

FORECASTING SOLAR CYCLES

By Joseph D'Aleo

In the ICECAP section on solar cycles, we explain why the sun is a driver for climate changes over time.

Historically, the sun undergoes changes on periods of 11, 22, 80, 180 years and longer. When the sun is more active it is brighter and warmer and when it is warmer, we are warmer. This direct effect is relatively small varying only 0.1% during the 11 year cycle and maybe 0.4% for the longer term.

However, there are accompanying effects from other solar changes that appear to magnify these irradiance cycles. An active sun is accompanied by increased ultraviolet radiation. Though the brightness/irradiance on the 11 year scale may only increase 0.1%, the ultraviolet changes by several percent especially at the lower wavelengths (X-rays) where factor of two changes may take place.

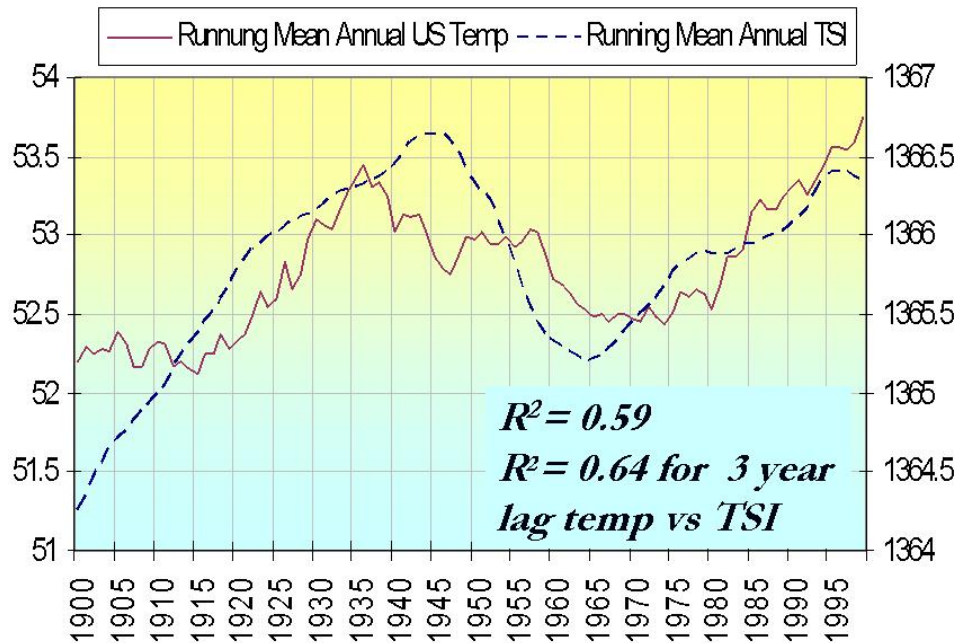
Labitzke has shown a variance of the heights and temperatures in higher levels in low and middle latitudes with the 11 year cycle correlated well with solar flux (which itself correlates well with UV). Shindell (NASA GISS) in 1999 in an excellent paper showed results from a global climate model which included a parameterization of stratospheric chemistry, how UV induced stratospheric ozone changes may amplify observed irradiance effects and have them penetrate into the troposphere, in effect confirming Labitzke's findings

Also an active sun leads to less cosmic rays and a reduction in the amount of low level (water droplet) cloudiness. Low clouds have a cooling effect by reflecting energy back to space. This was first proposed by Svensmark (1997), Bago and Butler (Astronomy and Geophysics 2000), and Yu and Tinsley (AGU 2002). Recently Svensmark was able to replicate water cloud droplet nucleation in a laboratory (Royal Society Proceedings A 2006). Shaviv (2005) estimated that the combination of cosmic ray cloud effects and brightness related increases in irradiance since 1900 could account for 77% of the changes in global temperatures.

Scafetta and West (GRL 2007) assuming the solar irradiance (using Lean) can be a proxy for the total solar effect (direct and indirect), they estimated the changes in the sun could account for up to 69% of the Northern Hemispheric changes since 1900.

We took the solar irradiance of Hoyt and Schatten and correlated it with the US HCN annual mean temperatures climate data for 1221 stations. We chose this data set because it is the most stable (the global data set had a dropout from 6000 to 2000 stations (many of them rural) after 1990 and a rapid increase in missing months, making it less trustworthy. We found a correlation strength (r-squared) of 0.64 for temperatures lagging solar by 3 years (most suggest lags of 3-6 years).

