Propagation Predictions and the New Sunspot Numbers
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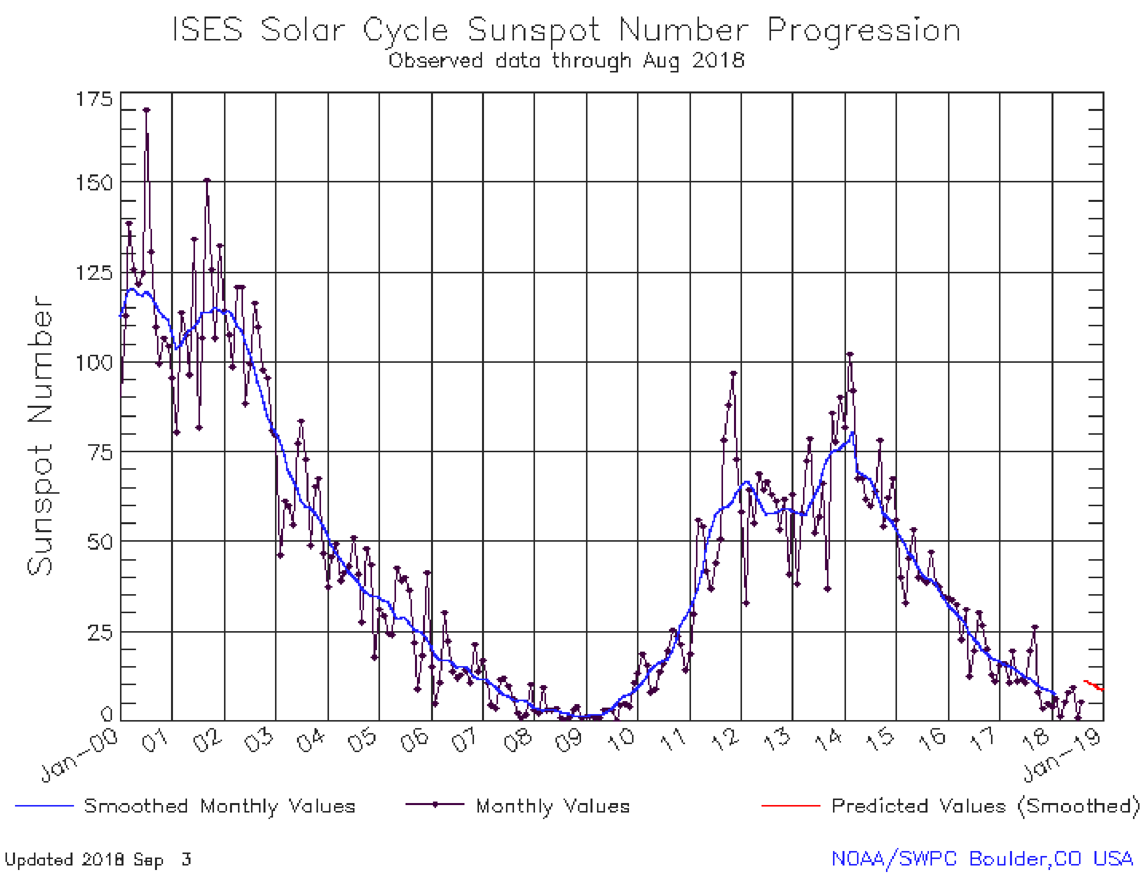
If you visit https://www.swpc.noaa.gov/products/solar-cycle-progression, the first plot you'll see on that page is sunspot numbers starting on January 2000 and continuing until the current date. These dates include the peak and decline of Cycle 23 (on the left), the solar minimum period between Cycles 23 and 24 (in the middle), and the rise and decline of Cycle 24 (on the right). Regardless of the fact that Cycle 24 was much smaller than Cycle 23, we had a good amount of 6m propagation via the F2 region (along with great 12m and 10m propagation) around Cycle 24's second peak in the fall and winter months.



