

Solar Cycle 24: Implications for the United States

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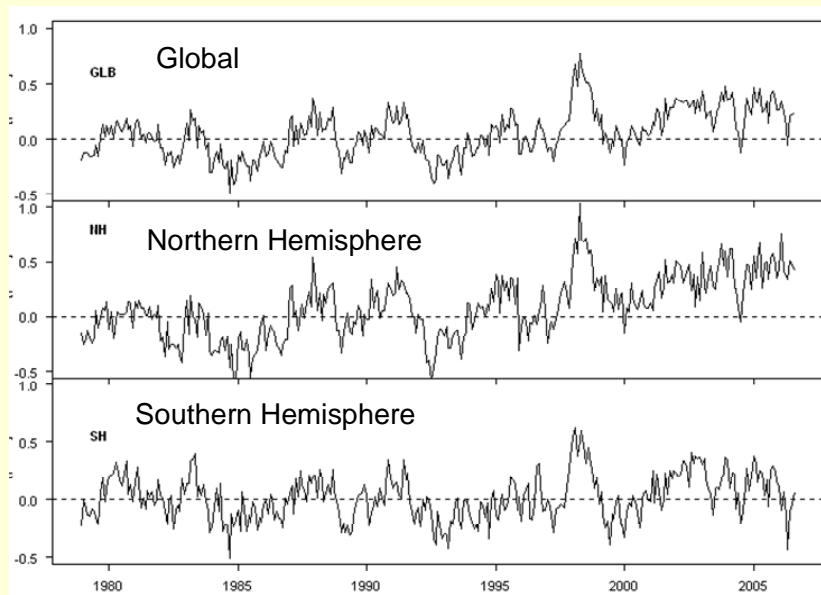
Do we live in a special time in which the laws of physics and nature are suspended? No, we do not. Can we expect relationships between the Sun's activity and climate, that we can see in data going back several hundred years, to continue for at least another 20 years? With absolute certainty.

In this presentation, I will demonstrate that the Sun drives climate, and use that demonstrated relationship to predict the Earth's climate to 2030. It is a prediction that differs from most in the public domain. It is a prediction of imminent cooling.

To put the solar – climate relationship in context, we will begin by looking at the recent temperature record, and then go further back in time.

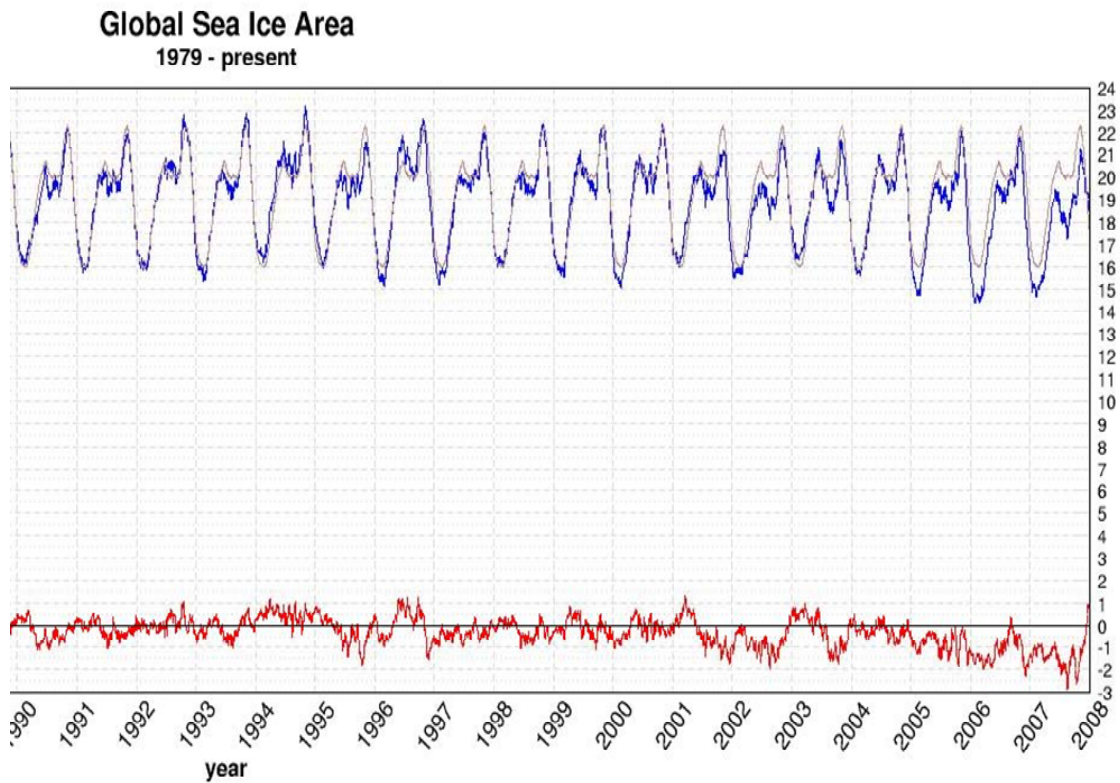
Then we will examine the role of the Sun in changing climate, and following that the contribution of anthropogenic warming from carbon dioxide. I will show that increased atmospheric carbon dioxide is not even a little bit bad. It is wholly beneficial. The more carbon dioxide we can put into the atmosphere, the better the planet will be – for humans, and all other living things.

The 29 years of High Quality Satellite Data



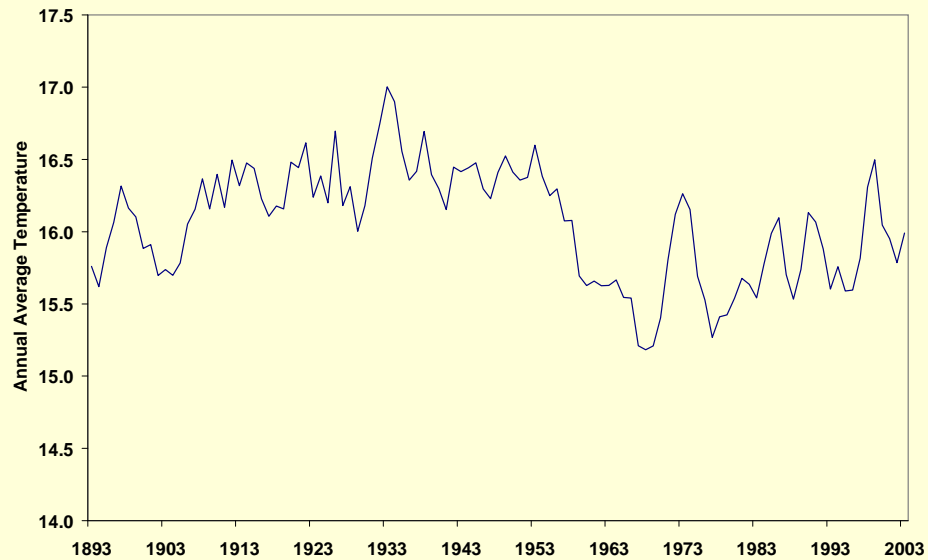
The Southern Hemisphere is the same temperature it was 28 years ago, the Northern Hemisphere has warmed slightly.

The satellite record is the highest quality temperature data series in the climate record. We have 29 years of satellite temperature data. It shows that the temperature of the Southern Hemisphere has been flat, with a slight increase in the Northern Hemisphere. Note the El Nino peak in 1998. Globally, we have had 10 years of temperature decline since that peak in 1998, with a rate of decline of 0.06 degrees per annum. I am expecting the rate of decline to accelerate to 0.2 degrees per annum from the end of this decade.



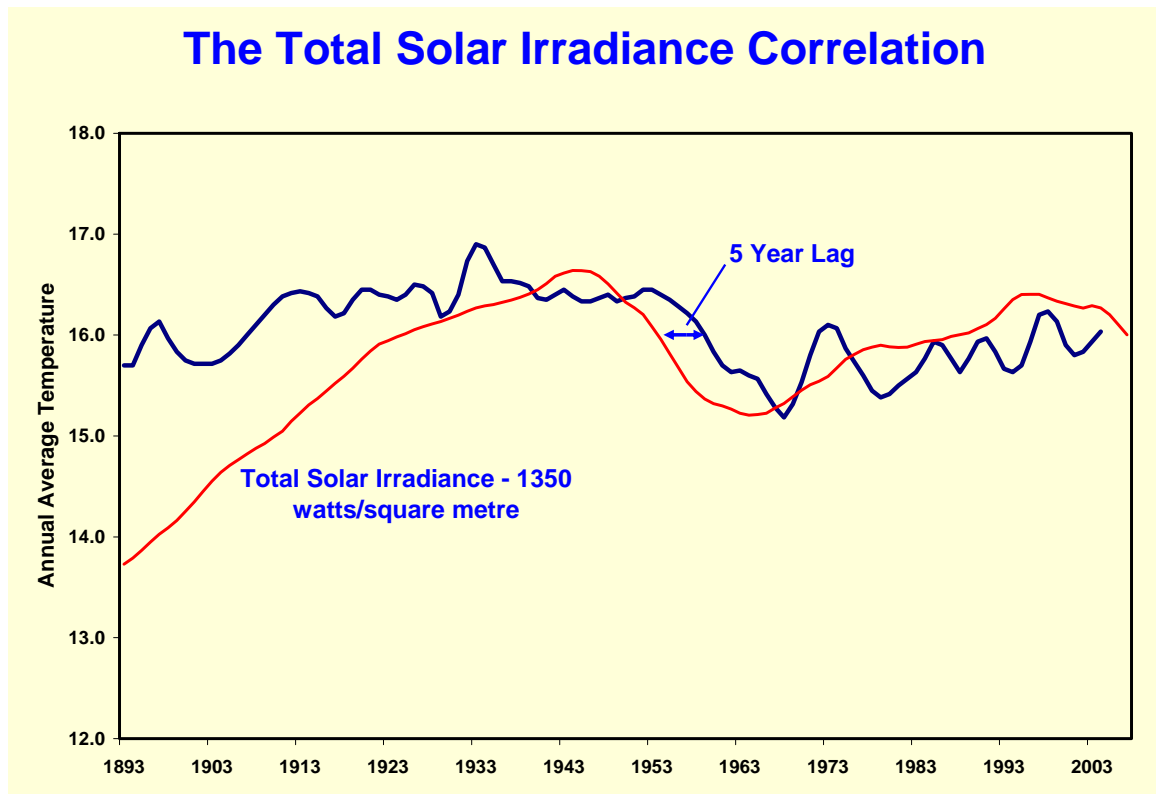
That satellite record is corroborated by the record of Antarctic and Arctic sea ice extent over the same period. There is no long term trend evident. Most recently, there has been a 1 million square kilometre increase over the long term mean. This is a five per cent increase.

A Rural US Data Set



The smoothed average annual temperature of the Hawkinsville (32.3N, 83.5W), Glennville (31.3N, 89.1W), Calhoun Research Station (32.5N, 92.3W), Highlands (35.0N, 82.3W) and Talbotton (32.7N, 84.5W) stations is representative of the US temperature profile away from the urban heat island effect over the last 100 years (Data source: NASA GISS)

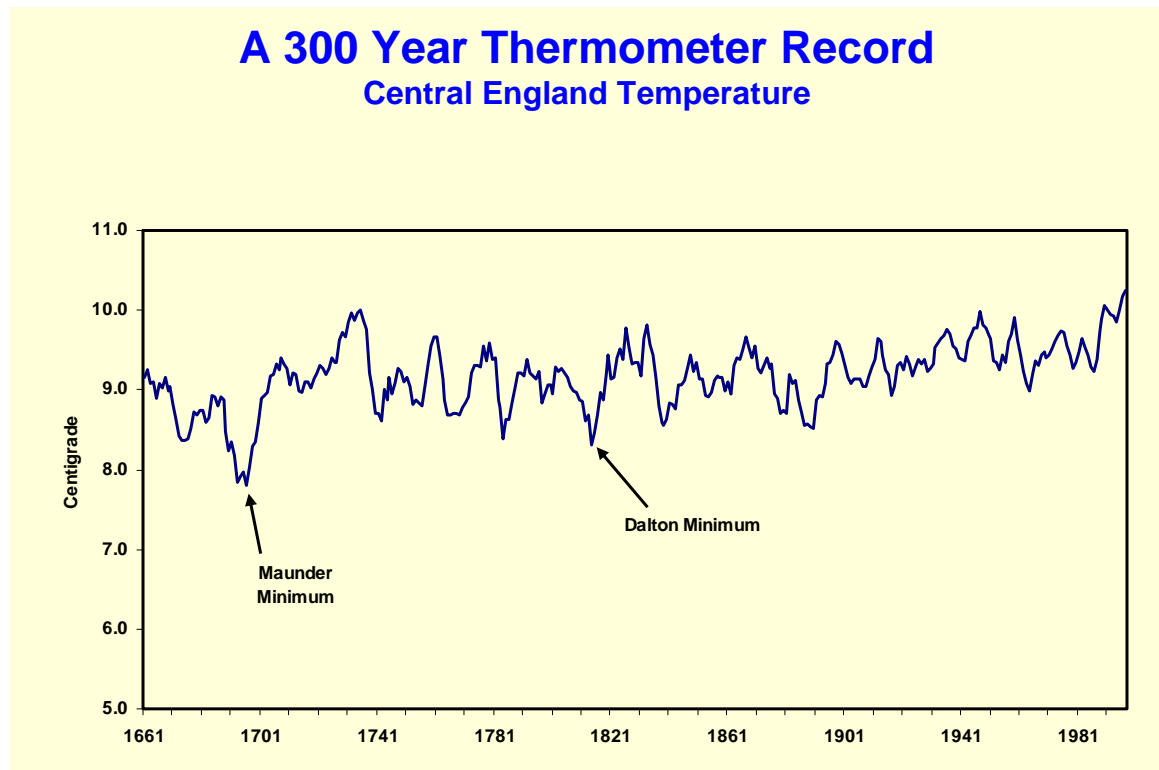
Most rural temperature records in the United States were set in the 1930s and 1940s. Greenland had its highest recorded temperatures in the 1930s and has been cooler since. That is why it is possible to select a number of rural US temperature records and come up with a reconstruction that shows that it is cooler now than it was seventy years ago, and in this case, appreciably cooler than it was seventy years ago. The 1.5° temperature decline from the late 1950s to the mid-70s was due to a weak solar cycle 20 after a strong solar cycle 19.



