

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.

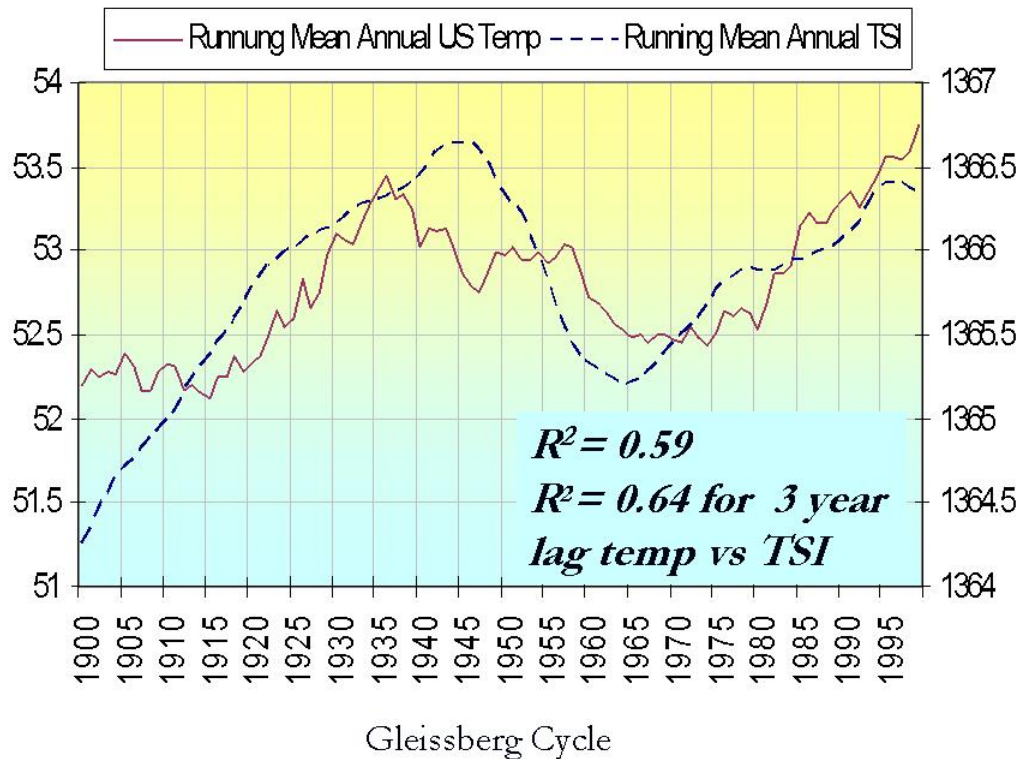
Labitzke has shown a variance of the heights and temperatures in higher levels in low and middle latitudes with the 11 year cycle correlated well with solar flux (which itself correlates well with UV). Shindell (NASA GISS) in 1999 in an excellent paper showed results from a global climate model which 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 2006) 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 50% 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).

