First Spotless Month Since 1913 - Possible Implications

By Joseph D'Aleo, CCM, Fellow of the AMS

The Sun is a variable star with changes in levels of activity including brightness and eruptive activity that varies on periods of 11, 22, 53, 88, 106, 213, and 429 years.

During these 'cycles" the sun varies in its brightness (for the 11 year about 0.1%, for the longer term 0.3-0.5%). The ultraviolet radiation in the spectrum changes 5 to 8 times greater.

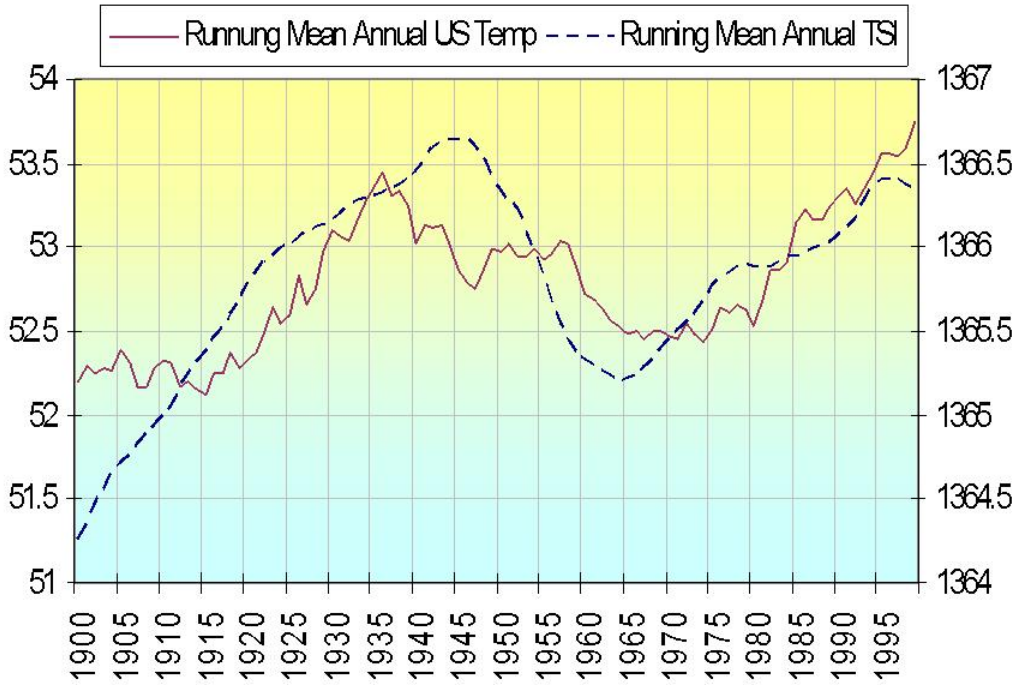
Anthony Watts in this post notes *"While sunspots are often cited as the main proxy indicator of solar activity, there is another indicator which I view as equally (if not more) important. The Average Planetary Magnetic index (Ap), the strength of which ties into Svensmark's cosmic ray theory modulating Earth's cloud cover. A weaker Ap would mean less cosmic rays are deflected by the solar magnetic field, and so the theory goes, more cosmic rays provide more seed nuclei for clouds in Earth's atmosphere. More clouds mean a greater albedo and less terrestrial solar radiation, which translates to lower temperatures."*

These and other direct and indirect solar factors affect the earth's temperatures. Some arrogantly discount the importance of the sun in observed global temperature changes, promoting the idea that man is responsible for our climate extremes and variability. Many arrogantly discount the importance of the sun in observed global temperature changes, thinking man is responsible. Whereas we do have influence on a local basis through urbanization and land use changes, the big changes are natural and ultimately are solar driven.