One thing I believe is that the Earth is a very sensitive thermometer to changes in the Sun. The US rural data set shows a good correlation with minute changes in Total Solar Irradiance in watts per square meter, suggesting that the Earth is indeed a very sensitive thermometer. This is the Total Solar Irradiance from the Hoyt and Schatten reconstruction, with eleven year smoothing, less 1350 watts per square metre.

The peak US temperature was in 1936, at much the same time that Total Solar Irradiance peaked. If you have wondered why US temperatures are still lower than what they were 70 years ago, the fact that Total Solar Irradiance is lower than what it was 70 years ago might provide an explanation.

Correlation does not necessarily mean causation though, and we will progress on to far better solar – temperature correlations.



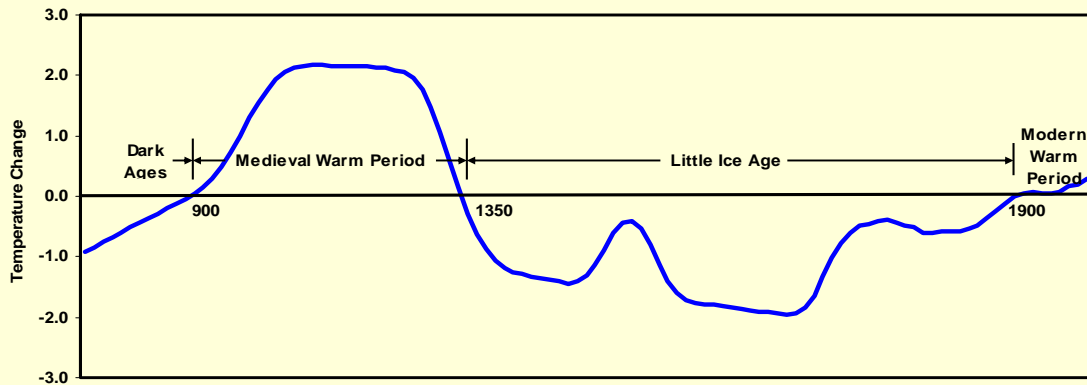
After the invention of thermometers, records started to be kept. This is one of the longest temperature series, and is actually an amalgamation of a number of sites. The recent record has been contaminated by the urban heat island effect.

A number of interesting things can be seen in this record, including the depths of the Little Ice Age in the late 17th century when the Thames regularly froze over, and the Dalton Minimum which was the last time the Thames froze over in the City of London. It last froze over upstream at Oxford in 1963. The warm period in the 1930s and 1940s was seen in the shorter US rural data set and the rise to the El Nino in 1998.

What is also interesting is the 2.2° temperature rise from 7.8° in 1696 to 10.0° in 1732. This is a 2.2° rise in 36 years. By comparison, the world has seen a 0.6° rise over the 100 years of the 20th century. That temperature rise in the early 18th century was four times as large and three times as fast as the rise in the 20th century.

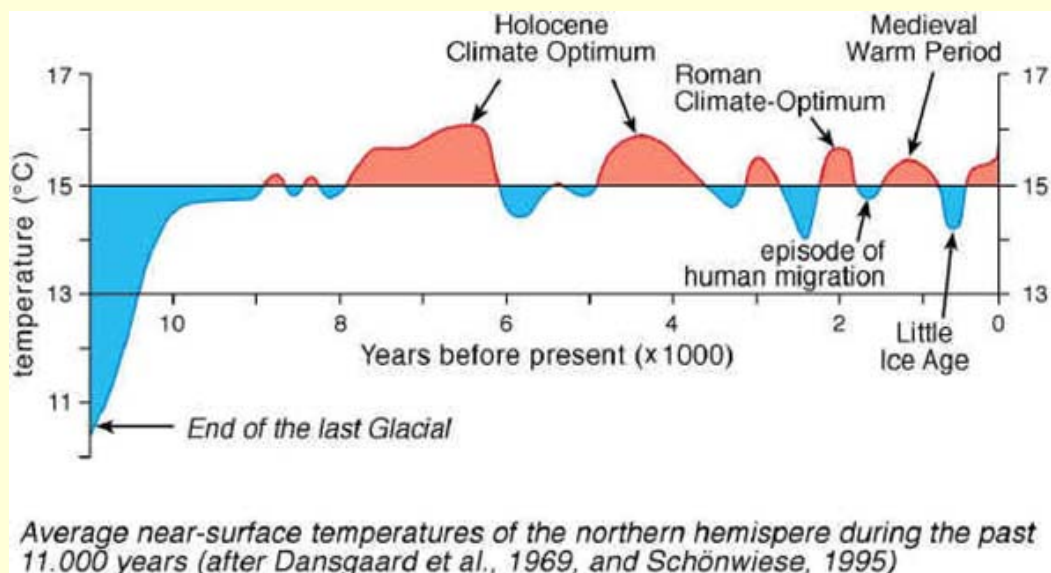
The significance of this is that the world can experience very rapid temperature swings all due to natural causes. The temperature peak of 10° in 1732 wasn't reached again until 1947.

Medieval Warm Period – Little Ice Age

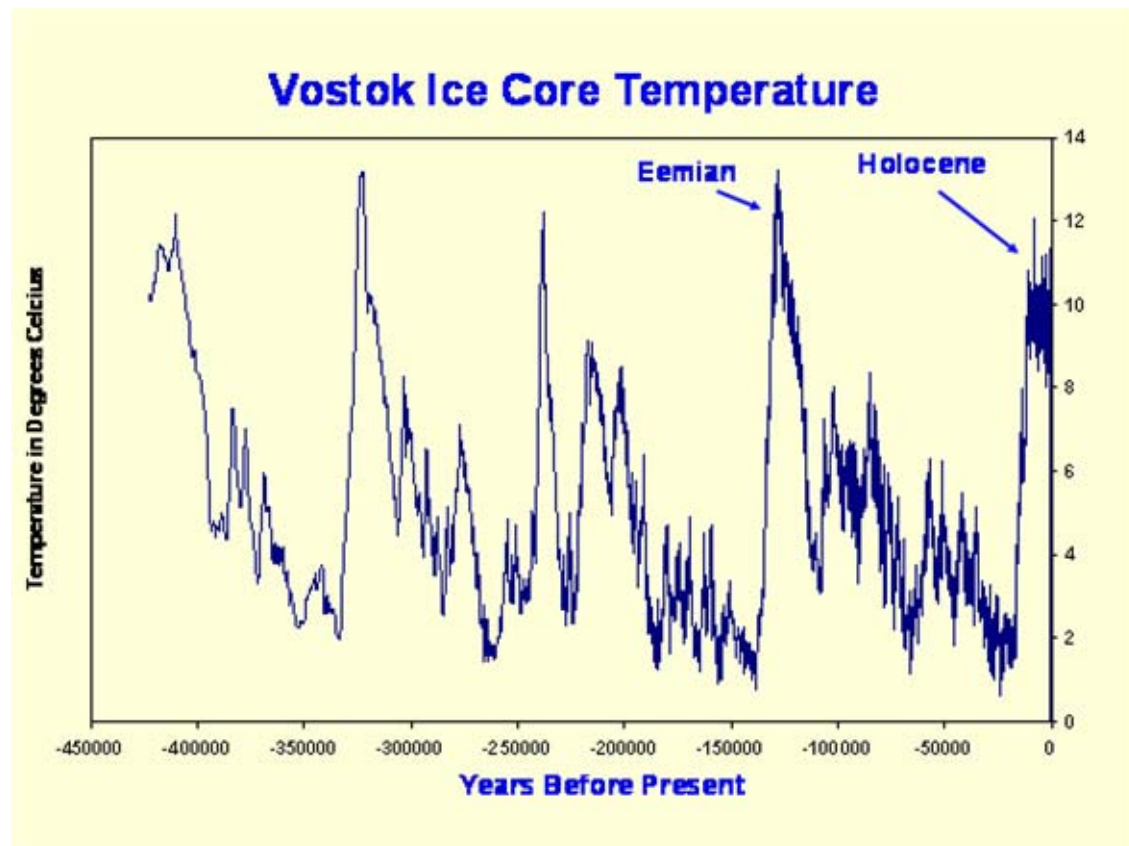


To reconstruct climate prior to thermometer records, isotope ratios and tree ring widths are used. This graph shows the Medieval Warm Period and Little Ice Age. The peak of the Medieval Warm Period was 2° warmer than today and the Little Ice Age 2° colder at its worst. The total range is 4° centigrade. The warming over the 20th century was 0.6 degrees by comparison. This recent warming has melted ice on some high passes in the Swiss Alps, uncovering artifacts from the Medieval Warm Period and the prior Roman Warm Period.

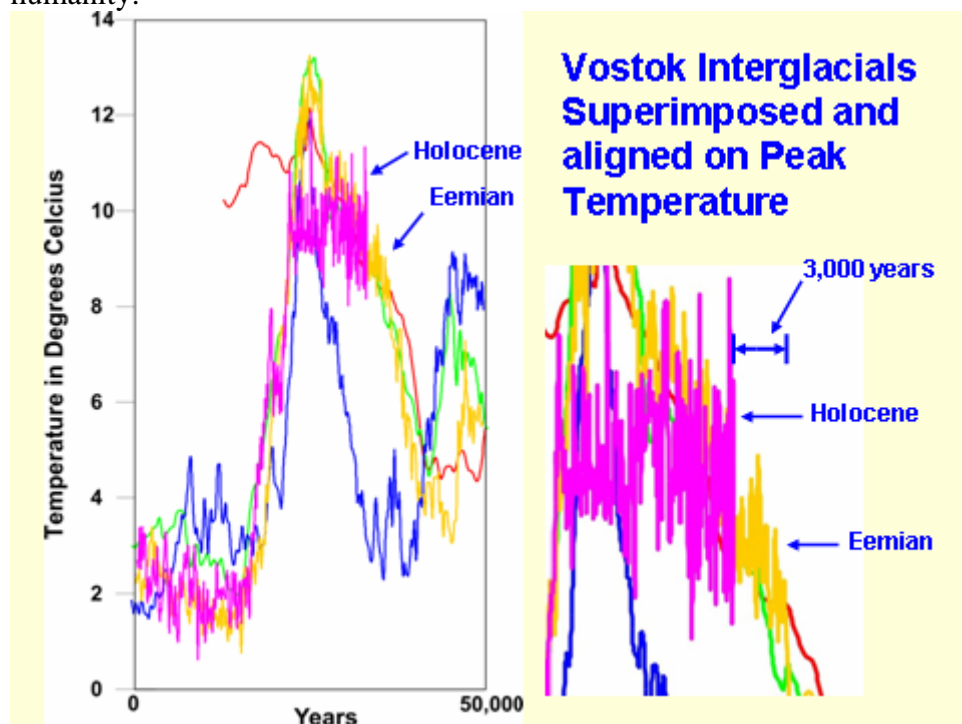
The Holocene Optimum



It was warmer again not long after the last ice age ended. Sea level was 2 metres higher than it is today. Since the Holocene Optimum about eight thousand years ago, we have been in long term temperature decline at about 0.25 degrees per thousand years.

