

# Global Warming – Man-made or Natural?

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## Introduction

One of the most interesting global questions today is whether the climate is changing and, if it really is, whether the reasons are man-made (anthropogenic) or natural - or maybe even both. The United Nations appointed Intergovernmental Panel on Climate Change (IPCC) has on several occasions warned that the climate is rapidly warming and that the reason for this is mostly the increased amount of carbon dioxide (CO<sub>2</sub>) in the atmosphere. This is an example of an “anthropogenic” effect. Former US Vice President Al Gore is known for advocating his “inconvenient truth” about the changing climate and forthcoming catastrophes and that the “science is settled”. But the question still remains: is this so called greenhouse effect by the CO<sub>2</sub> gas really of importance? How big is the effect on global warming? What other factors (or “forcings”) are involved? Can we trust the IPCC and Al Gore? IPCC talks about a “science consensus” that the CO<sub>2</sub> is to blame. But is this really true? Some say “No”. There is an increasing group of “climate sceptics” comprising various professionals, non-professionals, scientists, economists, etc., who ask questions and do not accept that scientific issues can be solved by a consensus vote. Is this group just an odd collection of people, outside the scientific mainstream? Not at all. A 2003 survey of 530 climate scientists in 27 countries, conducted by Dennis Bray and Hans von Storch at the GKSS Institute of Coastal Research in Germany, found that

- 82 percent said global warming is happening, but only
- 56 percent said it's mostly the result of human causes, and only
- 35 percent said models can accurately predict future climate conditions.

Thus the so called consensus on man-made global warming is not really there, not even among the IPCC scientist.

John Christy, Professor of Atmospheric Science, University of Alabama, leading researcher into temperature change and one IPCC's senior scientists has [this view](#) on one if IPCC's main statements:

“The signature statement of the 2007 IPCC report may be paraphrased as this: »We are 90% confident that most of the warming in the past 50 years is due to humans.« We are not told here that this assertion is based on computer model output, not direct observation. The simple fact is we don't have thermometers marked with 'this much is human-caused' and 'this much is natural'. So, I would have written this conclusion as »Our climate models are incapable of reproducing the last 50 years of surface temperatures without a push from how we think greenhouse gases influence the climate. Other processes may also account for much of this change.«”

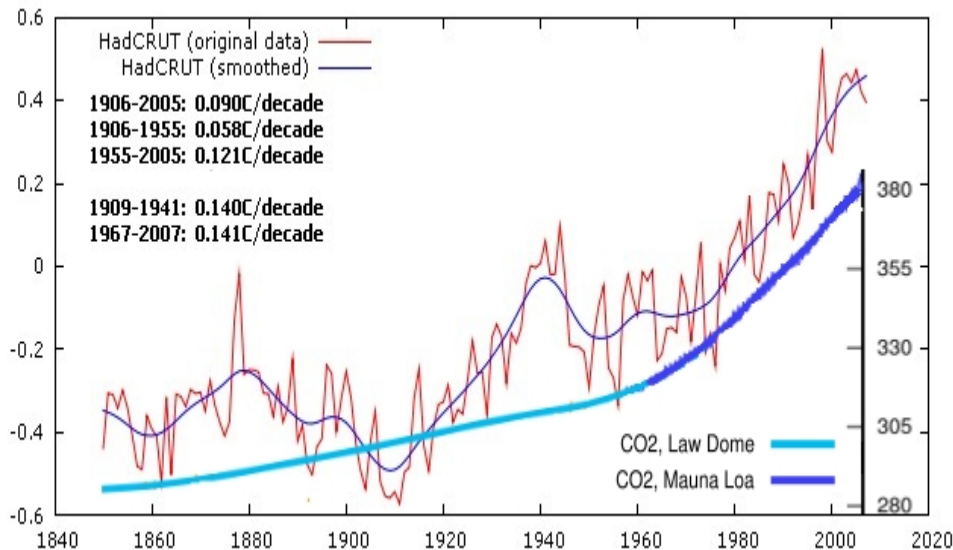
Let me state immediately before you read on that I count myself among the “sceptics”. I am not a climate scientist or specialist in meteorology or any related field. I am only a humble scientist with a PhD degree in physical chemistry and an interest in the history of the globe we inhabit. I have no connection with any oil or energy-related business. I have nothing to gain from being a sceptic, but I cannot avoid asking the question: how well founded is IPCC's statement that the CO<sub>2</sub> level is to blame and has to be dramatically decreased at any cost? The great Scottish philosopher Sir Karl Popper has said there are two kinds of theories: 1) theories that have been proved to be wrong, and 2) theories that have not YET been proved to be wrong. So, he really thinks there isn't a third case: theories proved to be right. Maybe he is a little bit too pessimistic, but I tend to believe there is something in his thinking. (He cannot be proved to be right, though). What he actually tries to say is that a human being can never know everything about the Universe, because only the Universe can know everything about itself. We can only take slices of time and space and make more or less intelligent guesses. Another great philosopher, the French scientist and mathematician Blaise Pascal, took another approach to the problem in the 17th century. He said, more or less: Simply believe in any theory that, if it is right, will do you good, and if it is wrong, will cause you no harm. Then you have nothing to lose. Well... How can a scientist believe without knowledge?

I have always been intrigued by the strange behavior of the climate on the Earth over time periods of 1000 years, 10,000 years, and 100,000 years and longer. Looking at what is known about the evolution of the climate on extended time scales leads to the question: is there not actually a very big possibility that the climate change we have seen during the last 150 years is due – at least partly – to natural reasons? If so, are we now in danger of imposing on ourselves a real threat in terms of poor political decisions to reduce the amount of CO<sub>2</sub> in the atmosphere at whatever cost? Is there actually ANYTHING we can do to stop the climate change – and is this risky endeavor really something we WANT to attempt?

IPCC states in their AR4 WG1 response to Frequently Asked Question 9.2 the

following: "It is very unlikely that the 20th-century warming can be explained by natural causes. The late 20th century has been unusually warm. Chapter 3 of the WG1 report begins: *Global mean surface temperatures have risen by 0.74°C ± 0.18°C when estimated by a linear trend over the last 100 years (1906-2005). The rate of warming over the last 50 years is almost double that over the last 100 years (0.13°C ± 0.03°C vs. 0.07°C ± 0.02°C per decade).*" But, is this really so? The graph in Figure 1 tells another story by showing the global temperature anomaly (difference from the reference year) for the last 155 years plus the evolution of the atmospheric carbon dioxide.

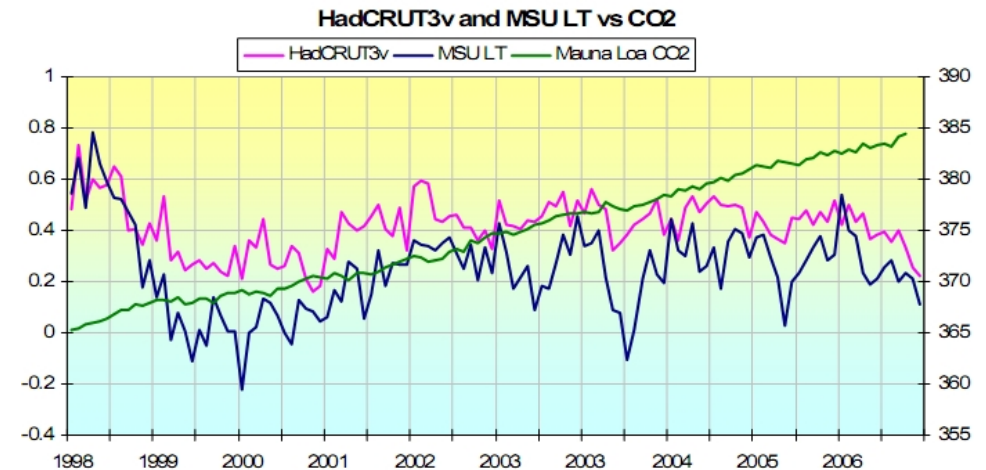
**Figure 1. Temperature and CO<sub>2</sub> during the last 150 years**



The temperature graph is taken from the following report on the Internet: [Evidence of a Significant Solar Imprint in Annual Globally Averaged Temperature Trends](#) by Basil Copeland and Anthony Watts. I have added the CO<sub>2</sub> data to their original graph, just as a reference. To check the statements by the IPCC cited above, the authors undertake a straightforward and simple statistical analysis of temperature data for the 20th century taken from two very reliable sources. One of the conclusions is the following: "In terms of the underlying rates of change, the warming of the late 20th century appears to be no more 'unusual' than the warming during the 1920's and 1930's." In other words, there was a noticeable increase in temperature during the years 1909 and 1941, which was in the same range as the

increase seen during the last 40 years. Why? The increase in CO<sub>2</sub> was very moderate between 1909 and 1941.

Let us look at the last ten years now. There has not been much of a change since the record-hot year of 1998 (which was a record year because of El Niño). Figure 2 shows temperature data from two different sources and CO<sub>2</sub> data from January 1998 and January 2008 from (graph originally produced by [Joseph D'Aleo](#))



**Figure 2. Global temperatures and CO<sub>2</sub> level between 1998 and 2008**

This graph indicates that the global temperature has not increased at all in the last ten years although the CO<sub>2</sub> level has continued to rise. But ten years is naturally a very short time to draw any conclusions about the global climate. Some people think 50 years is much more significant, others say you need 100 years. How about 500 or 1000 years? We will have a look at the history of the climate in the next chapter.

Let us now briefly investigate the scientific basis behind IPCC's carbon dioxide "greenhouse gas" effect. Anyone interested in the physics involved can study the following scientific report: [Falsification of the Atmospheric CO<sub>2</sub> Greenhouse Effects Within The Frame Of Physics](#) published in 2007. The abstract reads "The atmospheric greenhouse effect, an idea that authors trace back to the traditional works of Fourier 1824, Tyndall 1861, and Arrhenius 1896, and which is still supported in global climatology, essentially describes a fictitious mechanism, in

*which a planetary atmosphere acts as a heat pump driven by an environment that is radiatively interacting with but radiatively equilibrated to the atmospheric system. According to the second law of thermodynamics such a planetary machine can never exist. Nevertheless, in almost all texts of global climatology and in a widespread secondary literature it is taken for granted that such mechanism is real and stands on a firm scientific foundation.”*

The greenhouse gas effect behind IPCC's theories is in fact not just one single effect but a combination of various effects. **The enhanced greenhouse effect** is defined by IPCC (Climate Change 2001: Working Group I: The Scientific Basis) in these terms; *“The increased concentration of greenhouse gases in the atmosphere enhances the absorption and emission of infrared radiation. The atmosphere’s opacity increases so that the altitude from which the Earth’s radiation is effectively emitted into space becomes higher. Because the temperature is lower at higher altitudes, less energy is emitted, causing a positive radiative forcing. This effect is called the enhanced greenhouse effect, which is discussed in detail in Chapter 6.”* The discussion in Chapter 6 is not very convincing, without references to empirical data and scientific reports.

