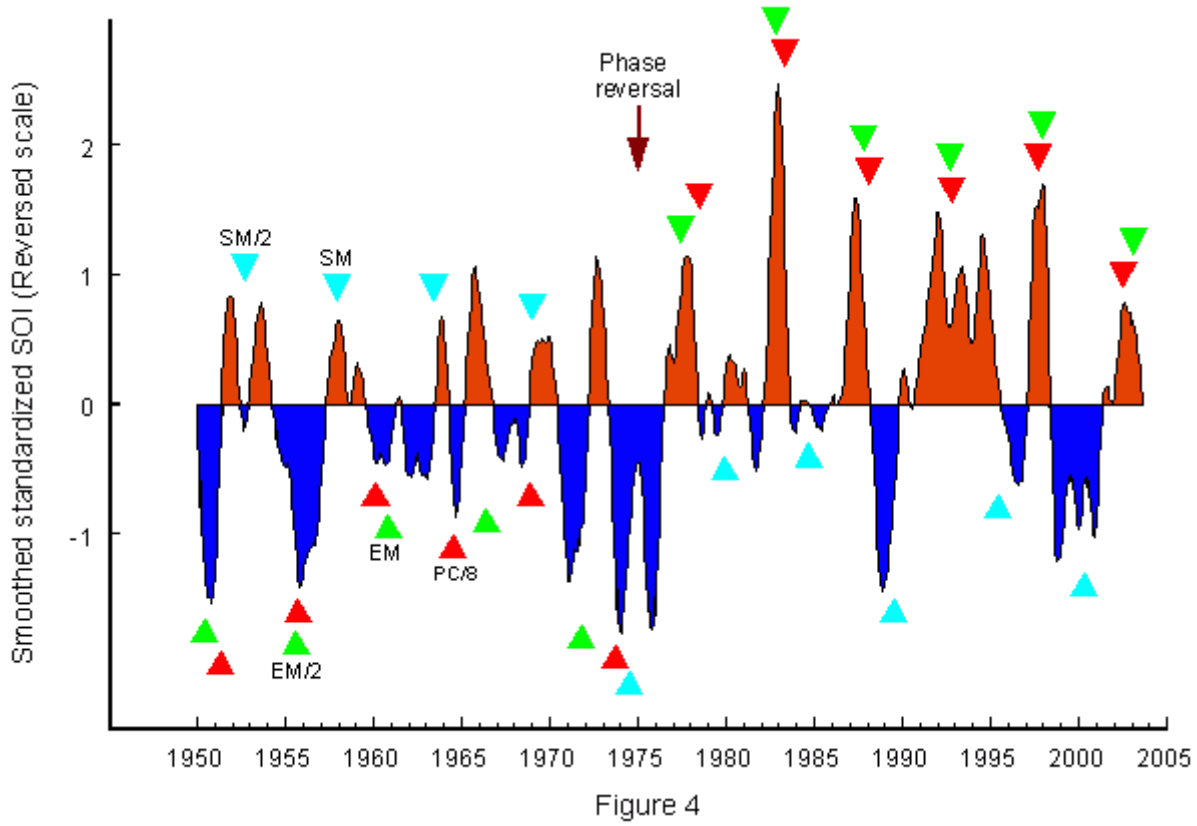

Figure 4

The curve in Figure 4 shows slightly smoothed standardized monthly data of the SOI, the Southern Oscillation Index **(Climate Prediction Center, 1998)**. It measures the pressure gradient across the tropical Pacific which, in turn, is an indicator of equatorial wind variations. Low negative SOI values, indicating El Niños, go along with weaker than normal trade winds over the central Pacific, warmer than normal sea surface temperatures (SST) over the eastern equatorial Pacific, and a reduced westward pressure gradient with changing wind stress values. High positive SOI values indicate La Niña conditions, just the opposite of the El Niño scenario. In Fig. 4 the data are reversed so that strong positive peaks point to El Niños (red areas) and negative deviations to La Niñas (blue areas).

It is evident that the cycle running from EM to EM (EMC) and its second harmonic are closely connected with ENSO events. EM and the zero phase of its second harmonic (EM/2) are indicated by green triangles. Before the phase reversal, indicated by an arrow, the EM and EM/2 phases coincide with La Niñas and afterwards with El Niños. The sunspot maximum SM as well as the second harmonic of a cycle running from SM to SM (SMC) show a similar connection, though reversed. SM and the zero phases of the second harmonic (SM/2) are marked by triangles in cyan colour. Before the phase reversal SM and SM/2 go along with El Niños and afterwards with La Niñas. The effects of EMC and SMC seem to be of opposed polarity, but the pattern before and after the phase reversal overall shows balanced symmetry, similar to EM and SM with respect to 0.5 in the 11-year unit cycle.

4. Phase reversals in solar cycles connected with ENSO events

In nearly all of my papers I could show that there are phase reversals in the climate time series related to solar cycles. These are not ad hoc inventions, but computable phases of instability that usually occur when zero phases of longer solar motion cycles coincide with zero phases of shorter solar motion cycles. Without such knowledge forecasts would lead astray. A predicted El Niño could turn out to be La Niña, or vice versa. Thorough analysis has disclosed that with regard to ENSO events there is another pattern of phase reversal that had escaped my notice.

I have shown that the North Atlantic Oscillation (NAO), the Pacific Decadal Oscillation (PDO),

extrema in global temperature anomalies, drought in Africa and U.S.A., as well as European rainfall and floods are linked to cycles in the sun's irregular orbital motion around the center of mass of the solar system **(Landscheidt, 1983-2003)**. The rate of change of the sun's orbital angular momentum L - the rotary force dL/dt driving the sun's orbital motion (torque) - forms a torque cycle (TC) with a mean length of 16 years **(Landscheidt, 2001a,b)**. Perturbations in the sinusoidal course of this cycle recur at quasi-periodical intervals and mark initial phases of a perturbation cycle (PC) with a mean length of 35.8 years. As to details, I refer to Figure 2 of my on-line paper *"Solar eruptions linked to North Atlantic Oscillation"* **(Landscheidt, 2001 a)**.

The zero phases of the PC play an important role in the long-range forecast of diverse climate phenomena. They indicate, for instance, the peaks of warm PDO regimes, the coolest phases of cold regimes, and shifts between these regimes **(Landscheidt, 2001b)** They are also linked to extended dry and wet spells measured by the U.S. drought index **(Landscheidt, 2003a)**. As to the details and physical implications of the Sun's irregular orbital motion I refer to my papers *"New Little Ice Age instead of global warming?"* **(Landscheidt, 2003b)** and *"Extrema in sunspot cycle linked to Sun's motion"* **(Landscheidt, 1999)**.

Another approach to the 35.8-year cycle has been presented in Fig. 3 of my paper *"Trends in Pacific Decadal Oscillation subjected to solar forcing"* **(Landscheidt, 2001b)**. It has been shown that absolute values of the torque cycle (|dL/dt|) form a shorter cycle that plays, e. g., a major role in solar forcing of the North Atlantic Oscillation **(Landscheidt, 2001a)** and discharges in river catchment areas **(Landscheidt, 2000c,d)**. When a Gaussian low-pass filter suppressing wavelengths shorter than 9 years is applied to |dL/dt|, new oscillations emerge as shown in Fig. 3 of the quoted paper for 1721 - 2077. Minima in the smoothed |dL/dt|-curve are identical with initial phases in the 36-year perturbation cycle. So it is easy to compute the precise dates of these phases for any period, as for instance 1829.5, 1867.2, 1901.8, 1933.6, 1968.9, 2007.2, 2044.9., and 2080.7.

Nature often repeats well-tried patterns on different scales. When the 36-year cycle is considered to be part of a fractal that also comprises the 11-year sunspot cycle, to which it is linked by the Sun's dynamics, the phase of the minor 0.382, comparable to the sunspot maximum in the 11-year cycle, may be expected to have special functions. One of them is, as far as I can see, the induction of phase reversals in subordinated cycles. Especially solar cycles that are linked to ENSO events are affected. This was confirmed by a comparison of Quinn's El Niño index **(Quinn et al., 1987)** going back to 1525 with phases 0.382 in respective 36-year cycles. This morphological relationship makes sense as the solar magnetic field reverses its polarity when the 11-year cycle reaches the sunspot maximum.

The initial phase of the current PC falls at 1968.9 and this cycle ends in 2007.2. So the minor 0.382 falls at 1983.5. The actual phase reversal, however, occurred in 1976 as will be confirmed by additional data presented in Figures 4 and 5. This is the only exception in more than 200 years. Unfortunately, just in the present cycle important for the current forecast another factor intervened, namely the 179-year cycle in the Sun's motion. Jose **(1965)** has found patterns in the rate of change in the Sun's orbital angular momentum that repeat at intervals of 178.8 years. In his pioneering computer analysis of the Sun's motion he discovered that sunspots, too, follow a cycle of this length.

According to Dansgaard et al. **(1973)**, a period of 181 years, rather close to 179 years, is the paramount cyclic feature of the oxygen isotope profile of the Camp Century ice core. This indicates a connection with climate I dealt with in several papers **(Landscheidt, 1983-2003)**. The Jose cycle could be shifted arbitrarily. I have shown, however, that it has well defined initial phases that fall, for instance at 1545.1, 1723.1, 1901.8. and 2080.7. As to a plot of the 179-year cycle I refer to Figure 3 of my on-line paper *"Trends in Pacific Decadal Oscillation subjected to solar forcing"* **(Landscheidt, 2001b)**.

The 179-year cycle, also linked to the Sun's dynamics, may be considered to be part of a comprehensive fractal that also comprises the 36-year cycle and the sunspot cycle so that the minor of the golden section also induces phase reversals in subordinated cycles. In the current cycle running from 1901.8 to 2080.7 the minor 0.382 falls at 1970.1. Detailed analysis shows that the phase reversal in 1976, indicated in Figures 4 and 5 by arrows, occurred just at the midpoint 1976.8 between 1970.1 and the 0.382 phase 1983.5 in the 36-year cycle. As the 0.382 phase in the

following 36-year cycle will not be reached before 2021, the pattern should continue as indicated in Figures 3 and 4 after the phase reversal in 1976. Those who want to make forecasts themselves should understand that a solution of the problem of phase reversals, neglected or even ridiculed by most climatologists, is crucial to skilful forecasts of ENSO episodes and other climate phenomena regulated by solar activity.

Intriguingly, the phase reversal in 1976 went along with a crucial regime and trend shift in global temperature. It is acknowledged that three phases can be distinguished in the development of global temperature: Steep rising trend from a deep point around 1910 to a crest about 1945, a cooling trend from 1945 to 1976, and from then on again a rising trend. The last regime shift in 1976 coincided with the described phase reversal in 1976. The phase reversals indicated by the phases 0.382 in the two preceding PCs fall at 1947.1 and 1913.9. They also coincide with the respective regime shifts.

5. Harmonics of perturbation cycle PC connected with ENSO episodes

The red triangles in Figure 4 indicate zero phases of the 8th harmonics (PC/8) of the 36-year solar motion cycle described above. Up to the phase reversal in 1976, these PC phases coincide with La Niñas and after the phase reversal with El Niños. It results in the same pattern of variations as with EM and EM/2. It should be noted that this seems to explain the preponderance of La Niñas up to 1976 and of El Niños after the phase reversal. Predominant La Niñas and El Niños are indicated by two factors from quite different solar cycles nearly simultaneously, whereas El Niños before 1976 and La Niñas after 1976 are only connected with a single solar factor. This seems to have a quantitative effect.

6. Special torque cycle involved in solar forcing of ENSO events

A further factor that seems to contribute to the solar triggering of El Niño and La Niña is a special form of the 16-year torque cycle TC described above. Its consecutive zero phases have a different quality. The Sun's orbital motion, from which the cycle is derived, is governed by difference forces in the same way as the planets' course around the Sun. Gravitation and centrifugal force are balanced overall, but in special phases of the orbit one of the two forces may prevail. Zero phases Zg initiate a period of prevailing gravitation and an orbital motion towards the centre of mass (CM) of the solar system, whereas the respective neighbouring zero phases Zc mark the start of dominant centrifugal force and a motion away from the CM. These changes in the physical quality of the solar motion have a strong effect on the distribution of solar eruptions in different regions of the Sun **(Landscheidt, 1986 a)**.

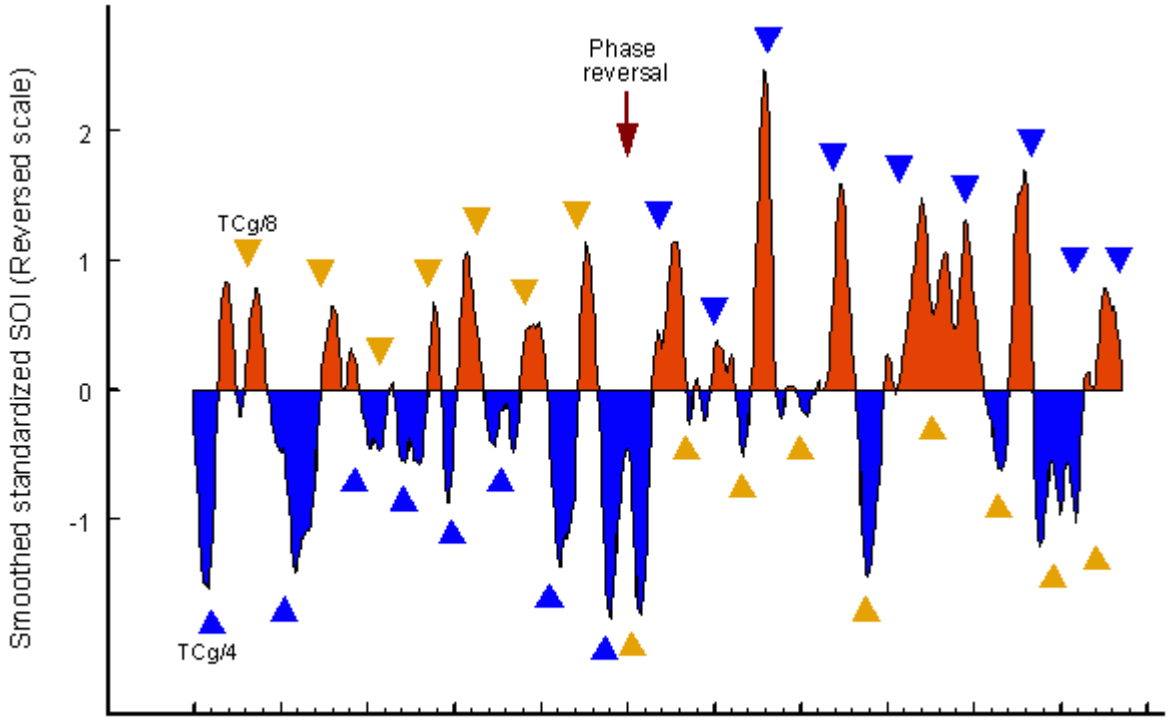

Figure 5

Torque cycles measured from Zg to Zg (TCg) have a mean length of 16 years, but there are strong variations between 10 and 23 years. Figure 5 shows a close connection between TCg and ENSO events. Zero phases of the 4th harmonic of TCg (TCg/4) are marked by blue triangles. Before the phase reversal they consistently coincide with La Niñas and after 1976 with El Niños. Zero phases of the 8th harmonic of TCg (TCg/8) are indicated by yellow triangles. They have the opposite effect. Before the phase reversal they are coeval with El Niños and after 1976 with La Niñas. Again there is overall symmetry. As to the preponderance of La Niñas up to 1976 and El Niños after 1976 there is no essential change. Without inclusion of the results presented in Figure 5 the ratio of the forcing was 2 to 1 and with inclusion 3 to 2 in favour of the predominant phenomenon. Again, the precision of the phase reversal is impressive, especially as the TCg phases are derived from another quite different solar cycle.

A comparison of Figures 4 and 5 shows that of the five solar factors involved – EM and EM/2, SM and SM/2, PC/8, TCg/4, and TCg/8 - often two or three are related to a single ENSO episode. The mean of their dates indicates the peak of the ENSO effect. If in rare cases not all of the single events presented in one of the Figures 4 and 5 are covered by one of the factors, a proper link is to be found in the other figure. If factors with opposite effect coincide, this cripples the ENSO response. TCg/4 in 1980 and SM in1979.9 are a case in point.

7. New Forecasts of El Niño and La Niña

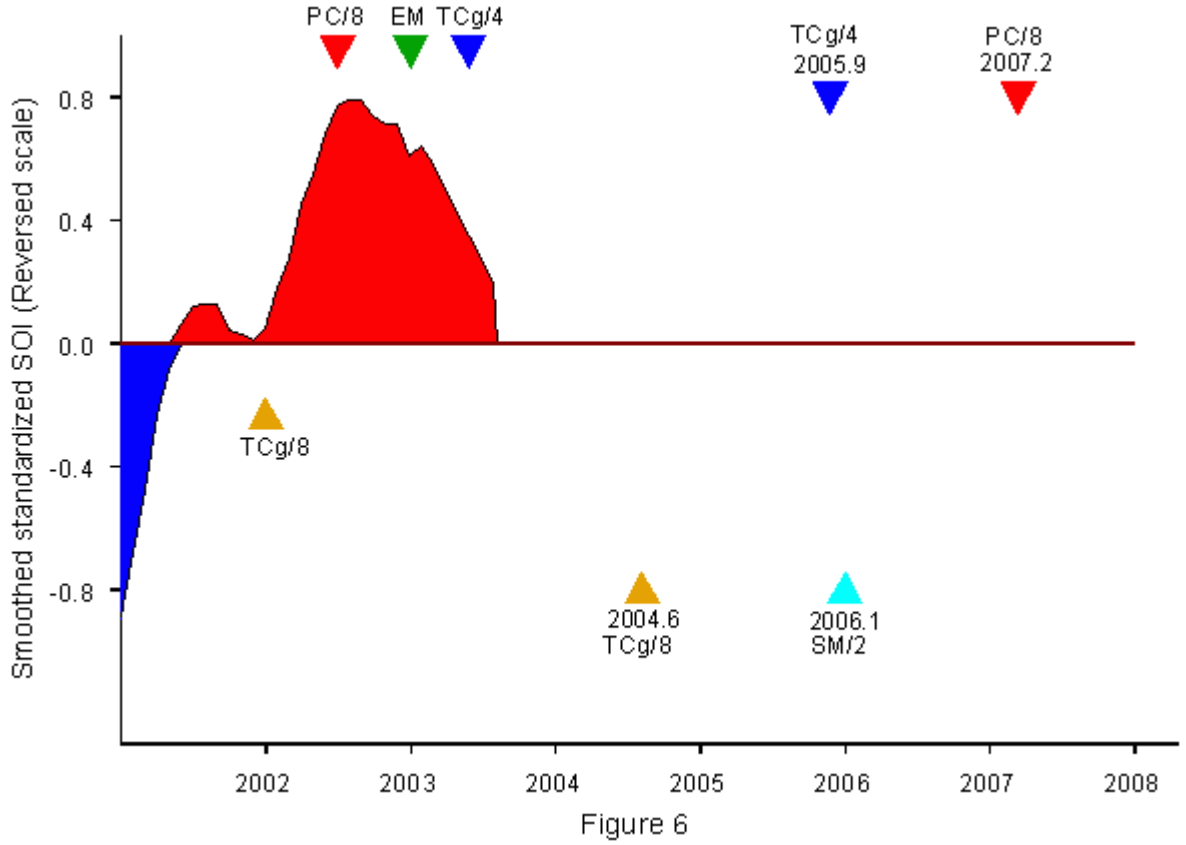

Figure 6

Figure 6 shows on the left the development of the last El Niño. The steep rise from the last cool episode to warm conditions, initiated by PC/8, was interrupted by TCg/8, but then supported by EM and TCg/4. As TCg4 fell at 2003.4, warm SST in the equatorial Pacific lingered far into 2003. A La Niña episode could not develop. As there is no other factor around that could interfere, neutral conditions should prevail from December 2003 to at least April 2004 (Probability 85 %).

TCg/8 in 2004.7, favouring cool conditions, is expected to release La Niña after April 2004 and last at least till April 2005 (Probability 90 %).

The forecast for the rest of the year 2005 is more difficult than at other times, as can be seen when Figure 6 is compared with Figures 4 and 5. TCg/4 in 2005.9 would release an El Niño lasting from about May 2005 to April 2006 if it were not opposed by SM/2 which is expected to occur at the beginning of 2006. It is probable (75%) that conditions like around 1980 will develop when TCg/4 in 1980 and SM in 1979.9 released opposing potentials at the same time. Figures 4 and 5 show that around 1980 there was only slight warming that did not reach the level of an El Niño. These conditions should last at least till May 2006. This situation would change if the next 11-year sunspot cycle No. 24 would turn out to be so weak that it reached the unusual length of more than 12 years. SM/2 would then shift to a later date and no longer oppose TCg/4.

PC/8 in 2007.2 has El Niño potential. As the date 2007.2 is closer to 2006/2007 than to 2007/2008 it is to be expected that El Niño will already emerge around July 2006 and last at least till May 2007 (Probability 80 %). The alternative to this early date is a release of the expected El Niño around April 2007; it should last till January 2008 (Probability 20 %).

As to a definition of ENSO based on the Southern Oscillation Index I refer to my paper "El Niño forecast revisited" **(Landscheidt, 2002)**. This definition is in accord with the NOAA's declarations about the state of ENSO published by the Climate Prediction Center/NCEP

8. Physical background and outlook

In spite of my well-documented successful ENSO forecasts years ahead of the respective events it is to be expected that the presented results will be dismissed as a statistical artefact as there is no

detailed causal explanation in strict terms of physics. This is no valid argument, however, as long as climatologists do not know how El Niño and La Niña come into existence. It is only known which meteorological processes go along with the development of ENSO episodes, not what releases them. So critics nonsensically demand a physical explanation of the solar relationship to processes that have not yet been explained by climatologists.

Though there are no strict physical arguments that could explain in detail how solar activity causes ENSO events, it is possible to develop working hypotheses that suggest potential mechanisms that could be of import if climatologists find out how El Niño and La Niña are triggered. Flares increase the Sun's UV radiation by at least 16%. Ozone in the stratosphere absorbs this excess energy which causes local warming and displaces the 70-mb polar vortex. This disturbance in the circulation is propagated downwards to the troposphere where it affects the intensity of the Hadley circulation. Hartley et al. **(1998)** have shown that there is a dynamical link between stratospheric polar vortex distortions and meteorological events in the troposphere.

General circulation models developed by Haigh **(1996)**, Shindell et al. **(1999)**, and Balachandran et al. **(1999)** confirm that circulation changes initially induced in the stratosphere can penetrate into the troposphere and influence temperature, air pressure, Hadley circulations and storm tracks by changing the distribution of large amounts of energy already present. As ENSO events are linked to trade winds and trade winds to Hadley cells that may be affected by flare induced circulation change in the stratosphere, it seems plausible that energetic solar eruptions may be an essential link in the causal chain triggering ENSO events, especially if there is a barrage of solar eruptions covering weeks.

Solar X-rays around 10 Å intensify by a factor of 100 or more during moderate-sized flares while strong flares can amplify the X-ray level by a factor of 1000. I refer to my paper *"Solar rotation, impulses of the torque in the Sun's motion, and climatic variation"* **(Landscheidt, 1988)** which describes how X-rays produced by energetic solar eruptions may enhance thunderstorm activity. Severe thunderstorms are linked to tropical cyclones **(Williams, 1977)** which may trigger and sustain El Niños **(Ramage, 1986)**.

Another possibility are seismic predictors of El Niño connected with solar eruptions. El Niños occur during sustained simultaneous abnormal weakenings of the high pressure cell in the South Pacific generally centered near Easter Island and abnormal strengthening of the low pressure cell near northern Australia. Walker **(1995,1999)** has found that located on the seafloor within the same region is one of the Earth's most rapidly spreading mid-ocean ridge system affected by strong seismic activity just before El Niños begin to develop. As the correlation between the seismic predictor and El Niños is highly significant, Walker assumes that massive episodic thermal intrusions may play an important role in disrupting the east-to-west interactions of the high and low pressure cells. Handler **(1989)** and recently Adams et al. **(2003)** also assume a connection between seismic activity and El Niños, but base them on explosive tropical volcanic forcing via aerosols.

According to Walker **(1999)** the rapidly spreading ridge system includes the Easter and Juan Fernandez microplates. Accumulated strain between such plates can be released by jumps in the Earth's rotational velocity. Rotational jumps of this kind were observed after energetic solar flares **(Danjon, 1959, 1960)**. The length of day increases in such cases by two milliseconds and it takes half a year to regain the rotational state before the flare. Strong geomagnetic activity reflects strong flare activity and could be indicative of jumps in the Earth's rotation. When I compared the geomagnetic aa index with seismic activity, I found a highly significant correlation. The result will be published in a separate paper.

There can be no doubt that solar eruptions generally have a strong effect on weather and climate as its integral. There are hundreds of observations which show clearly that within a few days after solar flares, coronal mass ejections, or eruptive prominences there are diverse meteorological responses of considerable strength. As to the wealth of publications I refer to Chapter 4 of my paper *"Long-range forecast of U.S. drought based on solar activity"* where I also quote papers on physical models that could explain the effect of solar eruptions on climate.

Even if there were no such observations and potential physical models, the lack of a viable

mechanism is not a valid scientific argument as most studies in natural sciences begin without knowledge of the responsible mechanisms **(Roederer,1993)**. Many practices in meteorology are on this heuristic level and mankind made use of electricity long before anyone knew that there are electrons. Epistemologically, the stages of gathering data, establishing morphological relationships, and setting up working hypotheses necessarily precede the stage of elaborated theories. We are able already to discern underlying patterns in a seemingly impenetrable thicket of data without correlations. Predictability, based on such patterns is one of the corner stones of science. Open-minded scientists should cooperate to achieve progress in this field.

IPCC proponents prayer-wheel-wise repeat the mantra that in recent decades the effect of solar activity, still prevalent in the first half of the 20th century, has marvellously disappeared. My correct long-range forecasts of the last three El Niños and the course of the last La Niña, exclusively based on solar activity, and the additional results presented in Figures 4 and 5 of this paper are evidence to the contrary.

Acknowledgement:

I confirm that I did this work without any support from any side.

References:

Adams, J. B., Mann, M. A., and Ammann, C. M. (2003): Proxy evidence for an El Niño-like response to volcanic forcing. Nature 426, 274-278.

Arnol'd, V. I. (1963): Small denominators and problems of stability in classical and celestial mechanics. Russ. Math. Surv. 18,85.

Balachandran, N. K., Rind, D., and Shindell, D. T., 1999: Effects of solar cycle variability on the lower stratosphere. J. Geophys. Res. 104, 27321-27339.

Child, M. S. (1993): Nonlinearity and chaos in atoms and molecules. In: Mullin, T., ed.: The nature of chaos. Oxford, Clarendon Press, 272.

Climate Prediction Center (1998): NOAA, Data and Indices. < http://nic.fb4.noaa.gov >

Danjon, A. (1959, 1960): Solar flares and changes in the length of day. C. R. Acad. Sci Ser. B; 249 (1959); 250 (1969).

Dansgaard, W., Johnsen, S. J., Clausen, H. B., and Langway, CC. (1973): Climatic record revealed by the Camp Century ice core. In: Turekian, K. K., ed.: The late Cenocoic ice ages. New Haven, Yale University Press, 43-44.

Haigh, J. D.,1996: On the impact of solar variability on climate. Nature 272, 981-984.

Handler, P. (1989): The effect of volcanic aerosols on global climate. J. Volcan. Geoth. Res. 37, 233-249.

Hartley, D. E., Villarin, J. T., Black, R. X., and Davis, C. A. (1998): A new perspective on the dynamical link between the stratosphere and the troposphere. Nature 391, 471-474.

Jose, P. D. (1965): Sun's motion and sunspots. Astron. J. 70, 193-200.

Kappraff, J. (1991): Connections – The geometric Bridge between art and science. New York, McGraw-Hill.

Keeling, C. D., Wharf, T. P., and the Carbon Dioxide Research Group (2003): Atmospheric CO2 concentrations (pomp) derived from in situ air samples collected at Mauna Loa, Hawaii. http://cdiac.esd.ornl.gov/ftp/ndp001/maunaloa.co2.

Kolmogorov, A. N. (1979): Preservation of conditionally periodic movements with small change in the Hamiltonian function. Lecture Notes in Physics 93, 51.

Kuo, C., Lindberg, C., and Thompson, D. J. (1990): Coherence established between atmospheric carbon dioxide and global temperature. Nature 343, 709.

Landscheidt, T. (1983): Solar oscillations, sunspot cycles, and climatic change. In: McCormac, B. M., ed.: Weather and climate responses to solar variations. Boulder, Associated University Press, 293-308.

Landscheidt, T. (1984): Cycles of solar flares and weather. In: Moerner, N.A. und Karlén, W., eds..: Climatic changes on a yearly to millenial basis. Dordrecht, D. Reidel, 475, 476.

Landscheidt, T. (1986): Long-range forecast of energetic x-ray bursts based on cycles of flares. In: Simon, P. A., Heckman, G., and Shea, M. A., eds.: Solar-terrestrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 81-89.

Landscheidt, T. (1987): Long-range forecasts of solar cycles and climate change. In: Rampino, M. R., Sanders, J. E., Newman, W. S. and Königsson, L. K., eds.: Climate. History, Periodicity, and predictability. New York, van Nostrand Reinhold, 421-445.

Landscheidt, T. (1988): Solar rotation, impulses of the torque in the Sun's motion, and climatic variation. Clim. Change 12, 265-295.

Landscheidt, T.(1990): Relationship between rainfall in the northern hemisphere and impulses of the torque in the Sun's motion. In: K. H. Schatten and A. Arking, eds.: Climate impact of solar variability. Greenbelt, NASA, 259-266.

Landscheidt, T. (1995): Die kosmische Funktion des Goldenen Schnitts. In: Richter, P. H., ed.: Sterne, Mond und Kometen. Bremen, Hauschild, 240-276.

Landscheidt, T. (1998 a): Forecast of global temperature, El Niño, and cloud coverage by astronomical means. In: Bate, R., ed.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), 172-183.

Landscheidt, T. (1998 b): Solar activity - A dominant factor in climate dynamics. http://www.john-daly.com/solar/solar.htm

Landscheidt, T. (1999): Extrema in sunspot cycle linked to sun's motion. Solar Physics 189, 415-426.
.

Landscheidt, T. (2000 a): Solar forcing of El Niño and La Niña. In: Vázquez , M. and Schmieder, B, ed.: The solar cycle and terrestrial climate. European Space Agency, Special Publication 463, 135-140.

Landscheidt, T. (2000 b): Solar wind near Earth: Indicator of variations in global temperature. In: Vázquez, M. and Schmieder, B, ed.: The solar cycle and terrestrial climate. European Space Agency, Special Publication 463, 497-500.

Landscheidt, T. (2000 c): River Po discharges and cycles of solar activity. Hydrol. Sci. J. 45, 491-493.

Landscheidt, T. (2000 e): New confirmation of strong solar forcing of climate. http://www.john-daly.com/po.htm.

Landscheidt, T. (2001 a): Solar eruptions linked to North Atlantic Oscillation. http://www.john-daly.com/theodor/solarnao.htm

Landscheidt, T. (2001 b): Trends in Pacific Decadal Oscillation subjected to solar forcing. http://www.john-daly.com/theodor/pdotrend.htm.

Landscheidt, T. (2002): El Niño forecast revisited. http://www.john-daly.com/sun-enso/revisited.htm.

Landscheidt,T. (2003 a): Long-range forecast of U.S. drought based on solar activity. http://www.john-daly.com/solar/US-drought.htm

Landscheidt, T. (2003 b): New Little Ice Age instead of global warming. Energy and Environment 14, 4. 327-350.

Landsea, C. W. and Knaff, J. A. (2000): How much skill was there in forecasting El Niño? Bull. American Meteorol. Soc. 81, 2107-2119.

Mayaud, P. N. (1973): A hundred year series of geomagnetic data. IUGG Publication Office, Paris.

McKay, R. S., Meiss, J. D., and Percifal, I. C. (1987): Resonances in Hamiltonian maps. Physica D 27, 1.

Metzner, H. (1996): Gibt es einen CO2 – induzierten Treibhauseffekt? In: Metzner, H., ed.: Treibhauskontroverse und Ozonproblem. Europäische Akademie für Umweltfragen, Leipzig.

Moser, J. (1973): Stable and random motions in dynamical systems. Princeton Univ. Press.

Neelin, J. D. and Latif, M., 1998: El Niño dynamics. Physics Today, December 1998, 32-36.

Newman, M., Compo, G. P.,and Alexander, M. A. (2003): Enso-forced variability of the Pacific Decadal Oscillation. J. Climate Letters 16, 3853-3857.

Peixoto, J. P. and Oort, A. H., 1992: Physics of climate. New York, American Institute of Physics, 415-433.

Quinn, W. H., Neal, T. V., and de Mayolo, S. E. A. (1987): El Niño occurrences over the past four and a half centuries. Journ. Geophys. Res. 92, 14449-14461.

Ramage, C. S. (1986). El Niño. Scient. American , June 1986, 59-61.

Roederer, J. G. (1993): STEP and global change. STEP International 3(4), 4.

Sakurai, K. (1974): Physics of solar cosmic rays. University of Tokyo Press, 149.

Shindell, D., Rind, D., Balachandran, N., Lean, J., and Lonergan, P., 1999. Solar cycle variability, ozone, and climate. Science 284, 305-309.

Siegel, C. L. (1942): Iteration of analytic functions. Ann. Math. 43, 607-612.

Smith, H. J. and Smith, E. v. P. (1963): Solar flares. New York, MacMillan, 219.

Solar-Geophysical-Data (2003): < http://www.ngdc.noaa.gov/STP/SOLAR_DATA >

Sussman,G. J. and Wisdom, J. (1992): Chaotic evolution of the solar system. Science 257, 56-62.

Venables, W. N., and Ripley, B. D. (2002): Modern applied statistics with S. Springer, New York.

Von Storch, H. and Zwiers, F. W. (1999): Statistical analysis in climate research. Cambridge University Press, 294,296.

Walker, D. A. (1995): More evidence indicates link between El Niños and seismicity. EOS 76, No. 4, January 24, 1995, 33.

Walker, D. A. (1999): Seismic predictors of El Niño revisited. EOS 80, M0 25, June 22, 1999, 281.

Williams, N. R. (1977): Tornadoes, whirlwinds, and waterspouts. Encyclopaedia Britannica, Macropaedia, 18, 518.

Note - Dr Theodor Landscheidt makes the claim in the above paper that he predicted the last El Niño and La Niña two to three years before they actually happened. I can confirm that the key paper in in which he predicted the 2002 El Niño and the preceding La Niña ("*Solar Activity Controls El Niño and La Niña*") , was published on this website in January 1999, fully three years before the actual event, and that the copy of that paper currently on this website is the original 1999 version.
Signed - John L. Daly (19 Dec 2003)

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SOLAR ACTIVITY:

A DOMINANT FACTOR IN CLIMATE DYNAMICS

APPENDIX VI (2)
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

by

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1. "Solar Constant" Variations in the 11-Year Sunspot Cycle and Climatic Effects

Atmospheric circulation, the cause of weather, is driven by the sun's energy. Climate is the integral of weather over periods of more than a year. This integral also depends on the flux of solar energy. The same applies to variations in the energy flux caused by the sun's varying activity. Satellite data show that the "solar constant" ***S*** is variable. The solar irradiance decreased from the sunspot maximum 1979 to the minimum 1986, increased again on the way to the next maximum in the 11-year sunspot cycle, and decreased anew in the descending phase. This came as a surprise as it is plausible that the dark sunspots with their strong magnetic fields impede the free flux of energy from the sun's interior to the outside. Yet P. V. Foukal and J. Lean **[22]** have shown that bright faculae in the vicinity of sunspots increase even more than sunspots when the activity grows stronger, so that an irradiance surplus is established.

IPCC scientists hold that the corresponding variation in the solar constant **(Delta *S*)** is smaller than 0.1% and has no impact on climate that could count in comparison with the greenhouse effect **[94]**. Yet they fail to appreciate that quotes of 0.1% in the literature refer to the absolute amplitude of the sinusoidal variation in the solar constant, not the whole change from minimum to maximum, or from maximum to minimum **[25, 32, 39]**. **Figure 1** after C. Fröhlich **[25]** shows this distinctly. The data at the top of the figure, designated by **`HF'**, represent NIMBUS-7 measurements. The smoothed curve shows the 81-day running average related to the interval of three solar rotations of 27days. The horizontal axis indicates the investigated period, above in years, below in days since the first day of 1980. The vertical axis measures the solar constant ***S*** in W/m^2. The scale in the middle of Figure 1 indicates the range of 0.1%. When this scale is taken to measure the variation in the smoothed curve from the sunspot maximum 1979 to the minimum in 1986, the result is **Delta *S*** approximately equal to **- 0.22%**. IPCC scientists cannot object to this higher value on the grounds that it is not a common practice to assess the total variation in such a way. They proceed equally by relating the rise in global temperature to the minimum at the end of the 19th century and not to the long-term temperature mean.