TOTAL SOLAR IRRADIANCE (BRIGHTNESS)

Scafetta and West (2008) in a paper in Physics Today believe that Total Solar Irradiance was a good proxy for the total (direct and indirect) solar effects and estimated the sun could account for as much as 69% of the increase in Earth's average temperature, depending on the TSI reconstruction used. See in the following diagram how the TSI provided by Hoyt and Schatten correlated with the US climate station annual data (with smoothing to eliminate the 11 year solar cycle).

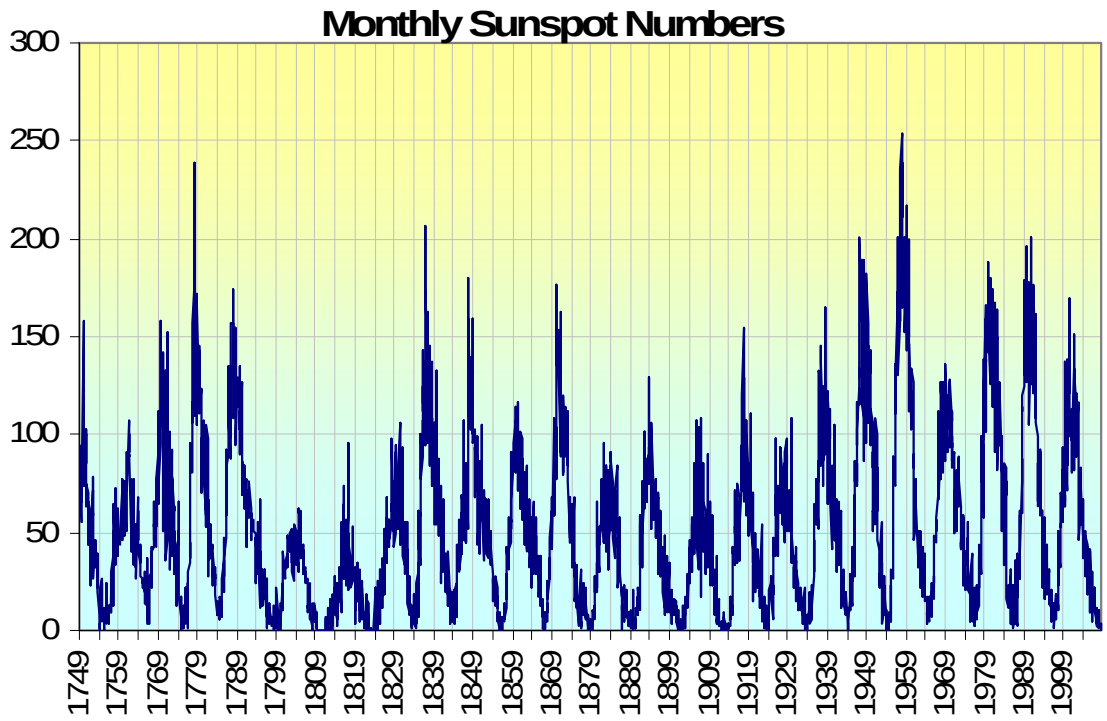
NCDC Annual Mean US Temperature vs Hoyt Schatten TSI



SUNSPOTS

The oldest measure of solar variance is the number of sunspots visible on the sun observed since the days of Galileo and the first telescopes on a daily basis. Sunspots are dark spots (cooler than the photosphere average, which lower irradiance by 0.1%). They are accompanied by bright flares and faculae which are warmer than the average surface (and increase irradiance by 0.2%). The net result of an active sun is that it is a little brighter (0.1%) and thus warmer.

These cycles of the monthly sunspot number is quite evident on the following plot with data from NOAA's National Geophysical Data Center (NGDC).