**Water vapour feedback** is a very important forcing factor according to IPCC: *“The so-called water vapour feedback, caused by an increase in atmospheric water vapour due to a temperature increase, is the most important feedback responsible for the amplification of the temperature increase. Concern has been expressed about the strength of this feedback, in particular in relation to the role of upper tropospheric humidity.”* This is definitely the most controversial issue in IPCC's thinking; there is no scientific, empirical proof of a positive feedback. Actually, a negative feedback is equally probable, due to the increasing cloud formation with higher humidity. IPCC says, *“Clouds are intimately connected to the water vapour pattern, as clouds occur in connection with high relative humidity, and cloud processes in turn affect the moisture distribution. Clouds affect OLR in the same way as a greenhouse gas, but their net effect on the radiation budget is complicated by the fact that clouds also reflect incoming solar radiation. As clouds form the condensation releases latent heat, which is a central influence in many atmospheric circulations.”* (OLR is short for outgoing longwave radiation.) So, are clouds cooling or heating the lower atmosphere? In the “An Introduction to Simple Climate Models used in the IPCC Second Assessment Report”, 1997, IPCC says: *“Clouds: changes in clouds are difficult to calculate reliably, as noted in Section 2.2.1. Clouds have a strong radiative effect, and are, therefore, likely to produce a noticeable feedback. This feedback depends on changes in the amount, altitude and characteristics of the clouds, as well as on the reflectivity of the underlying surface, so even the sign of the feedback is uncertain;”*

I miss references to sound scientific, empirical data in IPCC's reports, but [Roy Spencer](#) may have the answers. He says: *“Al Gore likes to say that mankind puts 70 million tons of carbon dioxide into the atmosphere every day. What he probably doesn't know is that mother nature puts 24,000 times that amount of our main greenhouse gas -- water vapour -- into the atmosphere every day, and removes about the same amount every day. While this does not 'prove' that global warming is not man-made, it shows that weather systems have by far the greatest control over the Earth's greenhouse effect, which is dominated by water vapour and clouds.”*

It can also be reliably inferred from palaeoclimatological data that no uncontrolled, runaway greenhouse effect has occurred in the last half billion years when atmospheric CO<sub>2</sub> concentration peaked at almost 20 times today's value. Given the stability of the climate over this time period there is little danger that current CO<sub>2</sub> levels will cause a runaway greenhouse effect. It is likely, therefore, that the IPCC's current estimates of the magnitude of climate feedbacks have been substantially overestimated, see for instance [the theoretical study](#) by Ferenc M. Miskolczi. Research by [Stephen Schwartz](#) also challenges claims of a runaway greenhouse effect.

It is worthwhile to keep in mind that clouds play a major part in establishing the heat and radiation budgets of the atmosphere. They transport latent heat from the oceans to the atmosphere, they reflect solar radiation back to space, reducing the net incoming radiative flux, and they trap infrared radiation, acting in a similar way as greenhouse gases. Any factor influencing cloud cover thus has the potential to seriously affect climate.

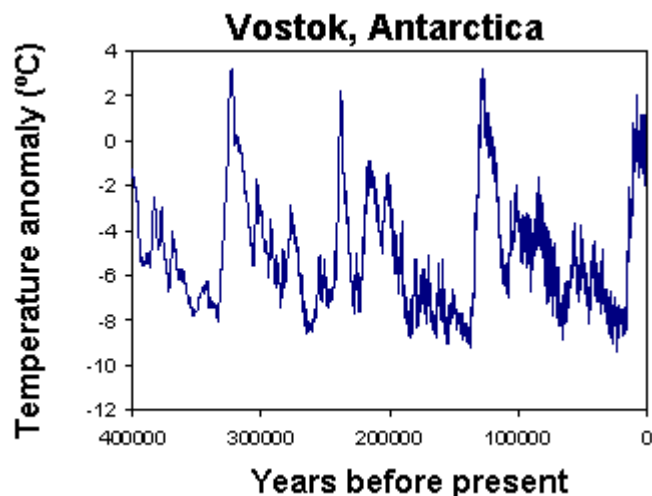
## ***The past history of the climate***

To learn more about the history of the climate on Earth the reader can go to his favorite search engine on the Internet and search for “Paleoclimatology”. At the time of writing one search engine found 366,000 sites. One of the first on the list might be the following one: NOAA Satellite and Information Service - [National Climate Data Center](#). The site explains well what Paleoclimatology is. I cite: *“Paleoclimatology is the study of past climate, for times prior to instrumental weather measurements. Paleoclimatologists use clues from natural "proxy" sources such as tree rings, ice cores, corals, and ocean and lake sediments to understand natural climate variability.”* And more: *“Paleoclimate evidence [from proxies] reveals that large changes in climate such as in temperature and precipitation have happened in the past. The changes have occurred over decades to centuries, sometimes affecting small regions and sometimes entire hemispheres. The changes are massive compared to anything we have experienced since people*

have been keeping records of climate. What if these abrupt climate changes were to occur in the future?

Below in Figure 3 is a graph showing temperature changes on a very large timescale, deduced from a 1-mile bore-hole in the ice in Vostok. Figure 3 shows a number of cold ice age periods with short, warm periods in-between.

**Figure 3. Temperature anomaly during the last 400,000 years**



**Figure 4. Temperature during the last 20,000 years**

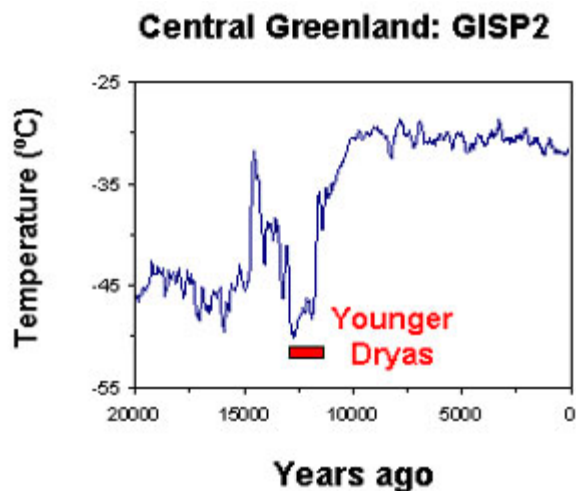


Figure 4 shows data from another bore-hole. The abrupt warming in Greenland that occurred at the end of the Younger Dryas as shown in Figure 4 is one of the most well known examples of an abrupt climate change. Figure 4 also indicates that overall the temperature was higher some 5,000-7,000 years ago. We now live in a warm period that has extended over 10,000 years (Figure 5), and which can be expected to end soon. Thus, a new ice age is coming! But not for the next few years though....

**Figure 5. Global temperatures during the last 11,000 years**

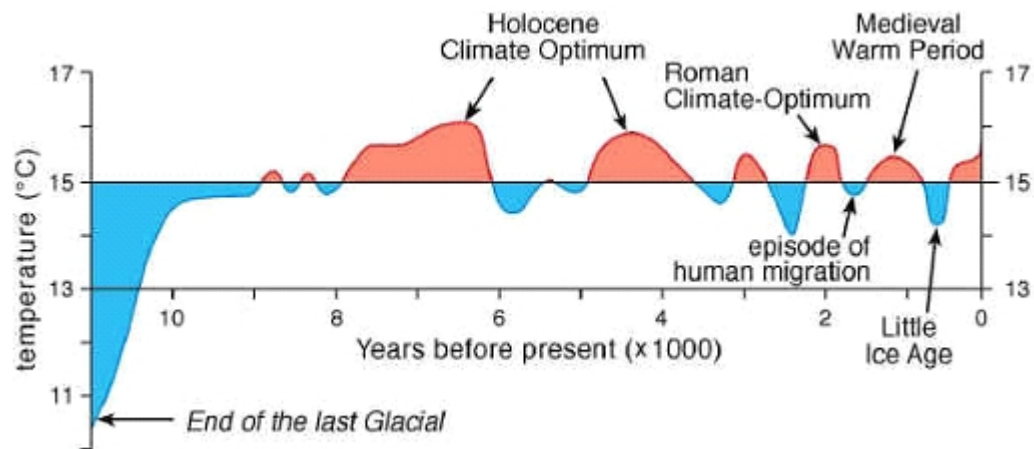
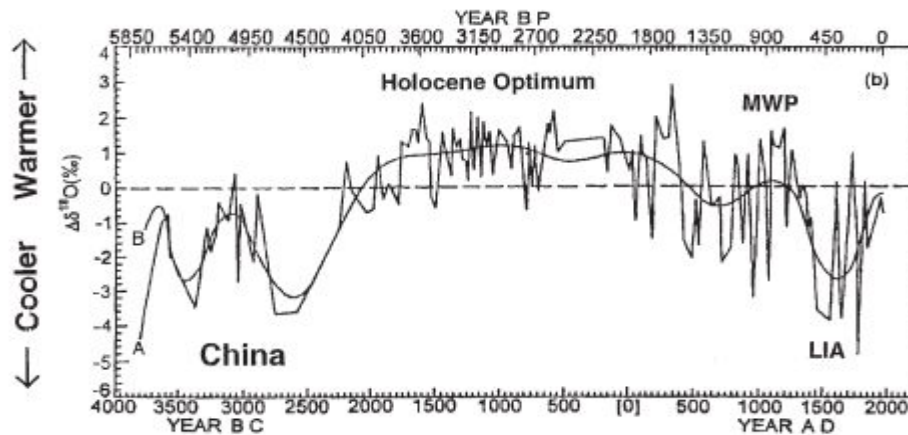


Figure 5 shows a close-up of the last 11,000 years. The graph shows a summary of the many warm and cold periods that have alternated throughout the years. Closest to us are two periods that are very well documented in history, the Medieval Warm Period (MWP) and the Little Ice Age (LIA). During the MWP the Vikings colonized Greenland and Nova Scotia. They also enjoyed a much nicer climate in "chilly" Scandinavia. There have been claims that these periods were only local North European anomalies. That is not the case; see for instance the [Medieval Warm Period Project](#). There are numerous research reports from all over the world showing similar behavior, for example, Figure 6 below, showing details from a Chinese study. (Both Figure 5 and Figure 6 are taken from "Climate History and the Sun", WASHINGTON ROUNDTABLE ON SCIENCE & PUBLIC POLICY, By Sallie Baliunas and Willie Soon, The George C. [Marshall Institute](#).)

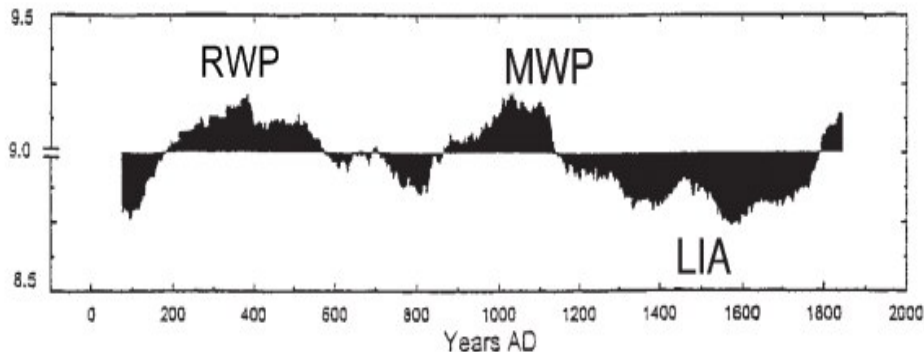
Figure 6 Temperatures in China during the last 4000 years

Figure 6 Temperatures in China during the last 4000 years



Even the cold Siberia has not always been so cold. Figure 7 shows the smoothed temperatures during the last 2000 years in Siberia as determined from tree rings. (Naurzbaev MM and Vaganov EA, J. Geophys. Res., Vol. 105, 2000) This is thus another proof that the Roman Warm Period (RWP) (the caption “RWP” inserted to the chart by me), the Medieval Warming Period (MWP) and the Little ice Age (LIA) where not only European artifacts. See this [Internet site](#) for more information about the Medieval Warming Period.