According to satellite measurements, the mean value of the solar constant is ***S*** = **1367 W/m^2**. 0.22% of this amount of energy equals **3 W/m^2** . This result may also be read from Figure 1. The maximum of the smoothed curve is at 1374.2 W/m^2 and the minimum at 1371.2 W/m^2 . The variation of 0.22% does not affect climate in its entirety. The solar constant defines the amount of energy which just reaches the outside of the earth's atmosphere. **30%** of this energy is not absorbed by the atmosphere, but reflected. Furthermore, it has to be taken into account that the irradiated sectional area of the earth constitutes only a quarter of the surface to which this thermal energy has to be distributed. So there is only **239 W/m^2** available to heat the atmosphere. Consequently, the variation of 3 W/m^2 has only a climate effect of **0.53 W/m^2** . How this affects global temperature depends on the general circulation model used to assess the climate sensitivity. C. Fröhlich **[25]** proceeds from a value between 0.3° and 1.4° C / W/m^2 . When we choose the mean value 0.85° C / W/m^2 to avoid an overestimation, the climate effect of 0.53 W/m^2 yields a temperature effect of **0.45° C**. The chosen

mean value lies within the range given in the literature **[19, 31, 33, 82, 87, 89, 115]**. Even if a four times longer smoothing interval is chosen as in Figure 1, the variation of the solar constant reaches 2.2 W/m^2 **[74]** with a temperature effect of **0.33° C.**

Variations in global temperature of 0.45° or 0.33° C in the course of seven years cannot be considered negligible. This all the more so as the observed rise of temperature during the last hundred years amounts to merely **0.4° C**. From the value 0.5° C, quoted in the literature, 0.1°C has to be subtracted because it is due to urban warming that causes a spurious rise in global temperature **[39]**. Observed climate data, which follow the rhythm of the 11-year sunspot cycle, indicate that the effect of irradiance variations on the atmosphere is enhanced by positive feed-back processes or stochastic resonance. This form of resonance involves the cooperative interplay of random and periodic stimuli. Noise can improve the response to small periodic or quasiperiodic signals so that the small input is able to entrain large scale fluctuations **[80, 116]**. This effect is strongest in nonlinear systems with a high level of noise.

The atmosphere meets these conditions. K. Labitzke and H. van Loon **[51]** have discovered a statistically significant connection between temperature-dependent 30-hP heights in the stratosphere and extrema in the 11-year sunspot cycle, which involves the troposphere and is strongest in special geographical regions. It is an indication of feed-back or resonance amplification that the temperature difference in the stratosphere between minimum and maximum of the 11-year cycle reaches 1.8° C and in the troposphere still 0.9° C **[50]**. In the Subtropic troposphere this difference even amounts to 2° C **[70]**. Northern and Southern Hemisphere show such sunspot related temperature patterns in a mirror-symmetric way. The geographic distribution of the temperature effect corroborates the hypothesis that a modulation of Hadley cell circulation is involved **[95]**. Experiments with models have shown that winds in the lower stratosphere can have an impact on circulation in the troposphere **[84]**. Strong temperature variations following the course of the 11-year sunspot cycle were not only observed in recent decades. According to M. Stuiver, P. M. Grootes, and T. F. Braziunas **[109]** the GISP delta ^{18}O climate record shows a close correlation with the 11-year sunspot cycle for hundreds of years. This data point to a regional temperature variation of **2.6° C** following the sunspot rhythm.

2. Gleissberg Cycle of Solar Activity and Climate Change

As to climate, seven years is a rather short interval. A climatic effect caused by total irradiance variations becomes more effective when its impact lasts longer. The Milankovitch theory in its modern form shows that a change of **0.1%** effective during a very long interval can release a real ice-age **[49]**. So it may be expected that the 90-year Gleissberg cycle of sunspot activity, which modulates the intensity of the 11-year cycle, possesses a considerable potential to accumulate an effective surplus of irradiance, or to induce a steadily decreasing level of radiant flux density, particularly since the Gleissberg cycle can reach a length of 120 years **[58]**. **Figure 2** after J. A. Eddy **[17]** shows the strong intensity variations in the 11-year sunspot cycle. When we connect the peaks by an enveloping curve, minima in the Gleissberg cycle emerge around the years **1670** (Maunder minimum), **1810**, and **1895**. They are marked by black arrows. Each of these secular sunspot minima coincided with cool climate in the Northern Hemisphere. The deeper the level of solar activity fell, the deeper sank the temperatures.

In **Figure 3** after E. Friis-Christensen and K. Lassen **[24]** this connection becomes quite evident. The thick curve shows the Northern Hemisphere surface temperature (right scale), while the thin line represents the length of the 11-year sunspot cycle (left scale) covering the years 1865 to 1985. Occasionally, this impressive synchronism is objected to on the grounds that the length of the cycle should be of no import, as only the intensity of sunspot activity would count in a potential climate effect. Yet the **length** of the 11-year cycle is a measure of its intensity. Short cycles generate high sunspot maxima, wheras long cycles are characterized by weaker sunspot activity. Friis-Christensen and Lassen have shown that the close correlation extends back to the 16th century **[68]**. C. J. Butler **[10]** corroborated these results when he investigated English temperature data since 1796. Together with the results elaborated by Labitzke and van Loon this is an indication that the solar influence on climate is considerably stronger than IPCC scientists assume.

Those scientists who spread anxiety in the eighties by predicting climate catastrophees cannot plead that at this time there were not any publications pointing to a relation between solar activity and

climate that had to be taken seriously. The relationship in **Figure 4** was presented at the international climate symposium ***"Weather and Climate Responses to Solar Variations"*** in Boulder, Colorado, as early as 1982 **[55]**. The plot shows a temperature time series after H. H. Lamb and C. D. Schönwiese at the bottom, radiocarbon data after J. E. Eddy **[16]** — proxy data reflecting solar activity — covering the interval 1000 to 1950 at the top, and in the middle data I had derived from a semiquantitative model of cyclic solar activity. S and M mark the Spoerer minimum and the Maunder minimum of sunspot activity, while O points to the medieval climate optimum which coincided with very strong solar activity. The synchronism of these three time series, covering 950 years, extends the connection elaborated by Friis-Christensen and Lassen 550 years farther back into the past and opens a possibility of long-range forecasts, as the data in the second curve are based on calculations that can be extended far into the future. On this basis, I forecasted, in 1982, that we should expect declining temperatures after 1990 and probably a new Little Ice Age around 2030. In further papers I specified this prediction **[58, 59, 63]**. I also expected considerably weaker sunspot activity after 1990. The slowly ascending new sunspot cycle, which started in May 1996, seems to follow the predicted trend.

When satellite observations had established that the solar constant is variable, phenomenological regression models were developed which assess the variations in irradiance in past decades and centuries. The model developed by D. V. Hoyt and K. H. Schatten **[39]**, shown in **Figure 5**, is based on proxy data related to secular changes in the convective energy transport or the convective velocities in the sun. They include the solar cycle length, the equatorial solar rotation rate, and sunspot structure. This solar-irradiance model has only two parameters: the amplitude of variations of the 11-year cycle and the Gleissberg cycle. The thick curve in Figure 5 shows the output of the model. The corresponding vertical axis on the left measures the irradiance in W/m^2. The dashed curve represents the smoothed annual mean Northern Hemisphere temperature variations (right scale) for 1700 – 1879 from B. S. Groveman and H. E. Landsberg **[28]**, and for 1880 to the present from J. E. Hansen and S. Lebedeff **[30]**. The two curves show a close correlation that points to a strong link between solar activity and climate.

As direct measurements of **Delta *S*** are not available before 1978, it is important that observations of the surface magnetism of solar type stars have yielded variations in irradiance up to 0.6% **[84]**. Variations of this order in the sun's activity could explain climate features like the "Little Ice Age", especially if it is assumed that the general magnetic network, which covers the photospheric surface even in a sunspot minimum, vanishes during activity lulls of the Maunder minimum type. Every fourth of the observed stars is in a state comparable to the Maunder minimum of the sun **[84]**. One star — HD 3651 — was even observed just in transition between the cyclic and the Maunder minimum phase. It showed periodic behaviour for about 12 years and then stopped fluctuating as its surface activity dropped to very low levels **[84]**. This indicates that the sun has a much stronger potential of irradiance variation than assumed. The satellite observations since 1978 cover only a small part of the sun's range of variability. S. Baliunas and W. Soon **[2]** have shown in addition that short star cycles produce stronger magnetic activy and irradiance than long cycles. This confirms the results published by Gleissberg, FriisChristensen and Lassen.

When measuring the equivalent width of the high excitation photospheric line of C 5380 Å in the solar irradiance spectrum since 1978, W. Livingston discovered that it increased in strength by 0.081 mÅ within 12 years. This implies a temperature increase of 4.6° K, an order of magnitude greater than the variation observed by satellites. Since change in the intensity of absorption lines points to change in the irradiance, D. V. Hoyt and K. H. Schatten **[39]** assume that there are components of varying irradiance beyond sunspots, faculae, and the magnetic network which are not yet known. A candidate could be those recently discovered huge streams of electronically charged plasma flowing beneath the surface of the sun, which ring the solar poles at about 75° latitude and resemble jet streams in the earth's atmosphere. There is also plasma flow similar to the earth's trade winds **[104]**. As these plasma streams move about 10% faster than their surroundings, the resulting shear induces concentrations in the magnetic fields "frozen" in the plasma which lead to stronger magnetic activity. It is to be expected that research into these features will result in a new index and a better explanation of solar activity. The steady increase in the intensity of the line C 5380 Å over 12 years, observed by Livingston, is independent of the 11-year cycle. It seems to point to a longer cycle of solar activity. Is this the Gleissberg cycle, or a new yet unknown cycle?

3. Variations in the Sun's Ultraviolet Radiation and Climate Models

Change in the ultraviolet radiation of the sun is much greater than in the range of visible radiation. The ultraviolet range of the spectrum lies between 100 Å and 3800 Å. Wavelengths below 1500 Å are called extreme ultraviolet (EUV). The variation in radiation between extrema of the 11-year sunspot cycle reaches 35% in the EUV- range **[119]**, 20% at 1500 Å **[21]**, and 7% around 2500 Å **[34,97]**. At wavelengths above 2500 Å, the variation reaches still 2% **[21]**. At the time of energetic solar eruptions, the UV-radiation increases by 16%. At a sunspot maximum the EUV-radiation raises the temperature in the Ionosphere by 300% in relation to the minimum **[21]**. Yet most important is that the UV-radiation below 2900 Å is completely absorbed by ozone in the stratosphere. The resultant rise in temperature is augmented by positive feed-back, as the UV-radiation also generates new ozone. Satellite observations show that the ozone content grows by 2% from sunspot minimum to maximum **[113]**. D. Rind and J. Overpeck are working on a model which explains how the rising temperature in the stratosphere influences the circulation in the troposphere. J. D. Haigh **[29]** has already assessed this effect in quantitative terms and shows that temperature in the Subtropics and North Atlantic storm tracks are especially affected.

Variations in radiation are not the the sun's only way to influence climate. Between energetic solar eruptions and galactic cosmic radiation modulated by the solar wind on the one hand and electric parameters of the atmosphere on the other, exist couplings, the strength of which varies by 10% in the course of days, years, and even decades **[113]**. The most important change is to be found in the downward air-earth current density, which flows between the ionosphere and the surface. R. Markson and M. Muir **[71]** have shown how this affects the thunderstorm activity, while B. A. Tinsley **[113]** assumes that electrically induced changes in the microphysics of clouds (electrofreezing) enhance ice nucleation and formation of clouds. These approaches have the advantage to be independent of dynamic coupling between different layers of the atmosphere, since these variations affect the whole atmosphere. Therefore, IPCC scientists who allege that there are not any physical explanations of a solar impact on climate change must be unaware of the relevant literature.

4. Cosmic Radiation, Solar Wind, and Global Cloud Coverage

The most convincing argument yet, supporting a strong impact of the sun's activity on climate change, is a direct connection between cloud coverage and cosmic rays, discovered by H. Svensmark and E. Friis-Christensen **[111]** in 1996. It is shown in **Figure 6**. Clouds have a hundred times stronger effect on weather and climate than carbon dioxide in the atmosphere. Even if the atmosphere's CO_2 content doubled, its effect would be cancelled out if the cloud cover expanded by **1%**, as shown by H. E. Landsberg **[53]**. Svensmark's and Friis-Christensen's result is therefore of great importance. The thin curve in Figure 6 presents the monthly mean counting rates of neutrons measured by the ground-based monitor in Climax, Colorado (right scale). This is an indirect measure of the strength of galactic and solar cosmic rays. The thick curve plots the 12-month running average of the global cloud cover expressed as change in percent (left scale). It is based on homogeneous observations made by geostationary satellites over the oceans. The two curves show a close correlation. The correlation coefficient is
r = 0.95.

Short-range variations in the intensity of cosmic rays, caused by energetic solar eruptions, have the same effect, though shorter. The plot shows that strong cosmic rays go along with a larger cloud cover, whereas weak cosmic rays shrink the cloud cover. The global cloud coverage diminished from its peak at the end of 1986 to its bottom in the middle of 1990 by more than **3%**. According to observations by V. Ramanathan, B. R. Barkstrom, and E. F. Harrison **[91]**, clouds have a net cooling effect of **-17 W/m²** . Svensmark and Friis-Christensen **[111]** conclude from the diminution of this cooling effect between 1986 and 1990 that the solar irradiance has increased by about **1.5 W/m²** within these three and a half years. A change of this order is quite remarkable, since the total radiative forcing by carbon dioxide accumulated since 1750 has been estimated by the IPCC not to go beyond 1.5 W/m² . This means that cosmic rays, strongly modulated by solar activity, achieve an effect within three and a half years for which the accumulation of carbon dioxide in the atmosphere needs centuries. This shows clearly to what extent the greenhouse effect has been overestimated in comparison with the solar contribution to climate change, which turns out to be the most important

factor.

There is also a physical explanation of the effect: the secondary ions produced by the cosmic rays serve as condensation nuclei with hygroscopic properties that enhance the formation of clouds **[4, 15, 23]**. Meanwhile, H. Svensmark **[112]** has extended his investigation that now covers the interval 1980 to 1996. As before, the correlation between cloud cover and cosmic rays is very close. Indirect measurements of the intensity of cosmic rays, which register myons instead of neutrons, go back to 1937. When H. Svensmark **[112]** compared these data with global temperature in the Northern Hemisphere, he again found a strong correlation which indicates that the connection between cosmic rays, cloud cover, and global temperature is real.

The primary cause of the solar modulation of cosmic rays is not the level of sunspot activity, but **the varying strength of the solar wind**. This supersonic outflow of plasma originates in the very hot corona of the sun and carries ionized particles and magnetic field lines from the sun. While it is expanding towards the boundary of the solar system, cosmic ray particles interacting with it lose energy. When the solar wind blows heavily, cosmic rays are weak, and when the solar wind is in a lull, cosmic rays become strong. The highest velocities in the solar wind are caused by energetic solar eruptions and coronal holes. Strong eruptions (flares and eruptive prominences) avoid sunspot maxima and even occur close to sunspot minima. So sunspots are not a good indicator of solar wind strength **[65]**. As cosmic rays, which have such a strong impact on cloud cover, are strongly modulated by eruptional features of the sun's activity, the solar contribution to climate change can no longer be considered negligible. This is all the more so as the already described changes in irradiance have an additional effect.

D. Rind and J. Overpeck **[93]** have shown that at least half of the rise in temperature since the end of the Little Ice Age can be attributed to the parallel rise in the sun's irradiance. D. Hoyt and K. H. Schatten **[39]** judge their elaborate results as follows: ***"From the record, we believe the sun plays a major role in natural secular climatic changes on time scales of decades to centuries."***. E. S. Posmentier, W. H. Soon, and S. L. Baliunas **[88, 107]** eventually derive from a model based on the same solar factors as in the Hoyt-Schatten-model that **78% of the rise in temperature between 1885 and 1987 can be explained by the sun's varying irradiance.** An additional statistical experiment corroborates this result, though it omits the Svensmark effect and other solar-terrestrial relationships which are independent from irradiance. There is not much room left for the anthropogenic greenhouse effect. H. N. Priem **[90]** aptly remarks:

> ***"Recent studies show that solar variability rather than changing CO pressure is an important, probably the dominant climate forcing factor ... The current and anticipated fleet of spacecraft devoted to the study of solar and solar-terrestrial physics will therefore pobably prove to have more bearing on the understanding and forecasting of climate change than the orchestrated assessments by politically motivated international panels biased towards global warming exclusively by the enhanced greenhouse effect."***

The discovery by Svensmark and Friis-Christensen highlights the IPCC objection (that exogenic factors are energetically too weak to have an impact on global temperature), as pointing in the wrong direction. Primary cosmic rays, which regulate cloud coverage, inject a total energy into the atmosphere equal to the intensity of starlight in the night skies **[23]**. J. G. Roederer **[95]** comes closer to reality with his remark:

> ***"The energy argument, however, is not valid for highly nonlinear, complex systems such as the coupled atmosphere-ocean-cryosphere-biosphere. It is well known that complex systems can behave chaotically, i.e. follow very different paths after the smallest change in initial or boundary conditions, or in response to the smallest perturbation. In a highly nonlinear system with large reservoirs of latent energy such as the atmosphere-ocean-biosphere, global redistributions of energy can be triggered by very small inputs, a process that depends far more on their spatial and temporal pattern than on their magnitude."***

5. Failure of Climate Predictions by IPCC Scientists

Precise forecasts that prove correct are a sharp criterion for efficient science. The protagonists of global warming remain empty-handed in this respect in spite of great material and personal expense. In the eighties S. Schneider from the National Center for Atmospheric Research in Boulder, Colorado, predicted in his book ***"Global Warming"*** a huge jump in temperature, polar ice melting away, seas surging across the land, famine on an epidemic scale, and ecosystem collapse. Today this is no longer taken seriously. Yet other climatologists, too, made forecasts in the eighties they no longer maintain. C. D. Schönwiese **[99]**, usually critical and cautious in his statements, still predicted in 1987 a 4.5° C rise in temperature until 2030, though only as an upper limit. He thought that the sea level in the German Bay could rise by 1.5 m till 2040 and in the ocean around India even 2 to 3 m. A projection of his temperature forecast yields **11.8° C** for the year 2100. At the climate conference in Villach in 1985 similar predictions were presented to the public. The IPCC still predicted in 1990 and 1992 that global temperature would rise **1.9° - 5.2° C** until 2100 **[100]** and thought that a rise in sea level by 1.10 m was possible **[36]**.

All these predictions have turned out to be untenable. It is accepted that global temperature has risen by **0.5° C** in the last hundred years. Yet during the last fifty years the temperature has remained approximately at the same level, even though 70% of the anthropgenic carbon dioxide contribution was injected into the atmosphere during this time. From 1940 to 1970 the temperature fell, and according to satellitite data available since 1979, which are in good accord with balloon data **[27]**, the trend in the lower troposphere has remained at **-0.06° C** per decade. The IPCC prediction made in 1992 proved so exaggerated that it had to be adjusted to reality three years later by reducing the rise range to 1° - 3.5° C by 2100. As to sea level rise, the IPCC meanwhile acknowledges (in accordance with a consensus in the specialized literature **[3]**) that sea level has risen by merely **18 cm** in the last hundred years. According to M. Baltuck et al. **[3]** it is very probable that the rising sea level is due to natural causes and not to man's contribution to the greenhouse effect.

The discrepancy between IPCC forecasts and observed data stands out very clearly as to temperatures in the polar regions. The general circulation models, presented by the IPCC in 1990, predict for the regions near the poles in a CO_2 doubling scenario a rise in temperature of more than **12° C** **[13]**. If this were true, in the last 40 years with their steep increase in CO_2 concentration, a warming trend with a temperature rise of several °C should have emerged. The opposite is true **[20]**. A joint investigation by American, Russian and Canadian scientists shows that the surface temperatures in the Arctic region observed between 1950 and 1990 are going down. They fell **4.4° C** in winter and **5° C** in autumn **[43]**. Satellite data too, available since 1979, do not indicate rising temperatures **[105]**. This agrees with data published by the world Glacier Monitoring Network in Zurich, according to which **55%** of the glaciers in high latitudes are advancing compared with 5% around 1950.

The main reason of the incompatibility of IPCC forecasts and observed data is the lacking suitability of the general circulation models (GCM) for the purpose of long-range climate predictions. GCMs are an excellent tool for research into data connections, the physics of which is just beginning to emerge. In such cases quantitative and qualitative aspects of the data pattern may be investigated which develop when the determining variables are changed. **The point here is learning, not predicting**. The development in the immensely complex nonlinear climate system with feed-back coupling of atmosphere, ocean, cryosphere, and biosphere may be forecast, if at all, only for rather short intervals.

GCMs are based on the same type of nonlinear differential equations which induced E. N. Lorenz in 1961 to acknowledge that long-range weather predictions are impossible because of the atmosphere's extreme sensitivity to initial conditions. It is inconceivable that the **Butterfly Effect** should disappear when the prediction interval of a few days is extended to decades and centuries. Some climatologists concede that there is a problem. C. D. Schönwiese **[100]** remarks in this respect:

> ***"Consequently we should conclude that climatic change cannot be predicted. It is correct that the varied and complex processes in the atmosphere cannot be predicted beyond the theoretical limit of a month via step by step calculations in circulation models, neither today, nor in the future. Yet there is the possibility of a conditioned forecast. The condition is that a special factor within the complex cause- and effect relationship is so strong in its effect that it clearly dominates all other factors.***

> ***In addition, the behaviour of that single dominant causal factor must be predictable with certainty or a high degree of probability."***

The dominant causal factor, meant here, is the anthropogenic greenhouse effect. However, there is no convincing evidence that this is an outstanding factor that clearly dominates all other factors which could have an influence on climate. The results presented here indicate clearly that the sun's varying activity is at least a non-negligible factor and probably the really dominant one. Furthermore, the greenhouse effect is contrary to Schönwiese's conditions in being not predictable to a high degree of probability, as the inadequate performance of IPCC forecasts shows. In addition, it is quite uncertain when doubling of the atmosphere's CO_2 content will occur. In the eighties it was surmised that doubling would happen as early as 2030. Now J. P. Peixoto and A. H. Oort **[86]** expect doubling in 2200. Another contentious point is how long CO_2 will stay in the atmosphere, several hundred years, or only five years? New results by P. Dietze and T. V. Segalstad show that shorter residence times are much more probable than the extended ones. Moreover, J. Barrett has shown that all the energy that can be absorbed by the atmosphere is already being absorbed by the lower atmosphere (water, aerosol, and CO_2) under present conditions. Finally, it has been assumed in the GCMs that the planet's population, responsible for the anthropogenic CO_2 contribution, will grow to 11.5 billion people by the end of the next century. The recent statistical survey published by the UN, ***"World Population Prospects: The 1996 Revision"***, shows clearly that the growth expected by the IPCC is utopian and will have to be revised sharply downward, thus reducing the imagined threat dramatically. In 1950 - 1955 the global total fertility rate (the world average number of children born per woman per lifetime) was five, explosively above the replacement rate of 2.1 children. In 1975 - 1980 the fertility rate sank to four. At present it has reached 2.8 and continues to sink. In Europe the rate has fallen by 20% during the last ten years and is at 1.4 now. The same applies for Russia and Japan. The developing countries are no exception. In Bangladesh the fertility rate has fallen from 6.2 to 3.4 in just ten years. So the CO_2 output will be much lower than that estimated in the GCM calculations.

When those equations that are thought to represent the climate system are subjected to a first integration with the anthropogenic forcing kept constant so that the result can be compared with a second integration based on increasing CO_2 forcing, the outcome can be considered convincing only if the differential equations represent the physics of the climate system exactly and completely. Yet this condition is far from being fulfilled. Not only do we not know enough about a wealth of details of complex feed-back problems **[114]**, but there is also a fundamental lack of data. In addition there are technical and mathematical difficulties. J. P. Peixoto and A. H. Oort **[86]** comment aptly:

> ***"The integration of a fully coupled model including the atmosphere, oceans, land, and cryosphere with such different internal time scales poses almost insurmountable difficulties in reaching a final solution, even if all interacting processes were completely understood."***

A fatal flaw however is that tiny deviations from the ideal initial conditions may lead to quite different courses in the development of climate. C. Wiin-Christensen and A. Wiin-Nielsen **[117]** have rightly pointed out that the resulting limited predictability is insurmountable as it is linked to the given nonlinearity of the differential equations.

6. Cycles in the Sun's Oscillation Affect Sunspots and Climate

The IPCC holds:

> **"Solar variability over the next 50 years will not induce a prolonged forcing significant in comparison with the effect of increasing CO concentrations."**

However, if, contrary to the IPCC's attitude, the sun is taken seriously as a dominant factor in climate change, this opens up a possibility to predict climate features correctly without any support by supercomputers. A string of examples will be presented. The chaotic character of weather and climate does not stand in the way of such predictions. Sensitive dependance on initial conditions is only valid with regard to processes within the climate system. E. N. Lorenz has stressed that only non-periodic systems are plagued by limited predictability. External periodic or quasiperiodic systems

can positively force their rhythm on the climate system. This is not only the case with the periodic change of day and night and the Milankovitch cycle, but also with variations in solar energy output as far as they are periodic or quasiperiodic. The 11-year sunspot cycle meets these conditions, but plays no predominant role in the practice of predictions. Most important are solar cycles which are without exception related to the sun's fundamental oscillation about the center of mass of the solar system and form a fractal into which cycles of different length, but similar function are integrated. The solar dynamo theory developed by H. Babcock, the first still rudimental theory of sunspot activity, starts from the premise that the dynamics of the magnetic sunspot cycle is driven by the sun's rotation. Yet this theory only takes into account the sun's spin momentum, related to its rotation on its axis, but not its orbital angular momentum linked to its very irregular oscillation about the center of mass of the solar system (CM).

Figure 7 shows this fundamental motion, described by Newton **[85]** three centuries ago. It is regulated by the distribution of the masses of the giant planets Jupiter, Saturn, Uranus, and Neptune in space. The plot shows the relative ecliptic positions of the center of mass (small circles) and the sun's center (cross) for the years 1945 to 1995 in a heliocentric coordinate system. The large solid circle marks the sun's surface. Most of the time, CM is to be found outside of the sun's body. Wide oscillations with distances up to 2.2 solar radii between the two centers are followed by narrow orbits which may result in close encounters of the centers as in 1951 and 1990. The contribution of the sun's orbital angular momentum to its total angular momentum is not negligible. It can reach 25% of the spin momentum **[60]**. The orbital angular momentum varies from -0.1×10^{47} to 4.3×10^{47} g cm^2 s^{-1}, or reversely, which is more than a forty-fold increase or decrease. Thus it is conceivable that these variations are related to varying phenomena in the sun's activity, especially if it is considered that the sun's angular momentum plays an important role in the dynamo theory of the sun's magnetic activity.

Variations of more than 7% in the sun's equatorial rotational velocity, going along with variations in solar activity, were observed at irregular intervals **[54, 56]**. This could be explained if there were transfer of angular momentum from the sun's orbit to the spin on its axis. I have been proposing such spin-orbit coupling for two decades **[56, 57]**. Part of the coupling could result from the sun's motion through its own magnetic fields. As R. H. Dicke **[14]** has shown, the low corona can act as a brake on the sun's surface. The giant planets,which regulate the sun's motion about CM, carry more than 99% of the angular momentum in the solar system, while the sun is confined to less than 1%. So there is a high potential of angular momentum that can be transferred from the outer planets to the revolving sun and eventually to the spinning sun.

The dynamics of the sun's motion about the center of mass can be defined quantitatively by the change in its orbital angular momentum. The rate of change is usually measured by derivatives. In some respects the running variance yields more informative results. It applies the well-known smoothing of two, three, or more consecutive readings to variance, the square of the standard deviation. Consecutive values of the running variance draw attention to the variation in variability and accentuate dynamical processes **[98]**. **Figure 8** displays the 9-year running variance of the orbital angular momentum for the years 730 to 1075. The 9-year running variance has been chosen because the narrow orbits with a stronger curvature have just this cycle length and yield interesting results. Surprisingly, the pattern in Figure 8 is shaped by a five-fold symmetry. For the sake of simplicity I call the features "big hands" and "big fingers". They emerge in a similar way in past and future millenia. Their five-fold symmetry is not their only interesting quality. They are linked to cycles which play an important part in solar-terrestrial relations. The big hand cycle has a length of 178.8 years. P. D. Jose **[41]** has shown in his pioneering computer analysis of the sun's motion that a cycle of this length appears in the sunspot data. The strongest cycle discovered by W. Dansgaard et al. **[63]** in the oxygen isotope profile in the Camp Century ice core has a length of 181 years, close to 178.8 years. This points to a relationship with climate. It is conspicuous that the Gleissberg cycle is just half as long as the big hand cycle. J. F. W. Negendank, A. Brauer, and B. Zolitschka **[83]** have found a cycle of 88 years in warves of the crater lake of Holzmaar which cover 13,000 years. The length of the cycle of a half big hand is 89.4 years. This points again to a connection with climate.

7. Cycles of 36 Years in Solar Activity and Climate

Cycles of big fingers have a mean length of 35.8 years (178.8 years [big hand] / 5 = 35.76 years [big fingers]). They are closely connected with solar activity. They coincide with maxima and minima in

the Gleissberg cycle and open up the possibility of predicting these crucial phases many years ahead **[62, 63]**. As will be shown below, they also define the length of the 22.1-year magnetic cycle of sunspot activity (Hale cycle). As far as climatic change is concerned, cycles of a length of 36 years are not new. Francis Bacon **[102]** has already pointed to a cycle in the Netherlands with a length of 35 to 40 years with cool and wet phases followed by warm and dry periods. E. Brückner **[7]** discovered this cycle again in 1887. He demonstrated that varied climatic phenomena in different regions of the world show synchronized phases in a cycle of 33 to 37 years. He had already surmised in those days a connection with the sun's activity. H. W. Clough **[11, 12]** followed this suggestion and found the Brückner cycle not only in 12 meteorological variables, but also in sunspots and especially in variations in the length of the 11-year sunspot cycle. D. V. Hoyt and K. H. Schatten **[39]** think that the reality of the cycle is confirmed by Scandinavian tree ring data which show its rhythm over hundreds of years. With regard to Brückner's supposition of a connection with the sun's activity, they ask which index of solar activity would conform with a 36-year cycle. The results presented here answer this question.

Figure 9 after P. D. Jones **[40]** shows the time series 1850 to 1987 of the annual-mean surface air temperature averaged over the Northern Hemisphere, expressed as departures in °C from the reference period 1951 to 1970. The arrows mark the start phases of big finger cycles (BFS) that fall in the data range. The triangle at the top of the plot points to the start phase in 1933 of a big hand cycle (BHS). BFSs 1867, 1901, and 1933 coincide with outstanding temperature maxima in the smoothed curve. BFS 1968, however, indicates the bottom of a downtrend that began after BHS 1933. Obviously, this is due to a phase reversal in the BFS pattern. Contrary to statistical investigations, the semi-quantitative model presented here can give an explanation that seems to solve the problem of sudden phase jumps in solar-terrestrial cycles hitherto unpredictable and unexplainable.

Experimentation with electrical and mechanical control equipment shows that at nodal points, where the response of the system is zero, the phase can shift by pi radians. The initial phase of a big finger cycle is such a nodal point. Yet it is crucial that BFS 1933 is at the same time the start of a big hand. Such nodal points higher up in the hierarchy of the fractal of cycles derived from the sun's motion about CM induce phase reversals or other forms of instability in subordinate cycles. This will be shown in a string of examples. The next BHS will be reached in 2111. So the new BFS rhythm is expected to hold for a long time. The epoch of the coming BHS phase 2007 should go along with another bottom in the global temperature.

Often the second harmonic of finger cycles is as important as the fundamental. The thickness of Lake Saki varves is related to local precipitation: the thickest warves ar linked to very wet years and the thinnest varves to very dry years **[101]**. I could show that maxima in the varve thickness are consistently correlated with cycles of half big fingers with a mean length of 17.9 years. The analysis covers the years 700 to 1894, nearly 12 centuries. A Monte Carlo model and Student's t-test yielded t = 8.2 for 33 degrees of freedom. The null hypothesis of no connection between the studied variables can be rejected at a high level of significance ($P < 6 \times 10^{-7}$) **[62]**.

BFSs represent minima of the running variance in the sun's orbital angular momentum. The maxima, too, have proven relevant. I call them big finger tips (BFT). They appear in **Figure 10** which shows the Palmer Drought Index for the U.S.A. The vertical axis measures the percentage of area covered by drought. The arrows designate consecutive epochs of BFSs and BFTs. Prior to the big hand start 1933, indicated by an open triangle, the starts of big fingers (S) coincided with drought maxima and the tips (T) with minima. After BHS 1933 the correlation with the big finger phases as such continued, but a phase reversal changed the rhythmic pattern. Now BFTs coincided with drought peaks and BFSs with minima. The new rhythm has been stable since 1933. There is a good chance that it will continue until the next BHS in 2111. Farmers in the U.S.A. may expect wet climate around the next BFS in 2007.

Yet, what is the meaning of those black circles in Figure 10 which alternately go along with drought maxima and minima and are also subjected to a phase reversal? They mark the Golden section between BFSs and BFTs. The five-fold symmetry in the dynamics of the sun's oscillation about the center of mass of the solar system, visible in **Figure 8**, establishes a relationship between the sun's motion and the Golden section, as this remarkable proportion is closely related to the number 5 **[45]**.

To show this intimate connection, all of the corners of a regular pentagon (the fundamental geometrical representation of the number five) are connected by diagonals. A five-pointed star emerges, a pentagram, the intersecting lines of which form a complex web of Golden sections. Within this star a new pentagram appears that contains a smaller star with further Golden section divisions, and so on, in an infinite fractal sequence.

As illustrated in **Figure 11**, the Golden section divides a frame structure like a line segment, a surface, a cycle, or any other delimited feature so that the ratio of the whole to the larger part (major) equals the ratio of the larger part to the smaller one (minor). Point G represents the irrational Golden Number
G = 0.618... It divides the unit height of the temple into major (0.618...) and minor (0.3819...). To find the major of a line segment, a cycle etc., it has to be multiplied by 0.618. Multiplication by 0.382 yields the minor. As the fundamental oscillation of the sun about CM depends on the masses and the positions of the giant planets, the relationship with the Golden section extends to the whole solar system. A. N. Kolmogorov **[47]**, V. I. Arnol'd **[1]**, and J. Moser **[79]** have proven theoretically, that the stability of the solar system hinges on the Golden section. This is crucial, as we know from publications by G. J. Sussman and J. Wisdom **[110]** as well as J. Laskar **[67]** that the orbits of all planets are chaotic. In my paper ***"The Cosmic Function of the Golden Section"*** **[64]** I have shown in practice how the Golden section, which stands for stability in polar opposition to instability, keeps the chaotic planetary orbits stable. The mean of the ratios of the perihelion distances of neighbouring planets from Mercury to Pluto, including the mean radius vector of the planetoids, turns out to be very close to the Golden number G. The difference between this mean and G is as small as 0.002. Fivefold quantities have deep roots in Nature. There are not four, but five physical forces. We merely have forgotten that electromagnetism is composed of different forces. First Maxwell unified electricity and magnetism and later on electromagnetism and the weak force was unified to constitute the electro-weak force **[44].**

Figure 12 after R. Mogey **[78]** presents a further practical example, the Great Lake (Michigan-Huron) water levels. After BHS 1933, marked by a filled arrow, the deepest levels coincide with BFSs (S, filled arrows) and the peak levels with BFTs (T, open arrows). A deep trough in the data is to be expected around 2007 and a new peak level around 2025. The flat triangles point to secondary peak levels, related to the minor 0.382 of the Golden section between BFS and BFT phases.

The Golden section has left its mark, too, upon the 11-year sunspot cycle. Reliable data are available since 1750. They show that the ascending part of the cycle has a mean length of 4.3 years **[73]**. The mean cycle length amounts to 11.05 years. The minor of the mean length falls at 4.2 years (11.05 years × 0.382 = 4.22 years). This is close to 4.3 years. Thus, the maximum of the 11-year cycle falls at the minor of the Golden section. The descending wing of the cycle has the length of the major. This contributes to the stabilization of solar activity which is characterized by phenomena generated by instability.