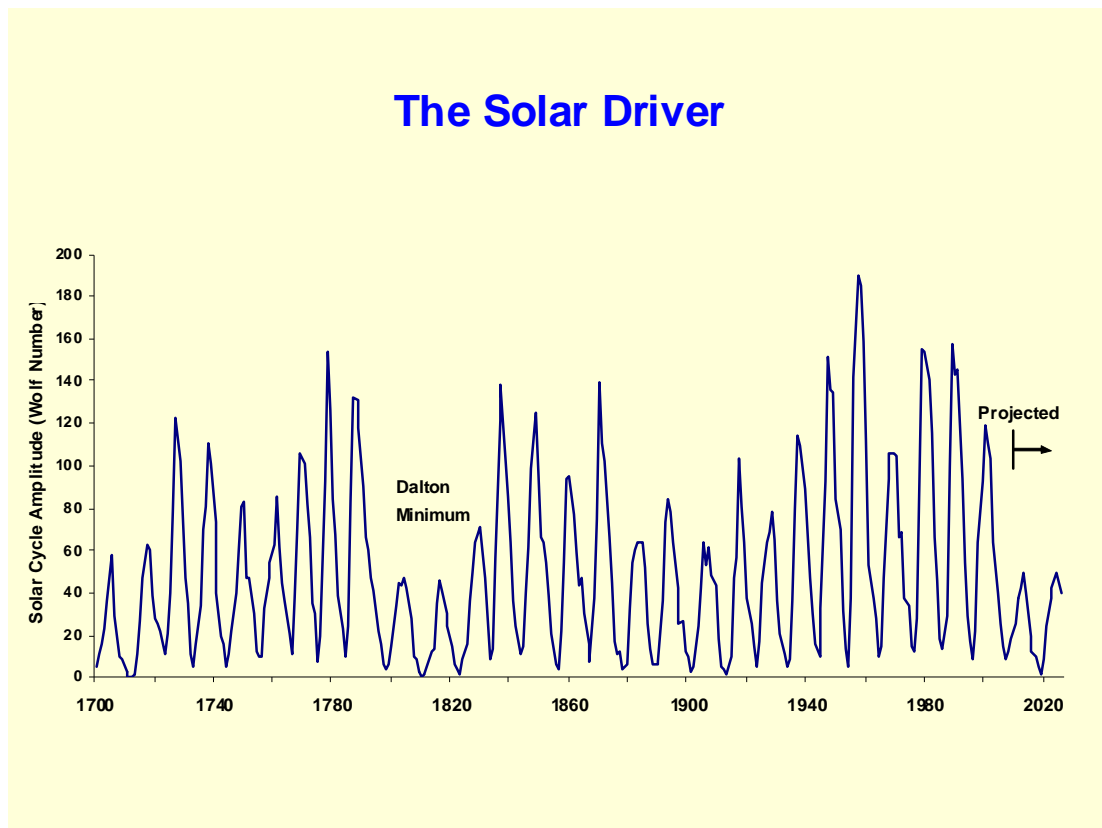


When I asked at the beginning of this presentation if we lived in a special time, well that is true in relation to the last three million years. The special time we live in is called an interglacial. Normally, and that is 90% of the time, the spot I am standing on is covered by several thousand feet of ice. Relative to the last four interglacials, we may be somewhere near the end of the current interglacial. The end of the Holocene will be a brutal time for humanity.



To paraphrase Thomas Hobbes, interglacials are short and then we enter the nasty brutishness of the glacial periods. This graph suggests that that may be soon. It shows the last five interglacials of the Vostok core superimposed on each other, all aligned on the peak temperature reached in each interglacial. I have expanded a portion of that on the right hand side.

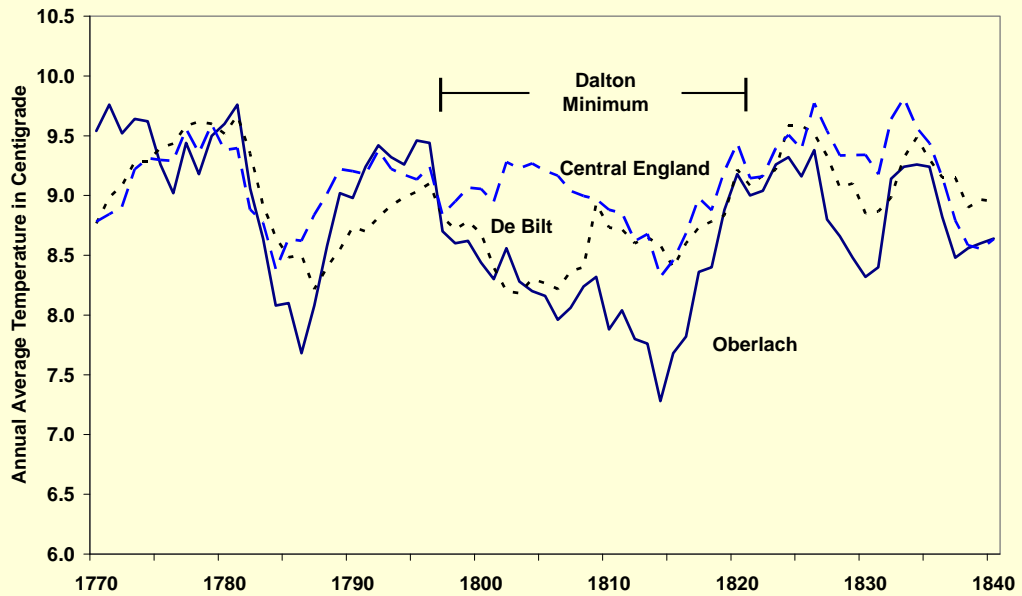
The Holocene, the period we are in now, is tracking along with three of the four previous interglacials. Of those three, if the Holocene ends up being like the Eemian, then we may have up to 3,000 years of Little Ice Age-like conditions before we plunge into the next glacial period. If not, then the plunge could start any time now.



The energy that stops the Earth from looking like Pluto comes from the Sun, and the level of this energy does change. This graph is of sunspot cycles since 1700.

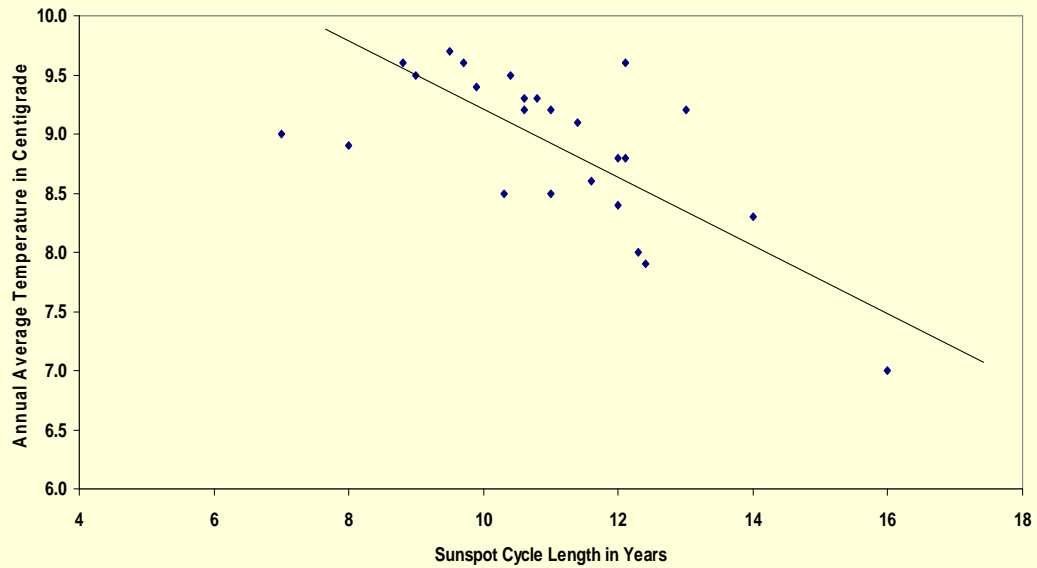
The average length of a sunspot cycle is about 11 years. The Dalton Minimum is a period of lower temperatures from 1796 to 1820 caused by the low amplitude of solar cycles 4 and 5. We are currently near the end of solar cycle 23. When solar cycle 23 ends is very important, as we will see in the next few graphs.

The Dalton Minimum at Three European Stations 1770 to 1840



This graph shows the temperature response to solar cycles 5 and 6 at three European stations. There was a 2° decline at Oberlach in Germany over that period.

Sunspot Cycle Length Relative to Temperature De Bilt, Netherlands 1705 - 2000



There is a better correlation between temperature and solar cycle length, rather than with solar cycle amplitude. I produced this graph using data from De Bilt in the Netherlands. The slope of the line is 0.6 degrees centigrade per year of solar cycle length.

Sunspot Cycle Length Relative to Temperature Armagh, Northern Ireland 1796 – 1992

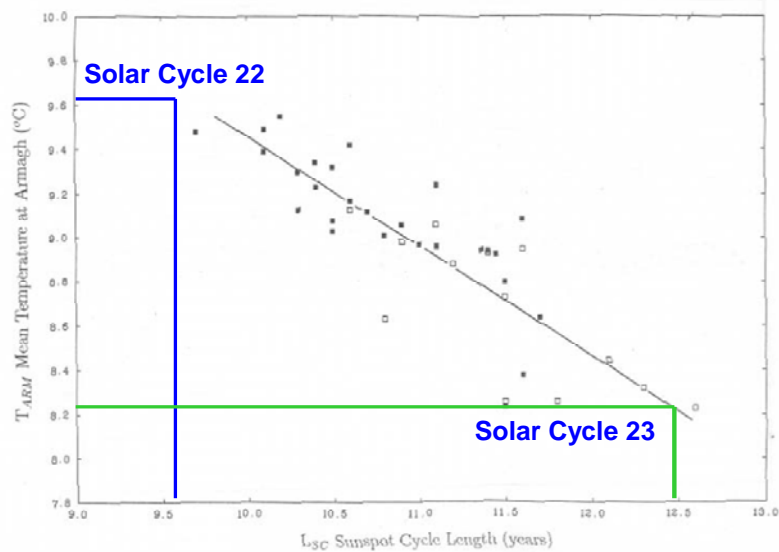


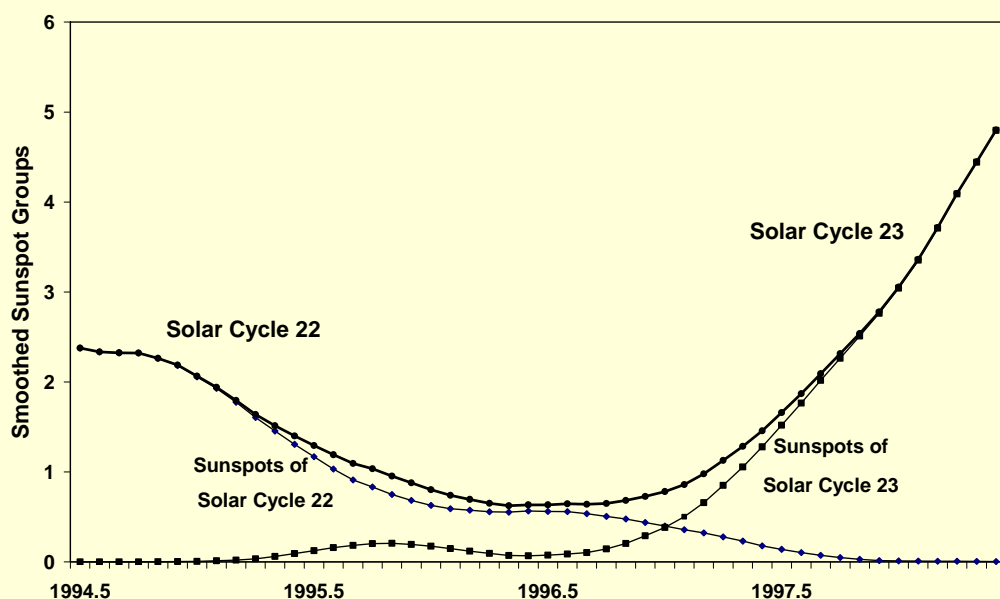
Figure 5. The mean temperature at Armagh for 11 year intervals, centred on years of sunspot maximum and minimum, plotted against the sunspot cycle length. Symbols: open squares - Series I, filled squares - Series II. The mean regression line is shown.

A strong relationship between solar cycle length and temperature is seen in other data sets. This is a figure from a 1996 paper by Butler and Johnson of the Armagh observatory. The slope of the line is half a degree centigrade per one year change in solar cycle length, which amounts to 1.4 thousands of a degree per day.

Let's assume that the relationship demonstrated in nearly 200 years of Armagh data, and 300 years of De Bilt data, is valid today. I have plotted on top of the original figure solar cycle 22, which was 9.6 years long. Solar cycle 23 hasn't finished yet. The first sunspot of Solar Cycle 24 was seen on 4th January, 2008, but the month of solar minimum may not be until mid 2009. I have plotted on this figure what a 13 year long Solar Cycle 23 would look like. It follows that the temperature at Armagh will be 1.6 degrees lower. This effect is upon us right now. In a few short years, we will have a reversal of the warming of the 20th century.