Figure 7. Temperatures during the last 2000 years in Siberia



The conclusion I draw from what is said and shown above is simply the following: **the climate has varied greatly before, without human intervention, and will most probably vary greatly in the future as well.** Although there are some indications that we have seen a “dramatic” increase in temperature the last decades, the climate has changed rapidly also before.

The natural question to ask then is this one: which were the forcings that caused the great ice ages? Which natural phenomenon stands behind the evolution of global temperatures during the last 3000 years, like the warming at the Roman age or the Holocene Optimum?

Let us return to Siberia for a moment. In a later [report](#), Naurzbaev and Vaganov state, and I quote:

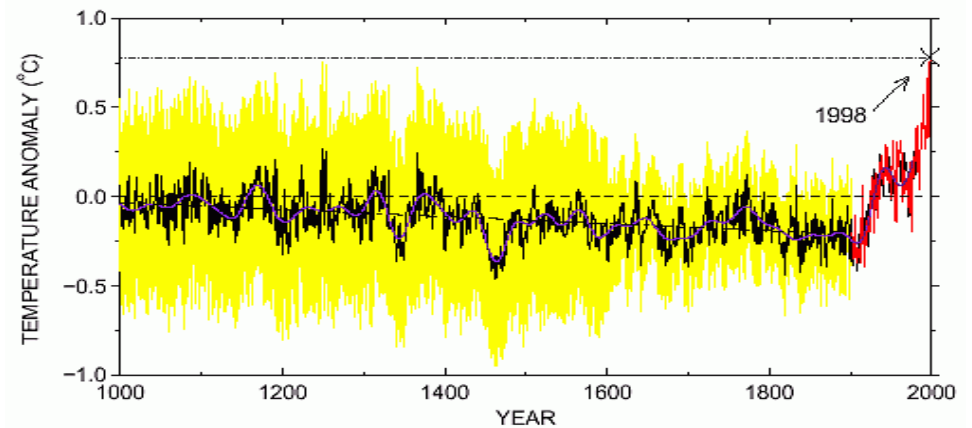
- “The Eurasian long-term tree-ring chronologies are revealed the global climate fluctuation (Medieval Warm Period, Little Ice Age, current warming).
- As last as a current temperature changes are characterized the spatial heterogeneity - different value of temperature fluctuation in different subarctic sectors.
- Current warming started at the beginning of the XIX-th century and presently does not exceed the amplitude of the medieval warming.
- The tree ring chronologies do not indicate unusually abrupt temperature rise during the last century, which could be reliably associated with greenhouse gas increasing in the atmosphere of our planet.”

The figures above constitute just a sample of many graphs available on the Internet showing how the temperature has evolved during the last 2000 years. There are numerous similar tree-ring studies to delve into. But the tree-ring proxy can be difficult to interpret, though. In 1999 a Ph.D. student by the name of Michael Mann (Department of Geosciences, University of Massachusetts) studied tree rings as a basis for assessing temperature changes during the last millennium. He added data from more recent centuries by using other proxies and applied some advanced data smoothing, thus managing to wipe out the Medieval Warm Period and Little Ice Age. His disastrous, but erroneous, conclusion was that the temperature had been linearly declining since 1,000 AD, only to rise several tenths of a centigrade during the very recent decades (as illustrated by the red line in figure 8).

The result was visually dramatic as the 20th century was portrayed as having a climate rocketing out of control. The red line extends to 1998, which was a record warm year because of El Niño. The data for the last decades is however misleading, as it is largely the result of urban heat islands (see for instance the series “how not to measure temperature” at [Watts Up With That?](#)).

**Figure 8. Mann's (in)famous “hockey stick”**

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It should be noted that the surface temperature records are not consistent with the satellite temperature records published by the National Research Council in 2000. Had the latter been used to represent the last 20 years, the effect would have been to make the 20th century much less significant when compared with earlier centuries.

New tree-ring studies that contradict Mann's data are continually published. For instance, the following is interesting: [“Torneträsk tree-ring width and density AD 500–2004: a test of climatic sensitivity and a new 1500-year reconstruction of north Fennoscandian summers”](#) by Håkan Grudd and recently published in *Climate Dynamics*.

Grudd concludes as follows in the abstract: *“The late-twentieth century, however, is not exceptionally warm in the new record: On decadal-to-centennial timescales, periods around AD 750, 1000, 1400, and 1750 were equally warm, or warmer. The 200-year long warm period centered on AD 1000 was significantly warmer than the late-twentieth century ( $p < 0.05$ ) and is supported by other local and regional paleoclimate data. The new tree-ring evidence from Torneträsk suggests that this »Medieval Warm Period« in northern Fennoscandia was much warmer than previously recognized.”* It shows that newer research results are published all the time and do not necessarily support the “hockey stick” theory.

Let me cite an article on the Web: "[Special Report: The Global Warming Two-Step](#)" by William Tucker, published in January 2007: "*THE BIG PROBLEM FOR GLOBAL WARMING alarmists is a period called »The Medieval Warming« which occurred from about 950 A.D. to 1350 A.D. It's well known from the history books. The Vikings colonized Greenland in 982 A.D. and stayed until 1425 A.D., when the cold weather and permafrost drove them out.*" It continues: "*In fact, the IPCC had known about the Medieval Warming all along. In 1996 it published a temperature graph that clearly showed the Medieval Warming. There wasn't any dispute at that point. What happened? Somehow [...] Michael Mann did some fancy things with some tree-ring data from California in 1998 and came up with the »hockey stick.« Such a blatantly ahistorical effort would have only raised eyebrows under ordinary circumstances, but it turned out to be just what the UN wanted -- proof that global warming was unprecedented! The IPCC made the hockey stick the centerpiece of its 2001 Climate Report. Bill Clinton also used it as the centerpiece of his 2000 National Report on Climate Change. The government of Canada sent a copy of the graph to every household in the country. In the end, the IPCC appointed Mann editor of its Journal of Climate -- not bad for a lowly Ph.D. student. Slowly the criticisms trickled in. Two Canadian statisticians, Stephen McIntyre and Ross McKittrick, examined Mann's algorithms and found that any random data plugged into the equations produced the same hockey stick.*"

In fact, Mann et al. made so many mistakes in their analysis that the graph has been dropped from the latest IPCC report. See for example the [Wegman Report](#) for an independent analysis.

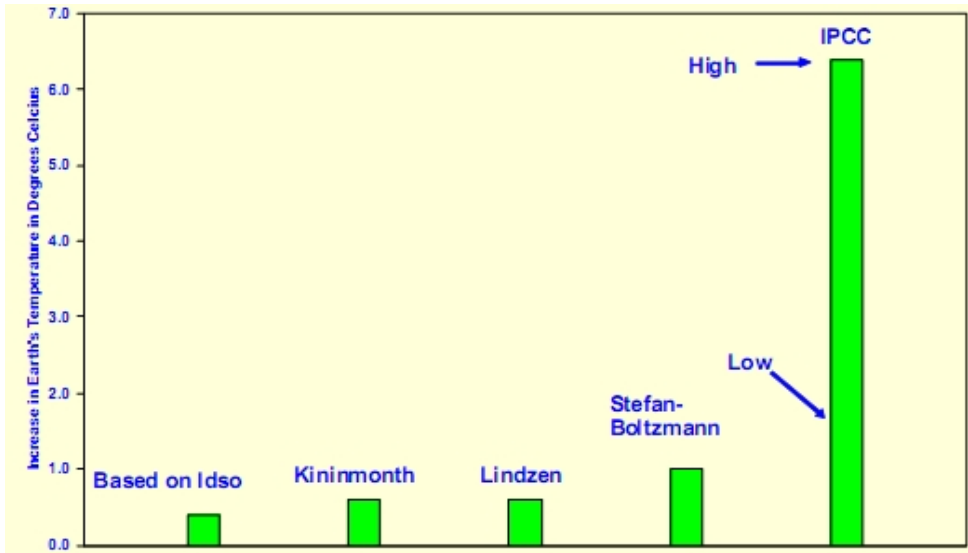
## **Carbon dioxide as a greenhouse gas**

Carbon dioxide is a greenhouse gas and exerts a greenhouse effect in the same way as water vapour and a number of other gases. The CO<sub>2</sub>, like any other greenhouse gas in the atmosphere, indeed helps to keep our planet warm. Water accounts for about 90-95% of the Earth's greenhouse effect, the rest is accounted for by the other gases; CO<sub>2</sub>, nitrous oxide, methane, ozone, etc. The greenhouse effect IS important. It has been calculated that without this effect the mean temperature of the Earth would be -18°C instead of the +15 °C considered the mean today. BUT – what is more interesting is that without the combined effect of evaporation and convection (convection is the physical effect of warm gas expanding, getting lighter and rising in the mass of air), the temperature would be close to 77 °C! There are many other climate forcings, including the ocean currents, aerosols and soot particles, clouds, land use, and – naturally – variations in the solar radiation.

IPCC has coined the term the *enhanced* greenhouse gas effect for the additional

warming due to anthropogenic CO<sub>2</sub>. Additionally IPCC has introduced *amplification* in the form of positive feedbacks. My concern is related to these issues. I do not believe that the *enhanced* greenhouse gas effect has such a dramatic effect on the climate as IPCC thinks and I am definitely not convinced that the positive feedbacks are that dramatic or even exist.

### **Figure 9. Comparison of climate sensitivity estimates**



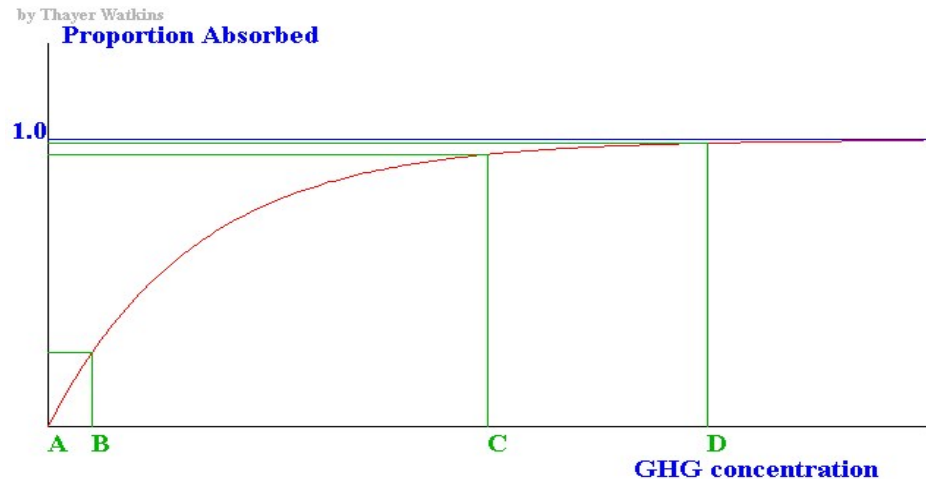
David Archibald presented the graph in Figure 9 at the [International Conference on Climate Change](#) held in New York, March 2008. The graph, taken from his report [Solar Cycle 24: Implications for the United States](#), shows four different estimates of the warming to be expected from a doubling of atmospheric CO<sub>2</sub> from the pre-industrial level of 280 ppm. IPCC's estimates "Low" and "High" stand clearly apart. There are more estimates by other authors that also conclude that the doubling of CO<sub>2</sub> levels will result in a temperature increase of less than one centigrade, for instance one [published by Hans Erren](#)

All climate studies by supporters of the greenhouse gas theory agree that if the global warming during the last century was produced by an increase in CO<sub>2</sub> in the atmosphere, the CO<sub>2</sub> would first warm the upper atmosphere, and after that the warmed upper atmosphere would warm the Earth's surface. However, measurements of atmospheric temperatures by satellites and balloons show no warming in the atmosphere during the last century.