Magnetic cycles of solar type stars show the same structure shaped by the Golden section **[64]**. The histogram in **Figure 13** after EOS **[18]** shows the distribution of higly energetic solar eruptions within the 11-year cycle. The accents are set by the Golden section within the subcycles formed by the ascending and descending part of the whole cycle. This pattern recurs in terrestrial cycles. The three curves in **Figure 14** after H. H. Lamb **[52]** connect the 11-year sunspot cycle with thunderstorm activity in central Europe. At the top of the plot, consecutive sunspot minima and the maximum in between are marked by small arrows. The upper curve presents for 1810 to 1934 the number of days with thunderstorm activity in Kremsmünster, the curve in the middle for 1878 to 1934 the thunderstorm frequency in Vienna, and the curve at the bottom the number of houses struck by lightning in Bavaria between 1833 and 1879. The peaks in all of the curves fall at minor and major of the solar subcycles. These Golden section phases are marked by open triangles.

The magnetic sunspot cycle of 22.1 years, also called the Hale cycle, is the true cycle of solar activity. Groups of sunspots are usually composed of preceding and following spots with different magnetic polarity. With the commencement of a new cycle the polarity reverses. Thus, the original polarity is only restored every second 11-year cycle. When the position of the major of the Golden section within a big finger cycle is calculated, it falls just at the length of the Hale cycle (35.76 years × 0.618 = 22.1 years). This helps to limit the instability which is inherent in solar activity. In climate, the

Hale cycle is a dominant feature in the global record of marine air temperatures, consisting of shipboard temperatures measured at night **[9]**, in the detrended Central England temperature record for 1700 to 1950 **[72]**, and in the drought severity index covering different areas of the Western United States **[77]**. The major of the Golden section within the cycle of the big hand (178.8 years × 0.618 = 110.5 years) yields a similar result. Japanese scientists found a cycle of just this length in sunspots when they applied a frequency analysis to the data **[120]**.

8. Cycles of "Small Fingers": a Solid Basis for Predictions of Solar Eruptions and Climate

A ubiquitous notion in present day science is the term fractal coined by B. B. Mandelbrot. A fractal is a geometrical shape whose complex structure is such that magnification or reduction by a given factor reproduces the original object. Self-similarity on different scales is a pre-eminent feature of fractals. The solar cycles derived from the sun's motion about the center of mass form such a fractal. The big fingers in big hands contain small hands with small fingers (SF). This becomes apparent by further amplification. **Figure 15** shows the 3-year running variance of the sun's orbital angular momentum. The circled numbers at the top mark epochs of BFTs. Tips of small fingers (SFT) are indicated by small numbers. Fat arrows and small triangles point to starts of big and small fingers. The vertical dotted line marks the initial phase of a big hand in 1933. The theoretical mean length of cycles of small fingers is
178.8 years / 5 / 5 = 7.2 years. Yet small fingers show a higher degree of "morphological" anomalies. There are sometimes hands that have only three or four fully developed fingers. There is a wider range of deviations from the mean length of small finger cycles. However, all of these variations can be computed and predicted.

The starts of the small finger cycle (SFS) are of special importance. The sun's orbital angular momentum *L* reaches extrema in these phases and d*L*/d*t* becomes zero. In **Figure 16** after R. Howard **[37]** two such initial phases at the end of 1967 and the beginning of 1970 are shown. They were initiated by heliocentric conjunctions of Jupiter, by far the largest of the giant planets, with the center of mass CM. The vertical axis measures the sun's rotational velocity. In both of these cases a striking jump in the sun's rotation occurred. In former decades this phenomenon, too, was observed **[54]**. As the sun's rotation on its axis and the sun's activity are connected, it is not surprising that energetic solar eruptions accumulate around SFSs, as I could show in a paper published in 1976 **[54]**. This relationship is so reliable that predictions can be based on it. My long-range forecasts of strong solar eruptions and geomagnetic storms, covering six years, achieved a prediction quality of 90% though such events occur at quite irregular intervals. Out of 75 events from quantitatively defined categories, 68 occurred at the predicted time **[57, 60, 61]**. The outcome of the forecast experiment was checked by the astronomers W. Gleissberg, J. Pfleiderer, and H. Wöhl as well as the Space Environment Services Center in Boulder, Colorado. The very strong geomagnetic storms in 1982 and around 1990 were also correctly predicted several years before the event **[56, 60]**.

Forecasts of energetic solar eruptions are of importance for weather and climate too, as they enhance the solar wind and weaken the galactic cosmic radiation, which according to Svensmark and Friis-Christensen have a strong impact on cloud coverage. So it is no longer inexplicable that I correctly predicted at an international climate symposium in Boulder, three years before the event, that the Sahelian drought would end in 1985 **[55]**.

Figure 17 shows how closely cycles of small fingers and energetic solar eruptions are connected. The plot presents the distribution of all X-ray eruptions X => 6 **[81]**, observed from 1970 to 1996, within the normalized small finger cycle. Intense X-ray eruptions have a stronger impact than flares categorized into classes of optical brightness. Fat arrows mark consecutive initial phases SFS of the cycle. It is conspicuous that the eruptions concentrate on a restricted range before and after SFS. This is already enough to base a rough prediction on. Yet a much more differentiated pattern emerges when the Golden section is taken into consideration. In the plot, one half of the major of the Golden section lies after the first SFS and the second half before the next SFS, whereas the minor is arranged in between. The filled triangles pointing downwards after the first SFS indicate the phases on which the eruptions concentrate. They lie just after the first SFS, at the boundary of the first half of the major, and at minor and major within this range. The open triangles pointing upwards just in the middle between the filled triangles indicate lulls in eruption activity. In the half minor range before the following SFS everything is reversed. The patterns before and after SFS are antisymmetric. The

probability that this distribution is due to chance is $P = 1.3 \times 10^{-15}$, though the sample comprises only 33 very energetic X-ray eruptions. When 163 X-ray eruptions in the range X = 2 to X < 6 **[81]** are investigated to check the pattern in Figure 17, the sceptical null hypothesis can be rejected at the level $P = 7 \times 10^{-10}$. 197 X-ray eruptions in the range X = 1 to X < 2 yield $P = 2.7 \times 10^{-11}$. The relationship is so manifest that dependable predictions can be based upon it.

After the publication of this result, a further strong eruption, an X9 flare, occured on November 6, 1997. It fell exactly at one of the active phases in Figure 17.

The primary cause of the solar modulation of cosmic rays, which regulates cloud coverage, is not the number of sunspots, but the varying strength of the solar wind. This was mentioned already. The highest velocities in the solar wind up to 2500 km/sec are generated by energetic solar eruptions (solar flares and eruptive prominences) which even contribute to cosmic rays. These solar cosmic rays have an impact on the strength of the solar wind, but show fluctuations different from the galactic cosmic rays that enter the solar system from the outside. Energetic solar eruptions shun sunspot maxima **[18]** and occur even close to minima. The number of eruptions does not depend proportionally on the intensity of 11-year sunspot maxima. **Figure 18** from Solar Geophysical Data **[106]** displays the monthly numbers of observed flares in sunspot cycles No 20 to 22. Cycle No 20 with the highest monthly sunspot number R = 106 was much weaker than cycle No 21 (R = 165) and cycle No 22 (R = 158), but it produced nearly as many flares as cycle No 21 and considerably more than cycle No 22. It is surprising, too, that cycle No 22, nearly as strong as cycle No 21 as to sunspots, generated such a low number of flares in relation to its predecessor. Solar-terrestrial connections like the Svensmark effect are much more dependent on energetic eruptions than on sunspots. Sunspot maxima are not predominant in this respect, but special phases in the small finger cycle, as shown in Figure 17, are.

A wealth of publications points to a connection between geomagnetic storms and weather **[60, 103, 113, 118]**. So it is informative that there is a close correlation, too, between the velocity of the solar wind and the Kp index of geomagnetic activity (r = 0.74) **[46]**. Geomagnetic storms, on the other hand, are closely related to solar eruptions, as satellite observations show which follow the causal chain from outbursts of energy on the sun's surface to disturbances of the earth's magnetic field. Reference for many cases of direct connections between solar eruptions and weather phenomena is given in the literature. A typical example are the investigations by R. Scherhag **[96]** and R. Reiter **[92]** which show that the quality of weather forecasts deteriorates significantly at the time of solar eruptions. The described effects are not negligible. M. Bossolasco et al. **[6]**, for example, observed an increase in thunderstorm activity by 60% after solar eruptions. Such effects of solar eruptions, well known for decades, should be taken seriously by the IPCC, particularly since the Svensmark effect alone has a stronger weight than the anthropogenic greenhouse effect.

It has been mentioned already that Hoyt and Schatten included structural changes in sunspots when they built their model which reflects the connection between varying solar irradiance and global temperature on earth. Large sunspots have a clearly distinguishable dark inner zone, the umbra, and a less dark surrounding area, the penumbra. The ratio of the areas occupied by umbra and penumbra varies continuously. The dynamical causes are not yet known. D. V. Hoyt **[38]** connects these structural variations with the strength of convection below the sun's surface. Sunspots are embedded in the convective zone. The penumbra becomes less extended when the convection increases and a more extended penumbra indicates a weaker convection. There is a link to climate since stronger convection enhances the sun's irradiance. **Figure 19** after D. V. Hoyt **[38]** shows the ratio of the umbra area to that of the whole spot (U/W) derived from Greenwich Observatory data. Hoyt and Schatten **[39]** rightly emphasize that the U/W curve resembles the global temperature curve shown in Figure 9.

The arrows in Figure 19 indicate initial phases of small finger cycles in which the difference forces are balanced just for a moment before gravitation begins to prevail. The sun's orbital motion about CM is governed by difference forces as well as the planets' course around the sun. These forces, gravitation and centrifugal force, are balanced overall. Yet in single phases of the orbit one force or the other can prevail. This has an effect on the sun's activity. I have shown that solar flares are subjected to a directional effect which is independent of the sun's rotation on its axis. When the sun moves away from CM after a strong impulse of the torque in its orbital motion, two times as many

flares are observed on the sun's side pointing away from CM than on the opposite side. When the sun moves towards CM, the number of flares on the side pointing to CM is significantly greater than on the other side. Yet this effect occurs only if the strength of the respective impulse of the torque in the SFS phase goes beyond a precisely defined quantitative threshold **[54, 57, 60].** The SFSs in Figure 19, indicated by arrows, coincide within the whole investigated interval of a century with peaks in the U/W values. This points to a close relationship between SFSs and the strength of solar convection. The respective SFSs beyond the time frame of Figure 19 fall at 1983.1, 1998.3, and 2008.4.

Figure 20 shows how big and small fingers interact with regard to climate data. The curve displays the smoothed 2-year running variance of yearly rainfall totals covering the years 1851 to 1983 derived from 14 German stations by F. Baur **[5].** Open arrows mark epochs of SFSs correlated with maxima in the variance, while open circles indicate epochs of SFTs that go along with minima. Only at the secular sunspot minimum of 1895 is the correlation weak, probably because of the lack of releasable magnetic energy available only in large sunspot groups. In statistical tests the sceptical null hypothesis was rejected at the level $P = 3 \times 10^{-5}$ **[60]**. This result was corroborated by rainfall data from England, Wales, U.S.A., and India as well as by similar investigations into temperature **[60]**. The variance amplitudes are modulated by starts (S) and tips (T) of big fingers, marked by flat triangles. BFTs show a correlation with high amplitudes and BFSs with small ones. They indicate maxima and minima that would emerge if the curve were smoothed. The next maxima in the curve are to be expected in 1998 with an amplitude in the medium range and in 2005 with an amplitude in the lower range.

Figure 21 after J. T. Houghton et al. **[36]** shows the growth rate of CO_2 concentrations since 1958 in ppmv/year at the Mauna Loa, Hawaii station. I owe the result presented here to P. Dietze who drew my attention to the fact that the CO_2 data reflect the rhythm of small finger cycles in a similar way as tropospheric temperatures measured by satellites (**Figure 23**). Filled triangles in Figure 21 mark SFSs and open triangles the major 0.618 within the SF cycles. If the length of the cycle goes beyond 8 years, the minor 0.382, too, gets involved. It is marked by diamonds. After BHS 1968 (fat arrow and dashed vertical line) all Golden section phases (open triangles and diamond) coincide with outstanding maxima in the CO_2 data. SFSs (filled triangles) indicate deep minimum ranges. Just in the middle between the marked phases (little arrows) is the location of secondary minima. Before BHS 1968, which released a phase jump, everything is reversed. Two CO_2 maxima on the right, marked by filled circles, do not match the pattern. They lie about six months past those SFSs that coincide with middle-range maxima in global temperature shown in Figure 23. This is a confirmation of the result, elaborated by C. Kuo et al. **[48]** and H. Metzner **[75]**, that warming of the atmosphere comes first and only five to seven months later the CO_2 concentration follows. Yet it can be seen in addition that the sun's activity is involved. The next CO_2 minimum is to be expected around 1998.3, the imminent SFS, and the next maximum around 2002.9, the Golden section phase 0.618 in the new small finger cycle. An intermittent maximum like that at the end of 1990 could possibly develop around the end of 1998.

The connection presented in **Figure 22** after J. T. Houghton et al. **[35]** solves a seemingly intractable problem of climatology and meteorology: the prediction of El Niño. This phenomenon represents a quasicyclic large scale atmosphere-ocean interaction which has climatic effects throughout the Pacific region and far beyond. It is the only true global-scale oscillation that has been identified so far. It is also called an ENSO event because of its links with the Southern Oscillation, a fluctuation of the intertropical atmospheric oscillation. The curve plots the monthly sea surface and land air anomalies 1961 to 1989 for the tropical zone extending from 20° N to 20° S. The outstanding peaks indicate ENSO events. After BFS 1968, marked by a big open arrow, all SFSs, indicated by open triangles, coincide with peaks in the plot. The same is true for the major of the Golden section within cycles formed by consecutive SFSs. These 0.618 phases are marked by filled circles. In case of small finger cycles longer than 8 years, also the minor 0.382 goes along with peaks. It is indicated by filled diamonds. Troughs in the time series are almost exactly linked to midpoints in between consecutive crucial phases, marked by small arrows.

Before the initial phase 1968 of a big finger cycle higher up in the hierarchy of the fractal of solar cycles, the pattern was reversed. SFSs as well as majors and minors within small finger cycles coincided with troughs, and the midpoints between these phases went along with peaks. A further El

Niño was to be expected in 1993. It appeared punctually. In my paper ***"The Cosmic Function of the Golden Section"*** **[64]** I extrapolated this pattern and predicted more El Niños for 1995 and 1998. Critics were sceptical about the 1995 event so close after the 1993 El Niño. Yet the forecast proved correct **[26]**. A new El Niño began to build up in 1997. At the end of 1997 the Australian Bureau of Meteorology thought that El Niño had faded away and La Niña would reign in 1998. However, as the new year opened, El Niño charged up again, contrary to the predictions of its early demise, and showed a strong performance in the following months, stronger than in the months July to December 1997.

Figure 23 shows yearly means of the global mean temperature in the lower troposphere observed by satellites **[108]**. In contrast to time series of "world temperature" constructed by IPCC scientists, these data are objective and free from distortions by the urban heat island effect. Different from the inhomogeneous and wide-meshed net of meteorological stations they cover the whole globe homogeneously. As can be seen from Figure 23, the temperatures in 1995 were not higher than in 1979 at the beginning of satellite observations, though IPCC scientists claim an unprecedented rise in global temperature in the eighties. The trend amounts to -0.06° C per decade. The quality of the satellite data is confirmed by radiosonde observations. For the same interval these balloon data yield nearly the same trend of -0.07° C **[27]**. Both of the data series show exactly the same course **[76]**. The cyclic variation in the data cannot be explained by general circulation models in spite of the entailing great expense. There is not even an attempt to model such complex climate details, as GCMs are too coarse for such purposes. When K. Hasselmann (a leading greenhouse protagonist) was asked why GCMs do not allow for the stratosphere's warming by the sun's ultraviolet radation and its impact on the circulation in the troposphere, he answered: ***"This aspect is too complex to incorporate it into models"*** **[8]**. Since there are other solar-terrestrial relationships which are "too complex" such as, for example, the dynamics of cloud coverage modulated by the solar wind, it is no wonder that the predictions based on GCMs do not conform to climate reality.

However, if the sun's dominant role in climate change is acknowledged, the further development of the time series in Figure 23 can be predicted. The filled arrows mark SFSs. Consecutive SFSs form cycles that can be subjected to the Golden section. The 0.618 phases within the small finger cycles are indicated by open arrows. All temperature maxima coincide with the phases marked by triangles. The midpoints between the crucial phases, designated by flat triangles, go along with minima in the temperature. On the basis of this pattern I predicted a middle-range minimum in the global temperature as measured by satellites for 1997.0 and a maximum for 1998.6 **[66]**. As to the minimum, the forecast has proven correct. Record-breaking minus temperatures were observed worldwide. The maximum prediction, too, has a good chance to turn out to be right. El Niño will take care of it. The current ENSO event and rising temperatures are interpreted by IPCC scientists as a case for the human impact on climate. Yet if this were true, how could the El Niño and the current warming be predicted by looking at cycles of solar activity?

In spite of the successful prediction of the middle-range temperature minimum 1997.0 it is to be expected that there will be objections that the relationship shown in Figure 23 covers only 18 years. Satellite data that start earlier are not available. Yet it would be possible to make use of time series of surface temperatures to check the correlation. They reach considerably higher levels, but H. Gordon **[27]** has shown that satellite temperatures and surface time series have nearly coincident phases. An even better match are balloon-borne radiosonde data **[76]**. **Figure 24** after J. P. Peixoto and A. H. Oort **[86]** is based on such data and extends the investigation back to 1958. The curve presents the monthly-mean atmospheric temperature anomalies in °C averaged over the Northern (top) and Southern (bottom) Hemispheric mass between the surface and about 25-km height for the period May 1958 to April 1988. The range of observation includes 22 km-height that plays an important part in the quoted investigations by K. Labitzke and H. van Loon. The anomalies are taken with respect to the 1963 - 1973 mean conditions. The smoothed curves show 15-month Gaussian-type filtered values.

Data for the Southern Hemisphere are not available before 1963. The filled triangles mark SFSs and the open triangles the Golden section phase 0.618 within cycles formed by consecutive SFSs. When the cycle length goes beyond 8 years, the minor phase 0.382 is indicated by filled diamonds. The correlation between the temperature maxima and the designated phases of small finger cycles is close. As far as there are deviations they only amount to a few months. Northern and Southern

Hemisphere also show a good conformance. This corroboration, which extends the satellite data result to four decades, indicates that the connection between middle-range temperature extrema and active phases of small finger cycles is real, particularly since it is part of a complex web of interrelations, the components of which confirm each other.

If we bear in mind that the correct forecasts based on the semiquantitative model of solar-terrestrial relations presented here are thinkable only if the sun's varying activity is a dominant factor in climate change, it seems difficult to resist the insight that once again an artificially constructed homocentric position is beginning to rock. A general survey of the given results indicates that climate variations are governed by the sun, not mankind.

References

[1] Arnol'd, V. I.: Small denominators and problems of stability of motion in classical and celestial mechanics. Russ. Math. Surv. 18 (1963), 85.

[2] Baliunas, S. & Soon, W.: Are variations in the length of the activity cycle related to changes in brightness in solar-type stars? Astrophys. J. 450 (1995), 896.

[3] Baltuck, M., Dickey, J., Dixon, T. & Harrison, C. G. A.: New approaches raise questions about future sea level change. EOS, 1. Oktober 1996, 385, 388.

[4] Barlow, A. K. & Latham, J.: A laboratory study of the scavenging of submicro aerosol by charged raindrops. Quart. J. R. Met. Soc. 109 (1983), 763.

[5] Baur, F.: Abweichungen der Monatsmittel der Temperatur Mitteleuropas & des Niederschlags in Deutschland. Beilage zur Berliner Wetterkarte des Instituts für Meteorologie der Freien Universität Berlin vom 24. 6. 1975.

[6] Bossolasco, M., Dagnino, I., Elena, A. & Flocchini, G.: Thunderstorm activity and interplanetary magnetic field. Riv. Italiana Geofis. 22 (1973), 293.

[7] Brückner, E.: Klimaschwankungen seit 1700. Geographische Abhandlungen 14 (1890), 325.

[8] Bührke, T.: Die Flecken der Sterne. Süddeutsche Zeitung vom 30. 10. 1997, 41.

[9] Burroughs, W. J.: Weather cycles - real or imaginary? Cambridge University Press,1992, 38, 128, 149.

[10] Butler, C. J.: A two-century comparison of sunspot cycle length and temperature change - the evidence from Northern Ireland. In: Emsley, J., Hsg.: The global warming debate. The report of the European Science and Environment Forum (ESEF). London, ESEF, 1996, 215.

[11] Clough, H. W.: Synchronous variations in solar and terrestrial phenomena. Astrophys. J. 22 (1905), 42.

[12] Clough, H. W.: The 11-year sunspot period, secular periods of solar activity, and synchronous variations of terrestrial phenomena. Monthly Weather Rev. 60 (1933), 99.

[13] Courtney, R. S.: Die Risiken des global warming. In: H. Metzner, Hsg.: Treibhaus-Kontroverse & Ozon-Problem. Tübingen, Europäische Akademie für Umweltfragen, 1996, 159.

[14] Dicke, R. H.: The sun's rotation and relativity. Nature 202 (1964), 432.

[15] Dickinson, R. E.: Solar variability and the lower atmosphere. Bull. Am. Meteorol. Soc. 56 (1975), 1240.

[16] Eddy, J. A.: Historical evidence for the existence of the solar cycle. In: White, O. R.: The solar output and its variation. Boulder, Colorado Associated University Press, 1977, 67.

[17] Eddy, J. A.: A new sun. The solar results from skylab. Washington, D. C., NASA, 1979, 12.

[18] EOS, Trans. Amer. Geophys. Union, 18. Oktober 1988, 1.

[19] Fichefet, T.: Solar radiation and global climate change: some experiments with a two-dimensional climate model. In:

B. Frenzel, Hsg.: Solar output and climate during the Holocene. Stuttgart-Jena-New York, Gustav Fischer Verlag, 1995, 169.

[20] Flohn, H.: Jüngste Klimaänderungen: Treibhauseffekt oder Beschleunigung des Wasserkreislaufs. In: Metzner, H., Hsg.: Globale Erwärmung - Tatsache oder Behauptung? Tübingen, Europäische Akademie für Umweltfragen, 1993, 91.

[21] Foukal, P. V.: The variable sun. Scient. American, Februar 1990, 39.

[22] Foukal, P. & Lean, J.: An empirical model of total solar irradiance between 1874 and 1988. Science 247 (1990), 556-558.

[23] Franke, H.: Lexikon der Physik. Stuttgart, Francksche Verlagshandlung, 1969, 845, 1603.

[24] Friis-Christensen, E. & Lassen, K.: Length of the solar cycle: an indicator of solar activity closely associated with climate. Science 254 (1991), 698.

[25] Fröhlich, C.: Variations in total solar irradiance. In: B. Frenzel, Hsg.: Solar output and climate during the Holocene. StuttgartJena-New York, Gustav Fischer Verlag, 1995, 125, 126, 127.

[26] Fu, L.L, Koblinsky, C. J., Minster, J. F. & Picaut, J.: Reflecting on the first three years of TOPEX/POSEIDON. EOS 77 (1996), Nr. 12, 19. März 1996, 109,111, 117.

[27] Gordon, A. H.: Bias in measured data. In: Bate, R., Hsg.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), Cambridge, 1998, 55.

[28] Groveman, B. S. & Landsberg, H. E.: Simulated northern hemisphere temperature departures 1579-1880. Geophysical Research Letters, 6 (1979), 767.

[29] Haigh, J.: On the impact of solar variability on climate. Science 272 (1996),981.

[30] Hansen, J. E. & Lebedeff, S.: Global surface air temperatures. Update through 1987. Geophysical Research Letters 15 (1988), 323.

[31] Hansen, J., Lacis, A., Rind, D., Russell, G., Stone, P., Fung, I., Ruedy, R. & Lerner, J.: Climate sensitivity: analysis of feedback mechanisms. In: J. E. Hansen & T. Takahashi, Hsg.: Climate processes and climate sensitivity. Geophys. Series 29. Washington, D. C., Am. Geophys. Union (AGU),1990, 130.

[32] Hansen, J. E., Lacis, A. A., & Ruedy, R. A.: Comparison of solar and other influences on long-term climate. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 142.

[33] Harvey, L. D. D.: On the role of high latitude ice, snow, and vegetation feedbacks in the climatic response to external forcing changes. Climatic Change 13 (1988), 191.

[34] Hood, L. L. & Jirikowic, J. L.: A mechanism involving solar ultraviolet variations for modulating the interannual climatology of the middle atmosphere. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 165.

[35] Houghton, J. T., Jenkins, G. J. & Ephraums, J.J.: Climatic change. The IPCC scientific assessment. Cambridge University Press, 1990.

[36] Houghton, J. T., Meira Filho, L. G., Callander, B. A., Harris, N., Kattenberg, A. & Maskell, K: Climate Change 1995. Cambridge, 1996, 81, 366, 381.

[37] Howard, R.: The rotation of the sun. Scient. American 232 (1975), 106.

[38] Hoyt, D. V.: Using the boundary conditions of sunspots as a technique for monitoring solar luminosity variations. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 44.

[39] Hoyt, D. V. & Schatten, K. H.: The role of the sun in climate change. New York-Oxford, Oxford University Press, 1997, 61, 70, 86, 184,188,194, 214.

[40] Jones, P. D.: Hemispheric surface air temperature variations. Recent trend and an update to 1987. J. Climate 1 (1988), 645.

[41] Jose, P. D.: Sun's motion and sunspots. Astron. J. 70 (1964), 195.

[42] Joselyn, J. A.: SESC methods for short-term geomagnetic predictions. In: Simon, P. A., Heckman, G. & Shea, M. A.: Solar-terretrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 1986, 404.

[43] Kahl, J. D., Charlevoix, D. J., Zaitseva, N. A., Schnell, R. C. & Serreze, M. C.: Absence of evidence for greenhouse warming over the Arctic Ocean in the past 40 years. Nature 361 (1993), 335.

[44] Kaku, M.: Quantum field theory. Oxford University Press, 1993, 14.

[45] Kapfraff, J.: Connections. The geometry bridge between art and science. New York, McGraw Hill, 1991, 85, 89, 308, 313.

[46] Kertz, W.: Einführung in die Geophysik. Mannheim, Bibliographisches Institut, 1971, 376-377.

[47] Kolmogorov, A. N.: Preservation of conditionally periodic movements with small change in the Hamiltonian function. Lecture Notes in Physics 93 (1979), 51.

[48] Kuo, C., Lindberg, C. & Thomson, D. J.: Coherence established between atmospheric carbon dioxide and global temperature. Nature 343 (1990), 709.

[49] Labitzke, K, & van Loon, H.: Sonnenflecken & Wetter. Gibt es doch einen Zusammenhang? Die Geowissenschaften 8 (1990), 1.

[50] Labitzke, K. & van Loon, H: Some recent studies of probable connection between solar and atmospheric variability. Ann. Geophysicae 11 (1993), 1084.

[51] Labitzke, K, & van Loon, H.: Associations between the 11-year sunspot cycle, the quasi-biennial oscillation, and the atmosphere. Philosophical Transactions of the Royal Society of London, A, 330 (1990), 577.

[52] Lamb, H. H.: Climate: Present, past, and future. Bd. 1. London, Methuen,1972, 186, 456.

[53] Landsberg, H. E.: Man-made climatic changes. In: Proceedings of the symposium on physical and dynamic climatology of the World Meteorological Organization 347 (1974), 262.

[54] Landscheidt, T.: Beziehungen zwischen der Sonnenaktivität & dem Massenzentrum des Sonnensystems. Nachrichten der Olbers-Gesellschaft 100 (1976), 12, 14-15.

[55] Landscheidt, T.: Solar oscillations, sunspot cycles, and climatic change. In: McCormac, B. M., Hsg.: Weather and climate responses to solar variations. Boulder, Associated University Press, 1983, 301, 302, 304.

[56] Landscheidt, T.: Cycles of solar flares and weather. In: Moerner, N.A. & Karlén, W., Hsg.: Climatic changes on a yearly to millenial basis. Dordrecht, D. Reidel, 1984, 475, 476.

[57] Landscheidt, T.: Long-range forecast of energetic x-ray bursts based on cycles of flares. In: Simon, P. A., Heckman, G. & Shea, M. A.: Solar-terretrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 1986, 85, 86, 87-88.

[58] Landscheidt, T.: Long-range forecast of sunspot cycles. In: Simon, P. A., Heckman, G. & Shea, M. A.: Solar-terretrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 1986, 53-55.

[59] Landscheidt, T.: Long-range forecasts of solar cycles and climate change. In: Rampino, M. R., Sanders, J. E., Newman, W. S. & Königsson, L. K.: Climate. History, Periodicity, and predictability. New York, van Nostrand Reinhold, 1987, 433-438.

[60] Landscheidt, T.: Solar rotation, impulses of the torque in the sun's motion, and climatic variation. Climatic Change 12 (1988), 267-268, 270, 277, 278-280, 283, 286-290.

[61] Landscheidt, T. & Wöhl, H.: Solares Aktivitätsminimum erst 1989/90? Sterne & Weltraum, November 1986, 584.

[62] Landscheidt, T.: Relationship between rainfall in the northern hemisphere and impulses of the torque in the sun's motion. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 260.

[63] Landscheidt, T.: Global warming or Little Ice Age? In: Finkl, C. W., Hsg.: Holocene cycles. A Jubilee volume in celebration of the 80th birthday of Rhodes W. Fairbridge. Fort Lauderdale, The Coastal Education and Research Foundation (CERF), 1995, 372, 373, 374-375.

[64] Landscheidt, T.: Die kosmische Funktion des Goldenen Schnitts. In: P. H. Richter, Hsg.: Sterne, Mond & Kometen. Bremen & die Astronomie. Bremen, Verlag H. M. Hauschild, 1995, 240-276.

[65] Landscheidt, T.: Klimavorhersage mit astronomischen Mitteln? Fusion 18 (1997), Nr. 1, 58.

[66] Landscheidt, T.: Forecast of global temperature, El Niño, and cloud coverage by astronomical means. In:Bate, R., Hsg.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), 1998, 172.

[67] Laskar, J.: A numerical experiment on the chaotic behaviour of the solar system. Nature 338 (1989), 237.

[68] Lassen, K. & Friis-Christensen, E.: Variability of the solar cycle length during the past five centuries and the apparent association with terrestrial climate. Journ. of Atmos. Terr. Phys. 57 (1995), 835.

[69] Livingston, W. C.: Secular change in equivalent width of C 5380, 1978-1990. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 336.

[70] van Loon, H. & Labitzke, K.: The 10-12-year atmospheric oscillation. Meteorol. Zeitschrift 3 (1994), 259.

[71] Markson, R. & Muir, M.: Solar wind control of the earth's electric field. Science 208 (1980), 979.

[72] Mason, B. I.: Towards the understanding and prediction of climatic variations. Quart. J. Roy. Soc. 102 (1976), 478.

[73] McKinnon, J. A. : Sunspot numbers 1610-1985. Boulder, World Data Center A for Solar Terrestrial Physics, 1987.

[74] Mecherikunnel, A. T. & Kyle, H. L: Solar constant data from Earth Radiation Budget measurements. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 316.

[75] Metzner, H.: Gibt es einen CO -induzierten Treibhaus-Effekt? In: H. Metzner, Hsg.: Treibhaus-Kontroverse & Ozon-2 Problem. Tübingen, Europäische Akademie für Umweltfragen, 1996, 89.

[76] Michaels, P. J. & Knappenberger, P. C.: The United Nations Intergovernmental Panel on Climatic Change and the scientific "consensus" on global warming. In: Emsley, J., Hsg.: The global warming debate. The report of the European Science and Environment Forum. London 1996, 166.

[77] Mitchell, J. M., Stockton, C. W. & Meko, D. M.: Evidence of a 22-year rhythm of drought in the Western United States related to the Hale solar cycle since the 17th century. In: B. M. McCormac & T. A. Seliga, Hsg.: Solar- terrestrial influences on weather and climate. Dordrecht,Reidel, 1979, 125.

[78] Mogey, R.: The cycles in inflation. Cycles 44 (1993), 102.

[79] Moser, J.: Stable and random motions in dynamical systems. Princeton University Press, 1973.

[80] Moss, F. & Wiesenfeld, K.: The benefits of background noise. Scient. American, August 1995, 66.

[81] National Geophysical Data Center, Boulder: X-ray flares. SOLRAD (1968-1974), GOES (1975-present).

[82] Neeman, B. U., Ohring, G. & Joseph, J. H.: The Milankocich theory and climate sensitivity. Part I: Equilibrium climate model solution for the present surface conditions. J. Geophys. Res. 93 (1988), 11153.

[83] Negendank, J. F. W., Brauer, A. & Zolitschka, B.: Die Eifelmaare als erdgeschichtliche Fallen & Quellen zur Rekonstruktion des Paläoenvironments. Mainzer geowiss. Mitt. 19 (1990), 235.

[84] Nesme-Ribes, E., Baliunas, S. L. & Sokoloff, D.: The stellar dynamo. Scient. American August 1996, 51-52.

[85] Newton, I.: Mathematische Prinzipien der Naturlehre. Darmstadt, Wissenschaftliche Buchgesellschaft, 1963, 532.

[86] Peixoto, J. P. & Oort, A. H.: Physics of climate. New York, American Institute of Physics, 1992, 466.

[87] Peng, L., Chou, M. D. & Arking, A.: Climate studies with a multi-layer energy balance mode. Part I: Model description and sensitivity to the solar constant. J. Atmosph. Sci. 39 (1987), 5505.

[88] Posmentier, E. S., Soon, W. H. & Baliunas, S. L.: Relative impacts of solar irradiance variations and greenhouse changes on climate, 1880-1993. In: Bate, R., Hsg.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), Cambridge, 1998, 159.

[89] Potter, G. L. & Cess, R. D.: Background tropospheric aerosols: incorporation within a statistical dynamical climate model. J. Geophys. Res. 89 (1984), 9521.

[90] Priem, H. N. A.: CO and climate: a geologist's view. Space Science Reviews 81 (1997), 193. 2

[91] Ramanathan, V., Barkstrom, B. R. & Harrison, E. F.: Climate and the earth's radiation budget. Physics Today, Mai 1989, 22.

[92] Reiter, R.: Influences of solar activity on the electric potential between the ionosphere and the earth. In: B. M. McCormac & T. A. Seliga, Hsg.: Solar-terrestrial influences on weather and climate. Dordrecht, Reidel, 1979, 251.

[93] Rind, D. & Overpeck, J. T.: Hypothesized causes of decadal-to-century-scale climate variability - climate model results. Quat. Sci. Rev. 12 (1993), 357.

[94] Robock, A: Solar, volcanic, and anthropogenic influences on climate for the past 500 years. Klimakonferenz "Klimaveränderungen - Ursachen & Auswirkungen", 10. -11. November in Bonn.

[95] Roederer, J. G.: Solar variability effects on climate. In: In: B. Frenzel, Hsg.: Solar output and climate during the Holocene. Stuttgart-Jena-New York, Gustav Fischer Verlag, 1995, 3, 17.

[96] Scherhag, R.: Die explosionsartigen Stratosphärenerwärmungen des Spätwinters 1951/52. Berichte des Deutschen Wetterdienstes der US-Zone Nr. 38 (1952), 51.

[97] Schlesinger, B. M., Cebula, R. P., Heath, D.F., DeLand, M. T & Hudson, R. D.: Ten years of solar change as monitored by SBUV and SBUV2. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 341.

[98] Schönwiese, C. D.: Northern hemisphere temperature statistics and forcing. Part B: 1579-1980. Arch. Met. Geoph. Biocl., Ser. B 35, 164.

[99] Schönwiese, C. D.: Der Treibhauseffekt: Weltweit wird das Wasser steigen. Bild der Wissenschaft, September 1987, 97, 98.

[100] Schönwiese, C. D.: Klima im Wandel. Hamburg, 1994, 99, 161.

[101] Schostakovitsch, W. B.: Bodenablagerungen der Seen & periodische Schwankungen der Naturerscheinungen. Mémoires de l'Institut Hydrologique 13 (1934), 95.

[102] Schriever, K. H. & Schuh, F.: Enzyklopädie Naturwissenschaft & Technik. Weinheim, Zweiburgen Verlag, 1980, 2227.

[103] Schuurmans, C. J. E.: Effects of solar flares on the atmospheric circulation. In: B. M. McCormac & T. A. Seliga, Hsg.: Solar-terrestrial influences on weather and climate. Dordrecht, Reidel, 1979, 105.