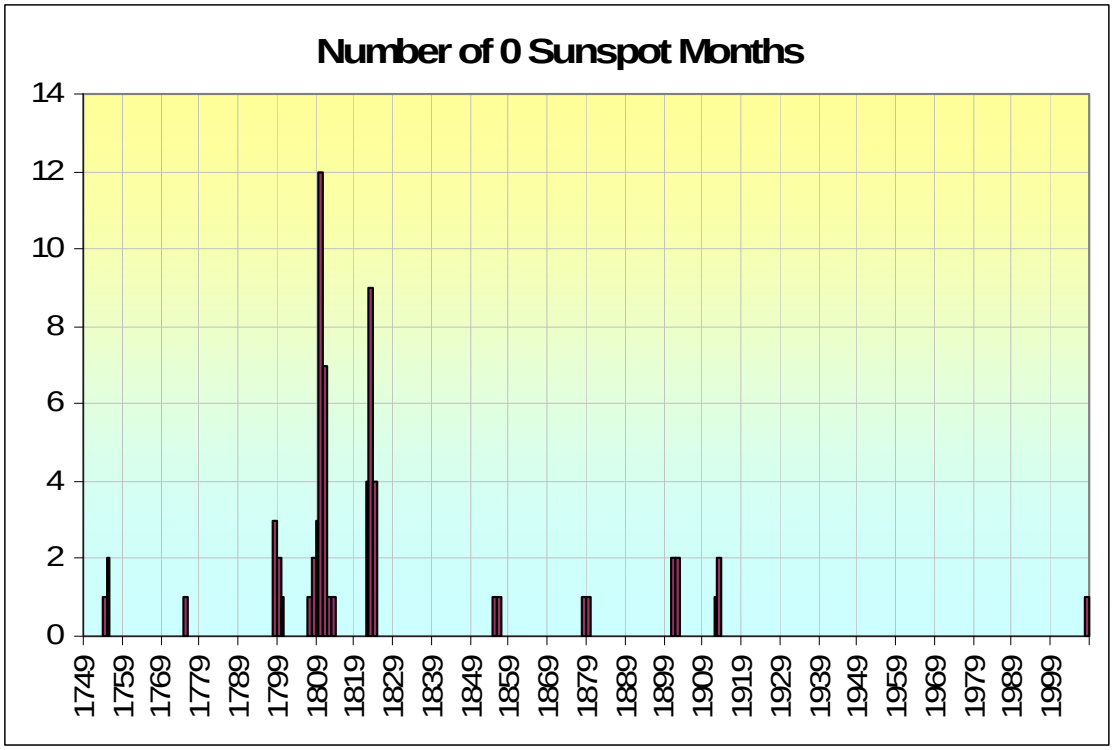


The 11 year cycle can be seen to vary in its amplitude and length (in the range from 9-14 years). The longer cycles tend too be associated with and followed by cycles of smaller amplitude.

Cycle 23 which peaked in 2000 is in its dying stages. Cycle 24 has yet to assert itself, although there were a few months back a few small spots with cycle 24 polarity (the polarity reverses across the solar equator and from one cycle to the next (why there is a 22 year cycle).

This month (August 2008) had an international sunspot number of 0. That marks the first time since 1913, we have had a 0 sunspot calendar month (there have been more 30 day intervals without sunspots as close as 1954 but they have crossed months).

Following is a plot of the number of months with 0 sunspots by year over this period.



LOOKING AHEAD

Note that cluster of zero month years in the early 1800s (a very cold period called the Dalton minimum - at the time of Charles Dickens and snowy London town and including thanks to the major volcanic eruption of Tambora, the Year without a Summer 1816), and again to a lesser degree in the early 1900s. These correspond to the 106 and 213 year cycle minimums.

There was a stretch of 21 straight months from October 1809 to May 1811 without a single observed spot. Two other long periods included 4 months from November 1822 to February 1823 and 4 months from August to November of 1823.

The superimposition of the 106 and 213 cycles would suggest that the next cycle minimum around 2020 could be especially weak. Even David Hathaway of NASA who has been a believer in the cycle 24 peak being strong, thinks the next minimum and cycle 25 maximum could be the weakest in centuries based on slowdown of the plasma conveyor belt on the sun.

"Normally, the conveyor belt moves about 1 meter per second—walking pace," says Hathaway. "That's how it has been since the late 19th century." In recent years, however, the belt has decelerated to 0.75 m/s in the north and 0.35 m/s in the south. "We've never seen speeds so low."