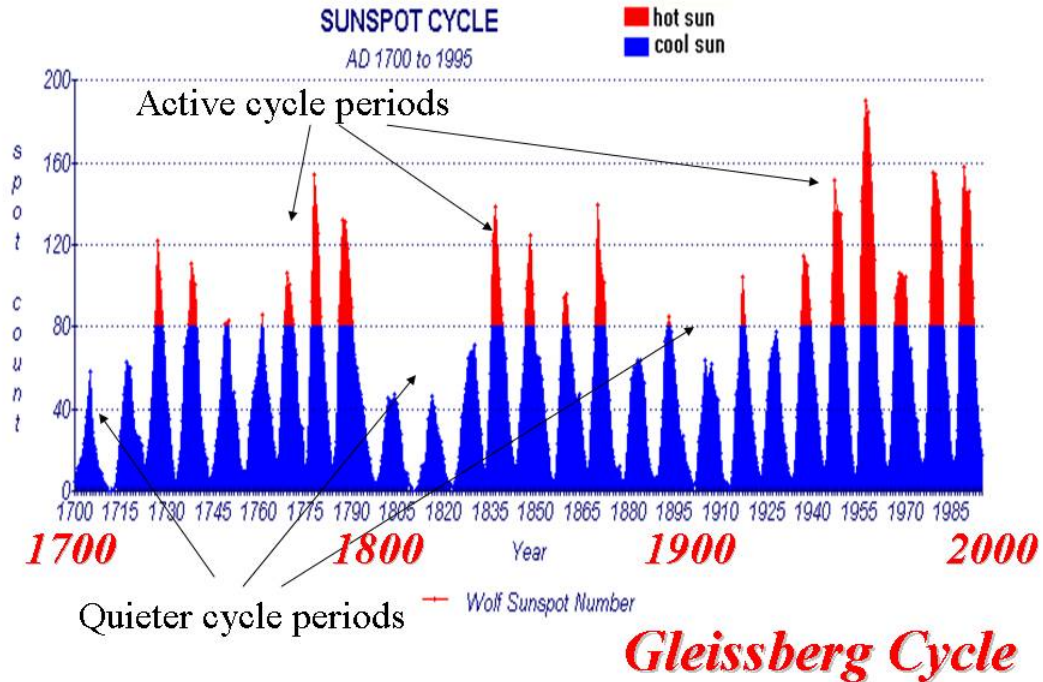
NCDC Annual Mean US Temperature vs Hoyt Schatten TSI



LONG TERM CHANGES

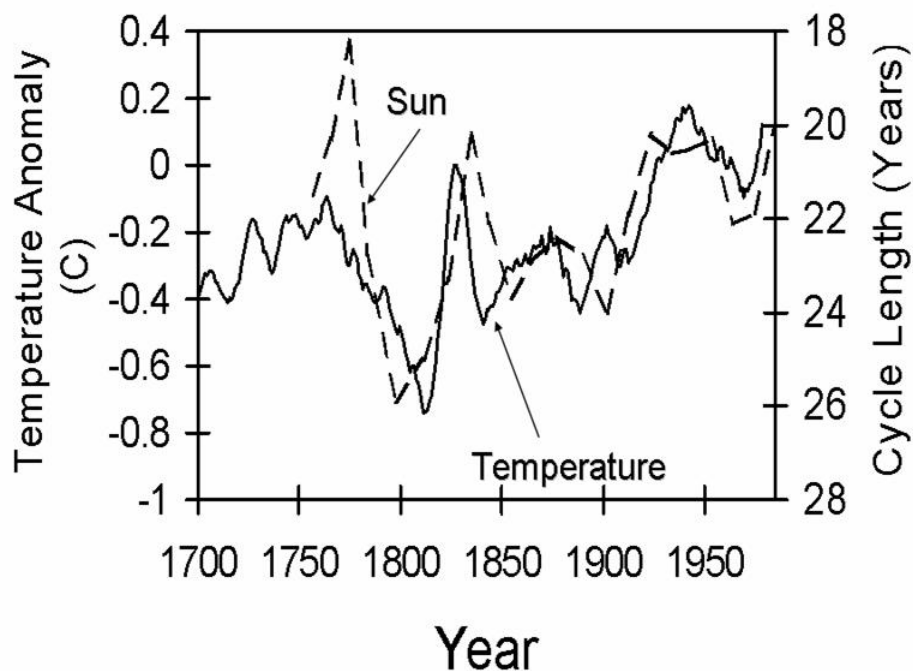
11 year cycles vary in their strength and length over the longer term. One key cycle is the Gleissberg 80+ year cycle.

11 year solar cycles themselves vary in their strength on a longer term with cycles of 80 to 100 years



Very nearly invariably, when the cycles are strong, they tend to be shorter in length, when they are weak (9 years), they tend to be longer (11 to 12 years). When they are stronger and shorter, the earth has been warmer and when they are weaker and longer, cooler.

Friis_Christensen and K. Lassen (<http://www.tmgnow.com/repository/solar/lassen1.html>) found and published this amazing correlation first in Science in 1991. It has been updated below by Baliunas and Soon.