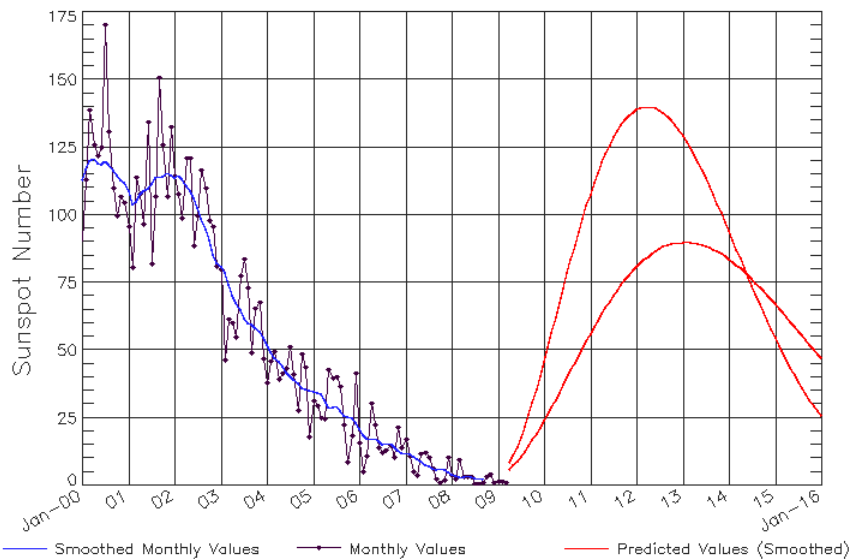
NCDC Annual Mean US Temperature vs Hoyt Schatten TSI



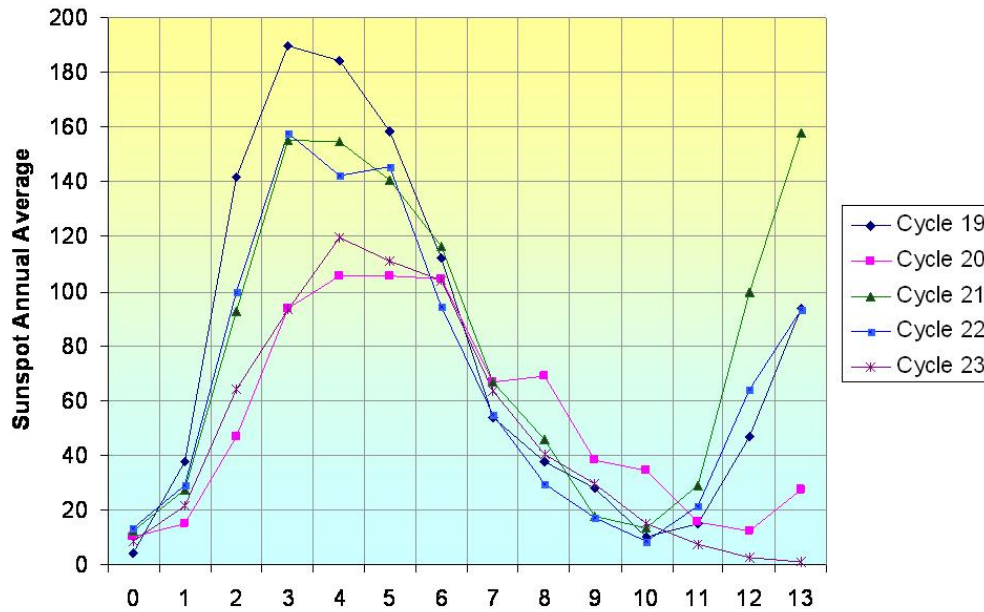
WHERE COULD WE GO FROM HERE?

The last solar cycle maximum in 2000 was 25% weaker than the prior two and the solar cycle length maximum to maximum (1989 to 2000) and minimum to minimum (1996 to 2009?) increased dramatically. The minimum was expected in 2006, but had not been definitively reached as of early 2009.