If Solar Cycle 24 is as weak as a number of solar physicists are predicting, then Solar Cycle 23 may be 13 years long, or longer. Solar cycle 4, preceding the Dalton Minimum, was 13.6 years long.

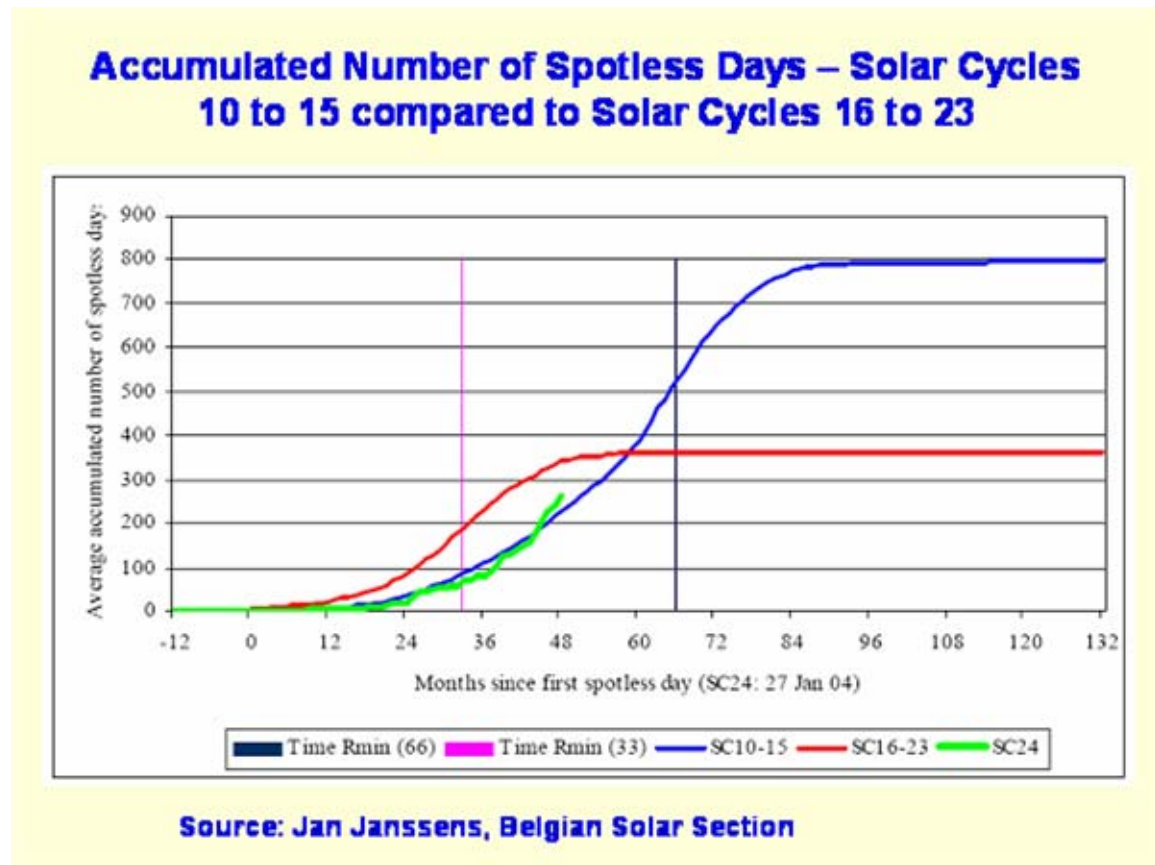
The Transition from Solar Cycle 22 to Solar Cycle 23



This graph shows the transition of one sunspot cycle to the next, using the example of the solar cycle 22 to solar cycle 23 transition.

The sun reverses magnetic polarity with each solar cycle, and sunspots of the new cycle start forming before the old cycle has completely died off. The average length of a solar cycle is 10.7 years. Solar Cycle 23 started in May 1996, rising to a peak of 120.9 in April 2000. For Solar Cycle 23 to be of average length, Solar Cycle 24 should have started in January 2007. The first sunspots of a new solar cycle appear usually at more than 20°

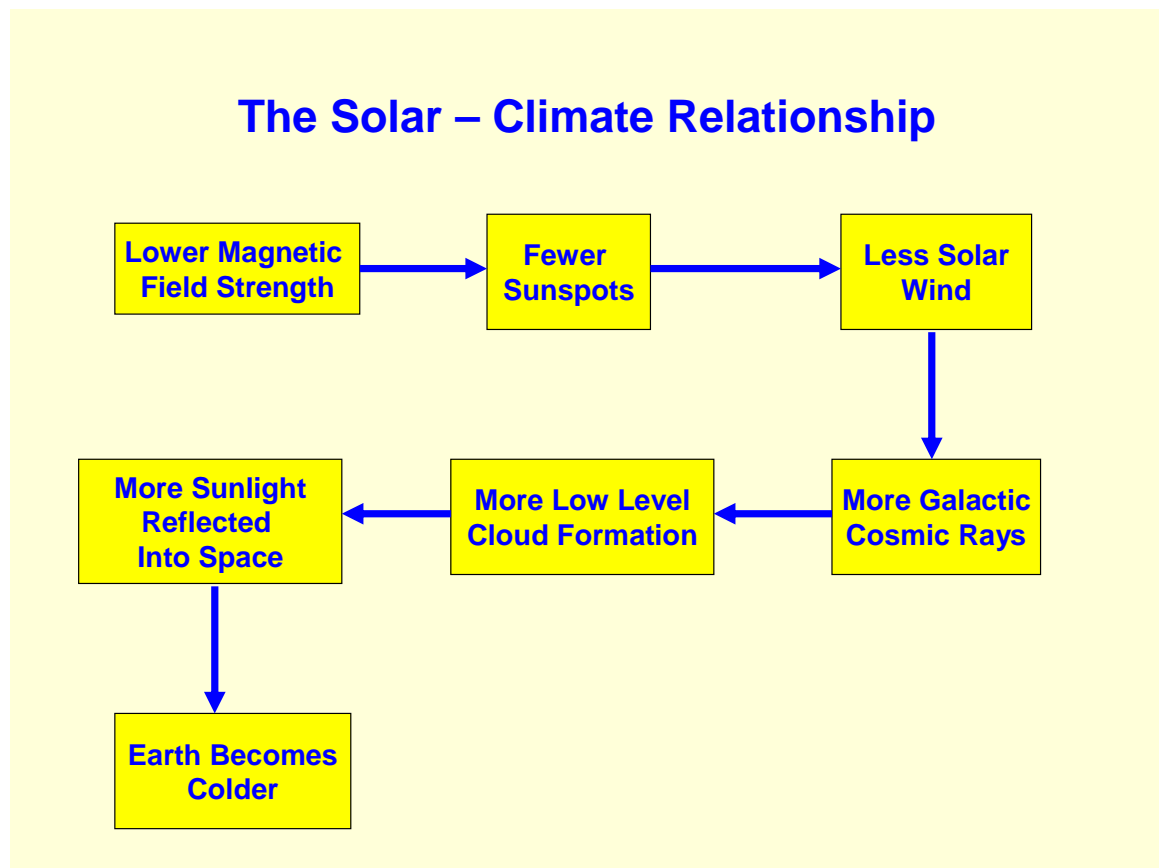
latitude on the Sun's surface. According to the last couple of solar cycles, the first sunspots appear twelve to twenty months prior to the start of the new cycle. With the first sunspot of Solar Cycle 24 seen on 4th January, 2008, Solar Cycle 24 may start from late 2008 to mid-2009.



This graph is another pointer that we are heading back to the weak solar cycles of the 19th century, with 19th century type winters to accompany them.

Solar cycles 10 to 15, from 1860 to 1917, had an average of 66 months from the first spotless day to solar cycle minimum. This was a time of considerable glacial advance in the European Alps. Since then, solar cycles have averaged half that at 33 months from first spotless day to solar cycle minimum.

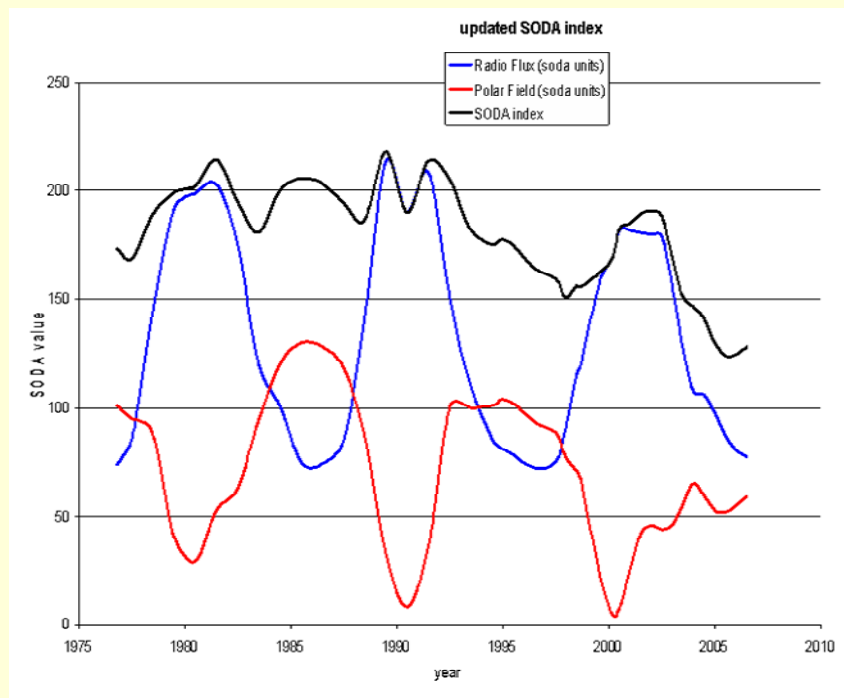
So far, solar cycle 24 is plotting on the 19th century line. With the first spotless day on 27th January, 2004, and if the 66 month observation holds, then solar minimum will be on or about July 2009. This would make solar cycle 23 thirteen years long.



At its simplest, the relationship between the solar magnetic field strength and the Earth's climate is this: lower magnetic field strength means few sunspots, fewer sunspots means less solar wind, less solar wind means more galactic cosmic rays, more galactic cosmic rays means more low level cloud formation, more low level clouds means more sunlight reflected back into space, which in turn means less heating of the Earth's surface and atmosphere.

Climate is not a random walk. If you can find a solar physicist to give you a prediction of solar activity, you can use that to make a prediction of climate. That prediction will be good for perhaps twenty-five years out.

The Solar Dynamo Index

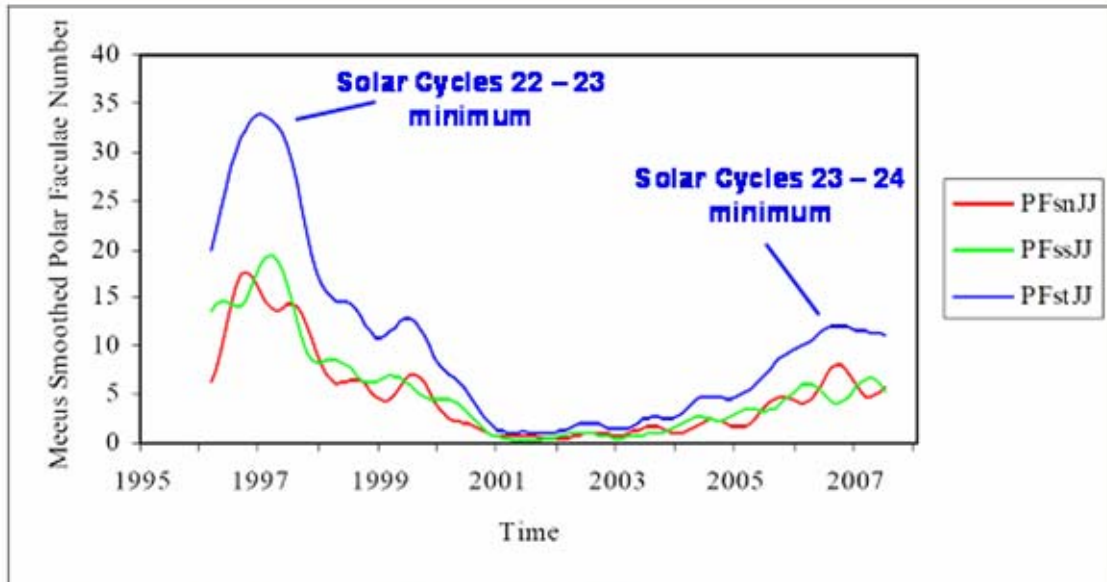


We can follow the path outlined in the previous slide. Ken Schatten is the solar physicist with the best track record in predicting the strength of solar cycles, using the solar dynamo theory he co-authored in 1978.