It could be argued that the level of CO<sub>2</sub> in the atmosphere as it was one hundred years ago already was high enough to result in the absorption of 99.9% of infrared radiation. This is due to the Lambert-Beer law of radiation absorption (also referred to as the Beer-Lambert law), according to which the transmission of radiation at a particular wavelength by a chemical compound is a logarithmic function of its concentration. See for example [this educational site](#) or [Wikipedia](#) on the Internet. The law states that  $T = 10^{(-aLc)} = 10^E$ , or that the amount of transmission  $T$  is equal

to 10 raised to the power of the product between a proportionality constant  $a$ , the length the radiation has to travel  $L$  and the concentration  $c$  of the absorbing compound. This function is illustrated by the graph in [Figure 10](#). The product  $aLc$  is also sometimes referred to as the extinction coefficient  $E$ . (As a reminder:  $10^3 = 10 \times 10 \times 10 = 1000$  and  $10^{-3} = 1 / 1000 = 0.001$ . This power function is sometimes express by using the character " $\wedge$ ":  $10^3$  means then "10 to the power of 3").

**Figure 10. Lambert-Beer's law**



This figure shows what happens when the concentration of the absorbing compound is increased from A to B, to C and D. On the horizontal axis, moving from A to B represents a small increase in concentration but it results in a substantial increase in the radiation absorbed. Between C and D there is a significant increase in concentration with a limited increase in radiation absorption. The level "1.0", which corresponds to 100 % absorption of radiation, cannot be crossed. Now, the question that arises is: where on this graph was the level of CO<sub>2</sub> for, say, 100 years ago? How much has the proportion of absorbed radiation increased since then? One answer may be found in an [article written by Dr. Heinz Hug](#), and the answer is: 100 years ago already 100 % of the radiation was absorbed by the CO<sub>2</sub> in the atmosphere. Today, the number is still 100%! Thus, the increased CO<sub>2</sub> concentration has had NO EFFECT or, at most, a very limited effect on the amount of infrared radiation absorbed.

But wait – it can't be this simple! In their 2001 report IPCC states: "*It has been*

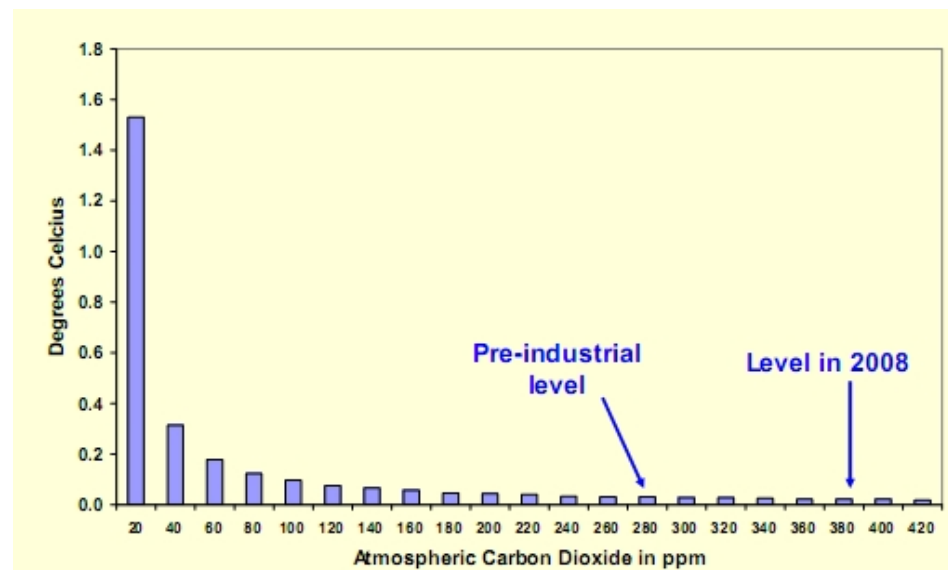
suggested that the absorption by CO<sub>2</sub> is already saturated so that an increase would have no effect. This, however, is not the case. Carbon dioxide absorbs infrared radiation in the middle of its 15 μm band to the extent that radiation in the middle of this band cannot escape unimpeded: this absorption is saturated. This, however, is not the case for the band's wings. It is because of these effects of partial saturation that the radiative forcing is not proportional to the increase in the carbon dioxide concentration but shows a logarithmic dependence. Every further doubling adds an additional 4 W/m<sup>2</sup> to the radiative forcing." This very important statement is the basis of the argument about man-made vs. natural. It is stated as such, with no reference to scientific material. An earlier IPCC report refers to the following article: [Uncertainties in Carbon Dioxide Radiative Forcing in Atmospheric General Circulation Models](#) by R.D. Cess et al. and published in Science in 1993. In effect, the article is not a scientific study aiming to quantify the radiative forcing due to absorption by the wings, but an attempt to explain why various other computer model studies that have used the so called General Circulation Models (GCMs) have reported three-fold variations in the predicted increase in the global mean surface temperature. The value of 4 W/m<sup>2</sup> is nothing more than the mean of all the corresponding figures quoted in the prior reports reviewed by Cess et al. and as such is not attributable to them.

Dr Heinz Hug has calculated that taking the full absorption spectrum into account, the doubling of the CO<sub>2</sub> level from 317 ppm to 714 ppm would increase absorption approximately 0.17%. This corresponds to an additional radiative forcing of 0.054 W/m<sup>2</sup>, substantially below IPCC's figure of 4 W/m<sup>2</sup>. An increase of this order would not result in a temperature increase of more than a tenth of a centigrade.

The biggest problem for the pro-IPCC scientific community is that there are no means to experimentally determine the effect of an increasing CO<sub>2</sub> level. Numerous theoretical calculations have been made using more or less complicated General Circulation Models. For these models to produce good results the data input for CO<sub>2</sub> absorptions in the wings needs to be very accurate. This is a considerable hurdle, mainly because the absorption spectrum of CO<sub>2</sub> at various pressures and temperatures is not known well enough. The most common source of spectrum data is the [HITRAN database](#) but the data in this database has been criticized lately. The data was update in 2004 (Version 12.0) but most of the original GCM studies have been carried out using the old, less accurate data.

There is no method for experimentally determining the degree of warming to be expected from an increase in CO<sub>2</sub> content in the atmosphere. Thus all mathematical models must be taken as models only. For example, [a report by David Archibald](#) presents a graph illustrating the theoretical warming due to increasing CO<sub>2</sub> levels. The graph is reproduced in Figure 11 below.

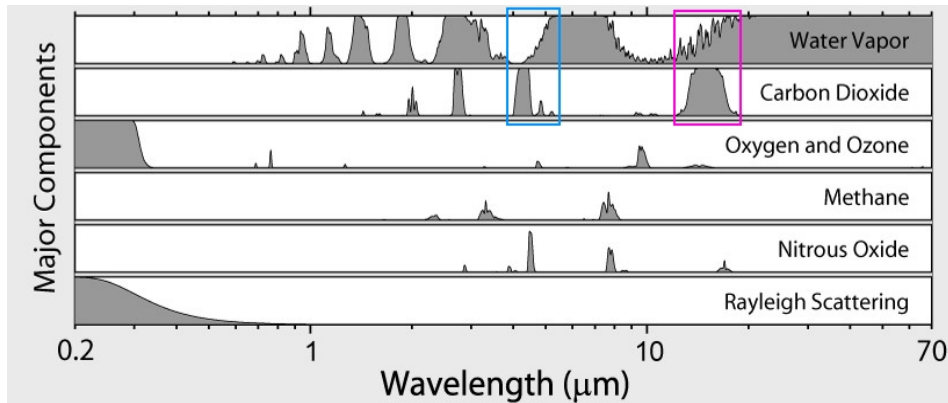
**Figure 11. The Warming Effect of Atmospheric CO<sub>2</sub>**



The graph in Figure 11 illustrates the fact that the warming must be logarithmic due to Lambert-Beer's law, i.e. each increment in CO<sub>2</sub> will have a smaller effect. Commenting on the graph, Archibald states: "Anthropogenic warming is real, it is also minuscule. Using the MODTRAN facility maintained by the University of Chicago, the relationship between atmospheric carbon dioxide content and increase in average global atmospheric temperature is shown in this graph."

One of the main issues that remain to be solved is the relative amounts of the infrared radiation absorbed by the CO<sub>2</sub> wings and the other greenhouse gases, like water vapour. The graph in Figure 12 shows normalized absorption spectra for the most common greenhouse gases. It shows that one major CO<sub>2</sub> peak, at 4.5 μm, falls within a frequency range where the absorption of the water spectrum is limited and that the other major peak, at 15 μm, is partially covered by water vapour. Only the radiation absorption of the left wing of this larger peak is not fully covered by water vapour absorption. It should be noted that Lambert-Beers law is valid also for calculating the combined transmission for two different compounds. The total transmission  $T$  at a particular wavelength is  $T = 10^{-(a_1 L c_1 - a_2 L c_2)}$ .

**Figure 12. Normalized absorption spectra for greenhouse gases**



More on the importance of water vapour as a greenhouse gas can be found in Appendix 3. Water vapour is most probably responsible for stabilizing the atmospheric temperature through negative feedback. When the temperature rise, more water evaporates from the oceans, more clouds are formed that in turn reflect more of the incoming solar radiation, thus cooling the planet. Water vapour thus functions as a buffer, keeping temperature fluctuations down.