[104] Showstack, R.: Rivers of sunlight, EOS, 9. September 1997, 382.

[105] Singer F.: Globale Erwärmung. In: H. Metzner, Hsg.: Treibhaus-Kontroverse & Ozon-Problem. Tübingen, Europäische Akademie für Umweltfragen, 1996, 31.

[106] Solar Geophysical Data - comprehensive reports: Monthly counts of grouped solar flares Jan 1965 - Mar 1997. Number 637, September 1997, 7.

[107] Soon, W. H., Posmentier, E. S. & Baliunas, S. L.: Inference of solar irradiance variability from terrestrial temperature changes, 1880-1993. An astrophysical application of the sun-climate connection. The Astrophys. J. 472 (1996), 891.

[108] Spencer, R. W., Christy, J. R. & Grody, N. C.: Global atmospheric temperature monitoring with satellite microwave measurements: method and results 1979-1984. J. Climate 3 (1990), 1111.

[109] Stuiver, M., Grootes, P. M. & Braziunas, T. F.: The GISP delta ^{18}O climate record of the past 16,500 years and the role of 18 the sun, ocean, and volcanoes. Quat. Res. 44(1995), 341.

[110] Sussman, G. J. & Wisdom, J.: Chaotic evolution of the solar system. Science 257 (1992), 56.

[111] Svensmark, H. & Friis-Christensen, E.: Variation of cosmic ray flux and global cloud coverage - a missing link in

solarclimate relationships. J. Atm. Sol. Terr. Phys. 59 (1997), 1225.

[112] Svensmark, H.: Possible mechanisms of solar activity modulation of the earth's climate. Klimakonferenz "Klimaveränderungen - Ursachen & Auswirkungen", 10. -11. November in Bonn.

[113] Tinsley, B. A.: Do effects of global atmospheric electricity on clouds cause climatic changes? EOS, 19. August 1997, 341, 344, 349.

[114] Weber, G.-R.: Smudged fingerprint: The elusive search for a human impact on the climate system. In: Bate, R., Hsg.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), Cambridge, 1998, 63.

[115] Wetherald, R. T. & Manabe, S.: The effects of changing the solar constant on the climate of a general circulation model. J. Atmosph. Sci. 32 (1975), 2044.

[116] Wiesenfeld, K.: An introduction to stochastic resonance. In: J. R. Buchler & H. E. Kandrup: Stochastic processes in astrophysics. New York, New York Academy of Sciences, 1993, 13.

[117] Wiin-Christensen, C. & Wiin-Nielsen, A.: Limited predictability and the estimated greenhouse effect. In: Bate, R., Hsg.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), Cambridge, 1998, 41.

[118] Wilcox, J. M.: Solar activity and the weather. J. Atmosph. Terr. Phys. 37 (1975), 237.

[119] Wolff, C. L. & Hoegy, W. R.: Solar irradiance observed from PVO and inferred solar rotation. In: K. H. Schatten & A. Arking, Hsg.: Climate impact of solar variability. Greenbelt, NASA, 1990, 58.

[120] Yoshimura, H.: The 110-year periodic modulations of solar magnetic cycle and solar total irradiance and luminosity. STEP GBRSC News, 5 (1995), No.2, 7.

A German language version of the above paper

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Solar Activity Controls El Niño and La Niña

APPENDIX VI (3)
Submission on Adapting to Climate Change,
Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

by

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(`Open Review' comments on this paper may be downloaded as a .zip file here)

1. Forecast of ENSO events

Anomalous warming (El Niño) or cooling (La Niña) of surface water in the eastern equatorial Pacific occurs at irregular intervals between 2 and 7 years in conjunction with the Southern Oscillation, a massive seesawing of atmospheric pressure between the southeastern and the western tropical Pacific.

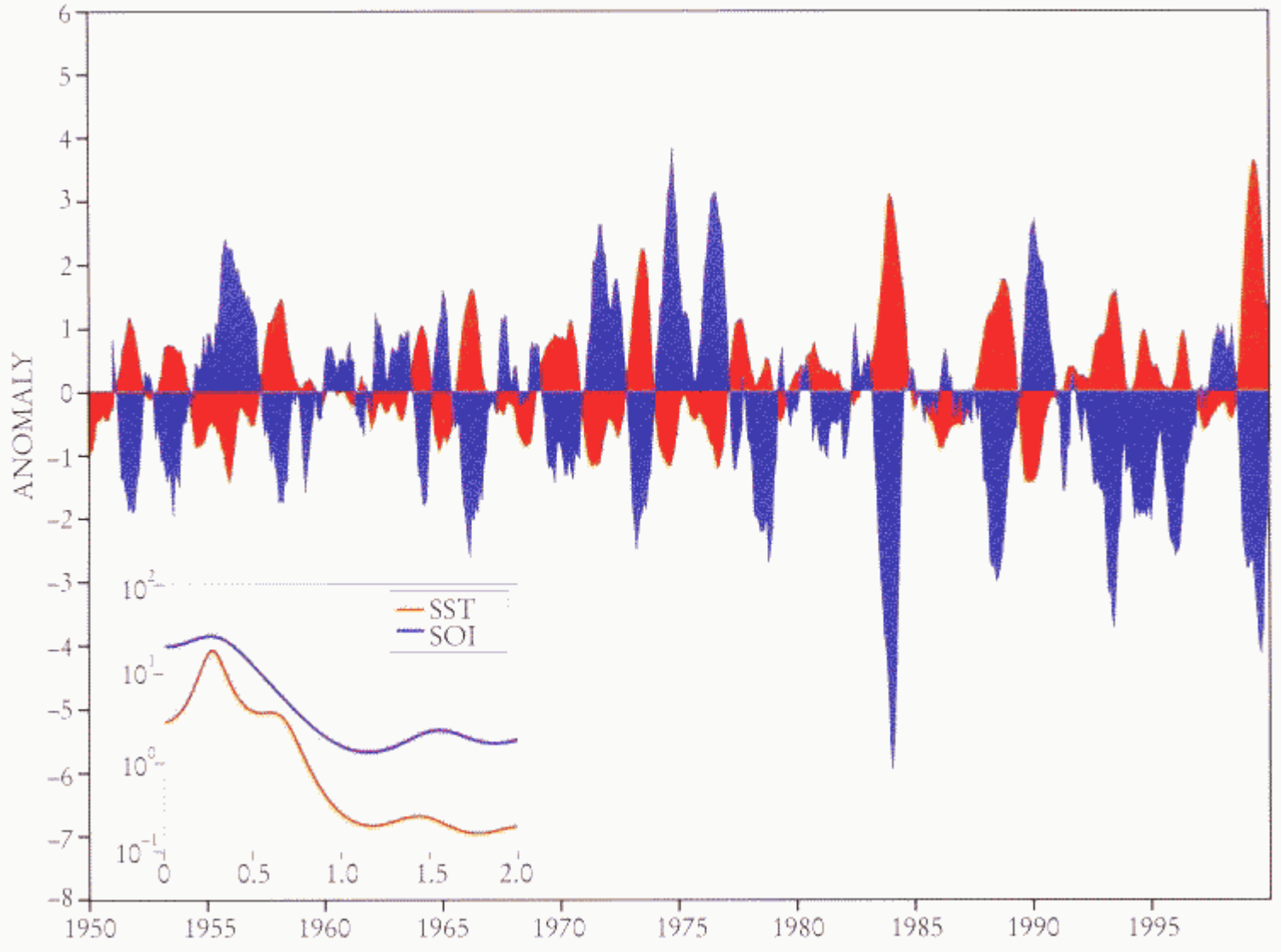


Figure 1 after J. D. Neelin and M. Latif [36] shows the anticorrelation of the covarying indices of these oscillations. Plotted in red are anomalies (deviations from the long-term mean) of sea surface temperatures (SST) averaged over the tropical east-central Pacific. Plotted in blue is the Southern Oscillation Index (SOI), the normalized pressure difference between Tahiti, in the mid-Pacific, and

Darwin, Australia. The SOI measures the pressure gradient across the tropical Pacific which, in turn, is an indicator of equatorial wind variations. When the SOI index reaches low negative values, a strong El Niño is in progress. High positive values indicate La Niña. Power spectra of the covarying time series (inset) show a distinct period at approximately 4 years. The inset axis measures cycles per year.

The coordinated El Niño/Southern Oscillation phenomenon (ENSO, for short) is the strongest source of natural variability in the global climate system **[41]**. During the severe ENSO event 1982/1983, when the sea surface off Peru warmed by more than 7° C, it was discovered that there are strong links to weather in other regions as, for instance, floods in California and intensified drought in Africa. The observation of this global connection implied that the oceanic and atmospheric anomalies of the equatorial Pacific might be the key to accurate seasonal weather forecasts in other regions. Since then there has been a continuous search for ENSO precursors and worldwide patterns of effect to make it possible to predict the event and its consequences for seasonal weather. This effort has a solid basis as far as the involved energy is concerned. **J. L. Daly** **[9]** has shown, that positive and negative anomalies in the global temperature of the lower troposphere, measured by satellites since 1979, are primarily driven by El Niños, La Niñas, and the Southern Oscillation. This is not easy to see as global temperature lags the SOI by 6 to 9 months. Only when severe volcanic eruptions occur, global temperature is modulated by their cooling effect.

J. P. Peixoto and A. H. Oort **[40]** have provided similar evidence covering the period 1958 - 1987. Their data include the whole troposphere and the lower stratosphere up to 25 km height. When they compared the time series of SST anomalies in the eastern equatorial Pacific with the time series of the atmospheric temperature averaged vertically and horizontally over the entire Northern Hemisphere, they found that the curves are highly correlated. The correlation is highest (r = 0.82) when the atmospheric temperature lags the ocean temperature by four months. They concluded: **"Since correlations with the mean Southern Hemisphere temperatures are also very high, it is clear that a large part of the observed variability in the global atmosphere must be connected with the ENSO events."** Peixoto and Oort **[40]** also observed that sea surface temperatures lag the SOI by 4.5 months. So they found that atmospheric temperatures lag the SOI by 8.5 months. This is just what Daly found in the satellite measurements of the lower troposphere.

When we look at Figure 1 and the rather irregular oscillations in the plotted time series, it seems impossible to predict ENSO events on a theoretical basis. Yet the NOAA tripwire open-ocean buoy array including 65 deep-ocean moorings and 135 surface drifters gives climatologists an early warning of 6 to12 months of an impending El Niño. In addition, a satellite borne microwave sensor allowed scientists in 1997/1998 to estimate the velocity and track of the large eastward-travelling Indonesian Kelvin wave and the quantity and temperature of the hot water migration from west to east. Daily observations of changes in SST, surface wind, upper ocean thermal structure, and ocean currents enable researchers to engage in modeling and predicting ENSO events. It seems to be very difficult, however, to develop models that extend the 1-year limit set by the observation of precursors. M. Cane and S. Zebiak of the Lamont-Doherty Earth Observatory of Columbia University made the first successful forecast of an El Niño in early 1986, one year ahead of the event, but their model did not indicate the strong 1997/1998 El Niño. At present, there exist no models that can skillfully predict ENSO events at lead times longer than twelve months **[36]**.

Neelin and Latif **[36]** think that ENSO's irregularity limits its predictability. They hold that weather noise, the changing background state of climate, and deterministic chaos, representing the internal variability of the climate system, set the fundamental limits to the lead time at which El Niño can be predicted. This view that ENSO events are exclusively internal phenomena of the climate system represents the accepted teaching in climatology, as expressed by Peixoto and Oort **[40]**:

> **"On the interannual time scale there are no large external forcings of the atmosphere-ocean system so that the variations must arise from internal interactions with many positive and negative feedbacks. The most spectacular example of an internal variation is the ENSO phenomenon that may be regarded as a free oscillation of the ocean-atmosphere system."**

I shall show that this is a preconception. Actually, El Niño and La Niña are subjected to external

forcing by the sun's varying activity to such a degree that it explains nearly all of ENSO's irregularities and makes long-range forecasts beyond the 1-year limit possible. This is no mere theory. My forecasts of the last two El Niños [28] turned out correct and that of the last one was made more than two years ahead of the event, beyond the 1-year limit discussed in the literature. Deterministic chaos, mentioned by Neelin and Latif, does not stand in the way of external forcing. Sensitive dependence on initial conditions and ensuing limited predictability are only valid with regard to processes within the climate system. External periodic or quasiperiodic systems can positively force their rhythm on it. This is not only the case with the periodic change of day and night and the Milankovitch cycles, but also with variations in the solar energy output as far as they are periodic or quasiperiodic.

2. 11-year sunspot cycle and the Golden section

The 11-year sunspot cycle meets these conditions of external forcing. Yet climatologists who exclusively consider the change in the sun's irradiance solely look at maxima and minima of the sunspot cycle. It is easy to see that these extrema show no consistent and sufficiently strong correlation with the El Nino phenomenon. However, recent research has shown that the solar wind, driven by solar eruptions (flares and coronal mass ejections) and plasma flux emanating from coronal holes, has a stronger impact on climate phenomena either directly or by modulating galactic cosmic rays [31]. The activity of coronal holes is not well correlated with sunspot activity, while energetic eruptions shun sunspot maxima and occur even close to minima. So it makes sense to investigate whether there are other phases than maxima and minima within the sunspot cycle which are closely correlated with El Niño events.

The 11-year sunspot cycle is not built symmetrically. The ascending part from minimum to maximum is shorter than the declining part from maximum to minimum. I have shown that the sunspot maximum divides the sunspot cycle according to the Golden section. It falls at the minor of this special irrational proportion. The Golden section divides a frame structure like a line segment, a surface, a cycle, or any other delimited feature so that the ratio of the smaller part (minor) to the larger part (major) equals the ratio of the larger part to the whole. When we set the whole equal to 1, we get 0.3819 ... : 0.618 ... = 0.618 ... : 1. To find the major of the length of a cycle, it has to be multiplied by 0.618. Multiplication by 0.382 gives the minor.

Reliable sunspot data are available since 1750. They show that the ascending part of the sunspot cycle has a mean length of 4.3 years. The mean cycle length amounts to 11.05 years. The minor of the mean length falls at 4.2 years (11.05 yrs * 0.382 = 4.22 yrs). This is close to 4.3 years, the observed mean of the interval from minimum to maximum. The descending part of the cycle has the length of the major. Magnetic cycles of solar type stars show the same structure shaped by the Golden section [28]. This is not merely a queer coincidence. The Golden section has a physical function. A. N. Kolmogorov [17], V. I. Arnol'd [1], and J. Moser [34] have proven theoretically that the stability of the solar system hinges on the Golden section. This is crucial, as we know from publications by G. J. Sussman and J. Wisdom [51] and also J. Laskar [32] that the orbits of all planets are chaotic. In my paper **"The Cosmic Function of the Golden Section"** [28] I have shown how the Golden section, which stands for stability in polar opposition to instability, has kept the solar system stable for 4.6 billion years in spite of chaos in all planetary orbits. The circumstance that the sunspot maximum falls at the minor of the sunspot cycle contributes to the stabilization of solar activity which is characterized by phenomena generated by instability. The sunspot cycle is no isolated case. It confirms the rule that minor and major of the Golden section within solar-terrestrial cycles indicate special phases with outstanding effects. I refer to numerous examples given in my paper **"Solar Activity: A Dominant Factor in Climate Dynamics"** [31]. Thus, an investigation of a potential correlation between the sunspot cycle and El Niños should take this point into consideration.

3. Fractal character of the sunspot cycle and energetic solar eruptions

Nature is fond of fractals. It makes use of well-tried patterns on different scales. The ascending and the declining part of the sunspot cycle could be looked at as cycles in their own right. So it should be considered whether these smaller cycles repeat the pattern of the whole sunspot cycle such that the

minor of the Golden section indicates a phase of outstanding activity. To test this hypothesis I checked the distribution of energetic solar eruptions within the two subcycles. This is together the involvement of a phenomenon that drives the solar wind. I chose all X-ray eruptions equal to or greater than X6, observed by satellites from 1970 to 1998 [35]. Intense X-ray flares have a stronger impact on climate than flares categorized into classes of optical brightness [25].

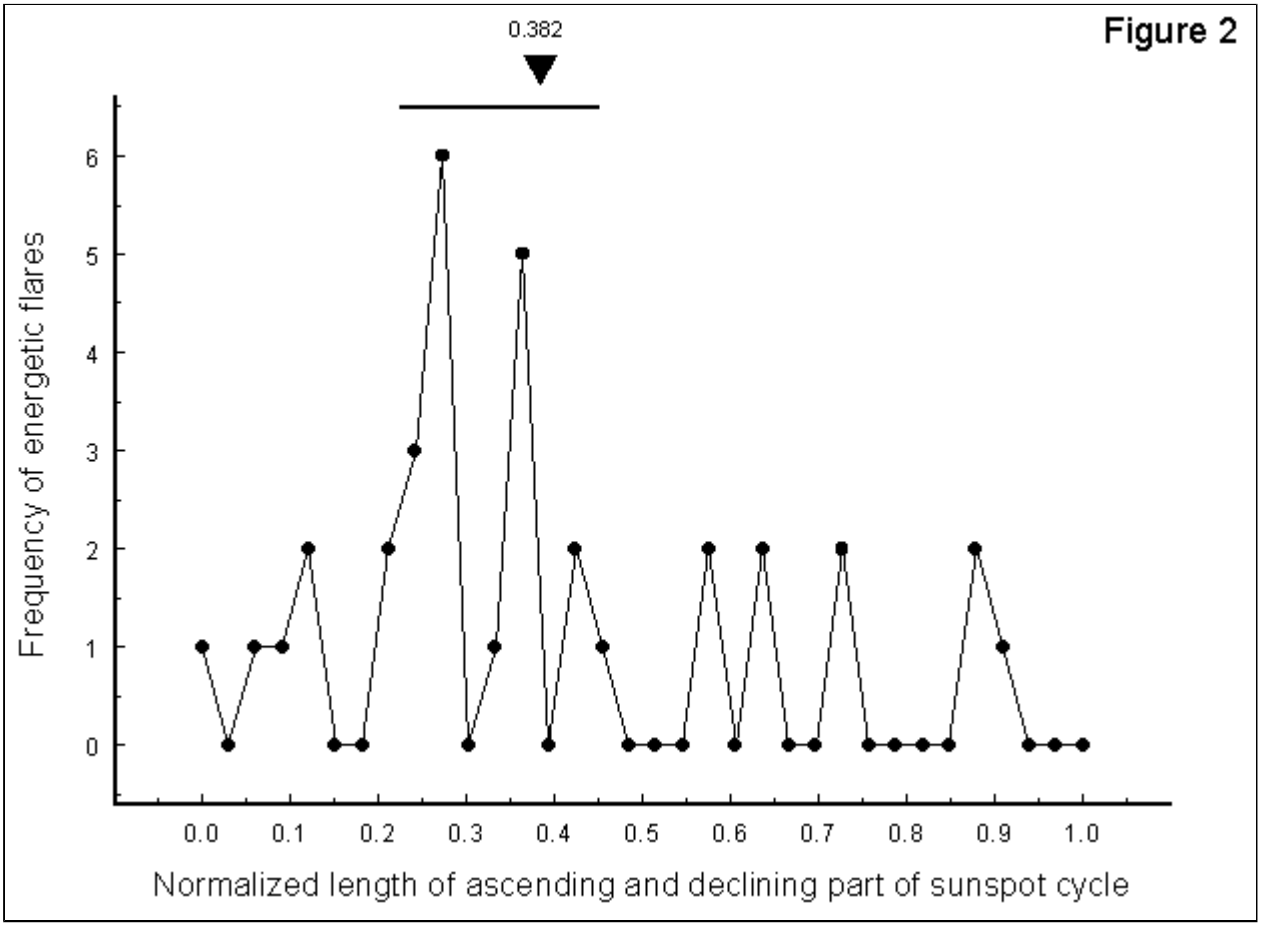
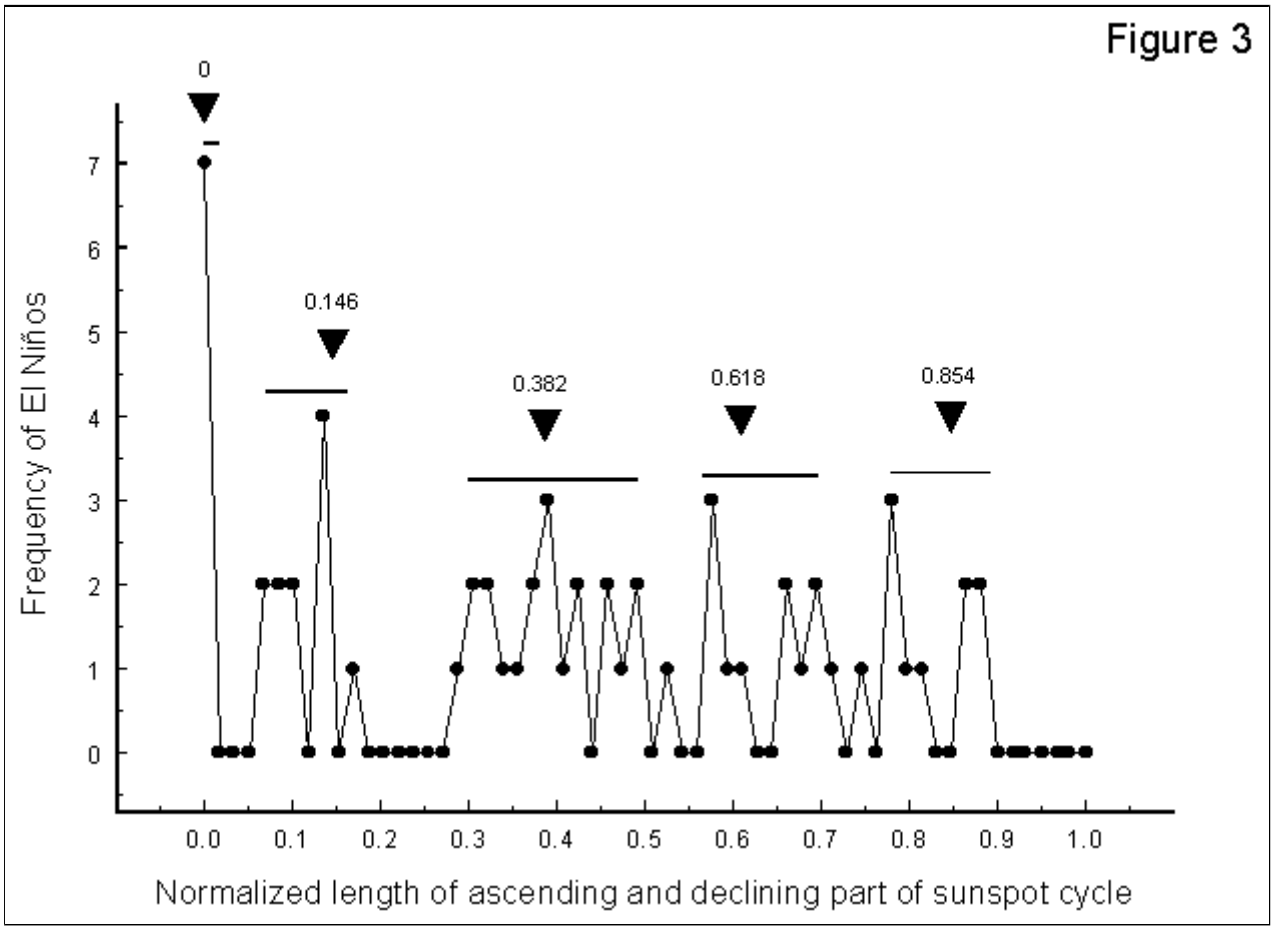


Figure 2 shows the superposed result for both of the subcycles which are normalized to emphasize identical phases in cycles of different length. The phase of the minor 0.382 is marked by a solid triangle. The energetic flares concentrate on the interval between 0.225 and 0.45 around the minor. As much as 19 of the 34 observed energetic flares fall at this interval and only 15 at the remaining interval covering a range of 0.775 on the unit scale. A chi-square test yields the value 21.7 for 1 degree of freedom. The probability that the observed distribution is due to chance is P = 0.000003. The sceptical null hypothesis can be considered rejected.

4. Distribution of El Niños within subcycles of the sunspot cycle since 1610

So it seems to make sense to look for a potential relationship between special phases in the ascending and declining subcycles of the 11-year sunspot cycle and El Niño events. Results based on short time series are always exposed to objections. This is why data covering nearly four centuries were chosen. Epochs of sunspot minima and maxima are available since 1610. El Niño data published by W. A. Arntz and E. Fahrbach [2], partly based on W. H. Quinn, V. T. Neal, and S. E. A. de Mayola [43], even go back beyond 1610. Only years of the event or periods of two years are given. To proceed consistently, the middle of single years, or the beginning of the second year of pairs of years was assumed to give the closest approximation to the event date. The dates of El Niños before 1875 and of sunspot extrema before 1750 cannot be considered precise, but if there is a strong correlation, it should nevertheless emerge. **Figure 3** shows the result.



There is the expected concentration of events around the minor 0.382 of the Golden section. 19 El Niños of the total of 60 fall at the interval between 0.32 and 0.5 and only 41 at the remaining interval 0.82. A chi-square test yields the chi-square value 7.6 and P = 0.006. The sceptical null hypothesis can be rejected at a high level of significance. Yet there are other deviations from the expected distribution. The accumulation around the major 0.618 complements the Golden section phases. This is also true of the concentrations around 0.146 and 0.854 though this is not easy to see. Practice shows that the larger intervals within a cycle between the initial phase and the minor and between the major and the following initial phase are often bridged by Golden sections of the second generation. The additional phase 0.146 falls at the minor of the interval between 0 and the minor 0.382, while the further phase 0.854 coincides with the major in the interval between the major 0.618 and 1. The phases 0.146, 0.382, 0.618, and 0.854 are symmetrically distributed about the phase 0.5 in the middle of the cycle. The accumulation at the phase 0, representing sunspot maxima and minima, is a surprise, as recent data show no connection of this kind. A statistical evaluation with the ranges of accumulation as indicated in Figure 3 by delimited horizontal lines yields a chi-square value 44.4 for 1 degree of freedom and $P = 3 \times 10^{-11}$. This clearly indicates that we are not dealing with a chance distribution, though there was no starting hypothesis covering the outstanding phases 0.146 and 0.854.

5. Distribution of SOI extrema within subcycles of the sunspot cycle since 1951

These first results should be checked by data that are not affected by inaccuracies and come as close as possible to the cause of ENSO events. Such events are characterized by a low negative Southern Oscillation Index (SOI), weaker than normal trade winds over the central Pacific, and warmer than normal sea surface temperatures (SST) in the eastern equatorial Pacific. A low SOI goes along with a reduced westward pressure gradient and changing wind stress values. According to Peixoto and Oort **[40]** the pressure change comes first, whereas the wind stress lags the SOI by two months. The SST lags it even by 4.5 months. So variations in the pressure gradient, expressed as change in the SOI, are closer to the cause of ENSO events than wind stress and rising sea surface temperature. This is why I investigated standardized monthly data of the SOI covering the period 1951 - 1998 **[38]**.

The curve in **Figure 4** shows these slightly smoothed data.

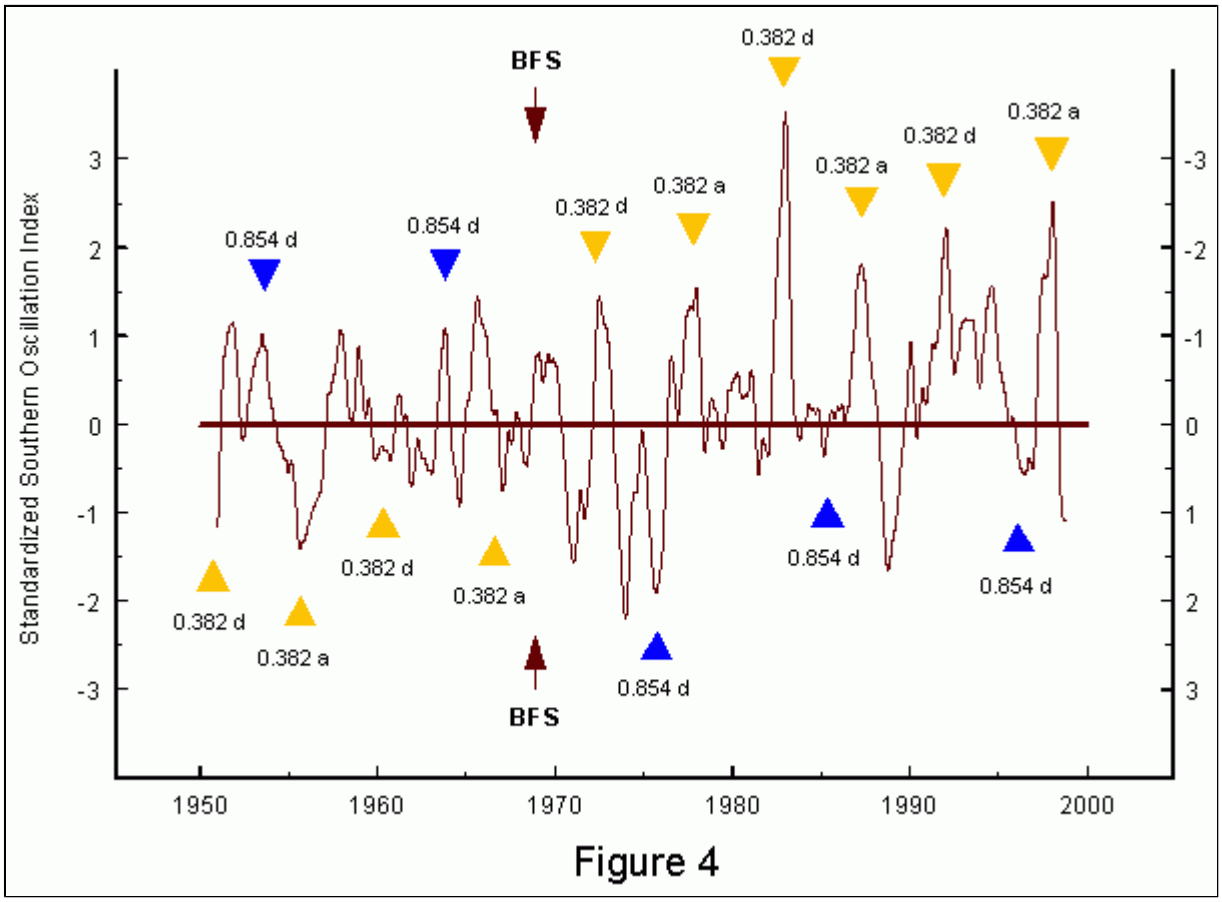


Figure 4

They have been inverted so that they run parallel with El Niños and La Niñas. The vertical scale on the right indicates the original orientation. Future verbal references to the SOI will always refer to this original orientation linked to the right scale. Obviously, extrema in the SOI are closely correlated with Golden section phases within the ascending (a) and declining (d) part of the 11-year sunspot cycle which already emerged in the El Niño investigation covering four centries. They are indicated by yellow and blue triangles. The minor 0.382 (yellow) with the strongest correlation in the earlier analysis appears as well in the ascending subcycle (0.382 a) as in the descending subcycle (0.382 d). After the year 1968, designated by arrows, the minor (0.382 a,d) marks precisely and without exception all observed strong negative extrema in the SOI, which are at the same time strong El Niños. Before 1968 the minor coincides with positive extrema in the SOI, which are at the same time La Niñas. The second generation phase 0.854 (blue) emerges only in the declining subcycle (0.854 d). Before 1968 it is consistently correlated with El Niños and after 1968 with La Niñas. The pattern is reversed in relation to the distribution of the minor 0.382. The overall impression is that of a symmetric distribution.

6. Phase reversals in climate cycles due to a fractal of solar cycles

Obviously, there was a phase reversal in 1968 that affected the relationship with ENSO events. What happened at that time? Fortunately, I can give a precise answer based on publications since 1976 [20-31]. There is an aggregation of solar-terrestrial cycles which are all related to the sun's fundamental oscillation about the center of mass of the solar system and form a fractal into which cycles of different length, but similar function are integrated. The solar dynamo theory, developed by H. Babcock, starts from the premise that the dynamics of the magnetic sunspot cycle is driven by the sun's rotation. Yet this theory only takes into account the sun's spin momentum, related to its rotation on its axis, not its orbital angular momentum linked to its very irregular motion about the center of mass. The contribution of the sun's orbital angular momentum to its total angular momentum is not negligible. It reaches 25 percent of the spin momentum. The orbital angular momentum can increase or decrease forty-fold within a few years. Thus it is conceivable that these variations are related to varying phenomena in the sun's activity. Variations of more than 7 percent in the sun's equatorial rotational velocity, going along with variations in solar activity, were observed at irregular intervals. This could be explained by transfer of angular momentum from the sun's orbit to the spin on its axis. Part of the necessary spin-orbit coupling could result from the sun's motion through its own ejected plasma. As R. H. Dicke [10] has shown, the low corona can act as a brake on the sun's surface. The

four giant planets, which regulate the sun's motion, carry more than 99 percent of the angular momentum in the solar system, while the sun is confined to less than 1 percent. So there is enough angular momentum that can be transferred from the outer planets to the revolving sun and eventually to the spinning sun.

I have shown that cycles derived from the sun's motion about the center of mass make it possible to predict different facets of solar activity, including solar eruptions, and climate phenomena like temperature anomalies, droughts, and El Niños. Observation shows that the aggregate of physically and structurally connected cycles forms a hierarchy such that cycles higher up in the hierarchy do not only modulate subordinated cycles, but also induce phase reversals. Experimentation with electrical and mechanical control equipment shows that at nodal points, where the response of the system is zero, the phase can shift by pi radians **[6]**. If a hierarchically dominant cycle reaches a zero phase, which is a nodal point, and a subordinated cycle is close to an initial phase at the same time, a phase reversal effect occurs in most cases in the dominated cycle. This seems to solve the problem of sudden phase jumps in solar-terrestrial cycles hitherto unexplainable and unpredictable. As to a string of examples I refer to my paper **"Solar Activity: A Dominant Factor in Climate Dynamics"** **[31]** and other publications **[27-31]**.

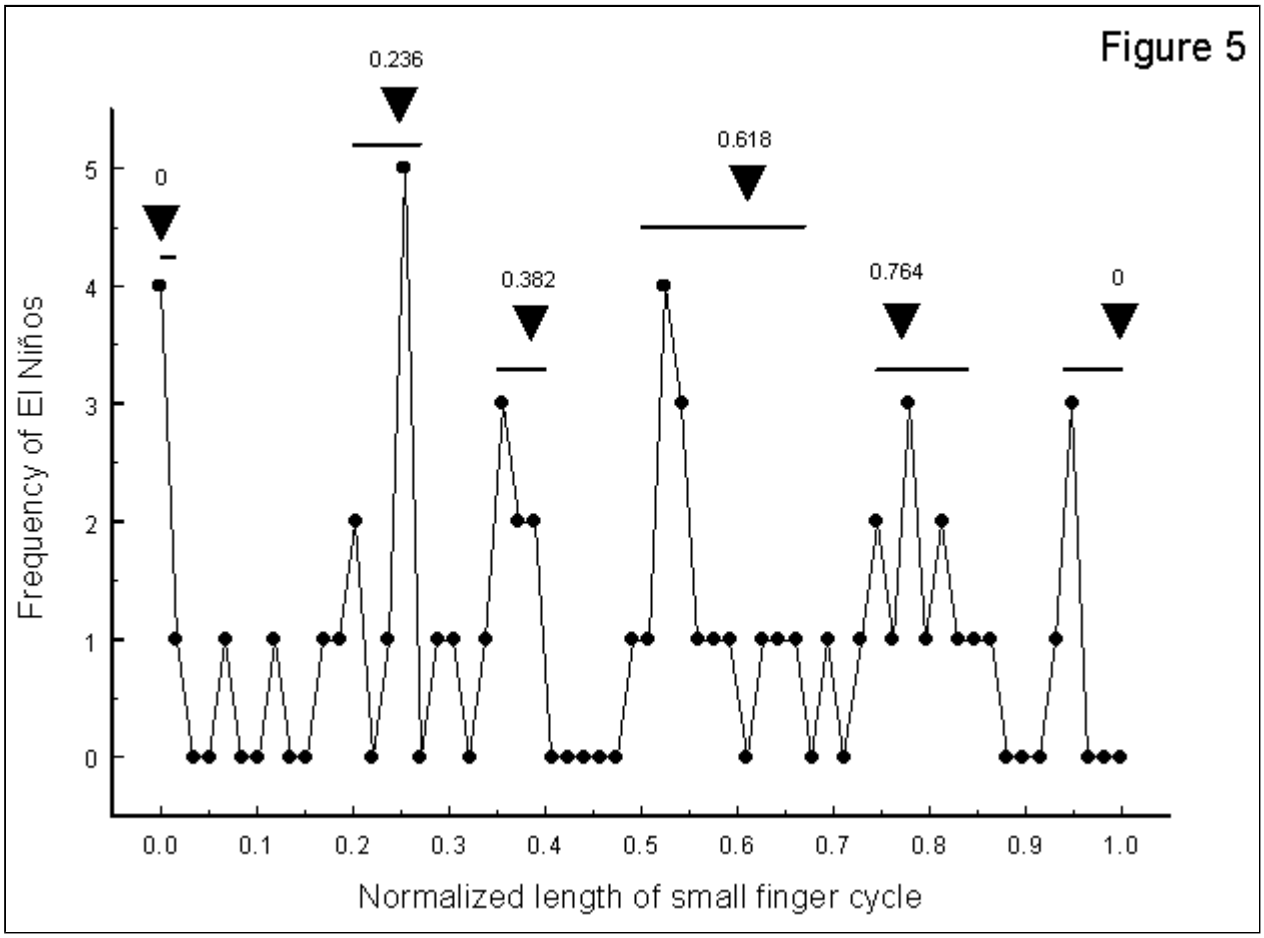
The solar cycles in question display five-fold symmetry and resemble hands and fingers when plotted. So I call them big hand cycle (178.8 years), big finger cycle (mean length 35.76 years), and small finger cycle (mean length 7.15 years). Details are given in my paper quoted above. The acronym BFS in Figure 4 refers to the starting phase of a big finger cycle. As the 11-year sunspot cycle is shorter than the big finger cycle, it ranges lower in the hierarchy of solar cycles and is exposed to the risk of a phase reversal. This all the more so, as the polar photospheric magnetic fields, linked to the sun's general magnetic field, underwent a polarity reversal just in 1968, the epoch of the big finger start in question. In addition, the initial phase of the big finger cycle coincided with the sunspot maximum 1968, the zero phase of the declining subcycle from maximum to minimum.