This is the basis of Ken Schatten's prediction. The red line is the strength of the polar magnetic fields on the Sun and the blue line is the strength of the toroidal magnetic fields. During a sunspot cycle, polar magnetic fields are converted to toroidal magnetic fields and back again.

Sunspots form from the toroidal magnetic fields breaking through to the Sun's surface. The black line sums the polar and toroidal magnetic field strengths. This has been in downtrend since the early 1990s. This downtrend means that there is much less magnetic force available to make sunspots, so solar cycle 24 will be much weaker than solar cycle 23.

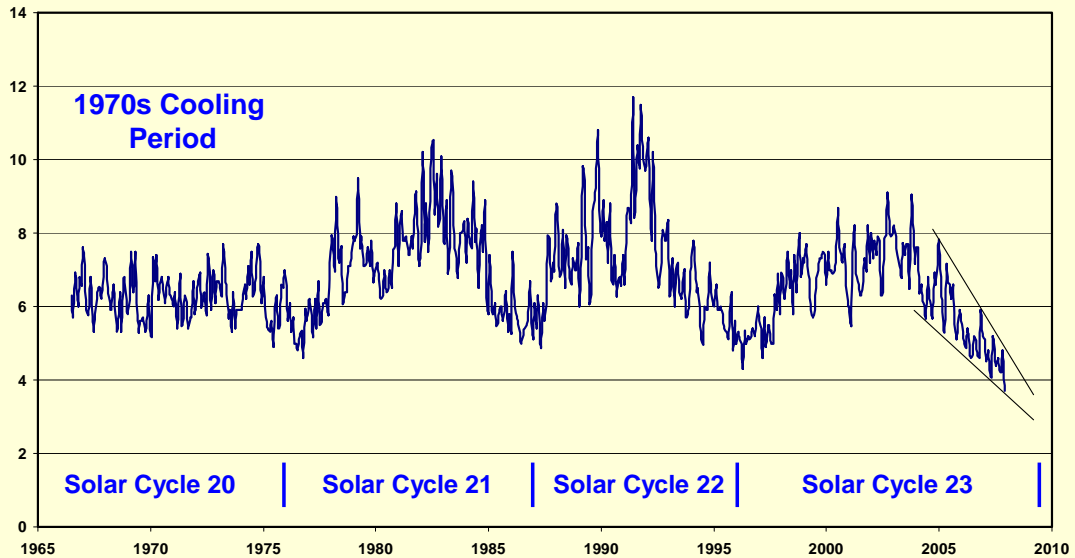
Polar Faculae



Source: Jan Janssens, Belgian Solar Section

Polar faculae are another sign of weaker magnetic fields on the Sun. Based on the relative number of polar faculae during this minimum relative to the last, and the intervening solar cycle peak of 120, I predict that the amplitude of Solar Cycle 24 will be 45. This is very similar to the amplitudes of Solar Cycles 5 and 6 during the Dalton Minimum.

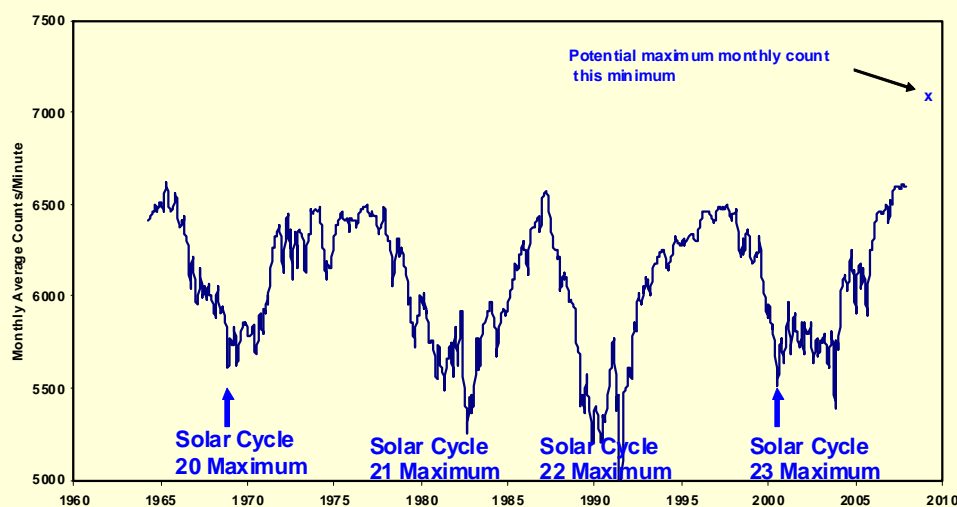
Interplanetary Magnetic Field



A weak solar magnetic field produces a weak interplanetary magnetic field. There are a few interesting features on this graph. Note that the flatness of the interplanetary magnetic field associated with the 1970s cooling period associated with Solar Cycle 20.

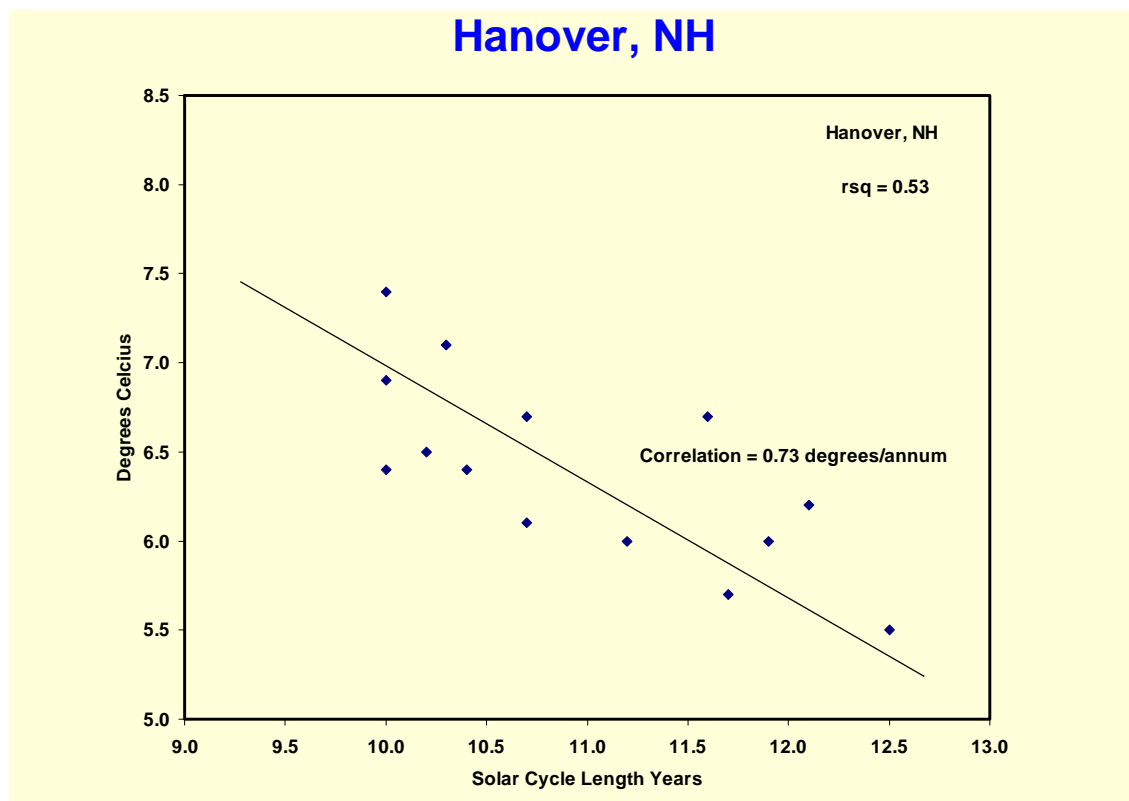
What is significant is that the strength of the interplanetary magnetic field has fallen below the levels of previous solar minima, and we are possibly still a year off the month of solar minimum.

Oulu, Finland Neutron Monitor Count 1960 - 2010



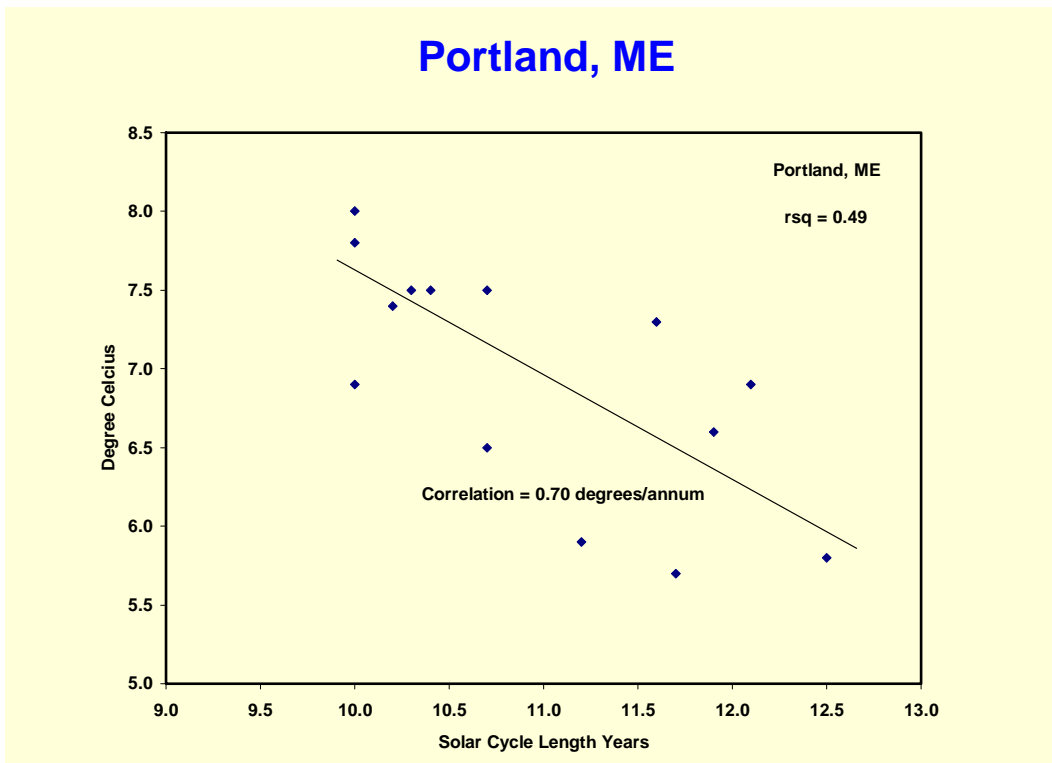
The first earthly consequence of a weak interplanetary magnetic field is a higher count of galactic cosmic rays, seen here in the neutron count of the Oulu station in Finland. I have plotted on this graph what I expect to be the maximum neutron count in this solar minimum, based on what the interplanetary field strength could fall to.

The increased galactic cosmic rays will cause increased cloudiness, which in turn increases the Earth's albedo, and the world then cools in search of a new equilibrium.

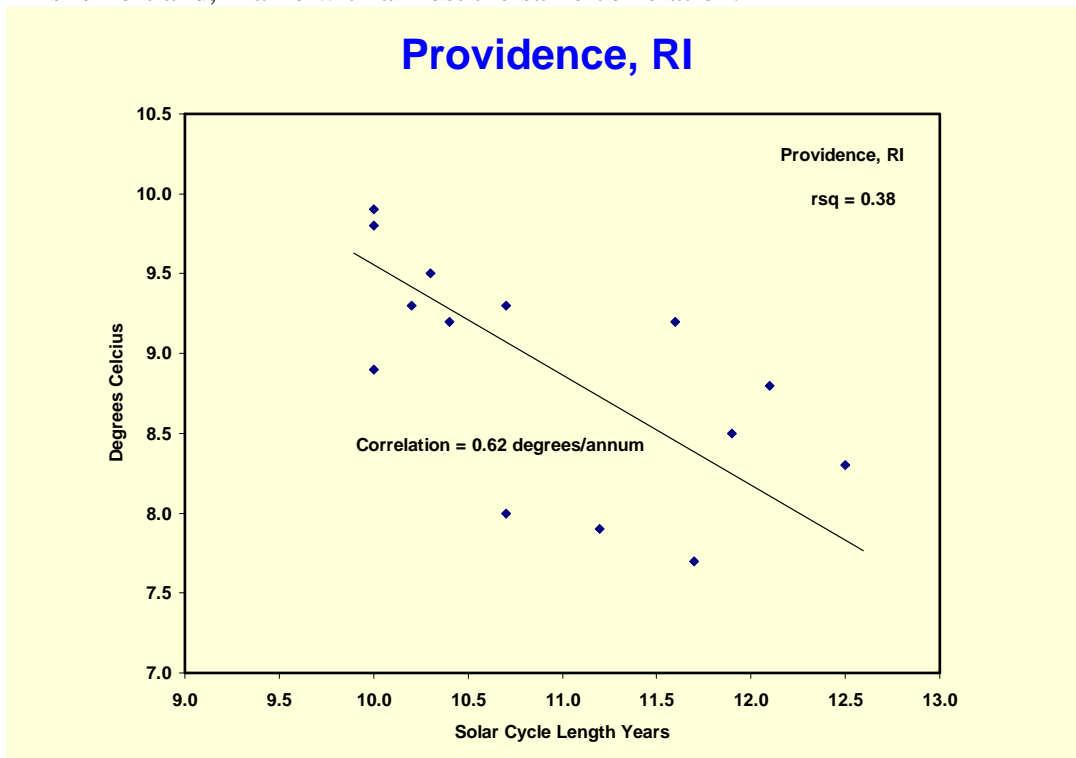


What are the implications of all this for the United States? We will now look at some longer term US temperature records in the context of solar cycle length.