"The slowdown we see now means that Solar Cycle 25, peaking around the year 2022, could be one of the weakest in centuries," says Hathaway.

In this plot of the cycle lengths and sunspot number at peak of the cycles, assuming this upcoming cycle will begin in 2009 show the similarity of the recent cycles to cycle numbers 2- 4, two centuries ago preceding the Dalton Minimum. This cycle 23 could end up the longest since cycle 4, had a similar sunspot peak and similarly had two prior short cycles.

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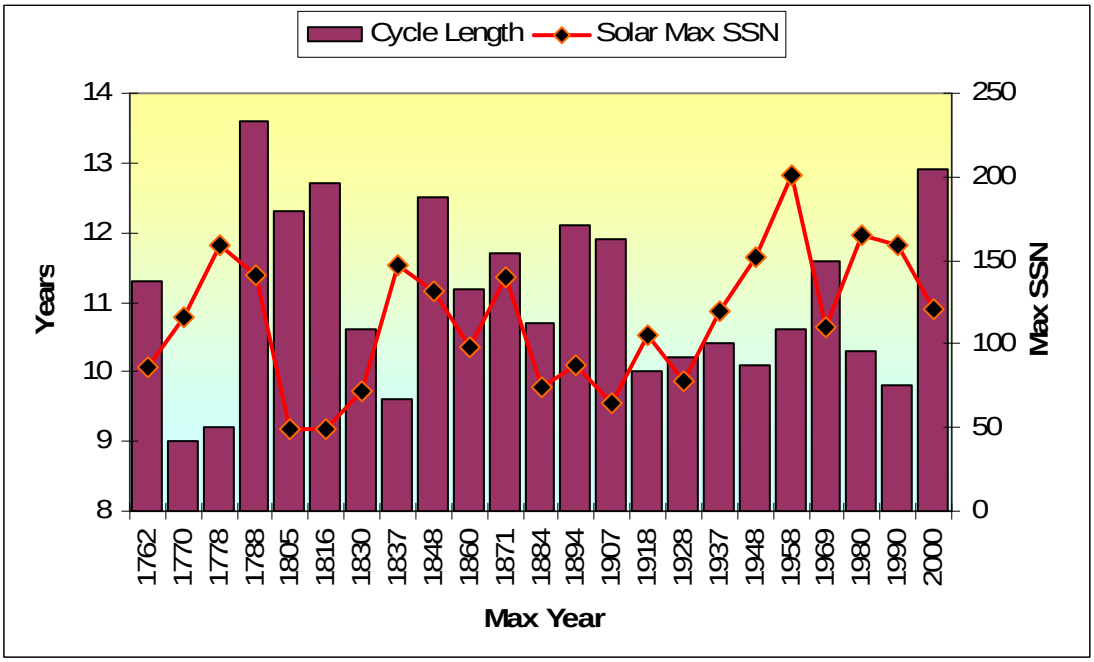
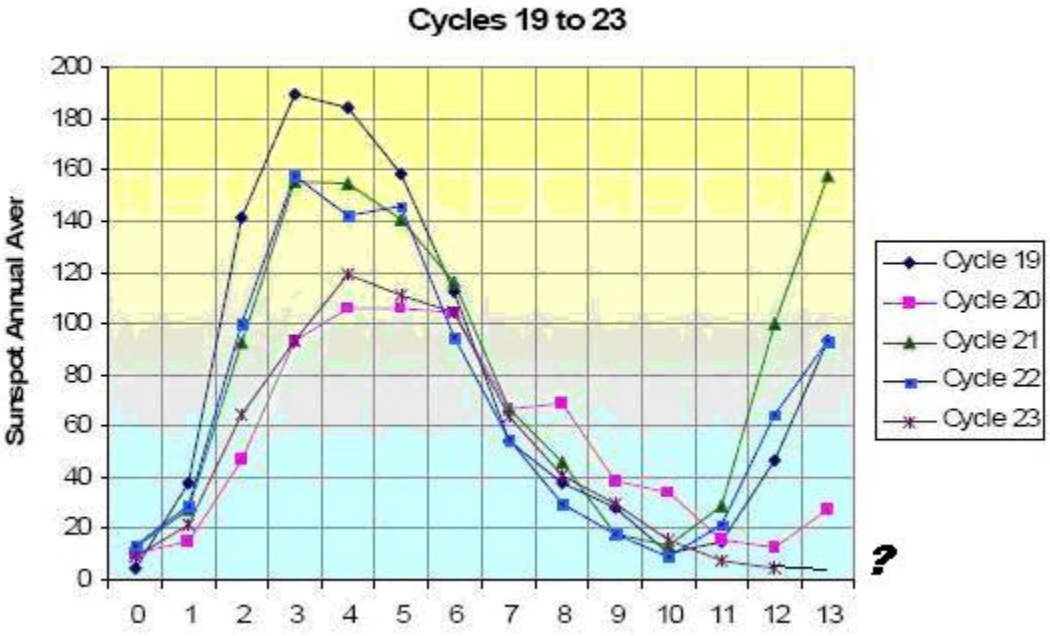