Though I was acquainted with phase reversals within the fractal of cycles created by the sun's oscillation about the center of mass, I had not expected that such events would also affect the 11-year sunspot cycle. Yet short reflection shows that it is the same sun that produces both kinds of cycles. And there is a further link. The magnetic cycle of 22.1 years, called Hale cycle, is the true cycle of sunspot activity. Groups of sunspots are usually composed of preceding and following spots with different magnetic polarity. With the commencement of a new cycle the polarity reverses so that the original polarity is only restored every second 11-year sunspot cycle. When the major of the Golden section within a big finger cycle is calculated, it turns out to be identical with the length of the Hale cycle (35.76 yrs * 0.618 = 22.1 yrs). This points to a close connection between the big finger cycle and the Hale cycle as well as the 11-year cycles that compose it.

The circumstance that the Golden section phases 0.618 and 0.146, which also stand out in Figure 3, do not emerge in the detailed investigation covering the SOI 1951 - 1998, does not mean that they are generally not valid. It could be that they are prominent in other intervals of the span of nearly four hundred years. In 1933, for instance, the big hand cycle reached a zero phase that could have affected the effects of the big finger cycle and eventually the subcycles of the sunspot cycle. It is imaginable that in such cases a switch occurs which exchanges the pair 0.382/0.854 for 0.146/0.618. Detailed analyses covering earlier periods are necessary to answer these questions

7. Distribution of El Niños within the small finger cycle since 1610

My correct forecast of the last two El Niños was based on an analysis of tropical seasurface temperatures in relation to the small finger cycle (SFC) covering the period 1960 to 1990. The analysis indicated that the initial phase of the SFC and the major 0.618 within this cycle are associated with El Niño events. When the cycle was longer than 7.5 years, also the minor 0.382 proved effective. A further investigation making use of the El Niño data going back to 1610 should confirm this result, if it is real. The evaluation of the small finger phases is no problem. They can be calculated back or ahead for thousands of years. **Figure 5** shows the resultant distribution.



The initial phase of the SFC, the minor 0.382, and the major 0.618 stand out. A chi-square test yields the value 15.2 for 1 degree of freedom. The null hypothesis of no correlation between the studied variables can be rejected at a high level of significance: P = 0.0001. As with the sunspot cycle, additional Golden section phases of the second generation emerge in Figure 5. The phase 0.236 falls at the major of the interval between 0 and 0.382, and the phase 0.764 is identical with the minor of the interval between 0.618 and 1. Again, the overall distribution of the four Golden section phases is symmetrical about the middle 0.5 of the unit cycle. A chi-square test of all outstanding phases with ranges of accumulation as indicated in Figure 5 by horizontal bars yields the chi-square value 34.7 for 1 degree of freedom. The probability of a chance distribution is $P = 4 \times 10^{-9}$. The hypothesis formulated at the outset does not cover the two additional phases that emerged unexpectedly, but the result deviates so far from the expected distribution that it points to a real connection.

8. Distribution of El Niños within the small finger cycle since 1951

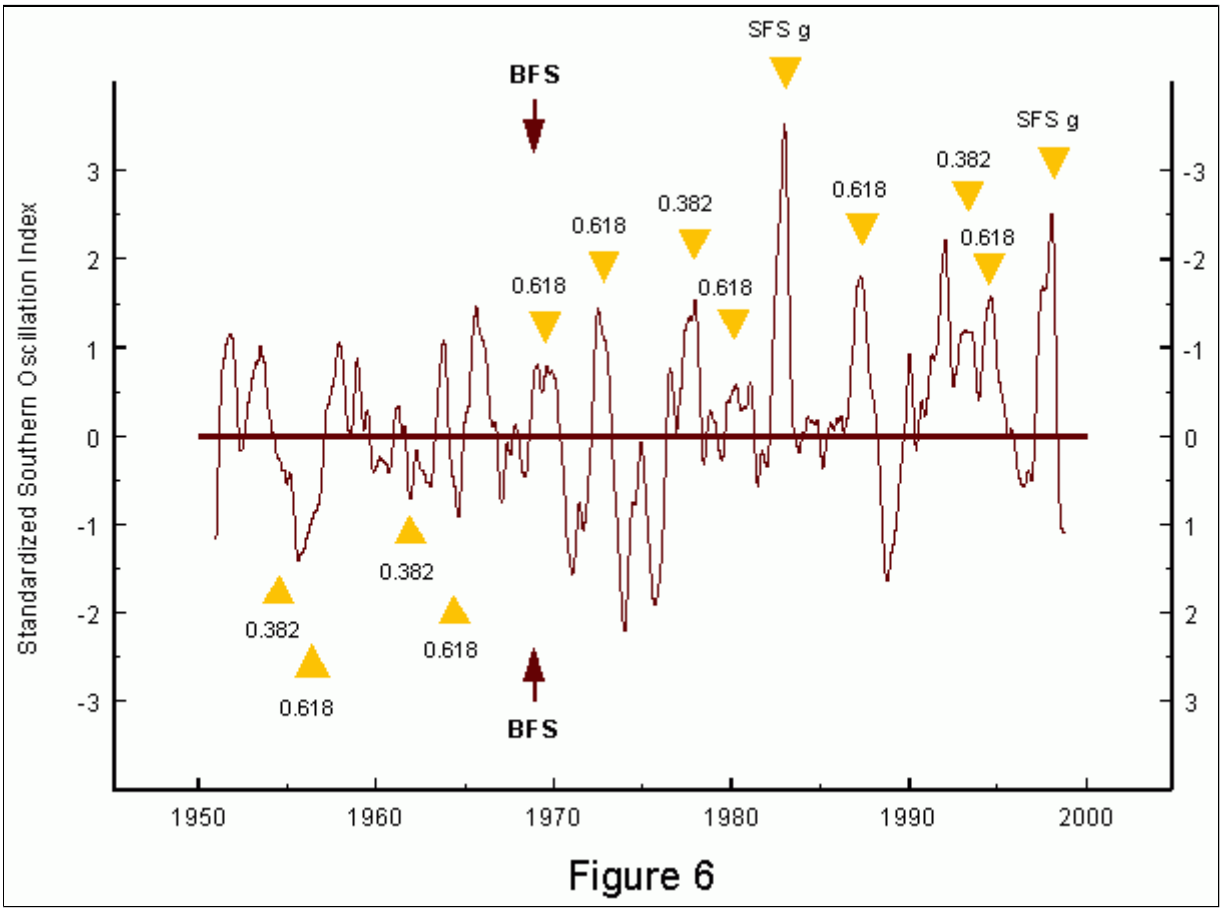


Figure 6

Figure 6 shows how the SFC phases 0.382 and 0.618, prominent in Figure 5, are in detail associated with SOI extrema in the interval 1951 - 1998. After BFS 1968 they are closely correlated with negative extrema (El Niños) and before 1968 with positive extrema (La Niñas). Initial phases of special small finger cycles (SFS g) are also indicated, but only tentatively and only after 1968. Before 1968 they do not show the usual reversed pattern, or better, there is no consistent pattern at all. This speaks against the dependability of this factor, at least in the period 1951 - 1998. This all the more so as the two cases where there is a coincidence with El Niños can as well be explained by 0.382 a,d within subcycles of the sunspot cycle.

Figure 7 displays the detailed relationship between the two other SFC phases 0.764 (yellow) and 0.236 (blue), outstanding in Figure 5, and the SOI 1951 - 1998.

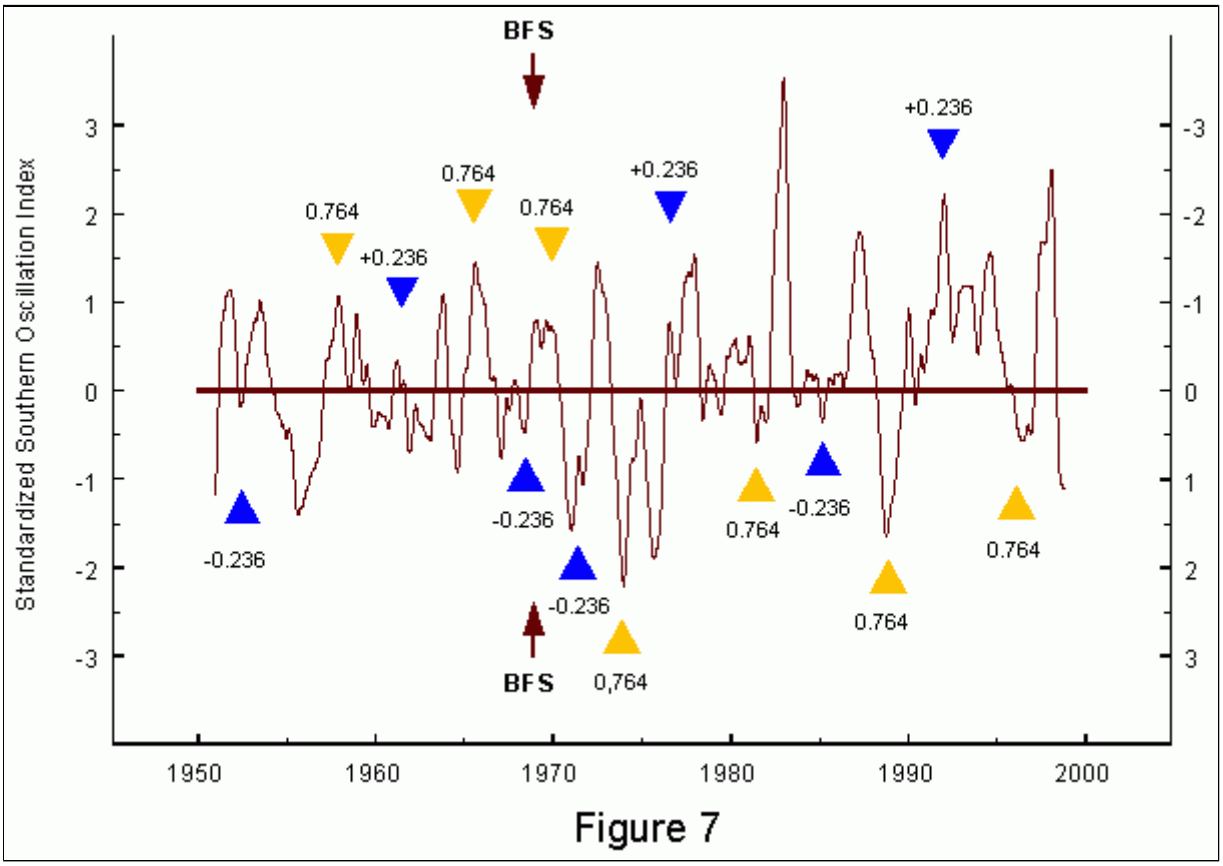


Figure 7

Before BFS 1968, the 0.764 phases are closely correlated with negative extrema (El Niños) and after 1968 with positive extrema (La Niñas). The distribution of the SFC phase 0.236 is again a surprise. It displays an alternating pattern, first an association with El Niño (+ 0.236), then with La Niña (- 0.236), again with El Niño and so on. BFS 1968 induced a phase reversal such that another association with La Niña occurred instead of the expected alternating association with El Niño. I observed such alternating patterns already in other relationships between cycles derived from the sun's oscillations about the center of mass and climate phenomena [31]. Such unexpected patterns show as well as the observed phase reversals that Nature seems to be much more inclined to vary, jump and permute than we expect. Our result teaches us that crude statistical investigations like my examination of four centuries of data can give some hints, but cannot replace a thorough, unprejudiced analysis that elaborates the implications of a significant correlation. Rigid dogmatism will surely prevent us from adjusting our world view to Nature's flexibility.

9. Synopsis of the correlation between solar cycles and ENSO events

Figure 8 shows the synopsis of the relationship between Golden section phases within the investigated cycles and SOI extrema phase-locked with El Niños and La Niñas.

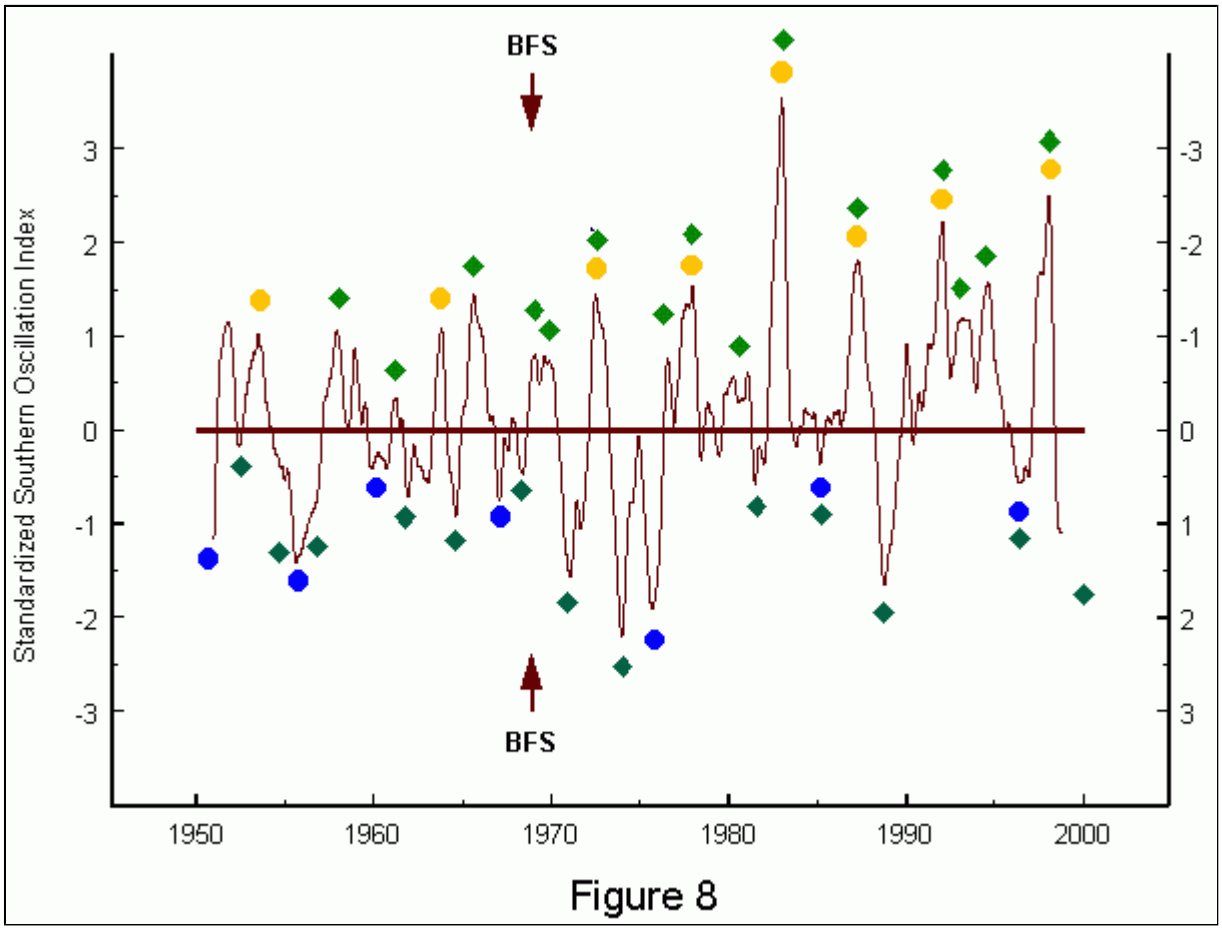
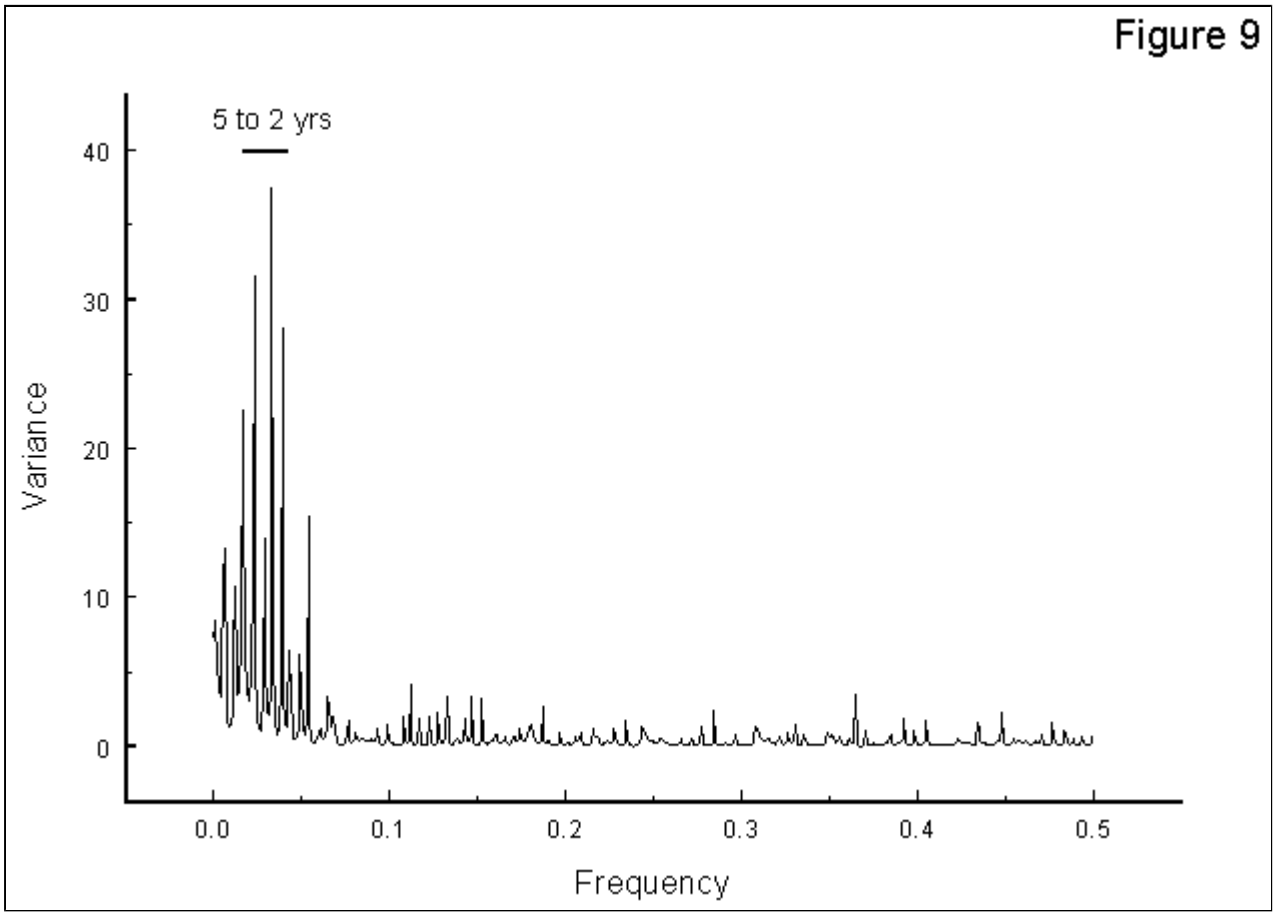


Figure 8

Yellow circles mark correlations of phases within the subcycles of the 11-year sunspot cycle with El Niños and blue circles with La Niñas. Bright green diamonds point to connections of SFC phases with El Niños and dark green diamonds with La Niñas. It is easy to see that all notable deviations from the zero line are explained with the exception of a single El Niño at the beginning of the curve. It should be noted that all of the respective Golden section phases that fall into the period 1951 - 1998 appear in the synopsis. There is not a single one that does not coincide with SOI extrema. Because of the phase reversal induced by BFS 1968 the same phases can be linked to El Niños as well as to La Niñas and can be used to predict both of these events depending on the phase of the dominating big finger cycle. There are no exceptions to this consistent pattern. Climatologists have been wondering why there were three consecutive El Niños without any interruption by La Niñas between 1991 and 1995. Figure 8 gives the answer. During the five years in question there were not any Golden section phases that indicate La Niñas, but four of them that point to El Niños.

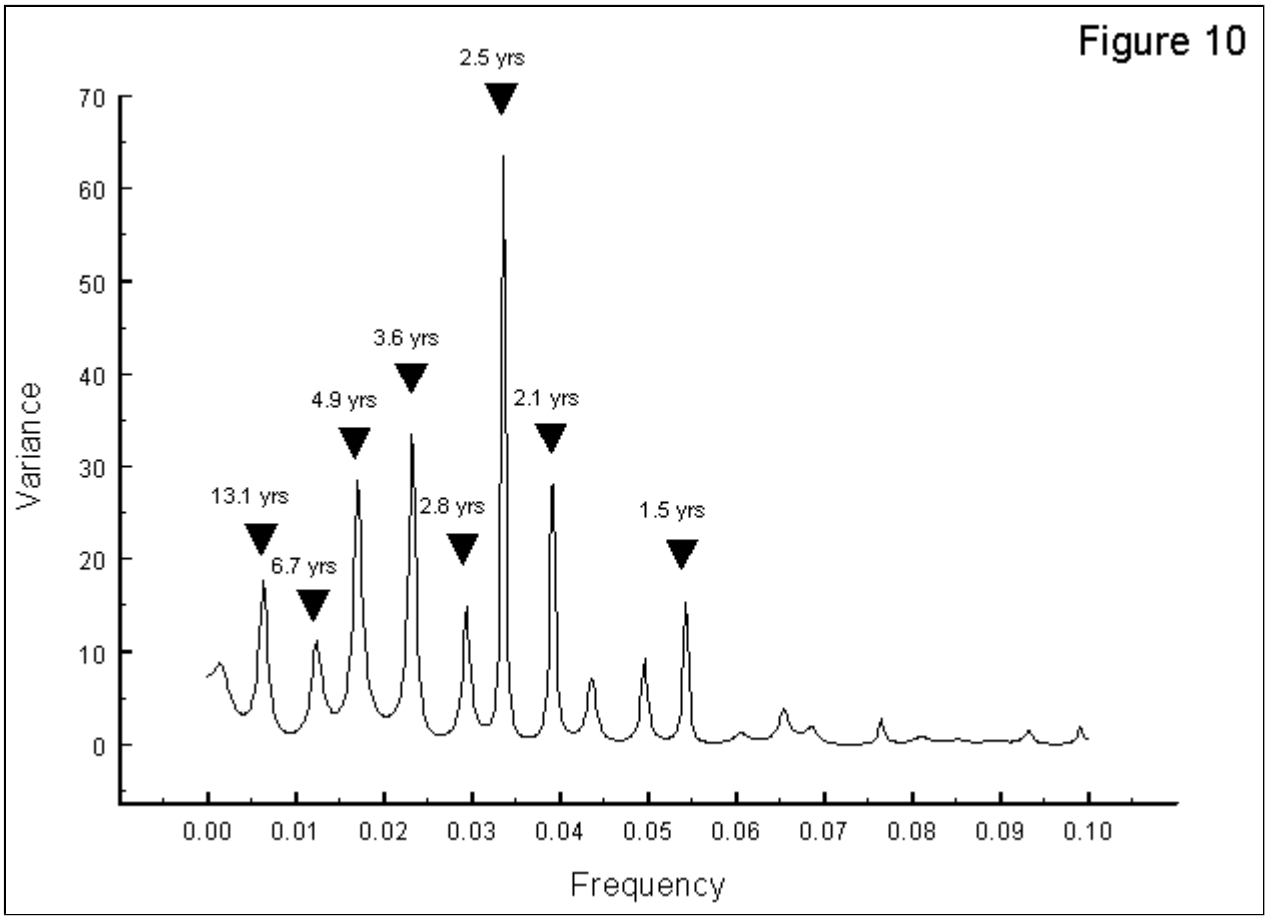
10. Maximum entropy spectral analysis of SOI data 1951 - 1998

These results are confirmed by a different approach. J. P. Burg [5] has developed a new form of spectral variance analysis, the maximum entropy spectral method which shows much higher resolution than earlier frequency analyses, especially at lower frequencies. **Figure 9** shows the maximum entropy spectrum of the SOI data 1951 - 1998.



The frequency is measured in cycles per month. The analysis is based on 575 data points and makes use of a filter length of 230, which is in accordance with the suggestion of most authors not to go beyond 40 percent of the length of the time series to avoid spectral shifts. The spectrum shows prominent peaks only in the frequency range 0 to 0.06. The four outstanding peaks lie in the period range between 2 and 5 years. The resolution is much finer than in the inset in Figure 1.

Figure 10 sets off the frequency range of interest between 0 and 0.1 and shows an even better resolution.



The periods of the prominent peaks are indicated. They can be compared with the distance of the crucial Golden section phases from the zero phases of the investigated three cycles. In the course of the years 1951 - 1998 these cycles had the following mean lengths: the ascending subcycle (a) of the sunspot cycle (SC) 3.4 years, the declining subcycle (b) 7.1 years, and the small finger cycle (SFC) 6.8 years. In the following, the distances of the Golden section phases from the beginning of the respective cycle are given first and then in parantheses the periods of the maximum entropy spectrum (MES) that come closest:

SC 0.382 a: 1.3 years (MES: 1.5 years)
SFC 0.236: 1.6 years (MES: 1.5 years)
SFC 0.382: 2.6 years (MES: 2.5 and 2.1 years)
SC 0.382 d: 2.7 years (MES: 2.8 and 2.5 years)
SFC 0.618: 4.2 years (MES: 3.6 years)
SFC 0.764: 5.2 years (MES: 4.9 years)
SC 0.854 d: 6.1 years (MES: 6.7 years)

Considering the uncertainties inherent in spectrum analysis, especially at low frequencies, this is a rather exact match. It is corroborated by comparing the means of the two data sets. The mean of the distances of the seven Golden section phases from the beginning of the respective cycles is 3.4 years. The mean of the outstanding SOI periods, marked in Figure 10, is also just 3.4 years when we exclude the long period of 13.1 years that is far beyond the range which is of interest in this respect. It should be noted, however, that 13.1 is close to the second subharmonic of the MES period 6.7 years. The long period could be of import with respect to the strength of ENSO events. The interval between the two very strong El Niños 1982/1983 and 1987/1988 is relatively close to that period. As to modulations of the strength of El Niños it is of interest, too, that the SC and SFC periods 1.3 years and 1.6 years as well as 2.6 years and 2.7 years are so close to each other that resonance is possible.

Finally, it should be noted that the highest spectral peak at 2.5 years falls at the phase 0.382 of the descending sunspot cycle that stands out in every respect and is together the phase of the outstanding accumulation of energetic solar eruptions in Figure 2. The prominent periods of the

maximum entropy spectrum are significant. An acknowledged reliability test of maximum entropy peaks does not exist, but according to a simple and useful rule of thumb, given by W. F. Stuart, V. Sherwood, and S. M. MacIntosh [50], a spectral peak is regarded to be significant if it contains at least three computed points which deviate from the noise and has a maximum two or three times greater than the surrounding noise level. On the basis of this standard the peaks marked in Figure 10 deviate significantly from the noise.

A further confirmation is provided by a Blackman-Tukey power spectrum [3] of the SOI data 1951 - 1998. The four outstanding peaks of this spectrum at 2.1, 2.6, 3.8, and 4.8 years nearly coincide with the respective maximum entropy peaks, and the mean of these four periods equals 3.3 years, rather close to the maximum entropy mean of 3.4 years. H. A. Panofsky and G. W. Brier [39] have developed a special reliability test of peaks in a Blackman-Tukey spectrum. Checked against a white noise background, the peaks in Figure 10 go far beyond the 99 percent confidence level. The significance of the deviation from the Markov red noise level, taking into account potential autocorrelation, reaches at least the 95 percent level.

11. Forecasts of future ENSO events

Precise forecasts that prove correct are the sharpest criterion of effective science. So I will try my third long-range El Niño forecast. It goes nearly three years beyond the lead time of 12 months, discussed in the beginning. **The next negative extremum in the SOI going along with an El Niño should occur around 2002.9 (± 6 months).** The last zero phase of a small finger cycle fell at 1998.3. The following one will occur in 2005.8. The length of the SFC cycle reaches just 7.5 years. So the probability is low, though not zero, that the phase 0.382 within the SFC will release an El Niño around 2001.2. The following 0.618 phase falls at 2002.9. It should be effective. This all the more so as around this time the descending part of the sunspot cycle is expected to reach the phase 0.382. The next negative 0.236 phase within the small finger cycle will fall at 2000.1. The present positive SOI and the accompanying La Niña seem to be related to it. So **La Niña conditions should prevail till 2000.1 and beyond.**

12. Objections to a strong link between solar activity and climate

Taken together, the lines of evidence presented here leave little doubt that the relationship between Golden section phases within solar cycles and ENSO events is real. Nonetheless, it is to be expected that sceptics will point at the lack of detailed cause and effect arguments and properly quantified physical mechanisms. Seen in a historical light, such objections are not valid. The lack of elaborate theory does not impair the heuristic importance of the results.You cannot achieve everything at the same time. Epistemologically, the stage of gathering data, establishing morphological relations, and setting up working hypotheses necessarily precedes the stage of elaborated theories. How can we solidly connect solar activity with climatic change as long as neither of these fields rests on a solid theoretical foundation? An accepted full theory of solar activity does not yet exist. What we have is only the hope of a future theory. According to P. V. Foukal [11] the mechanism that causes the solar magnetic cycle remains poorly understood, although it has been the focus of intense research during the past half century. There is a lot of literature about $\alpha\omega$-dynamos, but they are coping with incompatibilities of observation with theory, and they do not offer any explanation of longer solar cycles like the Gleissberg cycle that modulates the amplitudes of the 11-year cycle.

The understanding of climate change, too, is in a rudimentary stage. Especially complex coupling processes that could link the upper with the lower atmosphere are far from being well understood, and even the most advanced general circulation models yield contradictory results. Revealing is a recent statement by J. E. Hansen [13], a protagonist of global warming:

> **"The forcings that drive long-term climate change are not known with an accuracy sufficient to define future climate change ... The natural forcing due to solar irradiance changes may play a larger role in long-term climate change than inferred from comparisons with general circulation models alone."**

Hansen does not even mention the effect of solar eruptions and the solar wind on climate.

The usual additional objection that the solar effect is much too weak to affect climate, too, is not tenable. J. G. Roederer [47] has aptly remarked:

> **"The energy argument is not valid for highly nonlinear complex systems such as the coupled atmosphere-ocean-cryosphere-biosphere. It is well known that complex systems can behave chaotically, i.e., follow very different paths after the smallest change in initial or boundary conditions, or in response to the smallest perturbation. In a highly nonlinear system with large reservoirs of latent energy such as the atmosphere-ocean-biosphere, global redistributions of energy can be triggered by very small inputs, a process that depends far more on their spatial and temporal pattern than on their magnitude."**

H. Svensmark and E. Friis-Christensen [53] have demonstrated that this is in accordance with reality. Clouds have a hundred times stronger effect on weather and climate than carbon dioxide in the atmosphere. Even if the atmosphere's carbon dioxide content doubled, its effect would be cancelled out if the cloud cover expanded by 1 percent, as shown by H. E. Landsberg [19]. So it is of great importance that Svensmark and Friis-Christensen have shown that global cloud cover, observed by satellites, is linked to the strength of cosmic rays modulated by the solar wind. When the solar wind is strong and cosmic rays are weak, the global cloud cover shrinks. It extends when cosmic rays are strong because the solar wind is weak. This effect, attributed to cloud seeding by ionized secondary particles, causes a change in cloud cover by more than 3 percent within 3 ½ years. The corresponding change in solar irradiance reaches about 1.5 W/m^2. This is a considerable amount, since the total radiative forcing by carbon dioxide accumulated in the atmosphere since 1750 does not go beyond 1.5 W/m^2. One would assume that such a tremendous effect should be caused by a huge amount of energy, but cosmic rays inject a total energy into the atmosphere that is very small. Astonishingly, it is equal to the intensity of starlight in the night skies [16]. This is practical proof that Roederer's argument is not only of theoretical import.

13. Potential connections between solar eruptions and ENSO events

Though there are no strict physical arguments that could explain in detail how solar activity causes ENSO events, it is quite possible to develop working hypotheses that suggest potential connections. Figure 2 shows that energetic solar eruptions coincide with the Golden section phase 0.382 in the subcycles of the sunspot cycle which are closely correlated with ENSO events, as shown in Figure 4. Strong solar eruptions cause the highest velocities in the solar wind and create shockwaves that compress and intensify magnetic fields in the sun's plasma moving outward to the boundary of the solar system. The solar wind strenghtened by solar eruptions weakens cosmic rays. The ensuing Svensmark-effect is regionally strongest where cloudiness is highest. It is very high around Indonesia [40] where el Niños seem to develop. So one would think that shrinking cloud cover, stronger irradiance, intensified Hadley circulation and changing trade winds, caused by the modulating effect of solar eruptions on cosmic rays, improve the conditions for the birth of El Niños. This all the more so as M. Pudvokin and S. Veretenenko [42] as well as Svensmark and Friis-Christensen [53] have shown that Forbush decreases - dips in cosmic rays by several percent within 2 days after a strong solar eruption - are associated with immediate decreases in cloudiness by 2 - 3 percent that last a week or longer. Such short-term effects, especially when they trigger tropical cyclones [44], may release and sustain El Niños.

The enhancement of the Svensmark-effect by the very high cloudiness around Indonesia is countered by the circumstance that Indonesia is situated on the equator where the field lines of the Earth's magnetic field run parallel with the surface. As less energetic cosmic-ray particles follow the magnetic field lines on screw shaped trajectories, it is more difficult for them to penetrate into the atmosphere above the equator than near the poles where the field lines run vertically. This magnetic obstacle is especially effective when particles try to penetrate to the Earth's surface. They reach the ground only when their energy is at the 15 GeV level. Yet it is much easier to reach targets higher up in the atmosphere. One of the stations that observe cosmic rays, the Huancayo Neutron Monitor, is located close to the equator (12° S 75° W), but at an altitude of 3400 m where the cutoff rigidity is not

as high. The Huancayo reports reflect the change in cosmic rays as well as data by other stations at higher latitudes. Especially, it has to be taken into consideration that high clouds like cirrus, cirrocumulus, and cirrostratus reach altitudes of 18 km at the equator where the height of the tropopause goes far beyond that at the poles (8 km). Cumulonimbus reaching an altitude of 10 - 14 km at temperate latitudes climb to 16 - 22 km in the tropics, where they form huge cloud clusters covering ranges of more than 100 km **[33]**. The generation of secondary cosmic rays by primary cosmic rays and the related degree of ionization reach a maximum (300 pairs of ions/cm3 sec) just at 20 km altitude **[16]**, close to the altitude of tropical cumulonimbus as well as of cirrus, cirrocumulus, and cirrostratus.