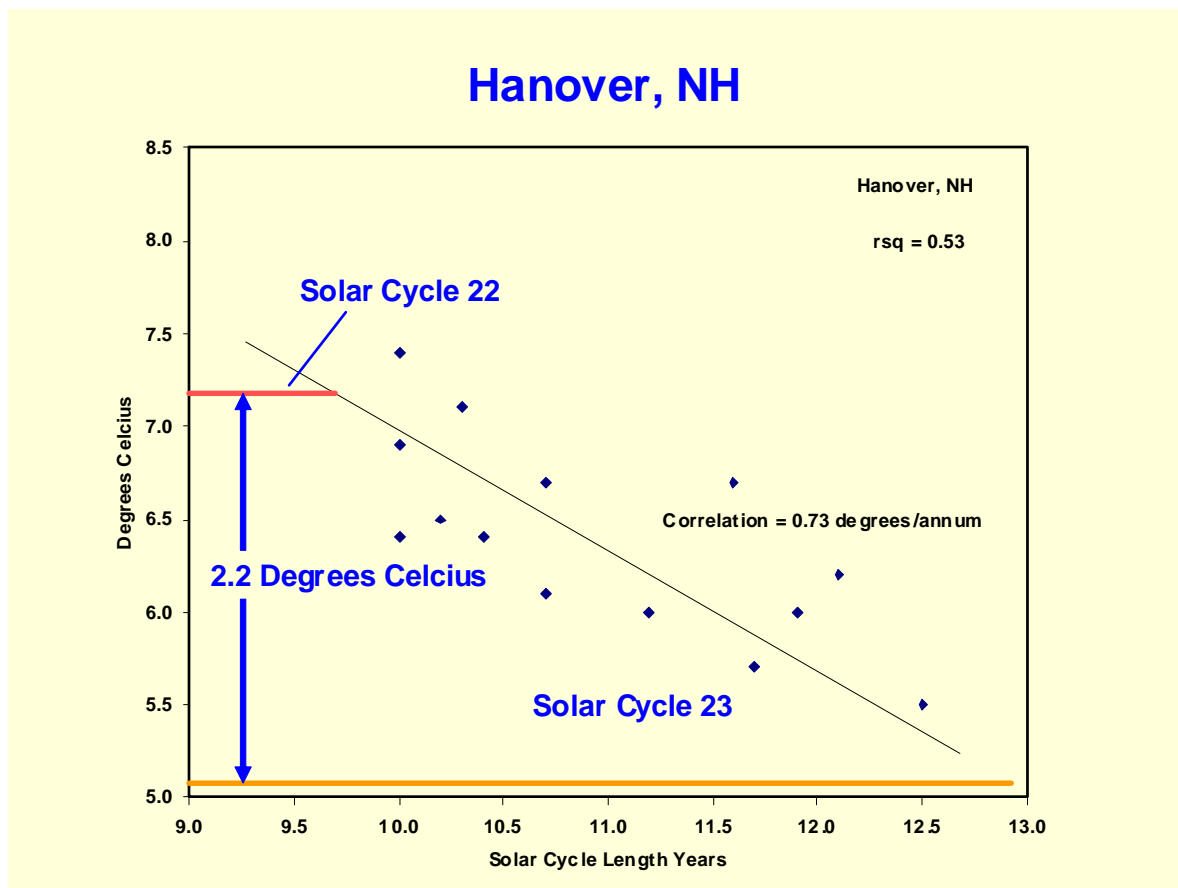
This is Hanover, New Hampshire with a very good correlation and a slope of 0.73 degrees celcius per year of solar cycle length of the previous cycle.



This is Portland, Maine with almost the same correlation.



This is Providence, Rhode Island with a wider spread of data points but still a good correlation.



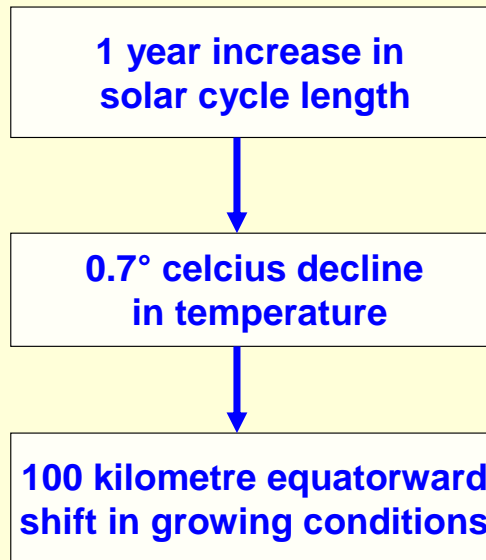
Now let's look at Hanover again and plot up where we are currently in terms of solar cycles. Solar Cycle 22 was 9.6 years long. On the basis that Solar Cycle 23 is thirteen years long, there will be a 2.2 degree celcius decline in temperature in Hanover, New Hampshire over the next decade. In terms of quantum, this is three times the temperature rise over the twentieth century, but in the opposite direction.

To date, society has only been concerned about solar cycles and sunspots and so on in terms of their effect on the longevity of low earth orbit satellites. That is an important business, but soon the focus will change to our ability to feed ourselves, and that is a subject that will concentrate a lot of minds.

The evidence from the Hanover solar cycle length to temperature relationship, and that of the other cities in this presentation, is incontrovertible. There will be a significant cooling very soon.

Our generation has known a warm, giving Sun, but the next generation will suffer a Sun that is less giving, and the Earth will be less fruitful.

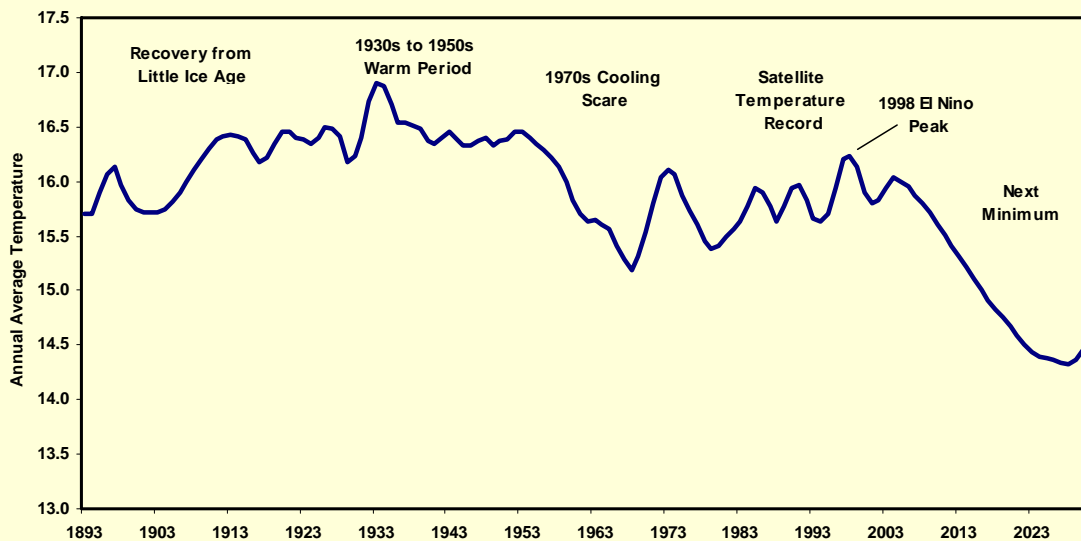
The Consequential Climate Shift



A cursory examination of the temperature map of the United States suggests that every 0.7 of a degree change in temperature will shift climatic conditions 100 kilometres.

The big consequence of this is that it will shrink the growing season. The 2.2 degree decline I am predicting will take two weeks off the growing season at both ends. Next decade will not be a good time to be a Canadian wheat farmer. For farmers further south, farm production will decline but that production will be worth a considerable amount more.

Projected Temperature Profile to 2030



Combining the rural US data set we saw earlier and the projected temperature response to the length of Solar Cycle 23, this graph shows the expected decline to 2030.

The temperature decline will be as steep as that of the 1970s cooling scare, but will go on for longer.

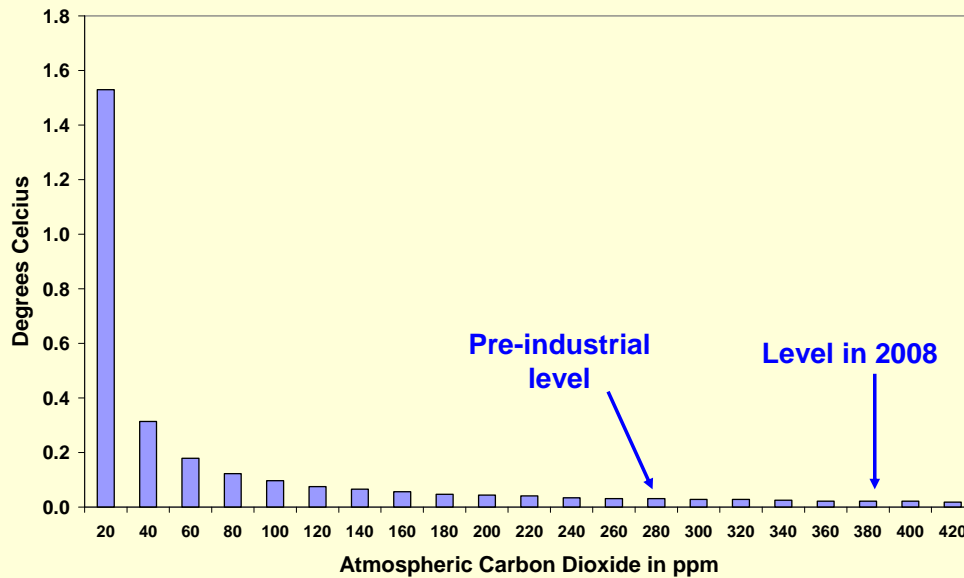
Another Dalton Minimum, or Worse?

“The surprising result of these long-range predictions is a rapid decline in solar activity, starting with cycle #24. If this trend continues, we may see the Sun heading towards a “Maunder” type of solar activity minimum - an extensive period of reduced levels of solar activity.”

K.H.Schatten and W.K.Tobiska, 34th Solar Physics Division Meeting,
June 2003, American Astronomical Society

It can get worse than a repeat of the Dalton Minimum. Ken Schatten is the solar physicist with the best track record in predicting solar cycles. His work suggests a return to the advancing glaciers and delayed spring snow melt of the Little Ice Age, for an indeterminate period.

The Warming Effect of Atmospheric Carbon Dioxide



Can global warming from increased atmospheric carbon dioxide save us from a collapse in mid-latitude agricultural production? Not at all.