Note how this cycle has compared with the prior four cycles. Three by the 12th year were well on their way back to high activity levels. Only cycle 20, was a long and quiet cycle but its minimum was not as low and it was starting to recover by this point in time.



See this very interesting paper by Livingston and Penn recently presented here predicting solar sunspots could vanish by 2015 as the magnetic activity associated with the sunspots has been decreasing irregardless of the cycle phase since the 1990s.

See this forecast that is becoming more credible with each passing quite month by Clilverd in this paper in 2005 in the Space Weather Journal. He predicts a peak sunspot number of 40 for cycle 24, similar to those cycles in the early 1800s based on the phasing of primarily the 52, 106 and 213 year cycles.

Archibald in this paper using regression of past temperature and an expected solar sunspot peak of 40 of less for the next few cycles predicts a drastic drop in global temperatures. Read still more in this very interesting Anthony Watts "2014-2015 - These years are a repeating theme in solar forecasts" story on the sun featuring a piece by Mark S. Lawson, Online Opinion, Australia.

Follow the sun daily here and monthly progression here.

Addendum: the changes occurring on the sun will continue to inspire new exploration of our life giving star. Just in the last few years, new facts have been discovered thanks to more powerful satellite monitoring systems.

For example, our notion of the mechanisms for the origin of sunspots has changed based on what is called the Trilobite movie.

The data were gathered by the Japanese Space Agency's Hinode spacecraft, launched in Sept. 2006 on a mission to study sunspots and solar storms. "This is the highest resolution magnetogram ever taken from space," says Tsuneta, Hinode's chief scientist at the National Astronomical Observatory of Japan in Tokyo. "We've never seen anything quite like it," says solar physicist Lika Guhathakurta from NASA headquarters.

"The Hinode observations of emergent sunspot 10926 challenge traditional views of sunspot formation. Before Hinode data came on line, a solar physicist might have described the birth of a sunspot as follows:

"Sunspots are formed when a 'rope' of strong magnetic field beaches the visible surface of the sun (the photosphere). Magnetic ropes develop deep below the photosphere and emerge as an arcade-like structure. When this arcade crosses the surface a pair of sunspots develops. As in a bar-magnet, one footpoint of the arcade has positive (northern) polarity, and the other footpoint has negative (southern) polarity."

The trilobite data show a different process at work:

"The emergence of the sunspot magnetism progressed in a very complex manner, with small pieces appearing to self-assemble into larger, more coherent structures," says Marc DeRosa, a scientist from Lockheed Martin Solar and Astrophysics Laboratory in Palo Alto, Calif.

So the trilobite movie, while entertaining, is not merely entertaining. "It has shown us something fundamentally new" about sunspot genesis, says Lika Guhathakurta."