Furthermore, the geomagnetic equator, not the geographical equator is relevant as to the cutoff conditions of cosmic ray particles. At present the observed geomagnetic pole in the Northern Hemisphere is at 73° N 100 W. Calculation shows that a location on the equator in Indonesia (longitude 105° E) has a geomagnetic latitude of -15° where particles can easier penetrate to those high altitudes where clouds are to be found in the tropics. All arguments taken together, it is not unimaginable that the Svensmark-effect works in the region close to the equator where El-Niños are thought to come into existence. Conditions should be favourable for La Niña when cosmic rays are very strong because the sun's eruptional activity is exceptionally weak.

Further working hypotheses may be based on the fact that solar X-rays and UV radiation increase sharply at the time of energetic solar eruptions. It would go beyond the frame of this paper to describe these working hypotheses in detail. They can only be presented in a nutshell. Flares increase the sun's UV radiation level by at least16 percent **[15]**. Ozone in the stratosphere absorbs this excess energy that causes local warming. The 70-mb polar vortex is displaced. This disturbance is propagated downward to the troposphere where it affects the intensity of the Hadley circulation. D. E. Hartley, J. T. Villarin, R. X. Black , and C. A. Davis **[14]** have shown that there is a dynamical link between stratospheric polar vortex distortions and meteorological events in the troposphere. Observations by other authors confirm this result **[12, 18, 37, 45, 46]**. As El Niños are linked to trade winds and tradewinds to the Hadley cells that may be affected by circulation change in the stratosphere, it seems plausible that energetic solar eruptions could be the cause of this chain of links. This all the more so as observations show distinct change in diverse weather phenomena within days after energetic solar eruptions **[4, 8, 48, 49, 55]**.

Solar X-rays around 10 Å intensify by a factor of 100 or more during moderate-sized flares, and strong flares can amplify the X-ray level by a factor of 1000. I refer to my paper "Solar Rotation, Impulses of the Torque in the Sun's Motion, and Climatic Variation" **[25]** which describes how strong X-rays produced by energetic solar eruptions may enhance thunderstorm activity. Severe thunderstorms are linked to tropical cyclones **[54]** which may trigger and sustain El Niños **[44]**. A marked lull in the sun's UV radiation and X-rays should be favourable for La Niñas.

These theoretical arguments were only presented to show that it is not out of the question that there are physical links between energetic solar eruptions and El Niños. Whether these lines of reasoning turn out correct or spurious is of no import regarding the practical results of this investigation. They leave little doubt that solar activity and ENSO events are closely connected to such a degree that long-range forecasts beyond the 12-month lead time are now possible. The consequences of these results for the hypothesis of anthropogenic climate change are far-reaching. As stated in the beginning, ENSO events are the strongest source of variability in the global climate system and explain most of the global temperature anomalies. Our result that solar activity regulates these powerful climate phenomena shows clearly that the impact of the sun's variability has been underestimated in a way that reverses the proportions. Recent research published by H. Svensmark **[52]** and N. Calder **[7]** corroborate this statement. Actually, solar activity turns out to be the dominant factor in climate change. IPCC scientists can no longer uphold their contention that **"solar variability over the next 50 years will not induce a prolonged forcing significant in comparison with the effect of increasing carbon dioxide concentrations."**

Acknowledgements

I owe special thanks to Nigel Calder for his suggestion to investigate associations between El Niños

and special phases in the 11-year sunspot cycle. I am a convert in this respect. Before Nigel Calder's stimulating intervention I thought that only cycles based on the sun's motion about the center of mass of the solar system could affect ENSO events.

References

[1] Arnol'd, V. I.: Small denominators and problems of stability of motion in classical and celestial mechanics. Russ. Math. Surv. 18 (1963), 85.

[2] Arntz, W. A. and Fahrbach, E.: El Niño. Klimaexperimente der Natur. Basel, Birkhäuser, 1991.

[3] Blackman, R. B. and Tukey, J. W.: The measurement of power spectra. New York, Dover, 1959.

[4] Bossolasco, M., Dagnino, I., Elena, A., and Flocchini, G.: Thunderstorm activity and interplanetary magnetic field. Riv. Italiana Geofis. 22 (1973), 293.

[5] Burg, J. P.: Maximum entropy analysis. Ph.D. thesis. Stanford University, Palo Alto, 1975.

[6] Burroughs, W. J.: Weather cycles - real or imaginary? Cambridge University Press,1992, 149.

[7] Calder, N.: The carbon dioxide thermometer and the cause of global warming. http://www.john-daly.com/calder/calder.htm.

[8] Cobb, W. E.: Evidence of solar influence on the atmospheric electric elements at Mauna Loa Observatory. Mon. Weather Rev. 95 (1967), 905-911.

[9] Daly, J. L.: El Niño and global temperature. http://www.john-daly.com/soi-temp.htm.

[10] Dicke, R. H.: The sun's rotation and relativity. Nature 202 (1964), 432.

[11] Foukal, P. V.: The variable sun. Scient. American, Februar 1990, 34-41.

[12] Haigh, J. D.: The impact of solar variability on climate. Science 272 (1996), 981-984.

[13] Hansen, J. E., Sato, M., Lacis, A., Ruedy, R., Tegen, I., and Matthews, E.: Climate forcings in the industrial era. Proceedings of the National Academy of Sciences 95 (1998), 12753-12758.

[14] Hartley, D. E., Villarin, J. T., Black, R. X., and Davis, C. A.: A new perspective on the dynamical link between the stratosphere and troposphere. Nature 391 (1998), 471-474.

[15] Heath, D.: The ultraviolet region. In: White, O. R.: The solar output and its variation. Boulder, Colorado Associated University Press, 1977, 32.

[16] Kertz, W.: Einführung in die Geophysik II. Mannheim, Bibliographisches Institut, 1971, 340, 341.

[17] Kolmogorov, A. N.: Preservation of conditionally periodic movements with small change in the Hamiltonian function. Lecture Notes in Physics 93 (1979), 51.

[18] Labitzke, K. und van Loon, H: Some recent studies of probable connection between solar and atmospheric variability. Ann. Geophysicae 11 (1993), 1084.

[19] Landsberg, H. E.: Man-made climatic changes. In: Proceedings of the symposium on physical and dynamic climatology of the World Meteorological Organization 347 (1974), 262.

[20] Landscheidt, T.: Beziehungen zwischen der Sonnenaktivität und dem Massenzentrum des Sonnensystems. Nachrichten der Olbers-Gesellschaft 100 (1976).

[21] Landscheidt, T.: Solar oscillations, sunspot cycles, and climatic change. In: McCormac, B. M., ed.: Weather and climate responses to solar variations. Boulder, Associated University Press, 1983, 293-308.

[22] Landscheidt, T.: Long-range forecast of energetic x-ray bursts based on cycles of flares. In: Simon, P. A., Heckman, G. und Shea, M. A., eds.: Solar-terretrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder,

National Oceanic and Atmospheric Administration, 1986, 81-89.

[23] Landscheidt, T.: Long-range forecast of sunspot cycles. In: Simon, P. A., Heckman, G. und Shea, M. A., eds.: Solar-terretrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 1986, 48-57.

[24] Landscheidt, T.: Long-range forecasts of solar cycles and climate change. In: Rampino, M. R., Sanders, J. E., Newman, W. S. und Königsson, L. K.,eds.: Climate. History, Periodicity, and predictability. New York, van Nostrand Reinhold, 1987, 421-445.

[25] Landscheidt, T.: Solar rotation, impulses of the torque in the sun's motion, and climatic variation. Climatic Change 12 (1988), 265-295.

[26] Landscheidt, T.: Relationship between rainfall in the northern hemisphere and impulses of the torque in the sun's motion. In: K. H. Schatten und A. Arking, eds.: Climate impact of solar variability. Greenbelt, NASA, 1990, 259-266.

[27] Landscheidt, T.: Global warming or Little Ice Age? In: Finkl, C. W., ed.: Holocene cycles. A Jubilee volume in celebration of the 80th birthday of Rhodes W. Fairbridge. Fort Lauderdale, The Coastal Education and Research Foundation (CERF), 1995, 371-382.

[28] Landscheidt, T.: Die kosmische Funktion des Goldenen Schnitts. In: P. H. Richter, Hsg.: Sterne, Mond und Kometen. Bremen und die Astronomie. Bremen, Verlag H. M. Hauschild, 1995, 240-276.

[29] Landscheidt, T.: Klimavorhersage mit astronomischen Mitteln? Nachrichten der Olbers-Gesellschaft Bremen, July 1997, 10-14, October 1997, 4-8.

[30] Landscheidt, T.: Forecast of global temperature, El Niño, and cloud coverage by astronomical means. In:Bate, R., ed.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), 1998, 172-183.

[31] Landscheidt, T.: Solar activity: A dominant factor in climate dynamics. Energy and Environment, in print. http://www.john-daly.com/solar/solar.htm.

[32] Laskar, J.: A numerical experiment on the chaotic behaviour of the solar system. Nature 338 (1989), 237.

[33] Möller, F.: Einführung in die Meteorologie I, Mannheim, B.I.-Wissenschaftsverlag, 1984, 192.

[34] Moser, J.: Stable and random motions in dynamical systems. Princeton University Press, 1973.

[35] National Geophysical Data Center, Boulder: X-ray flares. SOLRAD (1968-1974), GOES (1975-present).

[36] Neelin, J. D. and Latif, Mojib: El Niño dynamics. Physics Today, December 1998, 32-36.

[37] Neubauer, L.: The sun-weather connection. Sudden stratospheric warmings correlated with sudden commencements and solar proton events. In: McCormac, B. M., ed.: Weather and climate responses to solar variations. Boulder, Colorado Associated University Press, 1983, 395-397.

[38] NOAA, Climate Prediction Center, Data and Indices: http://nic.fb4.noaa.gov.

[39] Panofsky, H. A. and Brier, G. W.: Some applications of statistics on meteorology. The Pennsylvania State University, 1958.

[40] Peixoto, J. P. und Oort, A. H.: Physics of climate. New York, American Institute of Physics, 1992, 173, 415, 423, 426, 430.

[41] Philander, S. G. H.: El Niño, La Niña, and the Southern Oscillation. San Diego, Academic Press, 1990.

[42] Pudvokin, M. and Veretenenko, S.: Cloudiness decreases associated with Forbush decreases of galactic cosmic rays. J. Atm. Terr. Phys. 57 (1995), 1349-1355.

[43] Quinn, W. H., Neal, T. V., and de Mayolo, S. E. A.: El Niño occurrences over the past four and a half centuries. Journ. of Geophys. Res. 92 (1987), 14449-14461.

[44] Ramage, C. S.: El Niño. Scient. American, June 1986, 59-61.

[45] Reiter, R.: Influences of solar activity on the exchange intensity between stratosphere and troposphere. In: B. M. McCormac and T. A. Seliga, eds.: Solar-terrestrial influences on weather and climate. Dordrecht, Reidel, 1979, 289-296.

[46] Reiter, R.: Modification of the stratospheric ozone profile after acute solar events. In: McCormac, B. M., ed.: Weather and climate responses to solar variations. Boulder, Colorado Associated University Press, 1983, 95-116.

[47] Roederer, J. G.: Solar variability effects on climate. In: B. Frenzel, Hsg.: Solar output and climate during the Holocene. Stuttgart, Gustav Fischer Verlag, 1995, 3, 17.

[48] Schuurmans, C. J. E.: Effects of solar flares on the atmospheric circulation. In: McCormac, B. M. and Seliga, T. A., eds.: Solar-terrestrial influences on weather and climate. Dordrecht, D. Reidel, 1979, 105-118.

[49] Stolov, H. I. and Shapiro, R.: Investigation of the responses of the general circulation at 700 mb to solar geomagnetic disturbance. J. Geophys. Res. 79 (1974), 2161-2170.

[50] Stuart, W. F., Sherwood, V., and MacIntosh, S. M.: Pure appl. Geophys. 92 (1971), 150.

[51] Sussman, G. J. and Wisdom, J.: Chaotic evolution of the solar system. Science 257 (1992), 56.

[52] Svensmark, H.: Influence of cosmic rays on Earth's climate. Physical Review Letters, in print.

[53] Svensmark, H. und Friis-Christensen, E.: Variation of cosmic ray flux and global cloud coverage, a missing link in solar-climate relationships. J. Atm. Sol. Terr. Phys. 59 (1997), 1225.

[54] Williams, N. R.: Tornadoes, whirlwinds, and waterspouts. Encyclopaedia Britannica, Macropaedia, vol. 18, 518.

[55] Wilcox, J. M.: Solar activity and the weather. J. Atmosph. Terr. Phys. 37 (1975), 237.

In line with the `Open Review' policy of this website, comments are invited on the above paper by Dr Theodor Landscheidt and will be published in a separate file here. All comments, whether supportive or critical, will be published unedited
(excepting those of a personal or ad hominem nature).

Comments should be addressed to daly@microtech.com.au with "El Nino and the Sun" in the subject line. - John L. Daly

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Return to Climate Change Guests Debate

Return to "Still Waiting For Greenhouse" main page

`Top Climate Events'
Linked to Solar Motion Cycle

APPENDIX VI (4)
Submission on Adapting to Climate Change,
Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

by
Dr Theodor Landscheidt

Schroeter Institute for Research in Cycles of Solar Activity
Nova Scotia, Canada

(See also, Open Review Comments at the end of this paper)

In my papers **"Solar Activity: A Dominant Factor in Climate Dynamics"** and **"Solar Activity Controls El Niño and La Niña"** on this website, I have shown that solar motion cycles based on the Sun's irregular oscillation about the center of mass of the solar system are closely connected with solar activity and diverse climate phenomena.

These associations were corroborated by long-range climate forecasts that turned out correct without exception: The end of the Sahelian drought, the cold winter 1996/1997, the hot spring and summer 1998, and the last two El Niños. I had also predicted in January 1999 that the current La Niña would continue through the year 1999 at least. This proved correct though several ENSO forecasts based on coupled models and ENSO statistics had predicted the demise of La Niña for spring, summer, or fall 1999. The Climate Prediction Center/NCEP stated in its diagnostic advisory of 13 December 1999:

> "Cold episode conditions have persisted since June 1998, with below-normal SSTs, stronger-than-normal low-level easterlies, and reduced rainfall throughout the central equatorial Pacific. Accompanying these conditions tropical rainfall has been above normal over large portions of Indonesia, Malaysia, and the western Pacific. The pattern of subsurface oceanic temperature anomalies during November remained similar to that observed in October, and shows no sign of evolving toward a prewarm episode state. Thus it is likely that cold episode conditions will continue for the next several months. This assessment is supported by the most recent NCEP coupled model forecasts and other available model and statistical predictions indicating cold episode conditions persisting the first half of 2000."

I already predicted in March 1999 in the public discussion of my ENSO paper that La Niña would go on until 2000.5.I

NOAA's Big Climate Events of the 20th Century

Dozens of scientists from the NOAA contributed to a listing of global storms and climate events, which were notable for their atmospheric marvel and/or impact on human life.

The top global climate events were, in date order:

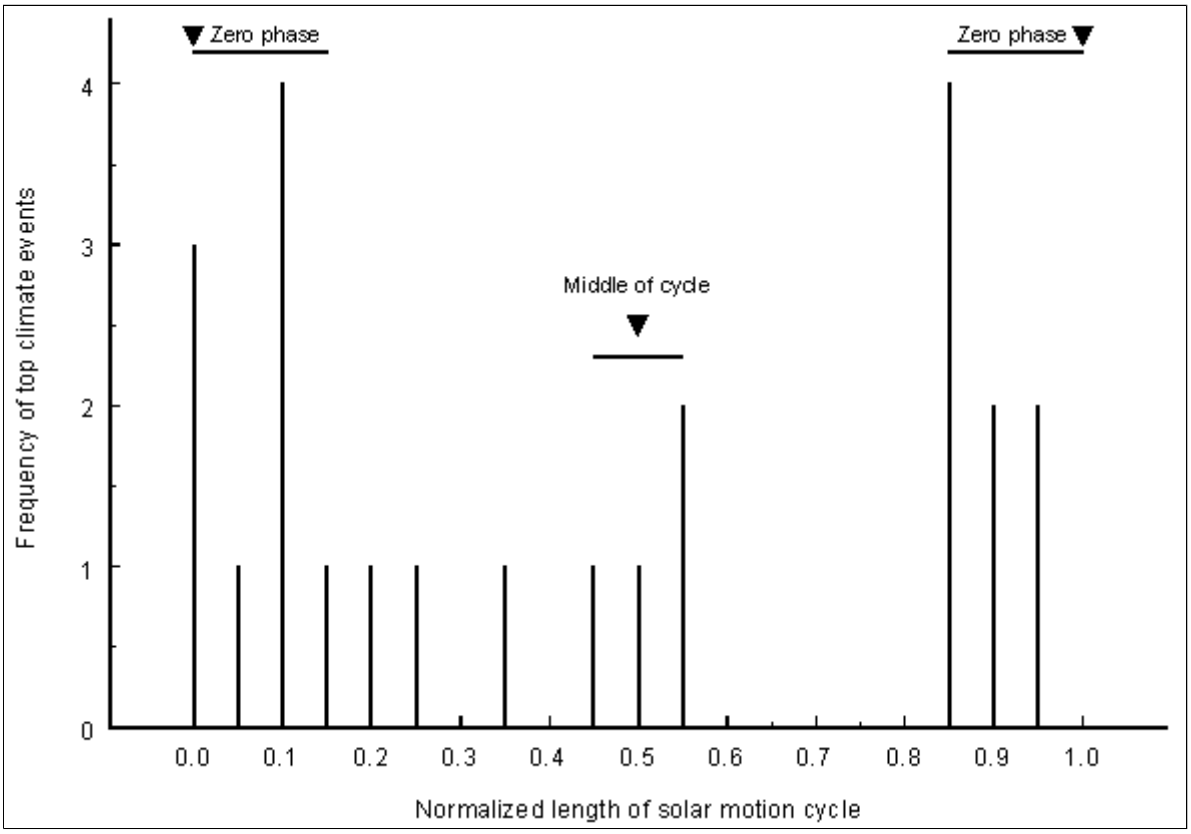
Drought, India 1900
Drought, India 1907
Drought, China 1907
Drought,. Sahel, Africa, 1910-14
Typhoon, China, 1912
Drought, Soviet Union, 1921-22
Typhoon, China, 1922

IPCC's draft of the Third Assessment Report **(TAR 2000)** continues to underestimate the Sun's role in climate change. According to the expert review "the temporal evolution indicates that the net natural forcing (solar and volcanic aerosol) has been negative over the past two and possibly even the past four decades." The solar forcing estimate remains the same as in "Climate Change 1995". It is "considerably smaller than the anthropogenic radiative forcings", and its "level of scientific understanding" is "very low", whereas forcing by well-mixed greenhouse gases "continues to enjoy the highest confidence level" as to its scientific understanding. Everything taken together, TAR 2000 considers it "unlikely that natural forcing can explain the warming in the latter half of this century." **Figure 24** in my paper *"Solar Activity: A Dominant Factor of Climate Dynamics"* shows however, that all maxima and minima in the global monthly-mean atmospheric temperature anomalies observed after 1958 can be explained by a solar cycle. A forecast experiment based on this relationship was successful. It

Drought, China 1928-30
Flood, Yangtze River, China, 1931
Drought, China 1936
Drought,. Sahel, Africa, 1940-44
Drought, China 1941-42
Great Smog of London 1952
Europe storm surge, 1953
Great Iran flood, 1954
Typhoon Vera, Japan, 1958
Drought, India 1965-67
Cyclone, Bangladesh, 1970
Drought,. Sahel, Africa, 1970-85
North Vietnam flood, 1971
Blizzard, Iran 1972
El Niño, 1982-83
Cyclone, Bangladesh, 1991
Typhoon, Philippines, 1991
Hurricane Mitch, C. Americ., 1998

correctly predicted the strong negative anomaly in winter 1996/1997 and the outstanding positive anomaly in 1998. How could this be if the Sun's varying activity were as weak as the IPCC pretends?

Here is a new piece of evidence for the strength of solar forcing. J. L. Daly has published NOAA's top global climate events at this web site. Dozens of scientists contributed to this listing of severe storms, droughts and other climate events deemed notable for their atmospheric marvel or their impact on human life. In the quoted papers I have shown that many climate events fall at the zero phase and some at the middle phase of a solar motion cycle the length of which varies between 3 and 14 years. So I investigated whether this is also true of NOAA's top events. Figure 1 below shows the result.



The density plot indicates the frequency of top events in different phases of the solar motion cycle normalized to 1. In the list of the 25 top events observed since 1900 the years are given, or in a few cases the period of 2 or 4 years over which the event extended. For my calculation I chose the middle of the given year or of the longer period. I skipped the Sahelian drought 1970-1985, as the period was too long. The investigated 24 events accumulate around the zero phase of the cycle and to a lesser extent around the middle phase.

The result is statistically highly significant.

20 cases fall at the ranges indicated by horizontal bars (together 0.4 of the unit cycle) and only 4 at the the rest of the cycle (0.6 of the unit cycle). A chi-square test yields 18.8 for two classes and 1 degree of freedom (P = 0.000015). If only the range around the zero phase is analysed, we get the chi-square value 15.4 (P = 0.000087). The null hypothesis of no correlation between the top climate events and the crucial phases of the solar cycle is disproved at a high level of significance.

The IPPC that continues to consider solar activity a minor factor in climate change is not in a position to present similar results produced by general circulation models or otherwise.

Review Comments Received

Subject: **`Top Climate Events Linked to Solar Motion Cycle'**
Date: Wed, 5 Jan 2000 13:39:31 GMT
From: richard@courtney01.cix.co.uk (**COURTNEY**)
To: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>

Dear Theodor:

I write to congratulate you on your paper titled `Top Climate Events Linked to Solar Motion Cycle' that is published on John Daly's web site.

You have yet again shown an empirical relationship between climate and solar activity. When will IPCC proponents abandon their prejudice in favour of virtual reality and contribute to investigation of observed effects in the real world ?

...

All the best **Richard**

Subject: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Wed, 5 Jan 2000 11:23:12 -0700
From: **Chick Keller** <cfk@lanl.gov>
To: richard@courtney01.cix.co.uk (**COURTNEY**), "\"**Dr. Theodor Landscheidt**\" <theodor.landscheidt@ns.sympatico.ca>

Richard,

Thanks for including me in these emails. I'll take a look at Theodor's latest. Correlations are important in leading to understanding. They are, of course, the beginning of an idea, not the end, which requires theoretical understanding. Nevertheless, we should not disregard correlations (see below)

But I hasten to give at least one answer to your rhetorical question below. I'm not sure what an "IPCC proponent" is unless it's a person who subscribes to IPCC's methodology for synthesizing what we know and giving relative certainty values to our knowledge. But I submit that IPCC is much more likely to take such work as Theodor's into account when they have read it in the refereed literature. For all its shortcomings, we must adher to this process. Without it, everyone's ideas and feelings are of equal merit and, as such, no merit at all. Let me give an examplekj from our work with correlations.

A few of us noticed some correlations between satellite and surface temperature anomaly records over the past 20 years. The correlations are with ENSO and stratospheric ozone depletion. They go a long way towards explaining why satellite temperature anomalies are not always the same as surface ones.

(Briefly, we see that until the Mt. Pinatubo eruption in 1991, MSU 2LTd anomalies are largely higher than the surface, being lower in only two years. Immediately after the eruption this satellite data shows a stepwise drop which holds constant for the next 6 years. We also see that before Pinatubo these anomalies are correlated with ENSO, but from 1992 to 1997 they are not.)

We gave a paper at the December AGU meeting about this, both to alert the community and to get initial feedback. We also are putting this paper on our web site (see address below in signature). But we are now also writing a paper to be submitted to a refereed journal. Without this final effort, we cannot get critical assessment of our findings from others who have looked at this data and know it better than we do. Our paper might get rejected for good reason. If it does, we will take it off the web site and go back to work.

To me this is the only orderly way to go especially in an area of such uncertainty as climate change.

Best wishes to everyone in your work,

Charles. "Chick" F. Keller,
Institute of Geophysics and Planetary Physics
University of California Mail Stop MS C-305
Los Alamos National Laboratory Los Alamos,
New Mexico, 87545
cfk@lanl.gov
Phone: (505) 667-0920
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http://www.igpp.lanl.gov/climate.html

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Wed, 5 Jan 2000 19:37:03 GMT
From: richard@courtney01.cix.co.uk (**COURTNEY**)
To: **Chick Keller** <cfk@lanl.gov>

Dear Chick: ...

You make several comments that I agree. Indeed, I applaud. For example, "Correlations are important in leading to understanding. They are, of course, the beginning of an idea, not the end, which requires theoretical understanding. Nevertheless, we should not disregard correlations."

And I strongly agree that only refereed work is acceptable, so I also agree with you when you say, "I submit that IPCC is much more likely to take such work as Theodor's into account when they have read it in the refereed literature. For all its shortcomings, we must adhere to this process. Without it, everyone's ideas and feelings are of equal merit and, as such, no merit at all." However, I suspect that your and my definitions of "refereed literature" may differ. Landscheidt has published his work on Daly's web site and - by that act - has challenged anyone to dispute it. Observation of other papers subjected to 'open review' on Daly's web site demonstrates that this review process is more severe than the peer review that is often applied to papers published in standard scientific publications.

Indeed, there is a problem with such 'standard' peer review. There are legion cases of poor work (including some blatantly fraudulent work) that has been passed for publication in respected scientific journals because its style and/or subject indicated that it originated from a "respected" source (e.g. the works of John Heslop Harrison who was the most respected botanist in Europe for most of the twentieth century although his most important scientific publications were known to be fraudulent by all competent botanists and by the journals that published them). Also, much good work has had great difficulty in being published because it did not concur with currently orthodox thinking (e.g. the Wright brothers were forced to publish the first technical details concerning powered flight in a journal on bee-keeping, and I believe that Pat' Michaels had difficulty publishing his sulphate aerosol cooling hypothesis until it became convenient to climate modelers). Hence, I consider that Landscheidt's papers on Daly's web site are examples of "refereed literature" of an especially valuable kind.

I applaud your decision to publish your coming paper on your web site, and I have two questions that I hope are helpful. Have you considered offering 'open review' on the web page in similar manner to that offered by John Daly on his web site ? Also, have you checked that the publication on your web site will not hinder your intended more traditional peer review ? Some journals (e.g Nature) have an editorial policy to not publish papers that have appeared on a public web site prior to their publication in the journal.

All the best

Richard

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Thu, 06 Jan 2000 12:53:52 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: **COURTNEY** <richard@courtney01.cix.co.uk>

Dear Richard:

I agree with your response to Chick Keller. As far as he submits that IPCC scientists are much more likely to take work such as mine into account when they have read it in the refereed literature, he does not take into account that much of my work has been published in peer reviewed journals. One of the many papers that describe the astronomical background of the connection between cycles of solar activity and climate change - Extrema in Sunspot Cycle Linked to Solar Motion - was just published in Solar Physics **[189(2), 413-424]**. Among many other papers published by university press or NASA, the relationship with climate was published in Climatic Change **[Solar Rotation, Impulses of the Torque in the Sun's Motion, and Climatic Variation, 12 (1988), 265-295]** and in the Journal of Coastal Research **[Global Warming or Little Ice Age, Special Issue No. 17 (1995), 371-382).**

As far as Chick Keller objects to my new paper **"Top Climate Events Linked to Solar Motion Cycle"** that it solely presents correlations which are only the beginning of an idea, not the end, which requires theoretical understanding, he should consider that I quoted two of my papers which describe quite solid physical relationships between solar activity and climate. I showed in these papers that the initial phase of the solar motion cycle goes along with strong eruptional activity on the Sun which drives the solar wind, the main factor in the Svensmark effect. As is well known, solar eruptions also affect the troposhere via ozone in the stratosphere; there are even models which show physically why this happens.

Kind regards, **Theodor**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 7 Jan 2000 08:21:34 GMT
From: richard@courtney01.cix.co.uk (**COURTNEY**)
To: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>

Dear Theodor:

Thankyou for the fine list of references.

There is long record of IPCC representatives make the false claim that their oponents don't publish in peer-reviewed journals. Having said that, I think it important to note that on this occasion Keller was responding to my comment on your recent item published on Daly's web site, not in a peer-reviewed journal, and so I think his response to me was proper.

In my opinion, the real problem is not whether information has been published in the 'right way' or 'right place'. I think the real problem is that science is pervaded by biases in favour of particular theorems. Information should be used to support, amend or reject a theorem. In reality, information is often accepted when it fits a preferred theeory but ignored when it is inconvenient to the theory. IPCC is not alone in behaving like this; most of science is affected by this behaviour. And the peer-review system promotes such behaviour. All reviewers are human and, therefore, they are likely to be less strict when confronted with information that supports the theory they have used in the adhancement of their careers. The IPCC is especially prone to bias because it is an "Intergovernmental" organisation, and pure science is not likely to be acceptable to politicians who have their own agendas.

Your published work is not alone in being ignored by the IPCC. For example, in May 1990 I publicly challenged John Wakeham (now Lord Wakeham but then a UK government Minister) to explain how the 'global warming' hypothesis could be correct in light of the work by Kuo et al.. He replied that a report "by 250 leading scientists" was to be published later that year and would it explain. I responded that I was willing to bet the IPCC Report would not discuss the work of Kuo et al. and if it did not then Wakeham "could draw his own conclusions". Wakeham and I exchanged several letters on the matter prior to publication of IPCC 1990, and when it was published I wrote to him to point out that it did not mention Kuo et al.. He did not reply.

Another example is IPCC's treatment of Barrett's work. The mention of his work in the 1994 IPCC Report shows a clear misunderstanding of the process described by Barrett. At the Bonn Climate Conference, Barrett said the IPCC had not consulted him to explain the matter, and they did not ask me for comment although I have published peer-reviewed comment in support of Barrett's argument.

All the best **Richard**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 7 Jan 2000 09:34:46 -0700
From: **Chick Keller** <cfk@lanl.gov>
To: richard@courtney01.cix.co.uk (**COURTNEY**), "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>

Dear Richard,

These examples notwithstanding, my experience with publishing in the refereed literature is that mostly referees worry about technical excellence and keep their biases to themselves. In cases where they don't, we have had good success appealing to the editor. Sometimes it has taken changing journals to get other referees. So, yes, individual biases are a problem, but in general this system is the best we've got. I must say that my experience in reading web sites such as Fred Singers, and Pat Michaels, and to some extent

John Daly's appear much more apt to give only one side of the story.

As to then getting into the IPCC documents, I haven't any experience. The documents are large and look very inclusive, and include a fairly broad range of opinions. When some work doesn't get in, it seems to me that rightly or wrongly it has failed to convince the combined authors of the chapter. Again, IPCC is not without its problems, but it is probably the best way we have of gathering together the most significant work and making sense of it. That the skeptics don't get much representation is obvious. I wonder how the community could at least answer their criticisms.

Encouraged by your emails, in which I find a real attempt at fairness, I am composing a response to Theodor's first article on John's web site about solar influences and other things. In brief, I find it not a balanced article, and probably not one that could stand peer review. His points about solar influence are hard to follow quantitatively, and leave out much other good work. I believe a strong peer review would do much to improve his paper and to have it make its central points better. To that end I will email my review soon, both to Daly's web site and to Theodor and you. While I'm sure that the three of us will then enter into some illuminating give and take, I'm less sure what will happen to my submission to Daly.

Regards and best wishes,

Charles. "Chick" F. Keller,
Institute of Geophysics and Planetary Physics/University of California
Mail Stop MS C-305
Los Alamos National Laboratory
Los Alamos, New Mexico, 87545
cfk@lanl.gov
Phone: (505) 667-0920 FAX: (505) 665-3107
http://www.igpp.lanl.gov/climate.html

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 07 Jan 2000 12:38:19 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: **COURTNEY** <richard@courtney01.cix.co.uk>

Dear Richard:

Again, your remarks about peer review are to the point. Those up to three referees you are dealing with, when you try to publish a paper, may be considered a statistical sample of the population of schools in science. If you are lucky, you get someone who is open to ideas beyond the horizon of the school he adheres to. If not, your paper won't be published if you are not a member of the school she or he favours. Your statistical chances are especially bad when you stand against a main trend like the positive attitude towards global warming. You nearly always get a referee who does not appreciate your results running against the trend. This happens on all levels. George Zweig, who independently from Gell-Mann developed the concept of quarks, was literally called a "charlatan" by his peers and did not get the professorship in physics he wanted because of this negative "review".

And there is often someone who loads the dice: the editor of the journal. She or he knows very well which referee is in favour or against a special result and can thus influence the outcome of the review process.

Considering all this, I think it is not fair of the representatives of a majority to tell those in the minority that their results have not the same scientific weight because they have not got as many publications in peer reviewed journals.

Kind regards, **Theodor**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 07 Jan 2000 14:42:06 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: "**Dr. Franz Gerl**" <gerl@Theorie.Physik.UNI-Goettingen.DE>

Dear Franz

You took took part in the open discussion of my paper **"Solar Activity Controls El Niño and La Niña"** at John Daly's climate web site. You vividly played the part of the sceptic, but were fair enough to concede that the outcome of my La Niña forecast would make a point.

End of February 1999, when La Niña got a bit weaker, you wrote in a letter to John Daly:

"Dear contributors to the discussion of Landscheidt's paper!

> The first test of Dr. Landscheidt's prediction scheme - the forecast of a prolonged La Niña event - promises to become quite thrilling. It is most interesting to compare the forecasts that have been issued during the last few weeks. The "predictability barrier" in early spring seems to be quite high this year... The majority of the physical models that I can assess predict a rapid transition to near normal conditions in spring ... The NCEP coupled model, most runs of the EMWCF-model, and the hybrid model of Scripps indicate an end of La Niña in spring ... We can see that the subsurface waters in the West Pacific have warmed rapidly in the past months. If this continues it may be the reason for an early end of La Niña ... If the opposite happens, of course this will be a data point for the camp skeptical of global change."

Meanwhile, I evaluated the positive outcome of the first part of my forecast at John Daly's web site in the short note: "Top Climate Events Linked to Solar Motion Cycle." Any comment?

Kind regards, **Theodor**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 7 Jan 2000 23:04:41 GMT
From: richard@courtney01.cix.co.uk (**COURTNEY**)
To: **Chick Keller** <cfk@lanl.gov>

Dear Chick:

Thankyou for observing that I try to be fair (although I sometimes fail). I also try to be clear and this often requires bluntness. For these reasons I keep falling-out with people on both sides of the 'climate debate' (including some of the people on the distribution list of this correspondence). There is a large degree of emotion displayed on all sides of the 'climate debate', and many people on all sides hold to their views with a rigour that is more appropriate to theology than science (I have some knowledge of both).

I agree with your assertions that the present peer review system is the best we have (it has become the only one we have for published work) and that is difficult to see ways for its improvement. However, nothing is perfect and I think it important to avoid complacency when considering the method we use to maintain scientific standards. Improvements to the system require observation of its flaws while always keeping in mind that the easiest way to address a problem is to replace it with a worse one.

You say; "I'm sure that the three of us [yourself, Theodor and me] will then enter into some illuminating give and take." I sincerely hope you are right because I for one would benefit from such discourse. As I see it, there are four quite seperate issues and the discussion would be hindered by confusing them. They are, in no special order,:
1. The normal peer review process and possibility of its improvement.
2. The IPCC peer review process and possibility of its improvement.
3. Effectiveness and possibility of improvement of 'open' peer review of the kind being developed by John Daly.
4. Evaluation and review of Theodor's work.

Again, thankyou for your consideration.

All the best **Richard**

Subject: **Top Climate Events**
Date: Tue, 11 Jan 2000 22:30:48 +0100
From: A.F.Gerl@t-online.de (**A.F.Gerl**)
To: daly@vision.net.au

Dear **Theodor**,

I am a physicist, but no climate scientist, and I just took part in the discussion to help enforcing standards on the predictive side.

I stated that given the historic record it had a chance of 1 in 2, and I now congratulate You for beating them. I would rate the successful prediction of the next El Niño as stated by You in the refined prediction would probably by around 1 in 3, and always considered it to be more interesting. I think the combined odds would merit a closer look at Your method. This point has not been reached yet for me.

The other point of interest is the failure of the physical models I could take a look at (with the exception of the Australian one). I have not read anything about it in the scientific journals, so I have to speculate a little bit: The physical and statistical models all show a spring predictability barrier, and it may as well be, that under many circumstances the course of ENSO is not decided in late winter.

When I wrote my statement, subsurface warming (which precedes the end of La Niña) was well under way, when a sudden mini-El Niño led to warming of the surface ocean in the East Pacific, and to a subsequent cooling of the subsurface. This in turn may have helped prolonging La Niña. Unpredictable noisy effects like this may well have their part with ENSO and limit forecasting.