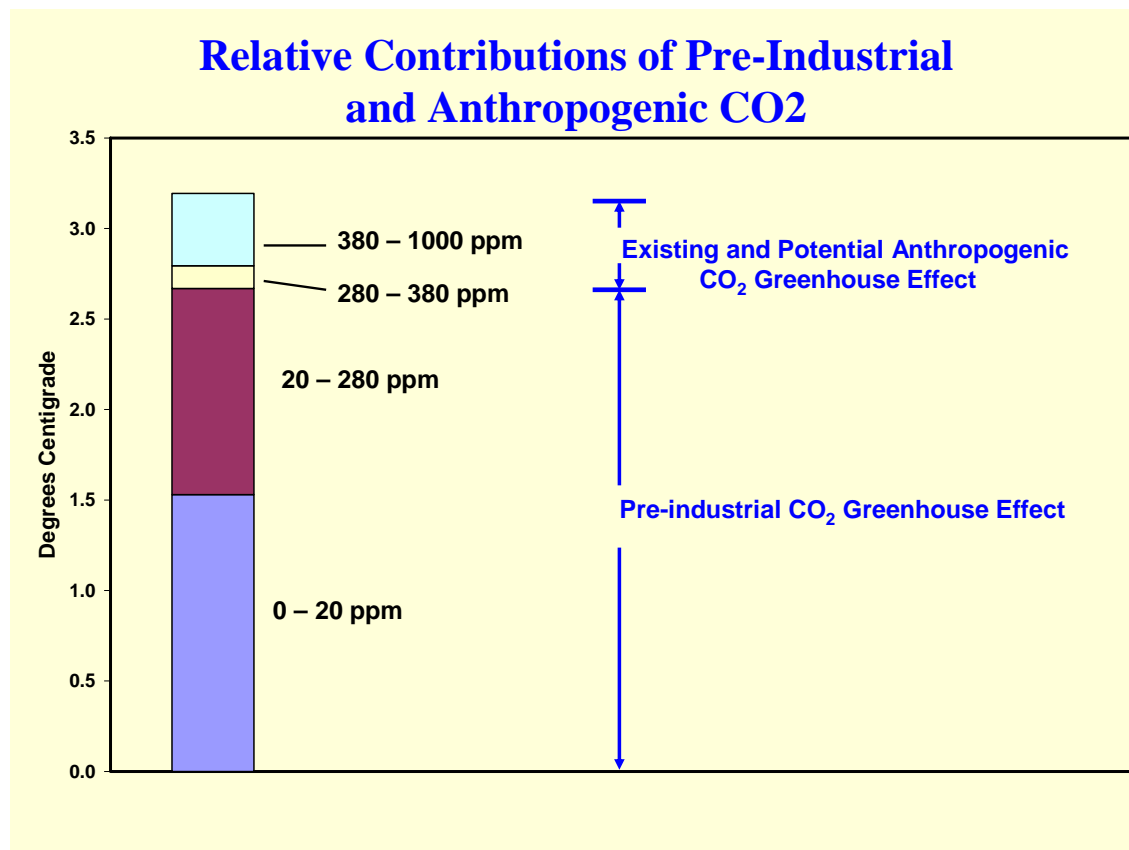
Anthropogenic warming is real, it is also minuscule. Using the MODTRAN facility maintained by the University of Chicago, the relationship between atmospheric carbon dioxide content and increase in average global atmospheric temperature is shown in this graph.

The effect of carbon dioxide on temperature is logarithmic and thus climate sensitivity decreases with increasing concentration. The first 20 ppm of carbon dioxide has a greater temperature effect than the next 400 ppm. The rate of annual increase in atmospheric carbon dioxide over the last 30 years has averaged 1.7 ppm. From the current level of 380 ppm, it is projected to rise to 420 ppm by 2030.

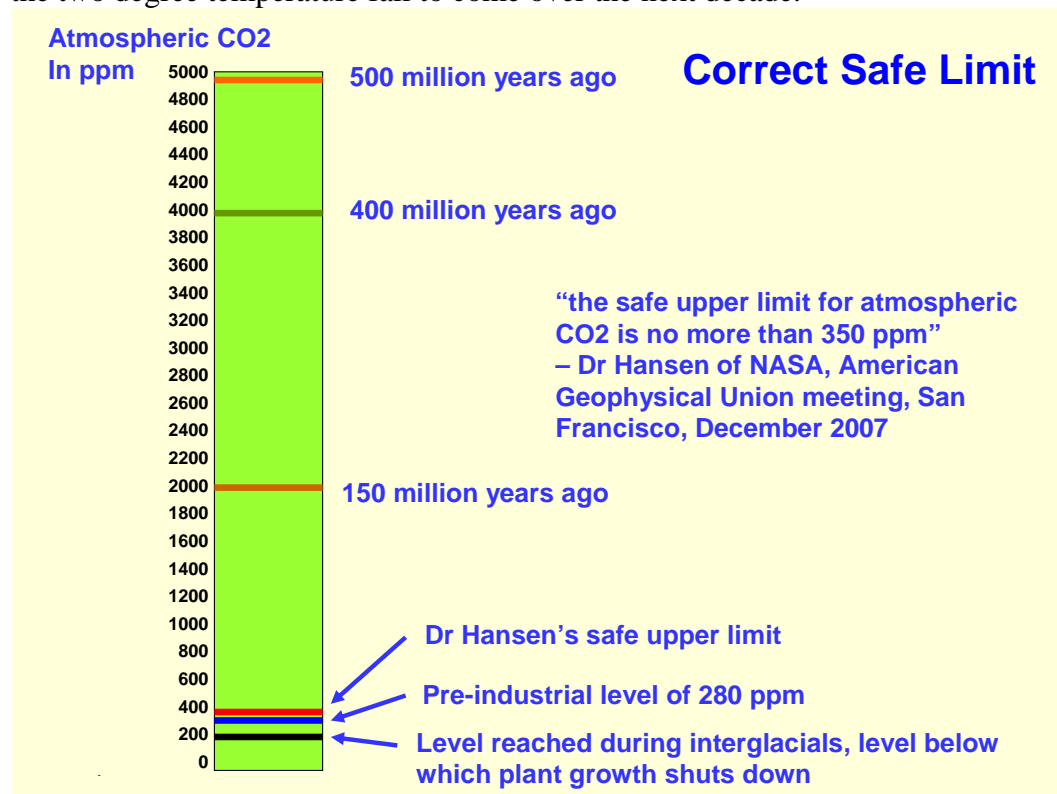
The projected 40 ppm increase reduces emission from the stratosphere to space from 279.6 watts/m² to 279.2 watts/m². Using the temperature response demonstrated by Idso (1998) of 0.1°C per watt/m², this difference of 0.4 watts/m² equates to an increase in atmospheric temperature of 0.04°C.

Increasing the carbon dioxide content by a further 200 ppm to 620 ppm, projected by 2150, results in a further 0.16°C increase in atmospheric temperature.

Since the beginning of the Industrial Revolution, increased atmospheric carbon dioxide has increased the temperature of the atmosphere by 0.1°.

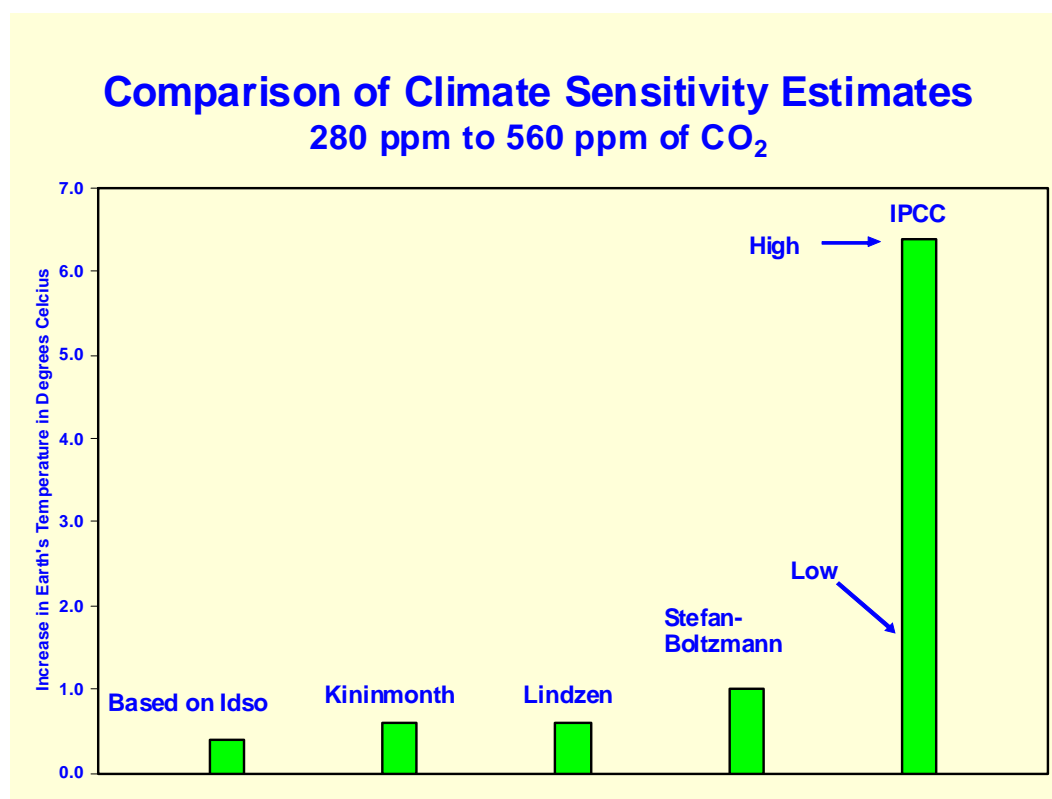


This isn't much, in fact it is almost next to nothing. To the end of time, and let's call that 1,000 ppm of carbon dioxide in the atmosphere, the total effect might be good for 0.4 degrees. It is hard to get excited or concerned about such a number. It is swamped by natural variability, for example the two degree temperature range of the 20th century, and the two degree temperature fall to come over the next decade.



Recently, a Dr Hansen of NASA made a statement that the maximum safe level of carbon dioxide in the atmosphere is 350 ppm, about 10% below its current level. To illustrate just how idiotic that statement is, this graph shows Dr Hansen's danger level of 350 ppm relative to levels that the Earth has experienced from the recent to the distant past. The Earth has happily survived levels more than ten times the level that Dr Hansen considers to be the threshold of disaster.

There are a couple of things to note from this graph. One is that carbon dioxide levels have fallen over geological time. Relative to the last five hundred million years, the natural level is around 2,500 ppm. The second thing is that prior to the Industrial Revolution, the atmospheric carbon dioxide level was bumping along the level required to sustain life on this planet. The more we take carbon dioxide above that minimum critical level, the safer life on this planet will be.



This graph compares my result, based on Idso's climate sensitivity derived from observations of Nature, with the estimates of the most prominent in this field. Commonly, sensitivity is based on what would happen if the carbon dioxide level in the atmosphere doubled from its pre-industrial level, as if this was something tragic, when in fact we know that that will be something wonderful when it does happen.

The Stefan Boltzmann figure of one degree centigrade is based on the Stefan-Boltzmann equation without the application of feedbacks. Everybody agrees that this is what would happen if there were no feedbacks involved.

Bill Kininmonth is a former head of Australia's National Climate Centre. His estimate of the forcing is 0.6C and this is based on water vapour amplification but also includes the strong damping effect of surface evaporation.

Richard Lindzen is America's most eminent climate scientist. His estimate of the forcing is based on water vapour and negative cloud feedback.

The models the IPCC rely upon take the one degree of heating from the Stefan-Boltzmann equation and apply an enormous amount of compounding water vapour feedback. At their worst, the IPCC models take one degree of heating and turn it into 6.4 degrees. As such, these models are based on the premise that the Earth's climate is tremendously unstable, prone to thermal runaway at the slightest disturbance.

The eminent climate scientists believe the opposite. This would be just an interesting divergence of opinion if it weren't for the fact that tens of millions of people stand to lose their jobs, and billions of people beyond that will suffer unnecessarily, as a consequence of those modelled feedback assumptions. Before hundreds of billions of dollars are squandered, resources misallocated, and many people driven into penury, it would be a productive exercise to examine the basis of the modelled feedback assumptions, especially when the eminent scientists in the field have the contrary opinion.