Although Willson showed the solar minimum irradiance in the middle 1990s was 0.05% higher than the prior minimum and may have suggested solar warming continued into the 1990s, the last 11 year cycle peak in 2000 was 25% less in magnitude and the cycle was longer in length than the prior two cycles.

This suggest perhaps that the solar long term cycle has peaked and will we see a decline in upcoming cycles (with global cooling) as we saw at the beginning of each of the last 4 centuries?

It must be said that like seasonal climate forecasting, the science of predicting solar cycles is a budding and promising one with many techniques and methods used. The Lund research group maintains an [excellent site](#) with the various forecasts for the upcoming cycle.

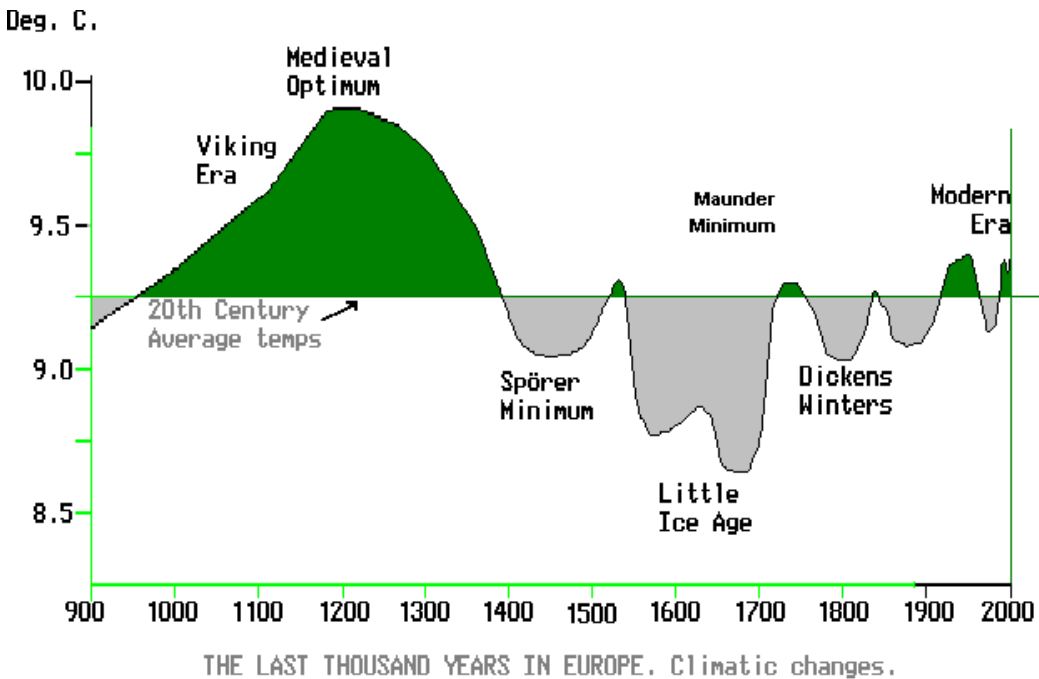
The most successful forecast for cycle 23 came from Sofia and Schatten, who in 1997 bucked the consensus opinion that cycle 23 would be another blockbuster in their [press release](#). They predicted a cycle peaking about where it did, some 25% below the prior to cycles. Dr Sofia indicated their method requires analysis at the solar minimum, which has not yet been reached and so their official forecast will be still a while away.

Schatten has issued some early projections here (http://www.ai-solutions.com/content/papers/Solar_Activity_and_the_Solar.pdf).

WHERE COULD WE GO FROM HERE?

The last solar cycle maximum in 2000 was 25% weaker than the prior two and the length maximum to maximum (1989 to 2000) and minimum to minimum (1996 to 2007?) increased dramatically. 9 of the 12 solar cycle forecast methods on the Lund site show cycle 24, which should start sometime in 2007 will be weaker still than cycle 23.

[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.

Needless to say all eyes will be on the sun the next 5 years to see if a decline is truly underway that could counter or even override any anthropogenic warming.

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Tracking solar activity

Solar Terrestrial Activity Report (daily updates and archived data)

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

Solar Cycle Progression (NASA) monthloy 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>