Anyway, its well to early to declare a winner, and it will take a few more rounds of predictions. The next test will be in a little more than one year - if I had to bet, I would bet upon an El Niño in 2001/02.

Greetings, **Franz Gerl**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Thu, 13 Jan 2000 18:44:29 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: **Chick Keller** <cfk@lanl.gov>, Jarl Ahlbeck <jarl.ahlbeck@abo.fi>

Dear Chick

In your letter of 7 January to Richard Courtney you referred to my paper "Solar Activity: A Dominant Factor in Climate Dynamics". You found it "not a balanced article, and probably not one that could stand peer review."

I agree with you, but the lacking balance was premeditated. Look at my recently published paper **"Extrema in Sunspot Cycle Linked to Sun's Motion" [Solar Physics, 189 (2), 413-424, October 1999]** to see how I write when I think that a balanced approach is appropriate. My paper about the impact of solar activity on climate change was intended to counterbalance IPCC's biased and unknowledgeable reports on the Sun's role in climate change. In such a case you have to stress the neglected arguments to reach your goal. Even in the draft of TAR2000 the imbalances continue to be obvious. Some time ago I sent you a list of papers published in peer reviewed journals showing that the Sun's contribution to climate change ranges between 50 and 100 percent. Though these papers are in the majority, TAR2000 does not quote them, but only those which point to a minor role of solar activity. As long as this state of affairs continues in this field and others, John Daly's climate web site and the papers of skeptics published there have a vital function.

You ask how peer review could be reformed to reduce partiality. Here is a suggestion that could easily be realized. French scientists have reported the outcome of a relevant experiment in "La Recherche".They took two dozens of papers that had been published already in peer reviewed journals, changed the names of the well known authors and the affiliations of repute by invented names and affiliations, and subjected them again for publication. Nearly all of these papers, the content of which remained unchanged, were rejected in the peer review. The moral of this true story: Let authors be as anonymous as reviewers. Do you think that this will happen though it is easy to organize?

Kind regards, **Theodor**

From: **Richard Courtney**
To: **Chick Keller**
Date: 14 Jan 2000

Dear Chick:

By coincidence, I this morning received a preprint of the paper by Soon et al. that is to appear in 'New Astronomy' and is titled **"Variations of solar coronal hole area and terrestrial lower tropospheric air temperature from 1979 to mid-1998: astronomical forcings of change to the Earth's climate ?"**.

Its abstract says:

> "The temperature of the terrestrial lower troposphere, inferred from the Microwave Sounding Unit (MSU) radiometers, is found to be inversely correlated with the the area of the Sun covered by coronal holes. The correlation between the monthly time series of global tropospheric temperature anomaly and total coronal hole area from January 1979 to April 1998 has a Pearson coefficient of -0.46, which is different from zero at the 95% confidence level. Physical reasonings for the explained and unexplained parts of the correlation are discussed. The coronal hole area is a physical proxy for both the global scale, 22-yr geometrical and shorter term, dynamical components of the cosmic ray modulation, as well as the corpuscular emission of the Sun. Other solar parameters that may indicate a solar radiative effect on climate are also evaluated. It is concluded that variable fluxes either of solar charged particles or cosmic rays modulated by the solar wind, or both, may influence the terrestrial tropospheric temperature on timescales of months or years."

Theodor's work indicates strong solar influence on climate, and you seem to be challenging it because it is 'not mainstream'. But the authors of the paper I cite are based at the Harvard-Smithsonian Centre for Astrophysics, the Dept. of Physics and Mathematics at Long Island University, and the Dept. of Physics and Astronomy at the University of Nigeria. I put it to you that these are very mainstream and authoritative sources for findings that concur with Theodor's and supports the 'Svensmark hypothesis'.

I repeat my question that initiated this series of correspondence; i.e. When will IPCC proponents abandon their prejudice in favour of virtual reality and contribute to investigation of observed effects in the real world ?

All the best **Richard**

From: **Chick Keller**
To: **Richard Courtney**
Date: 14 January 2000

Dear Richard,

Thanks so much for the heads up. This paper sounds interesting. I'll be very interested to see such a correlation since to my knowledge previous attempts to see the solar cycle in the data have only shown low amplitude temperature variations. Thus, the question is not, "can we find correlations between solar activity and atmospheric temperatures", we seem to be able to do that, but rather "can solar activity explain the observed securlar warming or any significant part of it?" This paper may add knew knowledge to our combined studies.

I'm up to my proverbial ears in deadlines here and so will not be doing as much discussing of all this, although I remain very interested and committed, but I need to clarify one point you make below. I am not challenging Theodor's work "because it is 'not mainstream'". In fact I'm not challenging his work at all. My two main objections were that it wasn't a balanced review of what's being done (which he just admitted in an email to me). I agree that just relying on "mainstream" publications also gives an unbalanced view of things. In my own case, our little team is about to submit our "non-mainstream" results for publication, so I appreciate how others feel. But I also see enough 'non mainstream' material in the refereed literature (Sally Baliunas for example is anything but mainstream and publishes regularly) that I still think it's the best way to go.

I recall the humorous story of the man who stuttered badly. When rejected for a job as radio announcer he rationalized he didn't get the job because: "the-the-they d-d-d-don't l-l-like C-C-Catholics!" So, if our paper is rejected, the first thing we'll do is see if we can't do better work. Of course finally there is the problem that some would rather not see the work of others in print, and we must guard against that. But for every paper that has trouble surfacing due to some prejudice of the "mainstream", there are a large number of papers that are and ought to be rejected. My review of Theodor's paper (I have only looked at the first part due to time restrictions) is along those lines. In its present form I would not think it would be accepted by JRG or similar journals mainly for the reasons I've given.

None of this however answers directly your complaint that, despite appearing in refereed literature, some work doesn't seem to get a fair hearing and review in the IPCC TAR. To the extent this is true, this is a significant problem. I will keep an open mind about it and see what happens.

All the best, **Chick**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 14 Jan 2000 09:44:16 +0200
From: "**Jarl Ahlbeck**" <jarl.ahlbeck@abo.fi>
To: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>, "**Chick Keller**" <cfk@lanl.gov>

Dear Theodor and Chick,

The normal peer-review system is in fact the best, but not a perfect way of separating junk from real science. But at the same time, many other ways of publishing science and discussing the reliability must be used. (Congress contributions, posters, Internet). Fortunately, some people like John Daly have done a great job to create Internet options.

All disciplines have their special clans or inner circles of "experts" who understand only reports written in a certain way, using certain therminology and referring to previos works written by the members of the clan. If you try to disturb this splendid harmony by entering from outside, you have no chance as you cannot communicate in a proper way. The history of science tells that many erroneous dogmas and famous failures have survived within these circles for very long time periods.

In my branch, chemical engineering science, this problem is obvious. A control engineer, using control engineering terms for describing chemical problems has no chance to get anything published for example in the journal **"Chemical Engineering Science"** The referees simply do not understand the text, or they do not care. He should publish in **"Journal of Process Control"** instead. But in reality, dynamic control theory is very useful when describing the kinetics of chemical processes.

There are no general experts of "climate change" either, and thats one reason for the existence of the IPCC. But according to some reason that I don't understand, IPCC is a failure. The TAR report is a sad story for a critically thinking scientist. The solar forcing research (for example Friis-Christensen) is not given a fair chance. The reliability of the balloon-satellite temperature records is heavily questioned, probably because they do not show the same tropospheric warming as obtained by the holy computer models. The surface records are critized too, but not as heavily. The TAR text gives the false impression that the global uptake mechanisms of carbon dioxide is today fairly well known and correctly modeled. These carbon dioxide people portion anthropogenic carbon dioxide

here and there around the globe and do not seem to understand much of diffusional mass transfer theory.

In fact, mankind still does not understand much of the climate. Why is is it so difficult to admit that? Is it because oversimplified and probably erroneous visions have been fed to the public all these years ?

Jarl

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 14 Jan 2000 22:44:47 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: **Chick Keller** <cfk@lanl.gov>

Dear Chick,

I looked at the paper by Miller, Cayan, and Lean you quoted in your letter of 13 January. My opinion is that this result does not represent reality because it is based on the belief that solar forcing can only be explained by the 11-year sunspot cycle. There are dozens of papers which relate climate phenomena to solar eruptions, not sunspots. I have been stressing for decades that such eruptions are poorly correlated with the intensity of sunspot activity. Energetic solar flares shun sunspot maxima and even occur close to sunspot minima. My forecasts of El Niño, La Niña and other climate events were successful because they took phases of energetic solar activity into account.

The preprint by Soon et al., quoted by Richard in his letter of 14 January, is on the right track. Coronal holes contribute to the solar wind, the true link between the Sun's activity and climate events. Yet coronal holes are the weakest factor contributing to the intensity of the solar wind. Much stronger are solar flares and coronal mass ejections. If you find already a correlation of -0.46 between coronal holes and temperature, you see what you have to expect when you include the really energetic eruptions. The dimension of the Svensmark effect is an indication of the corresponding strength of the solar wind forcing. Another striking example is the close correlation between temperature and eruptive phases in the solar motion cycle (Fig. 24 in 'Top Climate Events Linked to Solar Motion Cycle'), corroborated by correct forecasts of strong positive or negative deviations from the temperature trend. None of the papers quoted by the IPCC in TAR2000 takes this into account.

Moreover, it is quite clear now that all models that backcast the Sun's effect on climate on the basis of sunspot numbers yield misleading results. The number of eruptions does not depend proportionally on the intensity of 11-year sunspot maxima. Cycle 20 with the highest monthly sunspot number R = 106 was much weaker than cycle 21 (R = 165) and cycle 22 (R=158), but it produced nearly as much flares as cycle 21 and considerably more than cycle 22. You would expect that current cycle 23, which is at the same level as cycle 20 should produce a similar number of flares. Not so. The flare activity is weaker than at any time after the beginning of observations in the thirties. Those who do not take this into account draw conclusions that do not conform with reality. Did you find this argument in TAR2000?

Kind regards, **Theodor**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 14 Jan 2000 17:50:54 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: "**Dr. Franz Gerl**" <gerl@Theorie.Physik.UNI-Goettingen.DE>

Dear Franz,

I thank you for your fair comment on the first part of my forecast experiment. Yes, this was only the first round of predictions. Statistically, your bet on an El Niño beginning in 2001 has a good chance to turn out correct. On average El Niños occur at such intervals. We shall see whether the solar model knows better. As to a global judgement it should not be forgotten that this model already predicted the two last El Niños, the cold winter 1996/1997 and the warm year 1998.

Kind regards, **Theodor**

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Thu, 20 Jan 2000 18:34:37 -0400
From: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>
To: **Chick Keller** <cfk@lanl.gov>

Dear Chick

In your letter of 7 January to Richard Courtney you commented that my points about solar influence, made in the paper "Solar Activity: A Dominant Factor in Climate Dynamics" published at John Daly's web site, are hard to follow quantitatively. I have been waiting for a detailed justification of this general remark. As it did not come I respond to it as is.

All of my plots that indicate solar-terrestrial relationships are based on precisely defined and computed astrophysical quantities and climate data published in the peer reviewed literature. Different from the scenarios presented by the IPCC, my graphs show unambiguous connections that can be checked. Many or them were corroborated by successful forecasts, the experimentum crucis in science. This is the highest level of quantitative confirmation imaginable. What was computed turned out to conform with reality.

The distribution of X-ray flares presented in Fig. 17 was subjected to a chi-square test yielding P = 1.3 times 10 to the -15. The quantitative procedure of this statistical test is easy to follow as it is based on standard algorithms. By now, no scientist found fault with the result which explains why the solar motion cycles have such an important function in climate forcing.

Figure 24, also presented in the short paper "Top Climate Events Linked to Solar Motion Cycle" as a striking example of a close connection between solar activity and temperature on earth, shows such a conspicuous correlation that a statistical test would be redundant. Nevertheless, I mentioned that a chi-square test yields P < 0.00004. Though this quantitative result par excellence was subjected to Open Review, none of the challenged scientists tried to show that it is spurious. This is also true of the statistical evaluation of the connection between top climate events and main phases of the solar motion cycle, again a quantitative procedure par excellence. So what?

Kind regards,

Theodor

Subject: Re: **Comment on `Top Climate Events Linked to Solar Motion Cycle'**
Date: Fri, 21 Jan 2000 14:27:27 -0700
From: **Chick Keller** <cfk@lanl.gov>
To: "**Dr. Theodor Landscheidt**" <theodor.landscheidt@ns.sympatico.ca>

Theodor,

My comments were only about the first part of your article. I haven't even had time to read the rest which looks fascinating. So I only discussed the first part up to but not including "6. Cycles in the Sun's Oscillation Affect Sunspots and Climate".

Charles "Chick" F. Keller

Subject: "**Top Climate Events**"
Date: Tue, 08 Feb 2000 14:27:46 -0500
From: **Jim Hughes** <jhba345@pop.mail.rcn.net>
To: daly@vision.net.au, Richard@pop.mail.rcn.net, Courtney@pop.mail.rcn.net

Dear Richard ,

I was both pleased and saddened when I read your January 14th letter to Chick Keller. I'm referring to your comments about the possibility of coronal holes and their influence upon our climate. I have been forecasting both weather & climate events for almost five years now. I even wrote to both John & Theodor last September in reference to some of my own past research. I complimented Theodor on his research but I had also told him that he was missing something. I described this as the "Holy Grail" . Well it seems that someone else has come foward with this possible link now.

I have been trying for years to get some media attention around here in the Washington D.C. area but my success has been somewhat limited. It now looks like the cats finally out of the bag. I look foward to reading about these tropospheric air temperature correlations (if I possibly can).

I personally even wrote about the coronal hole subject matter late last summer but my media contacts were uninspired by it's possible influences.

Unfortunately I do most of my research during my spare time so my free time is limited because of my regular job. Most of my past forecasts have been on a more localized nature . Although some , like the 97' El Nino event , and my Cycle 23 sunspot forecast , have not been. I will not go into all the details but my past accuracy record speaks for itself.

I'm well known by the local television meteorologists an I've even had some contacts with some higher up at the Space Environment Center out in Boulder, Colorado in reference to my Cycle 23 sunspot forecast. (Smoothed monthly peak of 115)

<latest sunspot graph for cycle 23>

The one important thing that you did not mention though was the coronal hole's POLARITY. This is a HUGE factor. I have come to the conclusion that the biggest blunder by the scientific community has been to conglomerate all of the geomagnetic activity into **ONE** basket. Coronal holes are part of the whole oscillation affect between the sun and the planets. CME's , DSF, and GLE's are runaway renegades so they have an entirely different affect upon the Earth's environment.

I am very glad that some of this has been brought foward now and I personally hope that the scientific community abandons their conservative stance in relation to solar forcing. It's been there all along but they just haven't been looking in the right area. Theodor is 100% correct in the solar magnetic fluctations effect upon the El Nino & La Nina and it's actually just a tip of the iceberg.

Jim Hughes

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Return to "Still Waiting For Greenhouse" Main Page

El Niño Forecast Revisited

APPENDIX VI (5)
Submission on Adapting to Climate Change, Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

by
Dr Theodor Landscheidt

Institute for Research in Cycles of Solar Activity
Belle Côte, Nova Scotia, Canada

1. Background of ENSO Forecast

On 11 January 1999, my paper "Solar Activity Controls El Niño and La Niña" was published on this web site. It included a forecast of the next El Niño around 2002.9 (End of November 2002). As this date is approaching, it seems to be in order to give a short delineation of the background of this forecast for those readers who are interested in an explanation of the general concept, but shun technical details. This all the more so as there are first indications that an El Niño is in the making.

My forecast is exclusively based on cycles of solar activity. This does not conform to the dominating trend in official science. The Third Assessment Report, published by the Intergovernmental Panel on Climate Change (IPCC), continues to underestimate the Sun's role in climate change: "Solar forcing is considerably smaller than the anthropogenic radiative forcings", and its "level of scientific understanding" is "very low", whereas forcing by well-mixed greenhouse gases "continues to enjoy the highest confidence level" as to its scientific understanding. The Third Report considers it "unlikely that natural forcing can explain the warming in the latter half of the 20th century." There are also frequent assertions in the literature that there was only a negligible effect of solar activity on temperature in recent decades.

2. Effect of solar eruptions on climate stronger than variations in irradiance

The IPCC's judgement is based on the observation that the Sun's irradiance changes only by about 0.1 percent during the course of the 11-year sunspot cycle. It turns out to be untenable when the Sun's eruptional activity (energetic flares, coronal mass ejections, eruptive prominences) as well as solar wind contributions by coronal holes are taken into consideration. The total magnetic flux leaving the Sun, dragged out by the solar wind, has risen by a factor of 2.3 since 1901 **(Lockwood et al., 1999)**, while concomitantly global temperature increased by about 0.6°C. The energy in the solar flux is transferred to the near-Earth environment by magnetic reconnection and directly into the atmosphere by charged particles.

Energetic flares increase the Sun's UV radiation by at least 16 percent. Ozone in the stratosphere absorbs this excess energy which causes local warming and circulation disturbances. General circulation models developed by Haigh **(1996)**, Shindell et al. **(1999)**, and Balachandran et al. **(1999)** confirm that circulation changes, initially induced in the stratosphere, can penetrate into the troposphere and influence temperature, air pressure, Hadley circulation, and storm tracks by changing the distribution of large amounts of energy already present in the atmosphere.

3. Forbush events after solar eruptions affect temperature and cloud cover

The strongest contributors to the intensity of the solar wind are solar eruptions which create the highest velocities in the solar wind and shock waves that compress and intensify magnetic fields in the solar wind plasma. Indirectly, they modulate the strength of galactic cosmic rays that conceivably have an effect on cloud

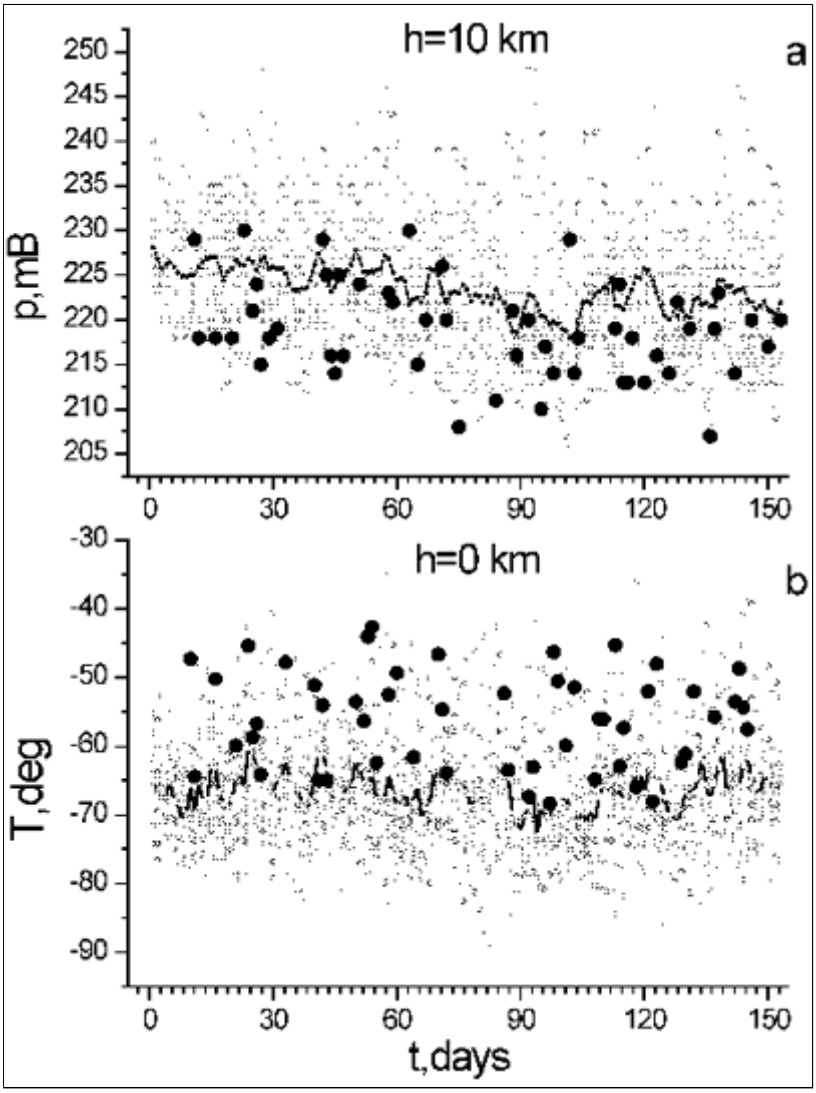

Figure 1

cover, attributed to cloud seeding by ionized secondary particles **(Svensmark et al., 1997; Pallé Bagó et al., 2000)**

Figure 1 after Egorova et al. **(2000)** provides evidence of this connection. From 1981 to 1991, Egorova, Vovk, and Troshichev **(2000)** observed surface temperature (lower panel) and atmospheric pressure at 10 km altitude (upper panel) at the Russian Antarctic station, Vostok. Tiny open circles indicate superimposed daily observations during the winter season. The solid line describes the 10-winter average. Fat circles mark Forbush events. These are sharp decreases in the intensity of galactic cosmic rays caused by energetic solar flares. As can be seen from Figure 1, temperature was nearly always above the mean after Forbush events, often reaching departures around 20°C.

These 51 experiments performed by Nature and observed by man show a clear connection between solar eruptions, a decrease in cosmic ray intensity, and a strong rise in temperature, not to mention the strong decrease in air pressure. It would be a redundant exercise to assess the statistical significance of this distinct result. It is consistent to assume that the rise in temperature was linked to shrinking cloud cover because of less intense cosmic rays, though the microphysical details of the effect are not yet clear. This link is confirmed by Pudvokin and Veretenenko **(1995)** who observed marked shrinking of local cloud cover by 3 % after Forbush events.

4. Solar eruptions have an impact on tropical circulation

El Niños occur in the tropical Pacific, far away from Antarctica. There is cogent evidence, however, that the Sun's eruptional activity, too, has a strong effect in the tropics. Fig. 2 after Neff et al. **(2001)** shows a strong correlation between solar eruptions, driving the solar wind, and tropical circulation and rainfall. The dark profile represents oxygen isotope variations (^{18}O) in a dated stalagmite from Oman. The ^{18}O record, covering more than 3000 years (9.6 to 6.1 kyr before present), serves as a proxy for change in tropical circulation and monsoon rainfall. The bright ^{14}C profile shows radiocarbon deviations derived from the analysis of dated tree rings. The level of radiocarbon production in the atmosphere depends on the changing strength of cosmic rays. Because of the reverse relationship of cosmic rays with solar activity, the radiocarbon record serves as a proxy of the Sun's activity. Most scientists think that this proxy is related to the activity of sunspots and faculae linked to relatively weak changes in irradiance.

Actually, the radiocarbon data are a proxy of the Sun's

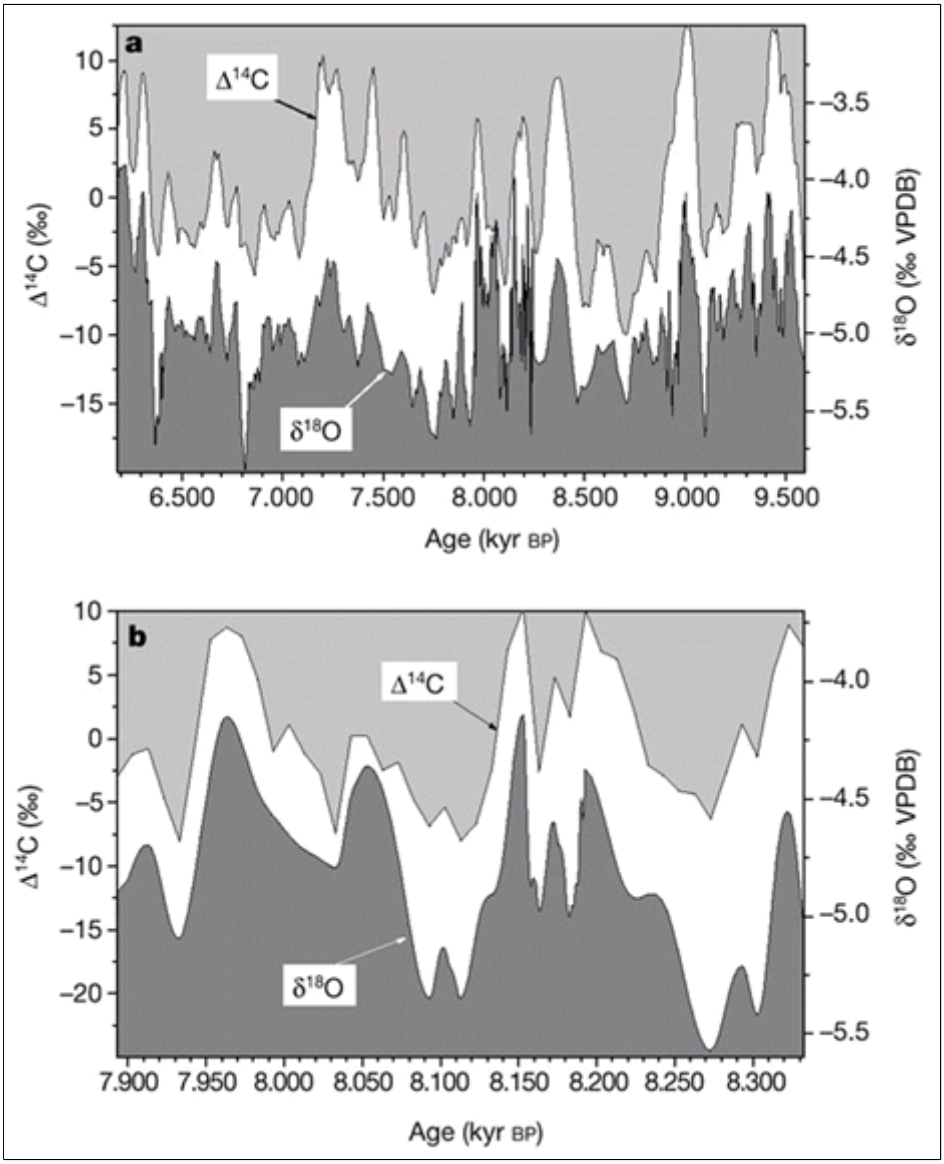

Figure 2

eruptional activity driving the solar wind. Energetic solar eruptions do not accumulate around the sunspot maximum. In most cycles they shun the maximum phase and can even occur close to a sunspot minimum.

The upper panel in Fig. 2 covers the whole investigated interval, whereas the lower panel shows the nearly perfect synchronicity in detail.

Lake bottom cores from the Yucatan Peninsula show a similar correlation, covering more than 2000 years, between recurrent droughts and the radiocarbon record linked to the Sun's eruptional activity via cosmic rays **(Hodell et al., 2001)**. These results and many less recent ones document the importance of the Sun's eruptional activity for climate change in the tropics. So it suggests itself to see whether other tropical climate phenomena show similar connections with solar eruptions.

5. Limited lead time of ENSO forecasts based on precursors

Anomalous warming (El Niño) or cooling (La Niña) of surface water in the eastern equatorial Pacific occurs at irregular intervals (2 to 7 years) in conjunction with the Southern Oscillation, a massive see-sawing of atmospheric pressure between the south-eastern and the western tropical Pacific. The coordinated El Niño/Southern Oscillation phenomenon (ENSO), also including La Niña, is the strongest source of natural variability in the global climate system. Anomalies in the global temperature (positive or negative deviations from a defined mean temperature) are primarily driven by ENSO events . Only when explosive volcanic activity intervenes, global temperature is additionally modulated by its cooling effect.

So it is plausible that there are strong links to weather in other world regions. As this might be the key to long-range seasonal forecasts, there is strong interest in precursors that could make it possible to predict ENSO events. The NOAA tripwire open ocean buoy array including deep ocean moorings and surface drifters gives climatologists an early warning of 3 to 12 months of an impending El Niño. Daily observations of changes in sea surface temperature (SST), surface wind, upper ocean thermal structure, and ocean currents enable researchers to develop models that can be tested by experimental forecasts.

It seems to be very difficult, however, to design skilful models that extend the 12-month limit set by the observation of precursors. Zane and Zebiak of the Lamont-Doherty Earth Observatory made the first successful forecast of an El Niño in early 1986, one year ahead of the event, but their model did not predict the strong El Niño in 1997. At present, there exist no physical or statistical models that can skilfully predict ENSO events at lead times longer than 12 months **(Neelin et al., 1998)**.

According to Neelin and Latif **(1998)** weather noise and deterministic chaos, representing the internal variability of the climate system, set the fundamental limits to the lead time. This emphasis on the exclusively internal character of ENSO events is in accordance with the tenet of climatology that ENSO phenomena are the most spectacular example of a free internal oscillation of the climate system not subjected to external forcing. If it could be shown that this tenet is not tenable because there is external forcing, this would have far reaching consequences for the global warming debate.

6. Eruptive phases in sunspot cycle linked to ENSO events

If there were external forcing, deterministic chaos would not prevent long-range forecasts. Lorenz has emphasized that sensitive dependence on initial conditions and ensuing limited predictability are only valid for processes within the climate system. External periodic or quasi-periodic energy flow can force its rhythm on atmosphere and oceans. Long-term climate effects due to varying solar irradiance, if strong enough, would be a case in point. Investigations into connections between irradiance variations in the course of the 11-year sunspot cycle and changing climate are usually focused on maxima and minima in sunspot activity. It is easy to see that these extrema fail to show a direct relationship with ENSO events.

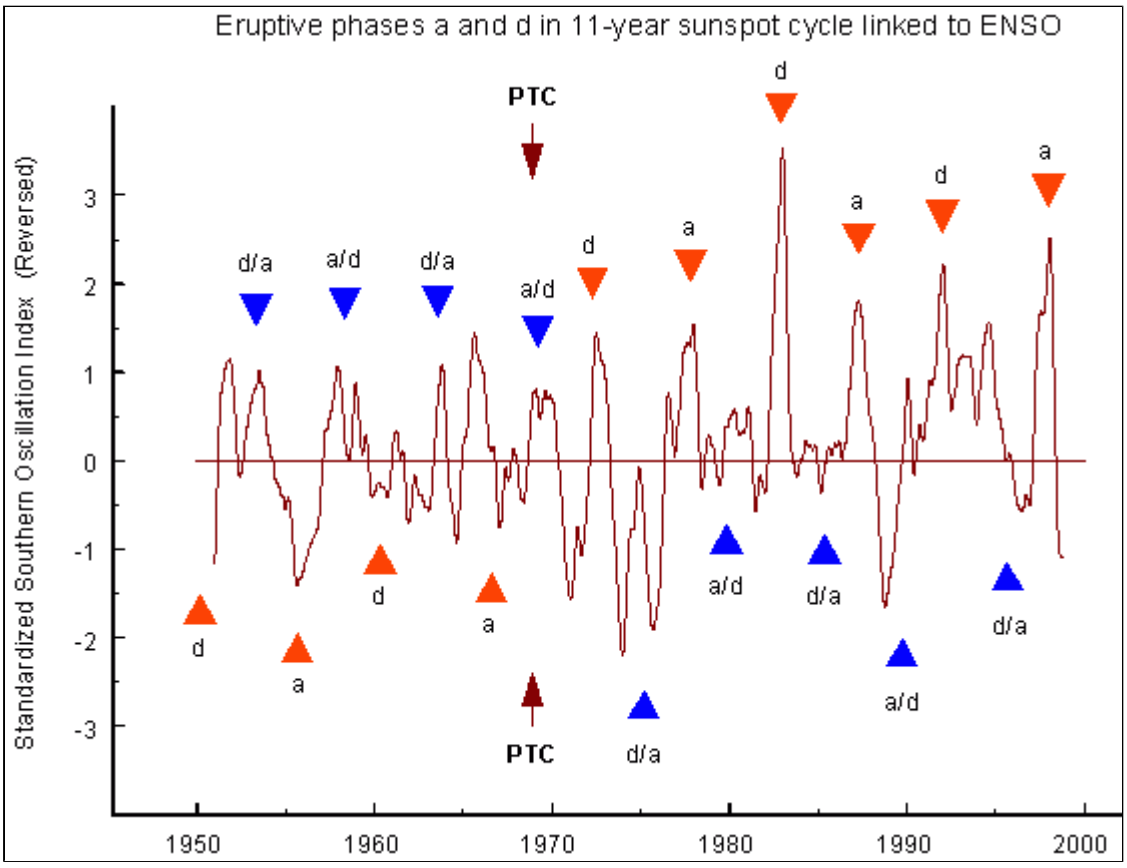

Figure 3

Fig. 3 demonstrates, however, that a close correlation emerges when other phases of the sunspot cycle are examined. The curve shows slightly smoothed standardized monthly data of the SOI, the Southern Oscillation Index, published by the Climate Prediction Center **(1998)**. It measures the pressure gradient across the tropical Pacific which, in turn, is an indicator of equatorial wind variations. Low negative SOI values, indicating El Niños, go along with weaker than normal trade winds over the central Pacific, warmer than normal sea surface temperatures (SST) over the eastern equatorial Pacific, and a reduced westward pressure gradient with changing wind stress values. High positive SOI values indicate La Niña conditions, just the opposite of the El Niño scenario. In Fig. 3 the data are reversed so that strong positive peaks point to El Niños and negative deviations to La Niñas.

After 1970, on the right of the two arrows marked by PTC, red triangles coincide with El Niños and blue triangles with negative deviations. All triangles mark special phases in the 11-year sunspot cycle. This cycle is not symmetric, but skewed to the right. Reliable observations available since 1750 show that the mean rise to the sunspot maximum (4.3 years) is considerably steeper than the

decline to the sunspot minimum (6.7 years). The mean ratio of the rising part to the whole 11-year cycle is 0.39.

Nature often repeats proven patterns on different scales. A whole session of the Fall Meeting 2001 of the American Geophysical Union was dedicated to the task to find out how such fractal patterns can be used to make better forecasts. The phases indicated by triangles represent such fractals. The red triangles mark points **a** and **d** which divide the ascending and the descending part of the sunspot cycle such that the ratio 0.39, found in the whole cycle, is again established in the respective parts. Around phases **a** and **d** we find new maxima, but this time accumulations of solar eruptions, not sunspots. A maximum entropy frequency analysis of monthly SOI data shows that the ratio 0.39 within the investigated parts of the sunspot cycle stands out in the frequency pattern with a significance beyond the 1%-level.

Midpoints between phases **a** and **d** (**a/d** and **d/a**), marked by blue triangles, are farthest away from points **a** and **d**. So it is consistent that they indicate the opposite effect, La Niña instead of El Niño in the range after 1970. Before 1970 everything is reversed. Blue triangles, indicating **a/d** and **d/a**, consistently point to El Niños, and red triangles, marking **a** and **d,** to La Niñas. Such phase reversals can be explained by predictable perturbations in the Sun's dynamics, the same dynamics the sunspot cycle is based on. I have presented many examples of such phase reversals in time series of diverse climate phenomena **(Landscheidt, 1983-2001)**. In an Open Review discussion of the results on this web site, lasting nearly 4 months, I have shown that the connection between phases **a** and **d** and ENSO events goes back to 1868, as far as reliable data are available, and that the phase reversals emerging in this interval are consistently linked to computed perturbations in the Sun's dynamics.