ISES Solar Cycle Sunspot Number Progression
 Data Through 31 Mar 09



Cycles 19 to 23

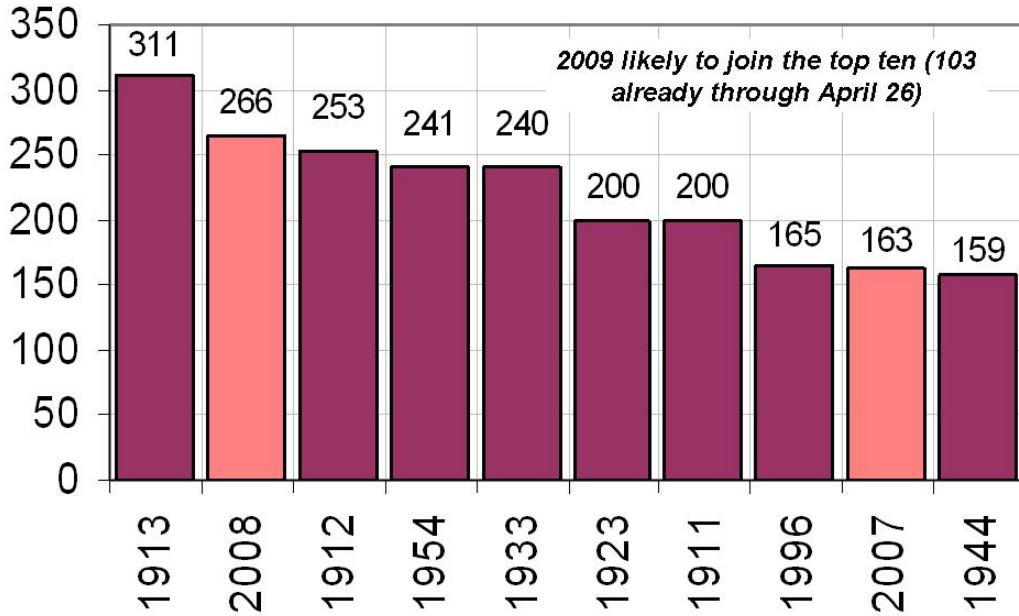


The prior cycles were already rebounding strongly by year 13 in fact cycle 21 had already reached the max of the following cycle (22) already.

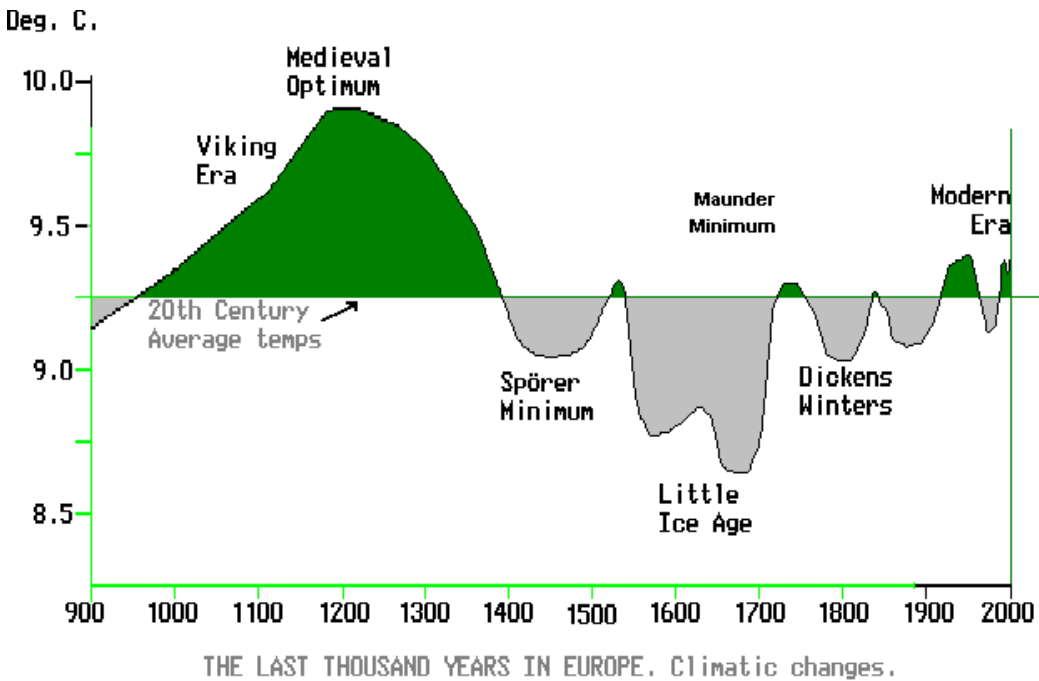
The number of sunspotless days this solar minimum is well over 600 and still increasing. This is more than twice the number of recent solar minima. The solar wind and solar irradiance levels are the lowest in the satellite era. 2008 had the most sunspotless days since 1913 the last century (266 days). 2007 ranked 9th and 2009 is likely to also join the top ten with 105 days already as of May 5.