The main factor determining the temperature equilibrium is not a greenhouse gas, however, but the Sun. The Sun is most likely behind the long-term climate variations described earlier. The Hudson Institute has published a book titled "Unstoppable Global Warming: Every 1,500 Years" in which S. Fred Singer and Dennis Avery present the theory that the Earth's climate goes through regular 1,500-year cycles of warming and cooling, driven by the fluctuating intensity of the Sun. In the book, the authors state six reasons why CO<sub>2</sub> is not to blame:

1. CO<sub>2</sub> changes do not account for the highly variable climate during the past 5000 years
2. CO<sub>2</sub> changes do not account for recent changes either, like the warming that occurred between 1850 and 1940. After 1940 the temperature declined until around 1975
3. Each increment of CO<sub>2</sub> in the atmosphere have less impact due to the logarithmic behavior of Lambert-Beer's law
4. When taking into account the increase of rural regions (supermarkets, highways, parking lots) close to old meteorology stations, the actual temperature increase will be only half of what is often reported
5. The failures of the IPCC computer models: the temperature close to the

surface has increased faster than at higher altitudes, which is not consistent with the models. Likewise, the models predict that warming should be more pronounced at the North and South Poles, but this is not the case. Finally the models predict that the amount of water vapour in the higher atmosphere should increase. This is not happening either.

6. For the last 240,000 years the level of CO<sub>2</sub> has been a *lagging* indicator of global warming, i.e. the temperature has changed first and only then the CO<sub>2</sub> level, and not vice versa as Al Gore believes.

As stated in point 5 above, according to the General Circulation Models, a noticeable warming should be taking place in the higher atmospheric layers. In reality, the higher atmosphere has been cooling. See for instance the following article: [Global, hemispheric, and zonal temperature deviations derived from radiosonde records](#)

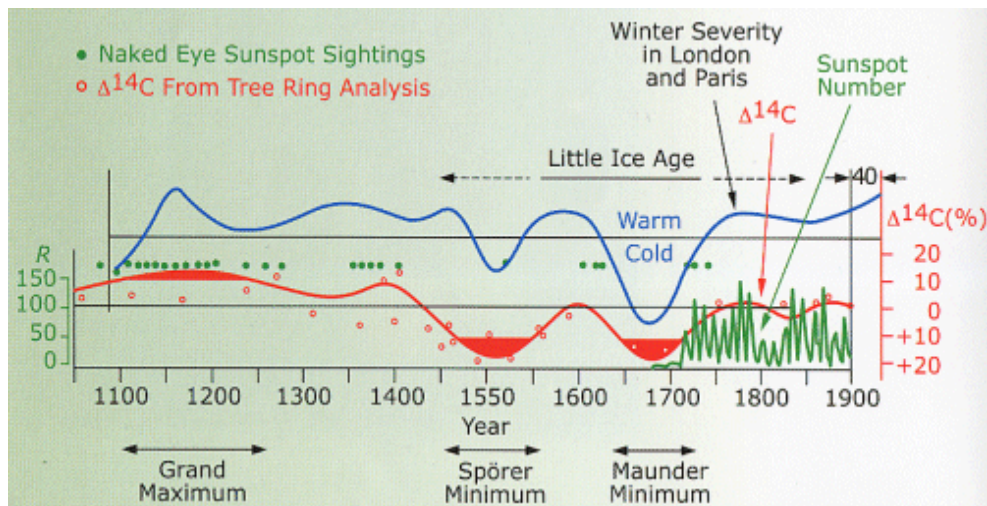
## The Sun as a forcing factor

William Herschel, a famous astronomer in England, was one of the first to notice that there was a connection between sunspots and the climate. "*From the price of wheat*" he wrote in 1801, "*it seems probable that some temporary scarcity or defect of vegetation has generally taken place, when the Sun has been without those appearances which we surmise to be symptoms of a copious emission of light and heat.*" He was talking about sunspots. The dark patches on the surface of the Sun that we call sunspots are a symptom of fierce magnetic activity inside. Sunspot observations stretch back to the early 17th century, when the telescope was invented, but it took until 1843 before the German amateur astronomer Heinrich Schwabe discovered the regular, approximately 11 years long sunspot cycle. For determining sunspot levels even further back in time than the 17th century, proxies based on the abundance of certain isotopes can be used. Sunspot cycles are numbered and at the time of this being written in April 2008 we are seeing the end of cycle 23 and still waiting for the beginning of cycle 24.

The relationship that has been identified between sunspot cycle length and temperature is simple: longer lengths coincide with lower temperatures. The more active the Sun is, the shorter the cycle: the pace of the solar cycle is more intense. One of the pioneers in this field is Jack Eddy. The graph in Figure 13 (taken from [NASA's Web site "The Inconstant Sun"](#)) is based on research he published as early as in 1976. It shows how the severity of winters in London and Paris over the last 900 years appears to follow variations in solar intensity. The red line illustrates solar intensity by presenting the abundance of carbon-14 in tree rings. (The <sup>14</sup>C scale has been inverted in the graph.) The carbon isotope <sup>14</sup>C is formed in the upper

atmosphere when incoming cosmic rays smash into CO<sub>2</sub> molecules. When the Sun's activity is low, its weakened magnetic field lets more cosmic rays into the solar system leading an increased <sup>14</sup>C concentration in the atmosphere.

**Figure 13. Jack Eddy: Sunspots, carbon-14 and temperatures**



It should not come as a surprise to anyone that quite a few climate scientists think that the Sun, with its solar cycles, is at the origin of most of the climate changes that have occurred during the last few thousand years. Looking carefully at proxies like the ice bore-hole records, it can be surmised that there are many solar cycles, but one of them is of particular interest to us: the 1,500 year long Dansgaard-Oeschger cycle. Willi Dansgaard and Hans Oeschger identified this cycle in the nearly one-mile long ice cores brought up from holes in the Greenland ice. Their original cycle length was not 1,500 but 2,550 years. Only later studies have concluded that a length of 1,500 ( $\pm 500$ ) is closer to reality. Where does this cycle originate? One obvious source is the Sun, but scientists have not identified any 1,500 long cycle in the Sun's behavior. There are two other cycles though that may, when they interact, result in 1,500 years long cycle: the 87 year Gleissberg cycle and the 210 year DeVriess-Suess cycle. One theory is based on the combined cycle that would become 1470 years long.

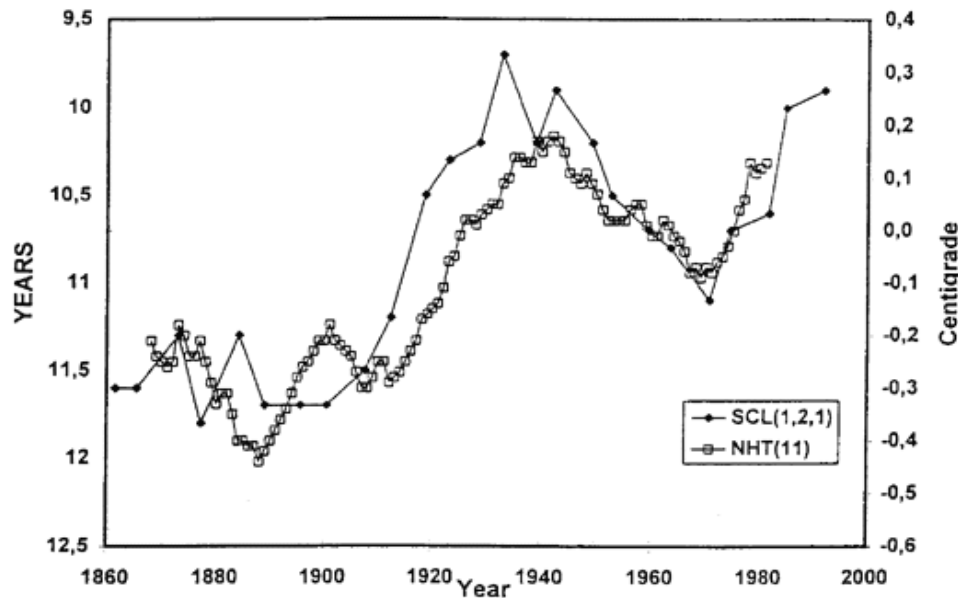
Solar ultra-violet, visible and heat radiation are the primary factors for the Earth's climate, including global average temperatures, and these energy sources appear to be quite constant. Across the solar cycle, the Sun's energy output varies only by about 0.1%. This is why scientists have been investigating mechanisms, which

could amplify the changes in solar output, scaling up the 0.1% variation into an effect that could explain the temperature changes during the last few decades. [Dr Theodor Landscheidt has pointed out](#) that the value 0.1% only refers to the absolute amplitude of the sinusoidal variation in the solar constant, not the whole range from minimum to maximum, which could be as high as 0.22%, at least on a longer time scale.

[Joanna Haigh](#) from Imperial College, London, points out that the Sun's energy output changes much more in the ultraviolet part of the spectrum; between 1% and 10%. This variation has an impact in the stratosphere through at least two phenomena. UV radiation can be absorbed by ozone in the stratosphere (the upper atmosphere) and also cause more ozone to be produced. A change in UV radiation will warm or cool the air at these heights. This is referred to as the "direct UV effect." The "Indirect UV effect" refers to the impact of radiation on middle atmosphere dynamics. Both the direct total solar intensity changes and the indirect UV effects result in temperature changes in the equatorial upper stratosphere and hence corresponding stratospheric zonal wind anomalies. This influences winter hemisphere planetary wave propagation. A cooler, denser stratosphere results in increased jet stream strengths, as well as a shift of the jet streams and mid-latitude storm-tracks toward the equator. For instance, a shift of the jet streams toward the equator leads to shrinking equatorial and temperate atmospheric circulation belts and expanding polar circulation belts, implying a net global cooling. Shrinkage of the upper atmosphere alters the height of the tropopause, which is the boundary between the troposphere and the stratosphere. The boundary acts as the effective "ceiling" for both weather and global atmospheric circulation. The intensity of the "El Nino" Southern Oscillation and other similar oscillations will also change. Because each stage in the chain is strongly nonlinear, a small change in solar UV and X-ray radiation can have a significant effect on weather and climate.

Eigil Friis-Christensen and Knud Lassen of Danish Meteorologic Institute have published one of the most striking illustrations of the relationship between global temperature and sunspot cycles. Their work, published in [Science Vol. 254](#) in 1991, compared the average temperature at the northern hemisphere with the average solar activity as defined through the interval between successive sunspot maxima. The original results are shown in the [figure 14 below](#).

**Figure 14. Mean solar cycle length and temperatures**



In Figure 14, the solid dot curve (SCL) displays the mean length of the sunspot solar cycle and the open dot curve (NHT) the eleven-year running mean value of the northern hemisphere land air temperature. The solar activity is generally increasing through an interval of 100 years. Since the middle of the 19th century the cycle length has decreased from around 11.5 years to less than 10 years. Within the same interval the Earth's average temperature has increased by approximately 0.7 centigrade. Even the finer structures in the two curves have similar appearances.

Changes in the magnetic field of the Sun and the solar cycle alter the solar wind, which is a continuous stream of particles from the solar atmosphere. The solar wind reaches out through the solar system, until it changes from supersonic to sub-sonic speed. This part of space, called the Heliosphere, encloses the whole solar system. Because of the magnetic structure of the Heliosphere, only some of the cosmic ray particles penetrate to the inner part of the solar system, in other words the magnetic field of the Heliosphere works as a shield. Because the magnetic activity of the Sun changes with the solar cycle, the flux of cosmic rays varies with the solar cycle. This is the basis behind the solar wind-cosmic rays-cloud theory put forth by [Knud Lassen, Eigil Friis-Christiensen and Henrik Svensmark](#). According to the theory

cosmic rays penetrating into the lower atmosphere can create charged condensation nuclei around which droplets can form and build up clouds. When the Sun is active the magnetic field and the shield are stronger and less cosmic rays can penetrate into the atmosphere and cause less clouds to form in the lower atmosphere. Some data that supports this theory are presented in Figure 15, which is from a [paper on Cosmoclimatology](#) by Svensmark. A reduction in lower clouds is expected to increase temperature. Over the last century the Sun has been unusually active - which means fewer cosmic rays and clouds and a warmer climate on Earth. See the [Danish National Space Center site](#) for more information about current research into the Sun-Climate relationship.