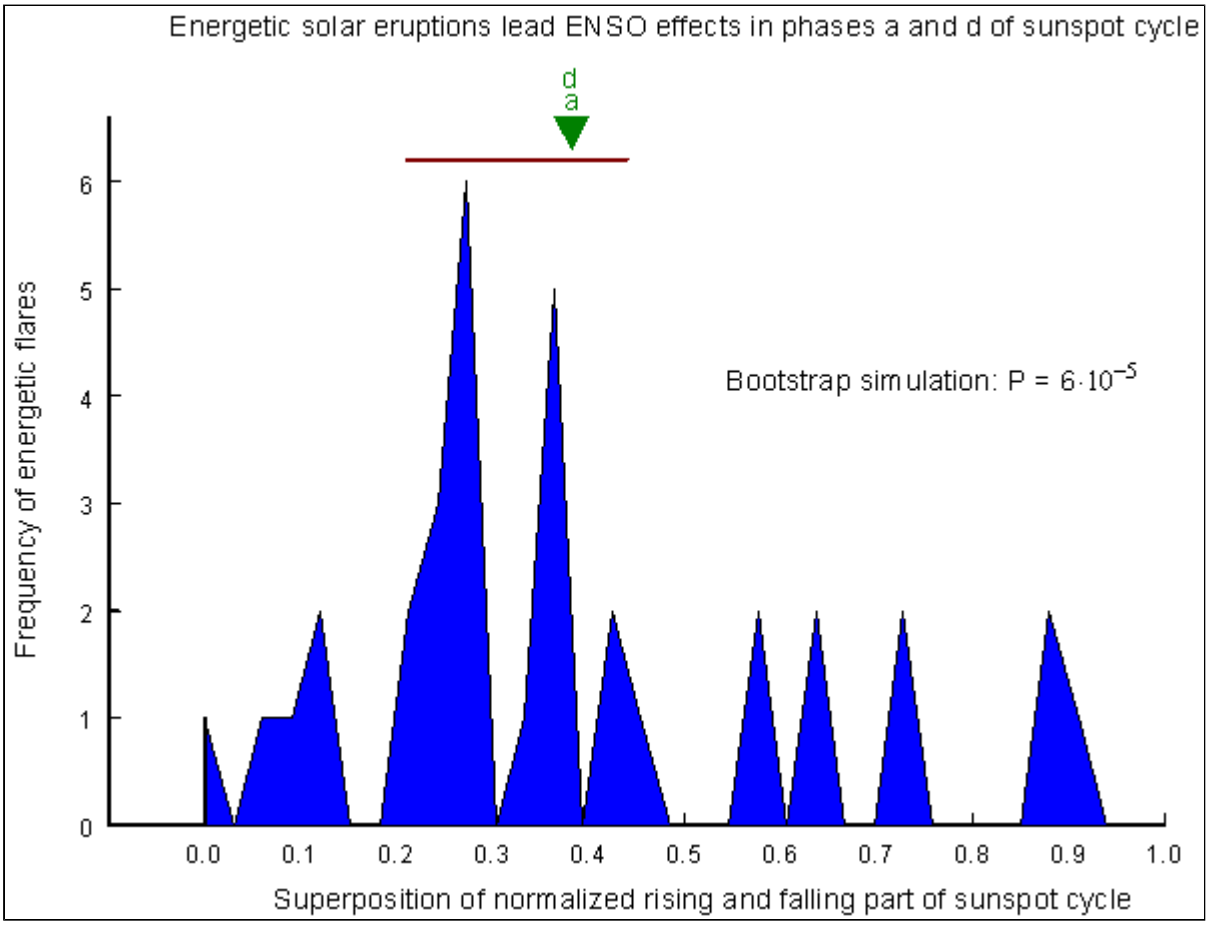

Figure 4

Fig. 4 provides evidence that phases **a** and **d** are actually linked to concentrations of energetic solar eruptions that could explain the climatic effects. It shows the distribution of highly energetic X-ray flares within the respective ascending and descending part of the sunspot cycle. The sample covers all flares X => 6 observed by satellites between 1970 and 1998. These data are available at the National Geophysical Data Center, Boulder. The rising and falling parts of different length were normalized to have equal length 1. Then they were superimposed to make it easy to recognize

identical phases. Intense X-ray flares, nearly always accompanied by heavy coronal mass ejections, are geophysically more effective than flares categorized into classes of optical brightness. As many as 19 of the 34 investigated X-ray flares concentrate on the short interval of 0.23 on the unit scale, marked by a horizontal bar at the top left. Only 15 of the flares fall at the remaining large interval covering a range of 0.77 on the unit scale.

The normalized position of points **a** and **d** is marked by a green triangle. The climate effect, observed at **a** and **d** lags the solar eruptions, the conceivable cause. Statistically, the flare accumulation is highly significant. Even when compared with the distribution of mean counts of grouped optical flares, chi-square tests as well as bootstrap re-sampling and randomization tests show that the probability of a false rejection of the sceptic null hypothesis is smaller than P = 0.0001. Highly energetic cosmic ray flares observed between 1942 and 1970 corroborate this result. All events listed by Sakurai **(1974)** were included in the sample except the weakest events with a cosmic ray increase <= 2%. The distribution shows a strong accumulation in the same range. As to potential physical mechanisms that could explain how the Sun's eruptional activity releases El Niños I refer to special publications **(Landscheidt, 1999a, 2000a)**.

The eruptive phases **a** and **d** in the 11-year sunspot cycle are not only related to ENSO events. As I have shown in my paper "Solar Eruptions Linked to North Atlantic Oscillation", published on this web site, they are also linked to maxima and minima of the NAO index. In discussions with Italian hydrologists evidence could be provided that extreme River Po discharges show such a strong connection with phases **a** and **d** that long range forecasts can be based on it.

7. History and evaluation of ENSO forecast

My original ENSO forecast on 11 January 1999, based on the Sun's eruptional activity, was quite simple:

**"The next negative extremum in the SOI, going along with an El Niño,
should occur around 2002.9 (± 0.6 months)
... La Niña conditions should prevail till 2000.1
(decimal notation equivalent to 6 February 2000) and beyond."**

As to La Niña, this forecast with a lead time of at least 13 months turned out correct. La Niña lasted longer than institutes specialized on ENSO predictions had expected though they made use of daily precursor observations and frequently changed their forecasts.

In the Open Review discussion a critic objected that my forecast was not precise enough, did not define El Niños and La Niñas, and did not cover the interval between 2000 and 2002. Though I thought that the scientific community had already presented sufficiently precise definitions of ENSO events, I included such a definition in an even more precise forecast published on 29 March 1999. I also closed the gap between 2000 and 2002 though none of the specialized public institutes had ever made forecasts with such a long lead time.

The extended formulation ran as follows:

"1999.25 - 2000.4: Prevailing La Niña interrupted by neutral conditions (85% probability). 2000.5 - 2002.3: Neutral conditions, no El Niño (85% probability). 2002.55 - 2003.25: Strong El Niño peaking within this period centered on 2002.9 (95% probability). The forecast is based on the Southern Oscillation Index (SOI) published by the Department of Natural Ressources (DNR), Queensland, Australia. It measures the differences in air pressure between Tahiti and Darwin and ranges from about +30 to -30. Conditions are considered neutral when the 90-day average of the SOI stays within the range ±5. A 90-day average beyond this range indicates La Niñas and El Niños."

This wording generally satisfied the critic. When he objected that regarding the interruption of La Niña by neutral conditions I should give a maximum amount of time spent in the neutral range, I answered publicly **"that the neutral range should not cover more than 4 months."** La Niña

actually prevailed till end of June 2000, as predicted. There were interruptions by neutral conditions, but they lasted exactly 4 months, as specified in the forecast. The prediction that La Niña would fade away in July 2001 and neutral conditions should develop instead, proved exactly correct though the lead time was as long as 15 months.

From 2000.5 till 2002.3 neutral conditions were expected. They developed from July to mid-October 2000. However, from then on till spring 2001 the neutral phase was interrupted by moderate cool conditions that lasted till mid-March 2001. During a period of 5 months the 90-day average of the SOI was below -5. Some scientists consider this isolated deviation from the already established neutral trend not a real La Niña. As the usual cold tongue along the equator did not form, they attributed the cool period to the Pacific Decadal Oscillation (PDO). I will not jump on this bandwagon, as I have defined neutral phases and ENSO events such that it is clear that there was a deviation from the expected neutral trend. I consider my results as working hypotheses that must be checked by objectively evaluated forecast experiments, the most effective test of the dependability of new results.

This does not mean, however, that this part of my forecast failed. I had omitted the interval between 2000 and 2002 in my forecast of 11 January 1999 because the investigation did not point as reliably to special trends as in other periods. So I gave my extended forecast of La Niña and the ensuing neutral phases, published on 29 March 1999, only a probability of 85%, which means that I expected that 85% of it would turn out right and 15% wrong. Institutes like the Space Environment Center, Boulder, do the same to be able to evaluate their skill at forecasting events in a flexible way. So the length of the forecast periods given a probability of 85% that turned out correct and those that proved wrong should be compared. It is certain that the 90-day average of the SOI will still be in the neutral range in March 2002. Since March 1999 a period of 5 months out of 36 months did not agree with the forecast. The corresponding ratio of 14% is below the expected failure rate of 15%.

8. Outlook

The El Niño forecast has been given the small failure rate of 5%. It remains to be seen whether this forecast with a lead time of nearly 4 years will turn out to be on the point. The auspices are favorable. In January 2002 NOAA's Climate Prediction Center officially announced that warming was being observed over the tropical Pacific which could lead to an El Niño by early spring. The announcement was supported by cloudiness and precipitation over the equatorial central Pacific observed for the first time since the 1997-1998 El Niño episode. On 7 March 2002 there followed an NOAA press release which stated that the evolution towards a warm episode continued during February 2002. Ocean surface temperatures warmed by 2°C in the eastern equatorial Pacific near the South American coast. The rainfall increased in that region. Cold-water anchovies have been replaced by tropical species. NOAA considers it likely that the subsurface and surface warming of the water will continue until early 2003.

The Climate Prediction Center cautioned that the SOI and other atmospheric indices did not yet agree with the warming trend indicated by the reported observations. Meanwhile, this has changed. On 12 March 2002, out of a sudden, the SOI plunged to values below -30. Models based on precursor data did not coherently foresee this development. NOAA's Climate Prediction Center stated in its El Niño/Southern Oscillation (ENSO) Diagnostic Discussion issued on 7 March 2002: "The latest statistical and coupled model predictions show a spread from slightly cooler-than-normal conditions to moderate warm -episode conditions during the remainder of 2002 ... Other techniques indicate that conditions will remain near normal or even return to slightly colder than normal for the remainder of 2002." The Climate Prediction Center's comment on these perplexing discrepancies "All such models have relatively low skill during the transition phases of ENSO" shows clearly that physical models, even if coupling atmosphere and oceans, are not yet able to make dependable long-range forecasts of ENSO events, though they are based on daily observations of precursors and continuously adapt their predictions to the most recent data.

If my El Niño forecast proved correct, this would be the third successful El Niño forecast in a row. The second one had a lead time of 2 years. There are other successful long-range climate forecasts exclusively based on solar activity: End of the Sahelian drought 3 years before the event; the last three extrema in global temperature anomalies; maximum in the Palmer Drought Index around 1999;

extreme River Po discharges around 2001.1 etc. **(Landscheidt 1983-2001)**. This is irreconcilable with IPCC's allegation that it is unlikely that natural forcing can explain the warming in the latter half of the 20th century. In declarations for the public, IPCC representatives stress that taxpayer's money will be used to develop better forecasts of climate change. What about making use of those that already exist, even if this means to acknowledge that anthropogenic climate forcing is not as potent as alleged.

References:

Balachandran, N. K., Rind, D., and Shindell, D. T., 1999: Effects of solar cycle variability on the lower stratosphere. J. Geophys. Res. 104, 27321-27339.

Climate Prediction Center, NOAA, Data and indices, 1998: http://nic.fb4.noaa.gov.

Egorova, L. Y., Vovk, V. Ya., and Troshichev, O. A., 2000: Influence of variations of cosmic rays on atmospheric pressure and temperature in the Southern pole region. J. Atmos. Solar-Terr. Phys. 62, 955-966.

Haigh, J. D.,1996: On the impact of solar variability on climate. Nature 272, 981-984.

Hodell, D. A., Brenner, M., Curtis, J. H., and Guilderson, T., 2001: Solar forcing of drought frequency in the Maya lowlands. Science 292, 1367-1370.

Landscheidt, T. (1983): Solar oscillations, sunspot cycles, and climatic change. In: McCormac, B. M., ed.: Weather and climate responses to solar variations. Boulder, Associated University Press, 293-308.

Landscheidt, T. (1986 a): Long-range forecast of energetic x-ray bursts based on cycles of flares. In: Simon, P. A., Heckman, G. und Shea, M. A., eds.: Solar-terrestrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 81-89.

Landscheidt, T. (1986 b): Long-range forecast of sunspot cycles. In: Simon, P. A., Heckman, G. und Shea, M. A., eds.: Solar-terrestrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 48-57.

Landscheidt, T. (1987): Long-range forecasts of solar cycles and climate change. In: Rampino, M. R., Sanders, J. E., Newman, W. S. und K”nigsson, L. K., eds.: Climate. History, Periodicity, and predictability. New York, van Nostrand Reinhold, 421-445.

Landscheidt, T. (1988): Solar rotation, impulses of the torque in the Sun's motion, and climatic variation. Climatic Change 12, 265-295.

Landscheidt, T.(1990): Relationship between rainfall in the northern hemisphere and impulses of the torque in the Sun's motion. In: K. H. Schatten and A. Arking, eds.: Climate impact of solar variability. Greenbelt, NASA, 259-266.

Landscheidt, T.(1995): Global warming or Little Ice Age? In: Finkl, C. W., ed.: Holocene cycles. A Jubilee volume in celebration of the 80th birthday of Rhodes W. Fairbridge. Fort Lauderdale, The Coastal Education and Research Foundation (CERF), 371-382.

Landscheidt, T. (1998 a): Forecast of global temperature, El Niño, and cloud coverage by astronomical means. In:Bate, R., ed.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), 172-183.

Landscheidt, T. (1998 b): Solar activity : A dominant factor in climate dynamics. http://www.john-daly.com/solar/solar.htm.

Landscheidt, T. (1999 a): Solar activity controls El Niño and La Niña. http://www.john-daly.com/sun-enso/sun-enso.htm.

Landscheidt, T. (1999 b): Extrema in sunspot cycle linked to Sun's motion. Solar Physics 189, 413-424.

Landscheidt, T. (2000 a): Solar forcing of El Niño and La Niña. ESA Special Publication 463, 135-140.

Landscheidt, T. (2000 b): River Po discharges and cycles of solar activity. Hydrol. Sci. J. 45, 491-493.

Landscheidt, T. (2000 c): Sun's role in the satellite-balloon-surface issue. http://www.john-daly.com/solar/temps.htm

Landscheidt, T. (2000 d): New confirmation of strong solar forcing of climate. http://www.john-daly.com/po.htm

Landscheidt, T. (2001 a): Solar eruptions linked to North Atlantic Oscillation. http://www.john-daly.com/theodor/solarnao.htm.

Landscheidt, T. (2001 b): Trends in Pacific Decadal Oscillation subjected to solar forcing. http://www.john-daly/theodor/pdotrend.htm.

Lockwood, R., Stamper, R., and Wild, M. N., 1999: A doubling of the Sun's coronal magnetic field during the past 100 years. Nature 399, 437-439.

Neelin, J. D. and Latif, M., 1998: El Niño dynamics. Physics Today, December 1998, 32-36.

Neff, U., Burns, S. J., Mangini, A., Mudelsee, M., Fleitmann, D., and Matter, A., 2001: Strong coherence between solar variability and the monsoon in Oman between 9 and 6 kyr ago. Nature 411, 290-293.

Pallé Bagó, E. and Butler, C. J. (2000): The influence of cosmic rays on terrestrial clouds and global warming. Astron. Geophys. 41, 4.18-4.22.

Pudvokin, M. and Veretenenko, S., 1995: Cloudiness decreases associated with Forbush-decreases of galactic cosmic rays. J. Atmos. Terr. Phys. 57, 1349-1355.

Sakurai, K. (1974): Physics of solar cosmic rays. Tokyo, University of Tokyo Press, 149.

Shindell, D., Rind, D., Balachandran, N., Lean, J., and Lonergan, P., 1999. Solar cycle variability, ozone, and climate. Science 284, 305-309.

Svensmark, H. and Friis-Christensen, E., 1997: Variation of cosmic ray flux and cloud coverage. J. Atmos. Terr. Phys. 59,1225-1232.

End Note: As proprietor of this website, I can affirm that Dr Theodor Landscheidt's original paper in which he predicted the next El Niño to peak late this year, was indeed published back in January 1999 on this website exactly as he claims above, and has not been altered in any way since then.

Furthermore, participants listed in the Open Review which followed publication of his paper can also attest to the publication date of his original paper. The Open Review itself contains extensive discussion about the predicted dates for the next ENSO events.

Since the El Nino prediction was made over 3 years ahead of the event (the best achievable by models being less than 1 year), it remains only to observe the course of the El Niño that is now unfolding to see if it lives up to his prediction made over 3 years ago. Since Dr Landscheidt wrote the above, the plunge in the SOI toward El Niño has continued apace. Since it is now starting as expected, the probability of his prediction succeeding is now very high.

- John L. Daly 18th March 2002

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APPENDIX VI (*6*)
Submission on Adapting to Climate Change,
Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

Sun's Role

in the

Satellite-Balloon-Surface Issue

by

Dr Theodor Landscheidt

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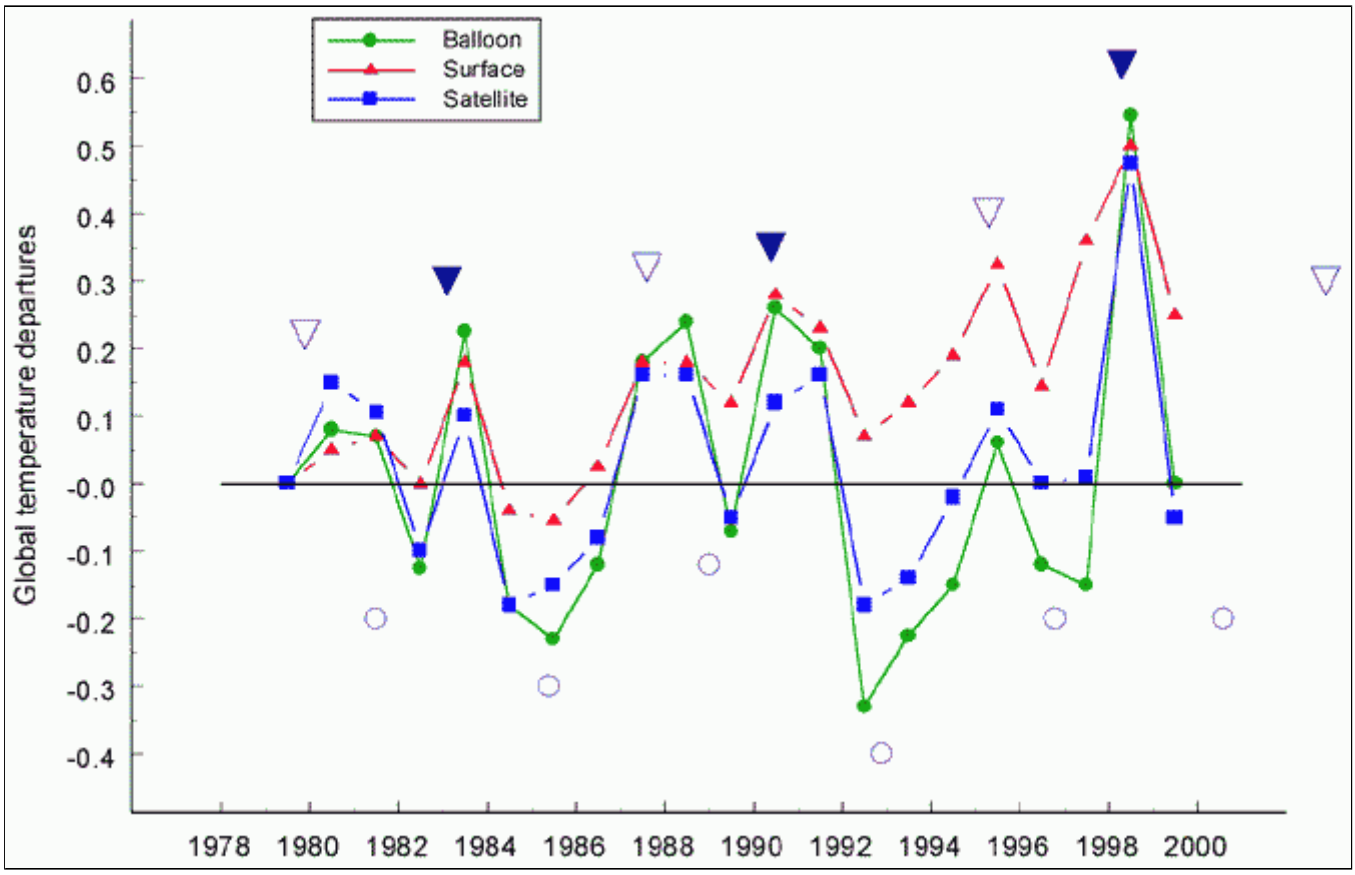
Nova Scotia, Canada

- There has been an unending discussion about why temperatures measured by satellites and balloon sondes, progressing almost in lockstep on a trend line close to the horizontal, diverge from surface temperatures that show, at least in the last decade, a steep warming trend. The figure below shows the course of the anomalies in the three data sets which are referenced to a common zero point in 1979 - the beginning of the satellite measurements - to show the subsequent comparative trends. This presentation follows the design of the "World Climate Report" chart. New is the relationship with the Sun's eruptional activity which forms a pattern fully conforming with the balloon and satellite data, but only to a certain degree with the surface temperatures.



- The filled triangles in the figure mark the initial phases of a solar motion cycle with a mean length of 8.6 years described in my paper **"Solar Activity: A Dominant Factor in Climate Dynamics"**. The empty triangles indicate golden section phases in between the initial phases that have been shown to play an important role in many solar-terrestrial cycles. Solar eruptions concentrate on both of these phases which correlate well with all peaks in the figure. Balloon data going back to 1958 confirm this relationship, as is shown in Figure 24 of the quoted paper. In spite of my explicit challenges, no IPCC scientist ever tried to show that these results are spurious.

- Empty circles mark midpoints between the respective phases which are correlated with troughs

in the data. The connection has been corroborated by correct long-range forecasts of the temperature trough in winter 1996/1997 and the crest in 1998. The next minimum in the temperature anomalies is to be expected after 2000.6 and the next maximum after 2002.9 as indicated in the figure. This forecast could be extended as the phases of the solar motion cycle can be computed. The temperature data consistently lag the solar phases by a few months, thus pointing to a causal relationship.

- Intriguingly, the three initial phases (filled triangles) indicate periods of close encounters of the three data curves. This was even so in 1998 after a strong divergence in the preceding years. The next encounter should occur a few months after 2005.8. The surface temperature diverges strongest from the two other curves around the midpoints between active phases of the solar motion cycle. Balloon and satellite data give in to the solar forcing quite naturally, whereas the surface data seem to be kept away from fully adjusting to the natural downward trend. Currently, such a development is in the making and is expected to show its full extension after 2000.6. The next such event should occur around 2004.4. The overall impression is that the satellite and balloon data behave naturally, whereas the surface data do not respond to the solar forcing in the same way. Lots of explanations have been given on this web site why this should be so.

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APPENDIX VI (7)
Submission on Adapting to Climate Change,
Enhancing Victoria Capacity
By Harry Horvath 7 Sept 2004

Variations in CO_2 Growth Rate Associated with Solar Activity

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1. Introduction

CO_2 concentrations in the atmosphere have increased from about 280 ppmv in pre-industrial times to 372.9 ppmv in 2002. This rise runs approximately parallel with the increase in CO_2 emissions from fossil fuel combustion. The 10-year mean of CO_2 concentrations increased steadily during the last century. Since 1990 there have been some indications that the increment is levelling off. The average annual increment over the last 10 years was 1.66 ppmv/yr. The curve of the global average CO_2 concentrations shows only small deviations from the trend line. The annual growth rates, however, vary significantly. In some cases they go beyond 3 ppmv/yr.

According to the World Data Centre for Greenhouse Gases **(2003)** "The high growth rates in 1983, 1987/88, 1994/1995, and 1997/1998 are associated with warm events of El Niño-Southern Oscillation (ENSO). The anomalously strong El Niño event in 1997/1998 brought about worldwide high increases in 1998. The exceptionally low growth rates in 1992, including negative values for northern high and mid-latitudes, were caused by low global temperatures following the eruption of Mt. Pinatubo in 1991." As this connection could be of great import **(Kuo et al., 1990; Metzner, 1996)**, it is subjected to a detailed analysis.

2. Connection between extrema in CO2 growth rates and crucial phases in the Sun's torque cycle

I have shown that ENSO events are closely connected with eruptive phases of the 11-year sunspot cycle. This relationship was corroborated by correct long-range forecasts of the last three El Niños and the course of the last La Niña. In addition, I have provided evidence that negative and positive extrema in global temperature anomalies like those in 1992 and 1998 show such a close relationship with solar motion cycles and solar activity that they can be predicted years before the respective event **(Landscheidt, 1983-2003)**. In view of the synchronism described by the World Data Centre for Greenhouse Gases it seems justified to investigate whether there is, too, a link between variations in CO_2 growth rates and the solar cycles used in the forecast of global temperature.

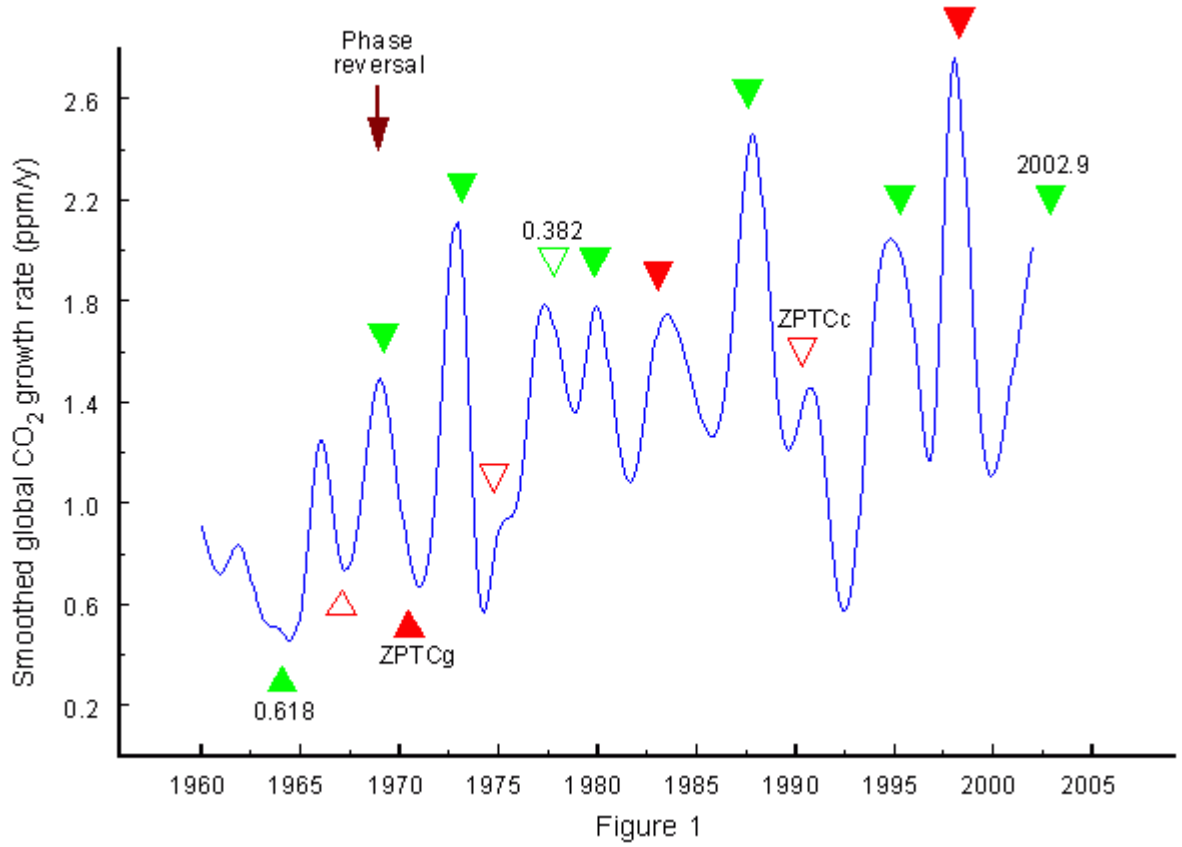

Figure 1

Fig. 1 shows the result. The blue curve displays the yearly growth rate of atmospheric CO_2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa Observatory **(Keeling and Whorf, 2003)**. The data were subjected to 2-year smoothing based on locally weighted least squares **(Lowess)**. The red triangles in the plot indicate zero phases in the absolute rate of change |d*L*/d*t*| (torque) in the Sun's orbital angular momentum related to its irregular oscillation about the centre of mass of the solar system (CM). The mean interval between these zero phases in a torque cycle (ZPTC), emerging in the |d*L*/d*t*| time series, is 8 years, but there is considerable variation.

The Sun's orbital motion is governed by difference forces in the same way as the planets' course around the Sun. Gravitation and centrifugal force are balanced overall, but in single phases of the orbit one of the two forces may prevail. In Figure 1 the filled red triangles mark zero phases ZPTCg that initiate a period of prevailing gravitation and an orbital motion towards the CM, whereas zero phases ZPTCc, indicated by open red triangles, mark the start of dominating centrifugal force and a motion away from the CM. These changes in the physical quality of the solar motion have a strong effect on the distribution of solar eruptions in different regions of the Sun **(Landscheidt, 1986 a)**.

The parameter P = 0.618 between consecutive ZPTCs, marked by green triangles, is a regulator of stability in dynamical systems. As to details I refer to Chapter 3 of my on-line paper "Long-Range Forecast of U.S. Drought Based on Solar Activity" **(Landscheidt, 2003 a)**. The arrow at the upper left of Figure 1 indicates a phase reversal in the connection between growth rate extrema and zero phases as well as the parameters 0.618 in the torque cycle. In nearly all of my papers I could show that such phase reversals are a regular feature in climate time series related to solar motion cycles. This is not an ad hoc invention, but a computable phase of instability which occurs when the zero phase of a longer solar motion cycle coincides with a zero phase of a shorter solar motion cycle **(Landscheidt, 1983-2003)**.

After the phase reversal in 1968, the zero phases ZPTC (red triangles) and the parameters P at 0.618 of the distance between consecutive zero phases (green triangles) consistently coincide with maxima in the CO_2 growth rate. Obviously zero phases ZPTCc (open red triangles) have a considerably weaker effect than zero phases ZPTCg and phases 0.618. In the case of an especially long torque cycle, the parameter 0.382, formed by the symmetry operation 1- 0.618, had a similar effect. This case is marked by an open green triangle. Around the phase of instability in 1968 a reversal in the relationship was in progress.

3. Principal component analysis of solar activity and CO2 growth rates

As the intervals between consecutive zero phases show strong variations between 3 and 8 years replicated by the intervals between consecutive growth rate extrema, the good fit cannot easily be dismissed as fortuitous. Monte Carlo experiments show that we are dealing with a rare species. The probability P of a false rejection of the sceptic null hypothesis is much smaller than 0.001. It is not easy to determine what this result means. It could be that ENSO events (El Niño and La Niña) and extrema in global temperature anomalies that have been shown to be predictable because of their connection with solar activity have a secondary effect on CO_2 growth rates.

It cannot be excluded, though, that there is also a direct effect of solar activity. So the relationship between CO_2 growth rates and solar activity has been subjected to a Principal Component Analysis (PCA) that leads to a significant reduction of the amount of data while retaining most of the variance. It has the advantage of identifying smaller subspaces that contain most of the dynamics of the observed system or relationship **(von Storch and Zwiers, 1999; Venables and Ripley, 2002)**. It is then easier to judge the impact of the involved variables on the investigated relationship.

The phases ZPTC (red triangles) and P of the torque cycle indicate that extrema of global temperature anomalies go along with enhanced eruptional activity on the Sun. These eruptions and their effect on Earth is best represented by Mayaud's geomagnetic aa index **(Mayaud, 1973)**. This is the first variable subjected to PCA. The second variable is the international smoothed yearly sunspot number R, as special phases of the 11-year sunspot cycle are linked to ENSO events. The third variable of interest is the yearly CO_2 growth rate. As the principal components depend on the scaling of the original variables and aa, R, and CO_2 are on very different scales, the variables were normalized to unit.

According to the PCA analysis, the first component explains 49 percent of the total variance, the second component 33 percent, and the third component 18 percent. The loadings in the first component as well as in the third component are exclusively ascribed to aa and R, whereas CO_2 growth rates solely get loadings in the second component. Overall, the loadings of variables representing solar activity outweigh the CO_2 growth rates by far. This is a first indication that in addition to an indirect solar effect via temperature there is a direct solar effect related to solar eruptions accumulating around crucial phases of the torque cycle in the Sun's irregular orbital motion and in special phases of the 11-year sunspot cycle.

Naturally, this first result does not yet provide striking evidence, but it opens new perspectives that should be explored by further investigations that yield more details. Hopefully, such additional results will make it less difficult to find a physical explanation of the potential relationship. As to models that generally explain the Sun's impact on climate change in different fields there is progress. I refer to the AGU Monograph "Solar Variability and its Effects on the Earth's Atmosphere and Climate System," edited by J. Pap et al., which is about to appear, and especially the chapter "Atmospheric Ionization and Clouds as Links Between Solar Activity and Climate" by Brian A. Tinsley and Fangqun Yu.

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References:

Keeling, C. D., Whorf, T. P., and the Carbon Dioxide Research Group (2003): Atmospheric CO2 concentrations (ppmv) derived from in situ air samples collected at Mauna Loa, Hawaii.
< **http://cdiac.esd.ornl.gov/ftp/ndp001/maunaloa.CO2** >**

Kuo, C., Lindberg, C., and Thompson, D. J. (1990): Coherence established between atmospheric carbon dioxide and global temperature. Nature 343, 709.

Landscheidt, T. (1983): Solar oscillations, sunspot cycles, and climatic change. In: McCormac, B. M., ed.: Weather and climate responses to solar variations. Boulder, Associated University Press, 293-308.

Landscheidt, T. (1984): Cycles of solar flares and weather. In: Moerner, N.A. und Karlén, W., eds..: Climatic changes on a yearly to millennial basis. Dordrecht, D. Reidel, 475, 476.

Landscheidt, T. (1986): Long-range forecast of energetic x-ray bursts based on cycles of flares. In: Simon, P. A., Heckman, G., and Shea, M. A., eds.: Solar-terrestrial predictions. Proceedings of a workshop at Meudon, 18.-22. Juni 1984. Boulder, National Oceanic and Atmospheric Administration, 81-89.

Landscheidt, T. (1987): Long-range forecasts of solar cycles and climate change. In: Rampino, M. R., Sanders, J. E., Newman, W. S. and Königsson, L. K., eds.: Climate. History, Periodicity, and predictability. New York, van Nostrand Reinhold, 421-445.

Landscheidt, T. (1988): Solar rotation, impulses of the torque in the Sun's motion, and climatic variation. Clim. Change 12, 265-295.

Landscheidt, T.(1990): Relationship between rainfall in the northern hemisphere and impulses of the torque in the Sun's motion. In: K. H. Schatten and A. Arking, eds.: Climate impact of solar variability. Greenbelt, NASA, 259-266.

Landscheidt, T. (1995b): Die kosmische Funktion des Goldenen Schnitts. In: Richter, P. H., ed.: Sterne, Mond und Kometen. Bremen, Hauschild, 240-276.

Landscheidt, T. (1998 a): Forecast of global temperature, El Niño, and cloud coverage by astronomical means. In: Bate, R., ed.: Global Warming. The continuing debate. Cambridge, The European Science and Environment Forum (ESEF), 172-183.

Landscheidt, T. (1998 b): Solar activity - A dominant factor in climate dynamics.
< http://www.john-daly.com/solar/solar.htm >

Landscheidt, T. (2000 a): Solar forcing of El Niño and La Niña. In: Vázquez , M. and Schmieder, B, ed.: The solar cycle and terrestrial climate. European Space Agency, Special Publication 463, 135-140.

Landscheidt, T. (2000 b): Solar wind near Earth: Indicator of variations in global temperature. In: Vázquez, M. and Schmieder, B, ed.: The solar cycle and terrestrial climate. European Space Agency, Special Publication 463, 497-500.

Landscheidt, T. (2000 c): River Po discharges and cycles of solar activity. Hydrol. Sci. J. 45, 491-493.

Landscheidt, T. (2000 e): New confirmation of strong solar forcing of climate.
< http://www.john-daly.com/po.htm >

Landscheidt, T. (2001 a): Solar eruptions linked to North Atlantic Oscillation.
< http://www.john-daly.com/theodor/solarnao.htm >

Landscheidt, T. (2001 b): Trends in Pacific Decadal Oscillation subjected to solar forcing.
< http://www.john-daly.com/theodor/pdotrend.htm >

Landscheidt, T. (2002): El Niño forecast revisited. < http://www.john-daly.com/sun-enso/revisited.htm >

Landscheidt,T. (2003 a): Long-range forecast of U.S. drought based on solar activity.
< http://www.john-daly.com/solar/US-drought.htm >

Landscheidt, T. (2003 b): New Little Ice Age instead of global warming. Energy and Environment 14, 4. 327-350.

Mayaud, P. N. (1973): A hundred year series of geomagnetic data. IUGG Publication Office, Paris.

Metzner, H. (1996): Gibt es einen CO2 – induzierten Treibhauseffekt? In: Metzner, H., ed.: Treibhauskontroverse und Ozonproblem. Europäische Akademie für Umweltfragen, Leipzig.

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