Sunspotless Days (SIDC) Since 1901

A total of 614 so far this transition 23 to 24



[David Hathaway](#) of NASA although forecasting cycle 24 to be active, believes that cycle 25 which peaks in 2022, could be the “*quietest in centuries*”. Quite solar historically as noted are cold periods. It was believed the sun was virtually spotless in the little ice age of the 1600. It was called the Maunder Minimum.

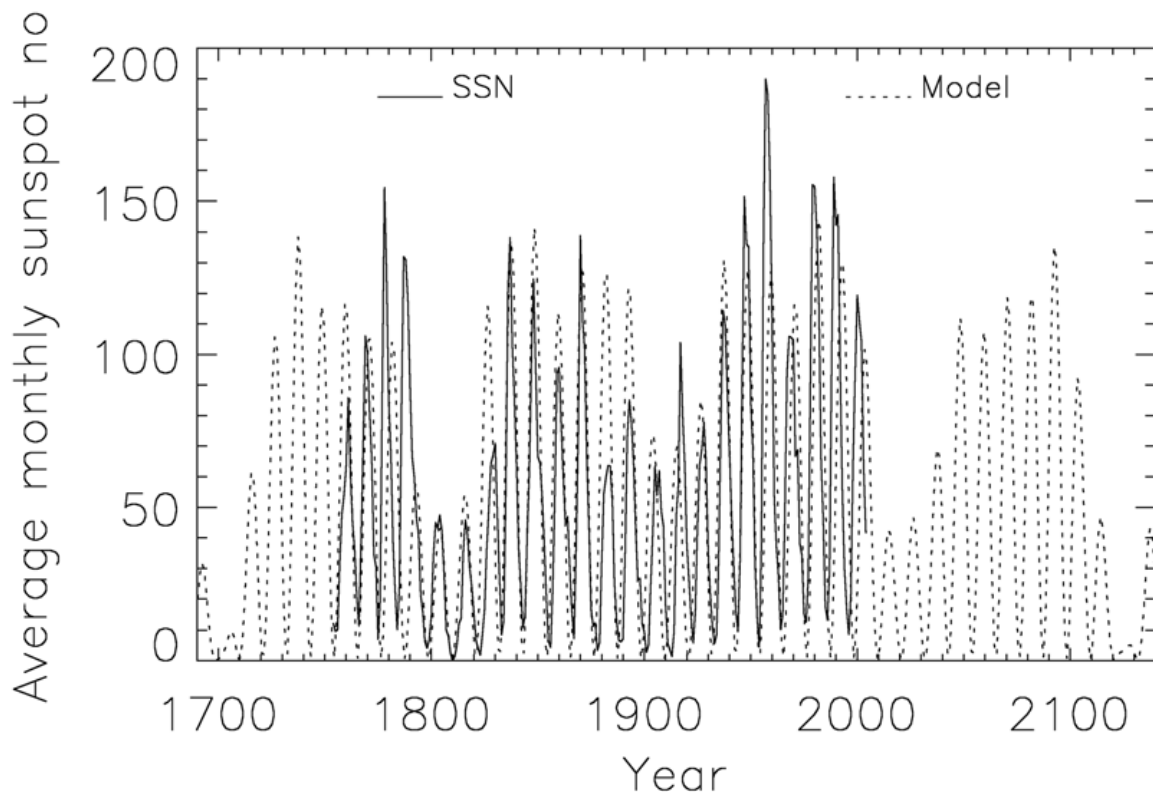


Theodore Landscheidt in New [Ice Age Instead of Global Warming](#) warned the decline could continue in solar activity until a Maunder Minimum like level was reached about 2030.