**Figure 15. Low cloud amount and cosmic ray intensity**

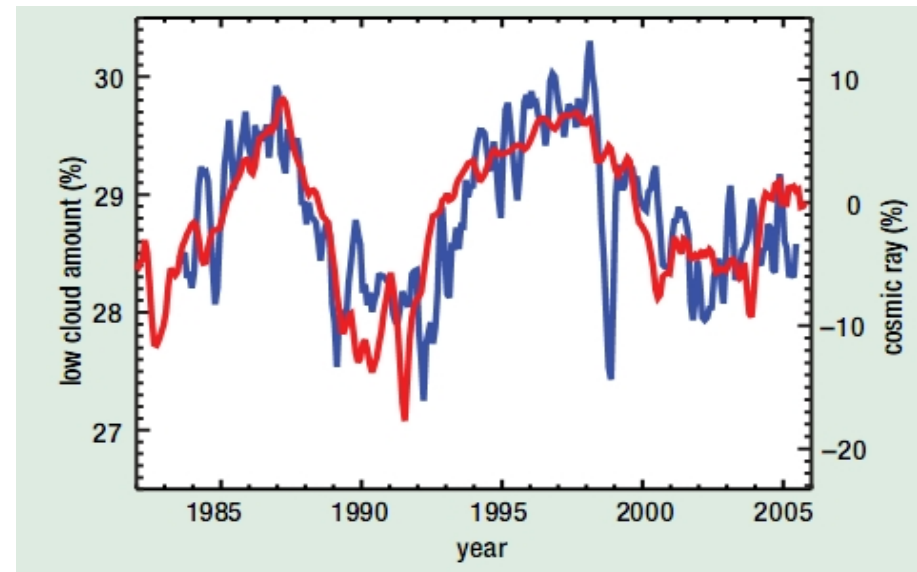


Figure 15 shows the relationship between low cloud amount (clouds below 3 km) and cosmic ray intensity. The blue line shows variations in low cloud cover while the red line is the record of monthly variations in cosmic ray intensity. Marsh and Svensmark originally published the data in Figure 15 in 2000 in Physical Review Letter (see the following [list of publications](#)). Svensmark et al also show that there is no matching phenomenon at altitudes above 3 km. The reason is that there are more than enough cosmic rays at these altitudes, so changes in the cosmic ray intensity do not effect formation of high clouds. Clouds influence the vertically

integrated radiative properties of the atmosphere in two opposing ways. On one hand, by reflecting incoming shortwave radiation they have a cooling effect, on the other, they act as heaters by trapping outgoing longwave radiation. The net radiative impact of a particular cloud is mainly dependent upon its altitude and its optical thickness. High altitude optically thin clouds tend to heat while low altitude optically thick clouds tend to cool.

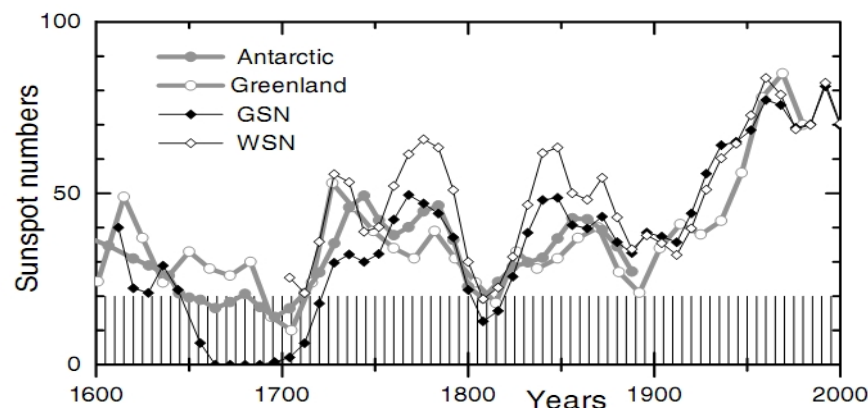
The [CLOUD project](#) launched by CERN (the European Organisation for Nuclear Research) in Geneva will take Svensmark's research to a new level. The project involves the simulation of the Earth's atmospheric environment in controlled laboratory conditions to help develop an understanding of the microphysics of the role of cosmic radiation in cloud formation.

Several recent studies by other scientists have shown that the Sun is more active now than it has been for a millennium. Solanski et al, at Max Planck Institute have coined the term 'grand maximum' to describe it. Ilya Usoskin, a geophysicist who worked with colleagues from the University of Oulu in Finland and with Solanski, has found that there have been more sunspots since the 1940s than during the past 1000 years. Usoskin's team used a physical model to calculate past sunspot numbers from levels of Beryllium-10 preserved in ice cores taken from Greenland and Antarctica. Beryllium-10 is produced when high-energy particles from space bombard the atmosphere, but when the Sun is active its magnetic field protects the Earth from these particles and levels of Beryllium-10 are lower. The Figure 16, published in [Astronomy and Astrophysics](#) in 2004, shows one compilation of their data. Comparing Figure 16 with previous figures, for instance Figure 1, it becomes evident that it looks like there is a strong correlation between sunspot numbers and the global temperature.

In a [report published in Nature in 2004](#) Usoskin et al. state: "According to our reconstruction, the level of solar activity during the past 70 years is exceptional, and the previous period of equally high activity occurred more than 8,000 years ago." In a more recent [report published in Geoscience](#) they say "In conclusion, a CR-climate link seems to be a plausible climate driver, as supported by the bulk of statistical studies and existing theoretical models." (CR means cosmic rays).

**Figure 16. Sunspot numbers from various sources.**

**Figure 16. Sunspot numbers from various sources.**



In a very [new study by Jasper Kirkby](#) at CERN the author concludes: "Numerous palaeoclimatic observations, covering a wide range of time scales, suggest that galactic cosmic ray variability is associated with climate change. The quality and diversity of the observations make it difficult to dismiss them merely as chance associations."

Naturally there are scientists critical of the theory linking incoming radiation and cloud formation, for instance visit the [Logicalsience Web site](#) for some very sceptical views. In a [recent article](#) Lockwood and Fröhlich put forward arguments that oppose the analysis that solar activity would have been responsible for any warming during the last 20 years. L & F state that from 1985, there is a discrepancy between solar activity, which decreased, and the global temperature, which increased. But has the global temperature really increased during the last ten years? See for instance Figure 2. Also see the response by Svensmark Friis-Christensen: [Reply to Lockwood and Fröhlich - The persistent role of the Sun in climate forcing](#).

Another paper often cited by pro-IPCC scientists is [one by Usoskin et al.](#), who conclude the following:

#### 4. CONCLUSIONS

The sunspot number index related to solar activity that has been reconstructed from the cosmogenic  $^{10}\text{Be}$  isotope data since AD 850 shows correlation with terrestrial northern hemisphere and global temperature reconstructions at a significance level above 95%.

Note that the most recent warming, since around 1975, has not been considered in the above correlations. During these last 30 years the solar total irradiance, solar UV irradiance and cosmic ray flux has not shown any significant secular trend, so that at least this most recent warming episode must have another source.

The alarmists have interpreted the paragraph to the right as meaning that warming should be attributed solely to the greenhouse effect. However, Usoskin et al. used the temperature data produced by the hockey-stick creator Michael Mann clearly overestimating the global warming during the last decades. Moreover, as already mentioned above, Usoskin et al. have later withdrawn the statement.

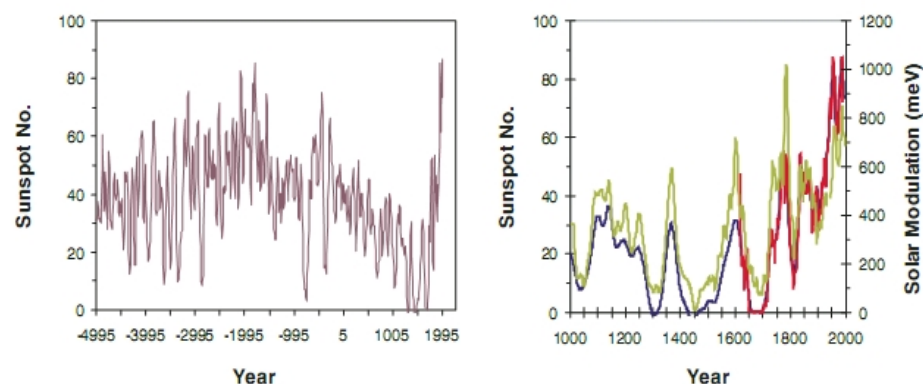
Lockwood and Fröhlich, and others that share their views, have erroneously overlooked the time lag caused by mass inertia that there always is between climate forcing and the corresponding response. Typically, one expects lags that depend on the time scale of the variations. The 11-year solar cycle gives rise to a 2-year lag in the observed temperature variations (which are within the range of  $\pm 0.1$  centigrade). Similarly, the response to the 20th century warming should typically be delayed by a decade. Climatologists, as well as the IPCC scientists very well know this. This lag can also be seen in the data in Figure 14.

Several reconstructions of solar activity show a strong upward trend from 1700 to the present. The minimum in solar activity around 1700 AD corresponds to the so-called Maunder Minimum period, which was characterized by very cold temperatures. See also the [report by the Independent Summary Group at the Fraser Institute](#), from which the Figure 17a and b (Figure ISPM-4 in the report) is taken.

The graph in Figure 17a is a reconstruction for the past 8,000 years by [Usoskin et al. \(2006\)](#). The graph in Figure 17b contains three reconstructions for the past millennium: blue is a reconstruction of sunspot numbers from residual  $^{14}\text{C}$  by Usoskin et al. (2006); red shows group sunspot numbers as compiled by [Hoyt and Schatten \(1993\)](#) and the green curve is a reconstruction of solar modulation from residual  $^{14}\text{C}$  by [Muscheler et al. \(2005\)](#).