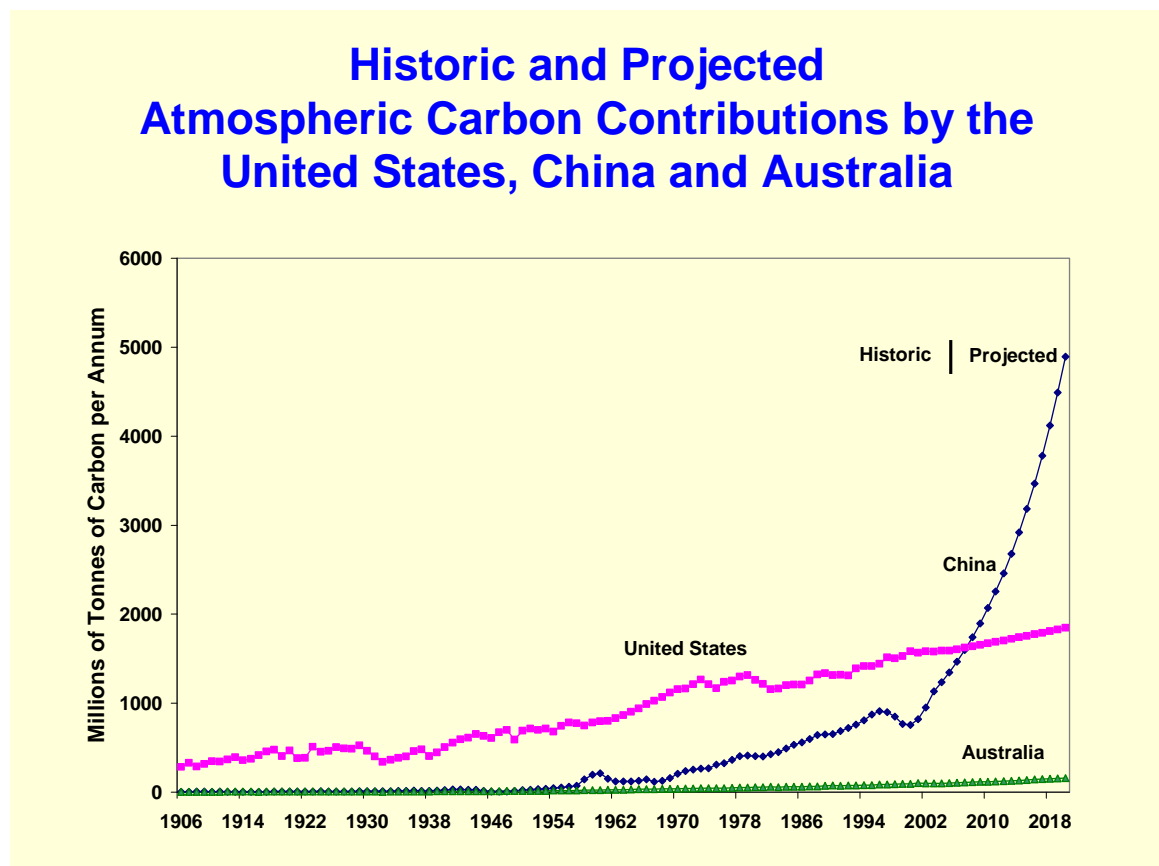
		Sunspot Cycle Length				
		Year of Minimum	Year of Maximum	Cycle from Minimum years	Cycle from Maximum years	Cycle No
<p>Replicating This Work</p> <p>US Historical Climatology Network:</p> <p>http://cdiac.ornl.gov/epubs/ndp/ushcn/usa_monthly.html#map</p> <p>Solar Cycle Length:</p> <p>Friis-Christensen, E., and K. Lassen, Length of the Solar Cycle: An indicator of Solar Activity Closely Associated with Climate, Science 254, 698-700, (1991)</p> <p>Carbon Dioxide Warming Effect – Modtran Facility:</p> <p>http://geosci.uchicago.edu/~archer/cgimodels/radiation.html</p>		1610.8	1615.5			
		1619.0	1626.0	15.0	13.5	
		1634.0	1639.5	11.0	9.5	
		1645.0	1649.0	10.0	11.0	
		1655.0	1660.0	11.0	15.0	
		1666.0	1675.0	13.5	10.0	
		1679.5	1685.0	9.5	8.0	
		1689.0	1693.0	9.0	12.5	
		1698.0	1705.5	14.0	12.7	
		1712.0	1718.2	11.5	9.3	
		1723.5	1727.5	10.5	11.2	
		1734.0	1738.7	11.0	11.6	
		1745.0	1750.3	10.2	11.2	
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		1766.5	1769.7	9.0	8.7	2
		1775.5	1778.1	9.2	9.7	3
		1784.7	1788.1	13.6	17.1	4
		1798.3	1805.2	12.3	11.2	5
		1810.6	1816.4	12.7	13.5	6
		1823.3	1829.9	10.6	7.3	7
		1833.9	1837.2	9.6	10.9	8
		1843.5	1848.1	12.5	12.0	9
		1856.0	1860.1	11.2	10.5	10
1867.2	1870.6	11.7	13.3	11		
1878.9	1883.9	10.7	10.2	12		
1889.6	1894.1	12.1	12.9	13		
1901.7	1907.0	11.9	10.6	14		
1913.6	1917.6	10.0	10.8	15		
1923.6	1928.4	10.2	9.0	16		
1933.8	1937.4	10.4	10.1	17		
1944.2	1947.5	10.1	10.4	18		
1954.3	1957.9	10.6	11.0	19		
1964.9	1968.9	11.6	11.0	20		
1976.5	1979.9	10.3	9.7	21		
1986.8	1989.6	9.6	11.0	22		
1996.4	2000.3		10.7	23		

Before we leave the solar and atmospheric science, it is important that other researchers are able to replicate the work that I have done. It is simple enough that high school students should be able to do it. The US Historical Climatology Network will provide temperature data. NASA GISS also provides temperature series.

The Friis-Christiansen and Lassen paper provides solar cycle data, which I have also replicated to the right.

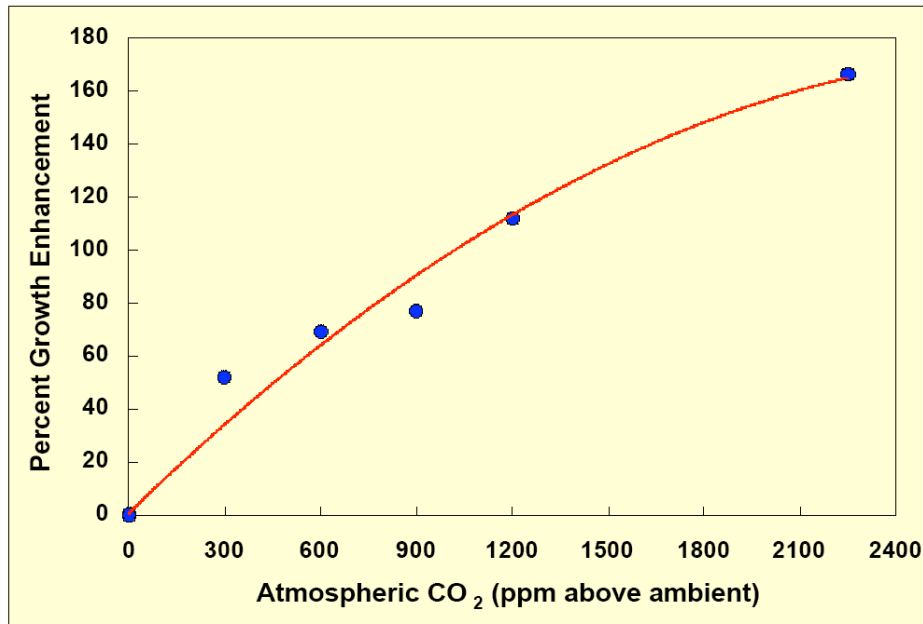
Confirming the logarithmic effect of carbon dioxide is possible using the MODTRAN facility hosted by the University of Chicago.

There is an interesting fact to be found in this reference page. The Maunder Minimum had decades without any sun spots. The sunspot cycles you seen here in this table were constructed from isotope levels, so the underlying mechanism was working in the absence of visible sunspots.



The projected increase in atmospheric carbon dioxide is likely to be brought forward if Chinese economic expansion continues for the next ten years at the same rate that it has demonstrated over the last ten years. This graph shows emissions of carbon to the atmosphere by the United States, Australia and China, with historic data to 2005 and a projection to 2020. Chinese emissions will overtake US emissions in 2008, and then double from the current level by 2016. Per capita emissions by the three countries will be equivalent by 2020.

Can Carbon Dioxide be even a little bit bad?



Carbon dioxide is not even a little bit bad. It is wholly beneficial.

This graph from a recent Idso paper shows plant growth response to atmospheric carbon dioxide enrichment. The 100 ppm carbon dioxide increase since the beginning of industrialisation has been responsible for an average increase in plant growth rate of 15% odd.

The 50% increase in plant growth rate due to a 300 ppm increase in atmospheric carbon dioxide can be expected about the middle of the next century. What a wonderful time that will be.

Average Growth Enhancement due to a 300 ppm increase in atmospheric carbon dioxide

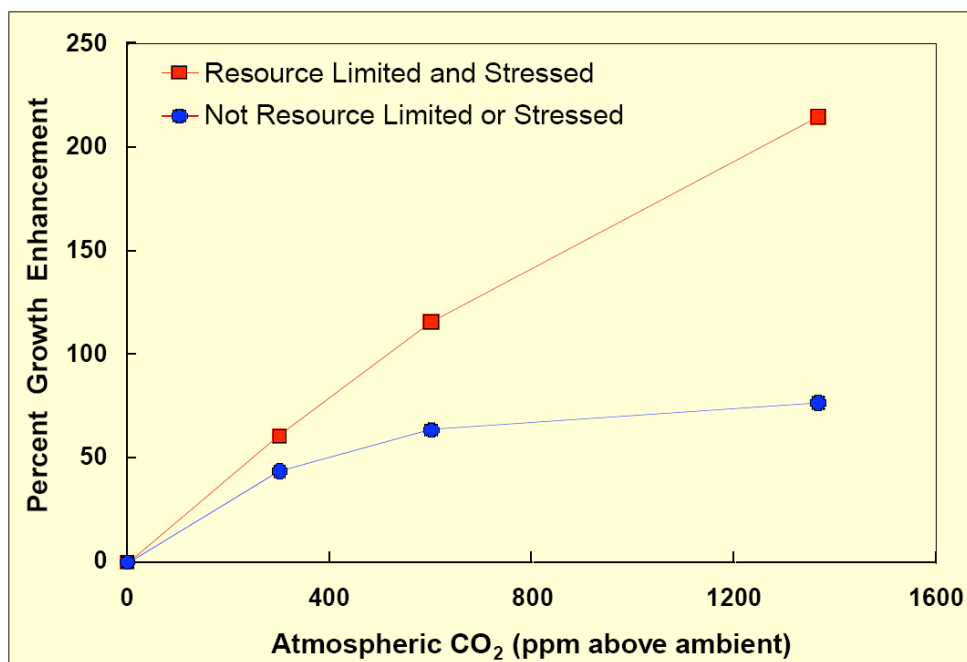
C₃ Cereals	49%
C₄ Cereals	20%
Fruits and Melons	24%
Legumes	44%
Roots and Tubers	48%
Vegetables	37%

Source: Idso May 2007

A 300 ppm increase is something that we can only dream about, but some future generation will get these sort of benefits from the current industrious burrowing of the Chinese in their coal mines.

C3 cereals include wheat and C4 cereals include maize.

Stressed relative to unstressed plant response



In a world of higher atmospheric carbon dioxide, crops will use less water per unit of carbon dioxide uptake, and thus the productivity of semi-arid lands will increase the most.

It's not all good news. We will need this increase in agricultural productivity to offset the colder weather coming.

It also follows that if the developed countries of the world wanted to be caring and sharing towards the third world, the best thing that could be done for the third world is to increase atmospheric carbon dioxide levels. Who would want to deny the third world such a wonderful benefit?

AGW Proponents are Exactly Wrong

- 1. The Earth is getting colder and this will accelerate.**
- 2. Carbon dioxide has a minuscule warming effect.**
- 3. Increased atmospheric carbon dioxide will increase agricultural productivity.**
- 4. The ideal atmospheric carbon dioxide level is a minimum of 1,000 ppm**

2008 is the tenth anniversary of the recent peak on global temperature in 1998. The world has been cooling at 0.06 degrees per annum since then. My prediction is that this rate of cooling will accelerate to 0.2 degrees per annum following the month of solar minimum sometime in 2009.

Dr Hansen's statement that the maximum safe level of carbon dioxide in the atmosphere is 350 ppm begs the question of what the actual ideal level is. I have taken the 1,000 ppm figure from the level that commercial greenhouse operators prefer to run their greenhouses at. The ability to grow food is going to be the overriding concern next decade.

Regarding that 1,000 ppm level, we will never get there. Atmospheric carbon dioxide levels have been much higher in the geological past. But most of that carbon is now bound up in the Earth's sediments where we can't get to it. Half of the carbon dioxide we are producing now is being gobbled up by the oceans, in soils and in the Russian tundra. At best, we might get to about 600 ppm.

What I have shown in this presentation is that carbon dioxide is largely irrelevant to the Earth's climate. The carbon dioxide that Mankind will put into the atmosphere over the next few hundred years will offset a couple of millenia of post-Holocene Optimum cooling before we plunge into the next ice age. There are no deleterious consequences of higher atmospheric carbon dioxide levels. Higher atmospheric carbon dioxide levels are wholly beneficial.

Implications for the United States

- 1. The climate-driven reduction in agricultural production should be planned for.**
- 2. Coal-fired power generation should be increased.**
- 3. Coal to liquid fuels capacity should be installed.**

We have to be thankful to the anthropogenic global warming proponents for one thing. If it weren't for them and their voodoo science, climate science wouldn't have attracted the attention of non-climate scientists, and we would be sleepwalking into the rather disruptive cooling that is coming next decade. We have a few years to prepare for that in terms of agricultural production.

Stopping coal-fired power generation due to carbon dioxide emissions is exactly wrong in science. The more carbon dioxide you put into the atmosphere, the more you are helping all living things on the planet and of course that makes you a better person.

A further big dimension to this debate is US fuel supply security. The oil price is now well above the level at which coal to liquid fuels plants are profitable. With a breakeven price of US\$40/bbl, they have become quite profitable.

The US has very large coal reserves and the conversion of this coal to liquid fuels could provide the US with fuel security. If the building of conversion plants is delayed by notions of supposedly harmful carbon dioxide emissions associated with the conversion process, those notions are unnecessarily harmful to US national security.

This is my message.

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