The Russians appear to agree. [Khabibullo Abdusamatov](#) of the Russian Academy of Science said he and his colleagues had concluded that a period of global cooling similar to one seen in the late 17th century - when canals froze in the Netherlands and people had to leave their dwellings in Greenland - could start in 2012-2015 and reach its peak in 2055-2060.

The late [Rhodes Fairbridge](#) of Columbia University had found with the help of NASA and the JPL, every 179 years or so, the sun embarks on a new cycle of orbits. One of the cooler periods in recent centuries was the Little Ice Age of the 17th century, when the Thames River in London froze over each winter. The next cool period, if the pattern holds, began in 1996, with the effects to be felt starting in 2010. Some predict three decades of severe cold. See recent story on Rhodes's findings also [here](#).

Clilverd et al (2006) in a [paper](#) "Predicting Solar Cycle 24 and Beyond"



Used an harmonic analysis of the multiple cycle frequencies of solar cycles in a model that correctly has caught the activity the past 250 years with a sunspot number standard deviation of 34. Their analysis suggest cycles 24 and 25 will be the lowest (quietest and thus coolest) in nearly 200 years.

David Archibald in *Energy and the Environment* and in the paper [The Past and Future of Climate](#) this last year agreed with this projection.

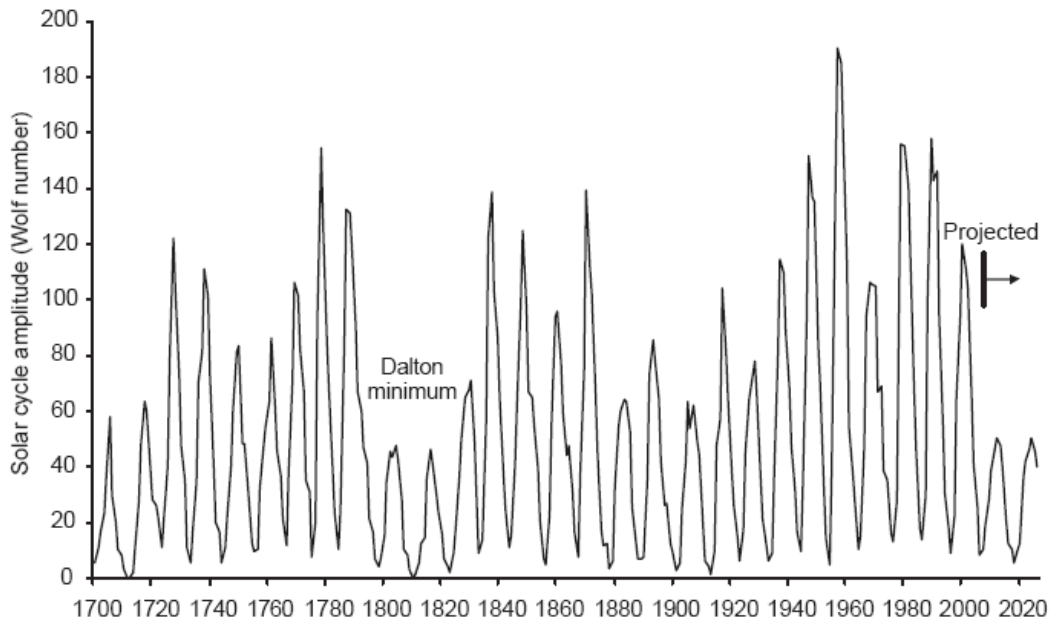
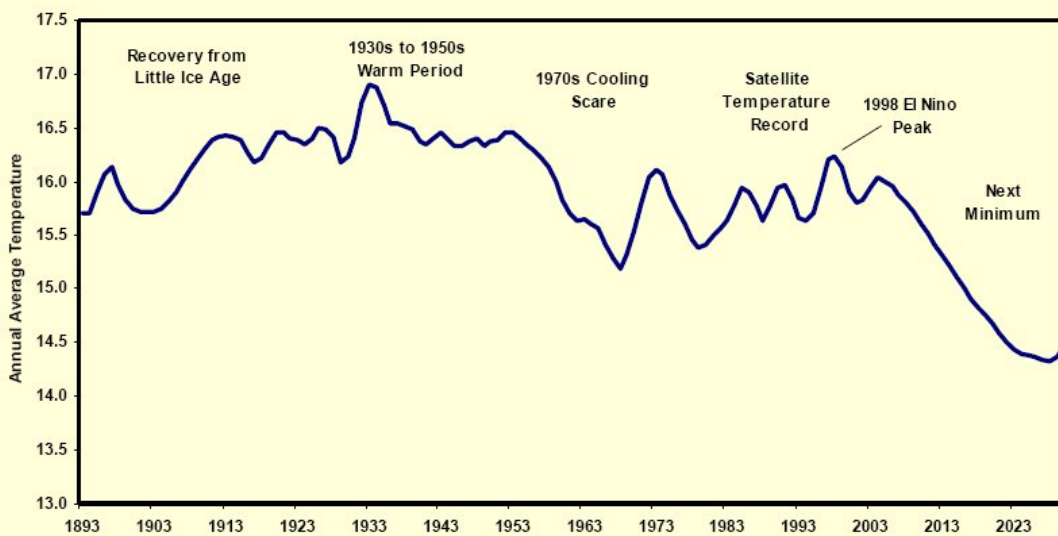


