

Solar Minimum and Spotless Days  
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The April 10, 2018 issue of The Daily DX™ (published by Bernie McClenny W3UR – for more information on The Daily DX, visit <http://www.dailydx.com/>) pointed to an article [note 1] about the approach of solar minimum between Cycles 24 and 25. The author (Robert Zimmerman) stated that it appears that the solar minimum has arrived, and it has done so one or two years ahead of schedule. Mr. Zimmerman then raised the question whether we're about to enter another grand solar minimum like the Maunder Minimum.

The next day's issue of The Daily DX (April 11, 2018) had some great comments about the Zimmerman article from Frank Donovan W3LPL. He said:

*Robert Zimmerman's article referenced in yesterday's DDX asserts that "it appears that Solar Minimum has arrived" based only on very frequent spotless days during the last six weeks.*

*More comprehensive physical evidence suggests it's more likely that we've just begun a lengthy Deep Solar Minimum Phase -- similar to late 2007 through late 2008 -- that's likely to last well into next year.*

*How did I reach that conclusion? An important solar physical event that precedes Solar Minimum (the date when Solar Cycle 24 transitions to Solar Cycle 25) hasn't yet occurred. Solar polar magnetic field strength peaks at least a year before Solar Minimum. While the north polar region reached peak field strength last year, the south polar region hasn't yet peaked. This suggests that Solar Minimum is likely to occur next year at the earliest.*

The ARRL Letter dated April 12, 2018 had more great comments about "solar minimum" from W3LPL's presentation in 2017 at a Fair Lawn (NJ) Amateur Radio Club meeting.

One of the important questions for a solar scientist is "when is solar minimum?" That may sound like a simple question, but it doesn't have a simple answer. There can be several ways to define the month and year when solar minimum occurs:

- 1) solar minimum is the month when the smoothed sunspot number minimizes
- 2) solar minimum is the month with the lowest monthly mean sunspot number
- 3) solar minimum is the month when the smoothed 10.7 cm solar flux minimizes
- 4) solar minimum is the month with the lowest monthly mean 10.7 cm solar flux
- 5) solar minimum is the month when there are an equal number of old and new sunspots
- 6) solar minimum is the month with the largest number of spotless days
- 7) solar minimum is the month when the smoothed total solar irradiance minimizes
- 8) and so on

There was an interesting paper titled "When is solar minimum?" by Karen L. Harvey and Oran R. White that appeared in Volume 104 of the Journal of Geophysical Research (September

1999). It discussed the problem in defining solar minimum. Although data was presented on the minimum periods between Cycles 11 and 12 through Cycles 22 and 23, the authors focused on the minimum between Cycles 22 and 23. Here's the Cycle 22-23 solar minimum data per the 7 criteria on the previous page.

Lowest smoothed sunspot number	Lowest monthly mean sunspot number	Lowest smoothed 10.7 cm solar flux	Lowest monthly mean 10.7 cm solar flux	Equal number of old and new sunspots	Largest number of spotless days	Lowest smoothed total solar irradiance
<b>May 1996</b>	<b>May 1996</b>	<b>May 1996</b>	<b>October 1996</b>	<b>January 1997</b>	<b>October 1996</b>	<b>February 1996</b>

As can be seen, the month of solar minimum could be anywhere from February 1996 to January 1997 – that's almost a year difference [note 2]. Why is it so important to pin down solar minimum to a specific month? It's important because comparative studies of sunspot cycles use the time of minimum as a timing mark for the alignment of the cycles curves and the starting point of statistical prediction schemes. Additionally, the times of solar minimum and maximum are used to determine the lengths of solar cycles and their rise and decline times, which may be correlated to the Earth's long-term global temperature excursions.