**Figure 17a and b. Past temperatures**

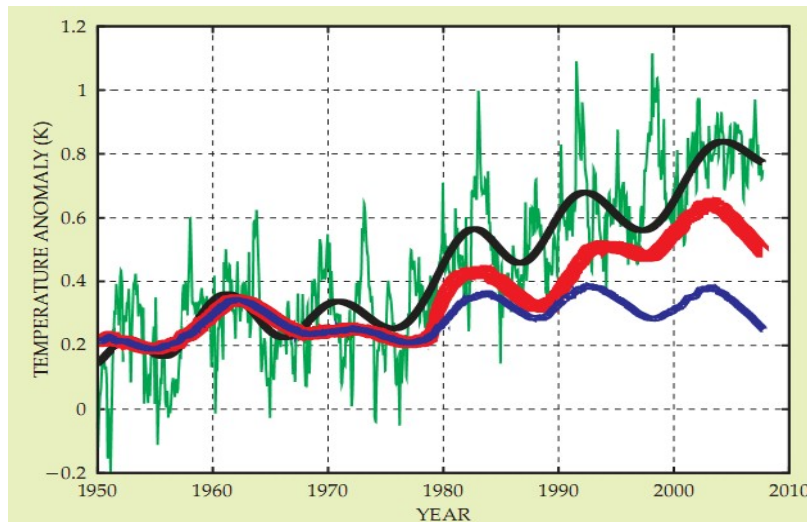
**Figure 17a and b. Past temperatures**



Next, I would like to highlight an analysis made by [Nicola Scafetta and Bruce J. West](#): In Figure 18 below the green line shows the raw data of the global surface temperature (GST) deviation between 1950 and 2007 from the time average of GST between 1890 and 1910. In the black line the GST data has been filtered and smoothed to remove any volcanic signal so as to stress the 11-year sunspot modulation. The combined red/blue line before 1978 constitutes a TSI (Total Solar Irradiance) proxy reconstruction for the period for which no satellite data is available. The red and blue lines after 1978 are based on two alternative TSI satellite composites. The figure shows excellent correlation between the 11-year solar cycles and cycles observed in the smoothed GST data. A 22-year cycle component in the temperature series also matches the 22-year solar cycle very well. Notably, since 2002 the temperature data present a global cooling instead of warming. This cooling seems to have been induced by decreased solar activity from the 2001 maximum to the 2007 minimum as depicted in two distinct TSI reconstructions. More research by these two scientists can be found in [the following paper](#) and [at the ACRIM Web site](#).

**Figure 18. Temperature anomaly and total solar irradiance since 1950**

**Figure 18. Temperature anomaly and total solar irradiance since 1950**

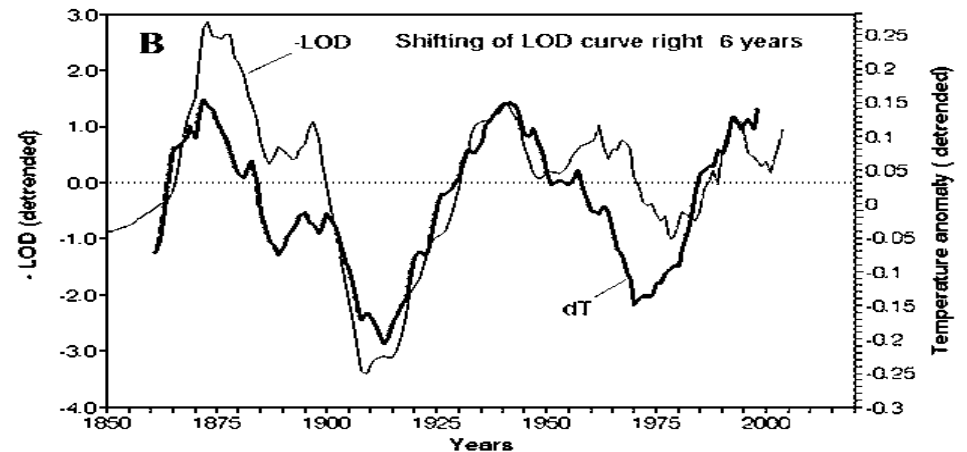


Before finishing the discussion on the correlation between various Sun cycles, UV and cosmic radiation, clouds and the climate, one more interesting correlation deserves to be described, namely the one between global temperature fluctuations and small variations in the Earth's rotational velocity. This velocity can be quantified in terms of Length of Day (LOD). In [Climate Change and Long-Term Fluctuations of Commercial Catches - The Possibility of Forecasting](#), a technical paper published by FAO fisheries in 2001, Prof. Leonid Klyastorin shows that there seems to exist an extremely close correlation between the changes in the mean global temperature and changes in the LOD during the past 150 years (see Figure 19 below). Mainstream climatologists have largely ignored this correlation. [The International Earth Rotation and Reference Systems Service \(IERS\)](#) provides very precise data of the rotational velocity. Their [data shows](#) that the velocity has increased since 1999.

Klyastorin's data in Figure 19 shows the inverted value of LOD, with a systematic downward trend removed, and the global temperature anomaly  $dT$ , also with a systematic upward trend removed. The LOD data was shifted six years forward to account for the expected time lag. According to [Gerhard Lobart](#) the correlation results from the effect that galactic vacuum density waves have on the Sun and the

Earth. But the change in rotational velocity could have other explanations as well. One explanation is that some of the Earth's mass has moved closer to the Earth's axis of rotation. This mass can be accounted for by changes in the atmosphere or by water accumulating as ice on the polar ice caps.

**Figure 19. Length of Day (LOD) and temperature anomaly**



In summary, the role of solar activity in climate change seems to be generally regarded as a complex question without a clear-cut answer. It is most obviously not only a question about the total radiation energy, but also the distribution of the Sun's radiation spectrum. There are mainly four theories for the effect that solar radiation has on the climate:

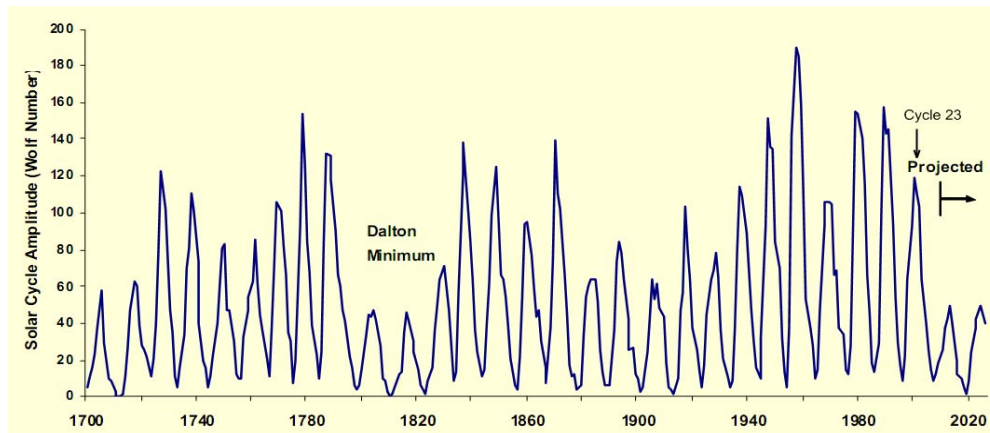
- The Sun has an impact on cosmic radiation and on cloud formation. (Friis-Christensen, Lassen, Stensmark and others).
- Variation in solar radiation intensity has a direct impact on global temperature. (Baliunas, Soon, Hoyt, Schatten, Wilson)
- The Sun has an impact on cosmic radiation and on other, yet unknown factors, such as geomagnetic storms that warm the atmosphere at high latitudes. (Landscheidt, Labitzke, Pycha)
- The Sun has an impact on ozone levels through variation in the UV radiation. (Haigh, Shindell, Labitzke).

[Joanna Haigh](#) has developed models for how ozone may influence the climate. For a good overview of these theories, please refer to [the article in Living Reviews in Solar Physics](#) or [Hadley Centre technical note 62](#).

## How about Global Cooling?

Some researchers have found that the Sun is now, 2008, getting into a quieter mode, and given the connection between solar activity and climate as described above, concern over the “risk” of global cooling may not be far away. For instance, in his presentation to the [International Conference on Climate Change](#), in New York in March 2008, David Archibald put forward a [prediction](#) of imminent cooling based on the assumption that the intensity of solar cycles is now diminishing, as shown in Figure 20.

**Figure 20. Solar cycle amplitudes, past and projected**



The graph in Figure 20 shows the solar cycle amplitudes for the last 300 years, and two projected cycles. At the time of writing in April 2008, cycle number 23 is ending and the emergence of the sunspots of [cycle 24](#) is awaited. But the [lack of activity on the surface of the Sun](#) to indicate that cycle 24 actually has started, could signal the beginning of another “Maunder Minimum” - an event which we now know occurs every couple of centuries and can last as long as a century. Archibald, [Landscheidt](#), [Zbigniew Jaworowski](#), and many other solar scientists expect that the amplitudes of the next few cycles will be very low, leading to a much colder climate.

Also based on the steady decrease of the rotational velocity LOD that started in December 2003, it can be concluded that the global temperature will decrease again in 2010 for the duration of three decades, as it did from 1872 to 1913 and from 1942 to 1972.

Two Chinese scientists, Lin Zhen-Shan and Sun Xian, has [studied the variation of](#)

[the annual mean temperature](#) of the global, Northern Hemisphere (NH) and China from 1881 to 2002 and concluded that the global climate will be cooling down in the next 20 years. Many other recent scientific reports have come to the same conclusion.

## What about the ocean?

In this article I have not covered a number of other factors that may have an impact on the climate. Of importance are certainly these three:

- Orbital changes in Earth’s motion around the Sun are believed to cause ice ages
- Internal variability in the climate system, e. g. changes in atmospheric and ocean circulation
- Large volcanic eruptions, which are known to cause a sudden cooling lasting 2–3 years

The oceans with their huge mass of water contain more than a thousand times more heat energy than the atmosphere. Thus, if only a small fraction of the heat is transferred to the atmosphere, the atmosphere will warm up drastically. Ocean currents are of great importance for the global climate. These circulation patterns distribute energy across the Earth. The Earth’s climate is also affected by large-scale oceanic systems called oscillations. A well-known example is the El Niño phenomenon, which occasionally produces unusually warm weather after Christmas in parts of North America.

It is naturally very difficult to thoroughly sample the ocean's temperature changes. Measurements only began in the 1950's and trends are often impossible to identify due to variations in the datasets. Temperatures in some parts of the ocean are almost impossible to measure, and there are large regions in the Southern Hemisphere that are not well sampled. The [worldwide Argo network](#) with 3000 aquatic robots for sampling ocean temperatures, currents, and salinity was only completed in the fall of 2007. Since the system was fully deployed in 2003, it has recorded no warming of the global oceans. There has been a very slight cooling, but nothing really significant has been observed. In recent years, heat has actually been flowing out of the ocean and into the air. This is a feature of the weather phenomenon known as El Niño. It is indeed possible the air has warmed but the ocean has not.

It is also evident that something less easily explained could be taking place considering observed changes in sea level globally. Higher ocean temperatures should mean higher sea levels as water expands when it becomes warmer. With

the oceans getting colder, sea level should rise less. In fact, the global sea level has risen by more than 1 cm in the past four years. This could partly be explained by an increase in the melting rate of glaciers in Greenland and Antarctica. Josh Willis at NASA's Jet Propulsion Laboratory thinks that there is a little bit of a mystery in the sea level rise. The melting of polar ice cannot account for all of the sea level increase seen over the last three or four years. One possibility is that the sea has, in fact, warmed and expanded and scientists are somehow misinterpreting the data from the aquatic robots. But if the aquatic robots are actually telling the right story, then a new question must be raised: Where is the extra heat all going? Kevin Trenberth at the National Center for Atmospheric Research thinks it is probably going back out into space. The Earth has a number of natural thermostats, including clouds, which can either trap heat and turn up the temperature, or reflect sunlight and help cool the planet. Their effect cannot be directly measured at the moment, however. It is also possible that some of the heat has been absorbed by deeper ocean layers still outside the scientists' reach. Or it is possible that scientists need to adjust their theories to take account of some still unknown feature of the planet?