Figure 1: Past Solar Cycles with a Projection of Solar Cycles 24 and 25.

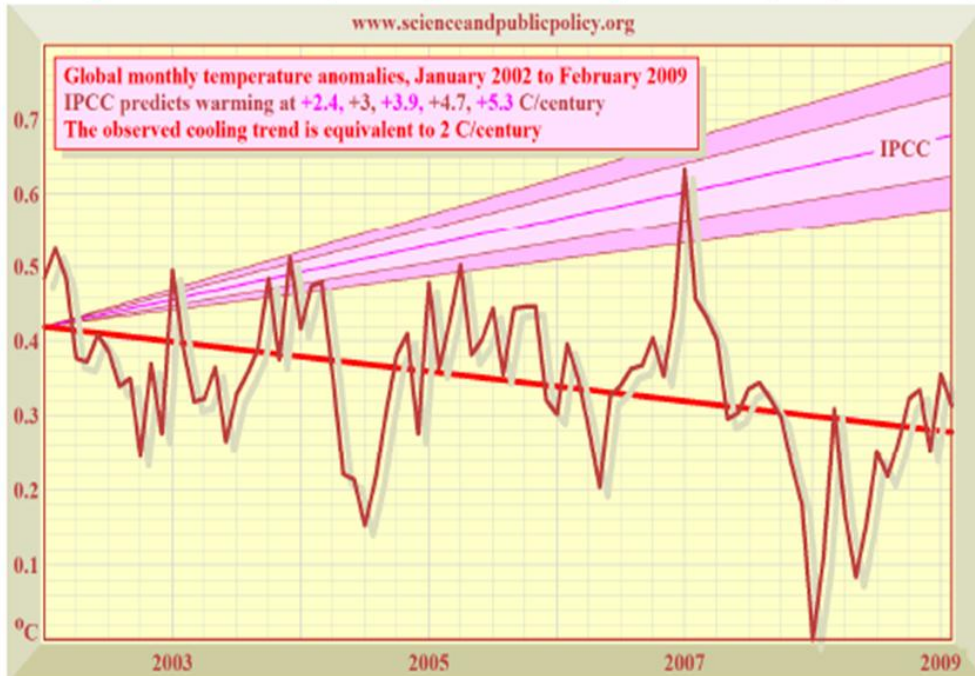
The temperatures with such a decline projected by [Archibald](#) are significant.

Projected Temperature Profile to 2030



That decline has already begun.

A long, fast decline: 7 years' global cooling at 3.6 °F (2 °C) / century



Needless to say much will be learned the next 5 years if the solar cycle decline with cooling temperatures continues.

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Tracking solar activity

Solar Terrestrial Activity Report (daily updates and archived data)

<http://dxlc.com/solar/>

Solar Cycle Progression (NASA) monthly tracking of solar flux, sunspot and geomagnetic activity

<http://www.sec.noaa.gov/SolarCycle/>

NOAA SEC Daily Solar Table

<http://www.sec.noaa.gov/ftplib/latest/DSD.txt>

Solar Cycle Predictions

<http://members.chello.be/j.janssens/SC24.html>

Lund Cycle 24 Forecasts

<http://flare.lund.irf.se:16080/rwc/cycle24/>