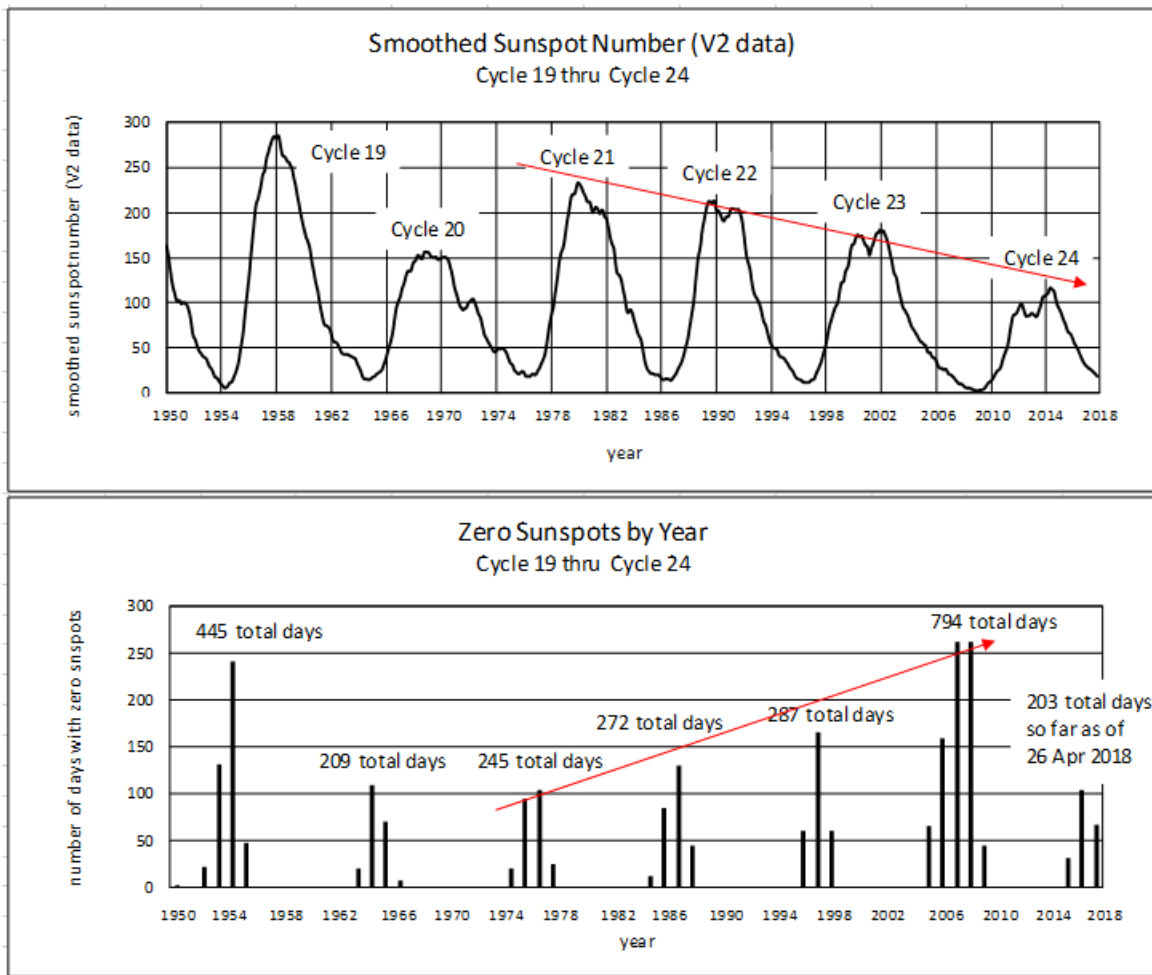
The bottom line here is that it's too early to pin down the official solar minimum point between Cycles 24 and 25. But I do agree that in terms of HF propagation, in a broad sense we are at solar minimum because things aren't going to get much worse. So in a 100,000 foot view, Robert Zimmerman is right. But for solar scientists and their ground level view, we're still not there.

Enough about solar minimum. Now for some words (and more importantly, some data) about spotless days.

As expected, spotless days occur around solar minimum. Some have suggested that the number of spotless days could be a good precursor for the magnitude of the next solar cycle. For example, perhaps many spotless days around solar minimum says the next cycle will be small. Similarly, perhaps few spotless days around solar minimum says the next cycle will be big.

One way to assess this hypothesis is to plot the number of spotless days versus time. I did this for solar minimums between Cycles 18 and 19 through the present using data at NOAA's ftp web site: [ftp://ftp.ngdc.noaa.gov/STP/GEOMAGNETIC\\_DATA/INDICES/KP\\_AP/](ftp://ftp.ngdc.noaa.gov/STP/GEOMAGNETIC_DATA/INDICES/KP_AP/). This was a tedious task, but the results are enlightening.

The results are plotted on the next page, with the smoothed sunspot number (V2) in the top plot and the number of spotless days per year in the bottom plot. The horizontal axes of both plots are aligned to easily correlate the two plots.



If we just look at the spotless days between Cycles 20 and 21 through Cycles 23 and 24, we'll see the total number of spotless days increasing while the maximum smoothed sunspot number of Cycles 21, 22, 23 and 24 decreasing. So it would appear that there's a decent correlation between spotless days and the next cycle.

But the number of spotless days between Cycles 18 and 19 really screw up this correlation, considering that Cycle 19 was the highest in recorded history. It should have had few spotless days.

All this says is that the Sun will do what it wants to do, regardless of what we expect it to do. Sometimes it sure makes life tough, doesn't it?

**Notes:**

1. <http://behindtheblack.com/behind-the-black/essays-and-commentaries/sunspot-update-for-march-2018-the-sun-crashes/>
2. Solar minimum between Cycles 22 and 23 was defined as September 1996