## Conclusion

Based on what has been said in the previous chapters, the question posed in the title of this article can be answered with two words: "probably both". The interesting question then is the relative importance of ALL the factors involved. My personal belief is that natural forcings have more importance than anthropogenic forcings such as the CO<sub>2</sub> level. The Chinese scientists mentioned above, and others like Theodor Landscheidt, have calculated that the Sun will start to "cool down" within the next few decades and warn about a forthcoming new Little Ice Age. Many scientists specialized in the Sun's cyclic behavior are today thinking along the following lines: the next solar cycles will be less intensive than the last ones. If these scientists are right, then the *enhanced* CO<sub>2</sub> greenhouse effect (if it really exists) could actually help us survive – until the Sun becomes more active again at some time in the future.

IPCC do not believe in global cooling – it does not fit their climate models for predicating the future climate. How reliable are their models then? At the UN conference in Bali In December 2007, Viscount Christopher Monckton et al. presented a paper that pointed out a serious error in IPCC's climate models: While the models predict that greenhouse gases would produce extensive hotspots in the upper troposphere over the tropics, according to satellite data no such hotspots have appeared. Monckton et al. had found that a large part of this discrepancy was due to a basic errors in the IPCC's use of the [Stefan-Boltzmann equation](#), which gives the amount of energy radiated from a body (such as the earth or a cloud) per

unit area and per unit time. When Monckton et al. applied their revised Stefan-Boltzmann factor to the effect of greenhouse gases, the temperature rise was about a third of that predicted by the IPCC. So by late last year it was evident that IPCC's forecasts of global warming were at least partly wrong. What will come next?

IPCC's spokesman Al Gore has often claimed that the "science is settled", but there is a growing group of scientists critical against the claims of "settled science" and overwhelming "consensus". See for instance the [Global Warming Petition Project](#) for a list of more than 31,000 American sceptical scientists.

One of the latest additions to the sceptics group is Atmospheric Scientist Dr. Joanne Simpson, formerly of the NASA Goddard Space Flight Center. She [has recently published this statement](#), an abbreviated version of which is quoted here:

"Since I am no longer affiliated with any organization nor receive any funding, I can speak quite frankly. [...] The main basis of the claim that man's release of greenhouse gases is the cause of the warming is based almost entirely upon climate models. We all know the frailty of models concerning the air-surface system. We only need to watch the weather forecasts. [...] The term 'global warming' itself is very vague. Where and what scales of response are measurable? One distinguished scientist has shown that many aspects of climate change are regional, some of the most harmful caused by changes in human land use. No one seems to have properly factored in population growth and land use, particularly in tropical and coastal areas. [...] But as a scientist I remain sceptical. I decided to keep quiet in this controversy until I had a positive contribution to make. [...] Both sides (of climate debate) are now hurling personal epithets at each other, a very bad development in Earth sciences."

I will finish by citing the [IPCC scientist John R Christy](#) whom I quoted in the introduction:

"Atmospheric carbon dioxide continues to increase due to the undisputed benefits that carbon-based energy brings to humanity. This increase will have some climate impact through CO<sub>2</sub>'s radiation properties. However, fundamental knowledge is meager here, and our own research indicates that alarming changes in the key observations are not occurring. The best advice regarding scientific knowledge, which certainly applies to climate, came to me from Mr Mallory, my high school physics teacher. He proposed that we should always begin our scientific pronouncements with this statement: »At our present level of ignorance, we think we know...« Good advice for the IPCC, and all of us."

## Appendix 1: Selected sites on the Internet

Please note that the comment about a Web site is retrieved from the site in question and not my view of the site's content or purpose, except when so stated. The classification of a Web site into one of the three groups "Anti-IPCC", "Pro-IPCC" or "ICPP-Neutral" is completely mine and can be discussed.

### Anti-IPCC "sceptical" sites

#### Climate science international

"ICSC - International Climate Science Coalition - is an international association of scientists, economists and energy and policy experts working to promote better public understanding of climate change science and policy worldwide."

#### Climate Audit

"Climate Audit by Steve McIntyre" My comment: This is a blog devoted to the analysis and discussion of climate data.

#### ICECAP

"ICECAP, International Climate and Environmental Change Assessment Project, is the portal to all things climate for elected officials and staffers, journalists, scientists, educators and the public."

#### Climate Science: Roger Pielke Sr. Research Group News

"Climate Science will thus provide a source of information on climate that, hopefully, will be useful to others, as part of a much needed effort to provide a balanced view of climate science."

#### Heartland Institute

"The mission of The Heartland Institute is to discover and promote free-market solutions to social and economic problems."

#### Junkscience - Greenhouse

"Does the Earth's atmosphere primarily behave like an actual greenhouse? No." About JunkScience: "All the junk that's fit to debunk."

#### National Center for Policy Analysis

"NCPA - National Center for Policy Analysis.", "NCPA is a non-profit public policy research institute seeking innovative private sector solutions to public policy problems."

#### Science is Broken

"Science is Broken – Science has become a propaganda machine to promote agendas instead of increase knowledge."

#### CO2science

"A weekly review and repository of scientific research findings pertaining to carbon dioxide and global change."

#### Science and public policy

"The Science and Public Policy Institute (SPPI) is a nonprofit institute of research and education dedicated to sound public policy based on sound science."

#### World climate report

"*World Climate Report*, a concise, hard-hitting and scientifically correct response to the global change reports which gain attention in the literature and popular press."

#### Friends of science

"It is our opinion that the Sun is the main direct and indirect driver of climate change."

#### Global warming skeptics

"Never look at the world through a straw and think you have all the answers"

#### Popular Technology -> The Anti "Man-Made" Global Warming Resource

"The Anti "Man-Made" Global Warming Resource, STOP the hysteria." My comment: This blog contains an extensive list of links to various Internet sites and publications.

#### Finding the Truth about Climate Change

"Climatepolice.com is dedicated to promoting an open exchange and dialog on climate change. To achieve that goal, research and articles with alternate views on climate change will be the primary sources of news and information on this site."

#### Kristen Byrnes

"The official site of the Kristen Byrnes Science Foundation." My comment: Byrnes is a teenage schoolgirl who has a very strong interest in global warming.

#### GlobalWarmingHoax

"This site is non-partisan and non-religious based. In fact we fight the new faith based religion of global warming." My comment: This site keeps a [mirror](#) of Kristen Byrnes's work mentioned above due to the tremendous interest in it.

#### Watts Up With That?

"Commentary on puzzling things in life, nature, science, technology, and recent news by Anthony Watts."

#### Errors in IPCC climate science

"On these web pages we take a critical look at climate change and particularly climate change over the last 25 years where data is good."

### Pro-ICPP "alarmist" sites:

#### IPCC

IPCC's main site

### [Realclimate](#)

“Commentary on climate science news by working climate scientists for the interested public and journalists.”

### [Skeptical science](#)

“So this website gets skeptical about global warming skepticism. Do their arguments have any scientific basis? What does the peer reviewed scientific literature say?”

### [Logical science](#)

“Our goal is to simply defend the international scientific consensus and summarize the industrial misinformation campaign in a way any layman can understand.”

### [The Pew Center on Global Climate Change](#)

Pew Center on Global Climate Change conducts research on global warming, its causes and effects, greenhouse gas emissions trends, environmental impacts and possible solutions.

### [Tamino's blog](#)

“Open mind”

### **“ICPP-Neutral” sites:**

#### [EPA - Climate change](#)

“EPA's Climate Change Site offers comprehensive information on the issue of climate change in a way that is accessible and meaningful to all parts of society – communities, individuals, business, states and localities, and governments.”

#### [Climate Debate Daily](#)

“Climate Debate Daily is intended to deepen our understanding of disputes over climate change and the human contribution to it. The site links to scientific articles, news stories, economic studies, polemics, historical articles, PR releases, editorials, feature commentaries, and blog entries.”

## Appendix 2: “IPCC-critical” books

[Shattered Consensus: The True State of Global Warming](#) by Patrick J. Michaels

[Unstoppable Global Warming: Every 1,500 Years](#) by S. Fred Singer and Dennis T. Avery

## Appendix 3: Importance of water vapour

Djedjiga Belmiloud et al. in [New Studies of the Visible and Near-Infrared Absorption by Water Vapour and Some Problems with the HITRAN Database](#), GEOPHYSICAL RESEARCH LETTERS, 2000, state that the HITRAN database used by many early

computer models was flawed: “*New laboratory measurements and theoretical calculations of integrated line intensities for water vapour bands in the near-infrared and visible (8500-15800 cm<sup>-1</sup>) are summarised. Band intensities derived from the new measured data show a systematic 6 to 26 % increase compared to calculations using the HITRAN-96 database. The recent corrections to the HITRAN database [Giver et al., J. Quant. Spectrosc. Radiat. Transfer, 66, 101-105, 2000] do not remove these discrepancies and the differences change to 6 to 38 %. The new data is expected to substantially increase the calculated absorption of solar energy due to water vapour in climate models based on the HITRAN database.*”

In the article [Could water vapour be the culprit in global warming?](#) published in Physics World, February 2003, Ahilleas Maurellis of the Space Research Organisation Netherlands (SRON), Utrecht, reveals the role water vapour plays in our atmosphere: “*It is easy to understand why most people - and many governments - are quick to blame "global warming" for apparently extreme variations in weather and seasonal trends. "Greenhouse gases" have long received a bad press, and carbon dioxide is often singled out as the culprit in global warming. Yet a recent study led by Richard Learner of Imperial College in London supports the possibility that water vapour could be a major contributor to atmospheric heating (D Belmiloud et al. 2000 Geophysical Res. Lett. 27 3703).*”

In another report in Physics World, March 2003, [The climatic effects of water vapour](#), Maurellis states: “*Contrary to common belief, the greenhouse effect may have more to do with water in our atmosphere than gases such as carbon dioxide.*” and “*Experiments that were performed by Roland Schermaul and the late Richard Learner at Imperial College in London in 2001 have cast previous measurements of the absorption spectrum of water into considerable doubt.*” and “*But when the absorption values in the HITRAN database are used in model-atmosphere calculations, the results are disturbing. For clear skies, the models predict that the atmosphere absorbs much less sunlight than is measured by a variety of satellite and aircraft.*”

In CLIMATE RESEARCH, 2001, [Modeling climatic effects of anthropogenic carbon dioxide emissions: unknowns and uncertainties](#), Soon and Baliunas et al. state: “*At this stage of incremental learning we conclude that no reliable predictions currently exist for the response of clouds to increased atmospheric CO<sub>2</sub>. So sensitive are certain cloud feedbacks to cloud micro-physics, for example, that a lowering of the radius of low-level stratus-cloud droplet size from 10 to 8 μm would be sufficient to balance the warming from a doubling of the air's CO<sub>2</sub> concentration. Likewise, a 4% increase in the area of stratus clouds over the globe could also potentially compensate for the estimated warming of a doubled atmospheric CO<sub>2</sub> concentration.*”