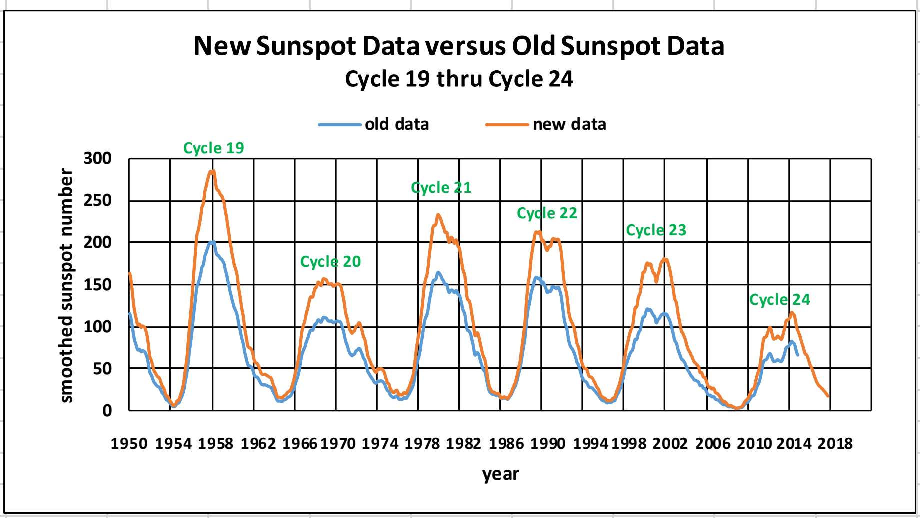
Per the legend below the plot, you'll see the monthly mean sunspot number (the spiky data), the smoothed sunspot number in blue, and a predicted smoothed sunspot number in red (way off to the right). The monthly mean sunspot numbers are the average of the daily sunspot numbers for each month. The smoothed sunspot numbers are a running average of twelve monthly mean sunspot numbers centered on the desired month, and that curve is not spiky at all – hence it allows us to better see what is going on with a solar cycle – including the peaks (and the dip in between) if a cycle has two peaks (as Cycle 23 and Cycle 24 did).

A good question to ask is "why is the predicted smoothed sunspot number in red so much higher than the actual smoothed sunspot number data in blue?" The answer is that the plotted monthly mean sunspot numbers and the plotted smoothed sunspot numbers are of a different version of sunspot numbers than the predicted smoothed sunspot numbers. If that's confusing, you're right. But there is an explanation.

If you read my April 2016 Monthly Feature titled "The NEW Sunspot Numbers" [note 1], you'll remember that four workshops were held to review the existing sunspot numbers. This was done to make sure the historical sunspot numbers were as accurate as possible. The bottom line of these workshops was that additional older sunspot numbers were discovered, and there was unintentional observational bias by some of the official observers over the centuries. Corrections were then made to the existing sunspot record. This was not a surprising result, as early records were limited by early telescopes and it is difficult to accurately count sunspots (especially in very small sunspot areas).

On July 1, 2015, the Royal Observatory of Belgium (the official organization that counts sunspots) began reporting the new Version 2 (V2) sunspot numbers. The plot shown on the first page continues to report the old Version 1 (V1) monthly mean sunspot numbers and the old V1 smoothed sunspot numbers. The red line has the new V2 predicted smoothed sunspot numbers. At solar minimum, V1 and V2 should pretty much be equal, and the plot will then start reporting all V2 numbers [note 2].

The following plot shows the difference between the V1 smoothed sunspot numbers and the V2 smoothed sunspot numbers from 1950 to the present.



What's obvious is that the V2 smoothed sunspot numbers are noticeably higher than the V1 smoothed sunspot numbers. Realizing that the model of the F2 region of the ionosphere in our propagation predictions was developed based on V1 smoothed sunspot numbers, it's easy to conclude that our propagation predictions might be off now due to using the higher V2 smoothed sunspot numbers. Let's see how much of a difference there is in our propagation predictions with V1 and V2 smoothed sunspot numbers.

To do this we'll look at the actual monthly median MUF (maximum useable frequency) for a 3000 km hop over the Boulder ionosonde for November 1994 at 2100 UTC. Then we'll use VOACAP to give the predicted monthly median MUF at the V1 smoothed sunspot number and at the V2 smoothed sunspot number [note 3]. As a side note, W6ELProp should give very similar results.

From the V1 versus V2 plot (or other historical data), the V1 smoothed sunspot number (SSN) for November 1994 was 26. The V2 smoothed sunspot number for November 1994 would have been 43. Going through this exercise with VOACAP gives the following results.

Actual MUF	Predicted MUF with SSN = 26	Predicted MUF with SSN = 43
25.4 MHz	26.8 MHz	29.1 MHz

Using the V1 smoothed sunspot number in VOACAP over-predicts the actual MUF by 5.5% (not bad considering that the correlation between the smoothed sunspot number and monthly median ionospheric parameters is high but not perfect). The V2 smoothed sunspot number over-predicts the actual MUF by 14.6%. Our rough conclusion is that in general the new V2 smoothed sunspot numbers will give us somewhat of an over-optimistic prediction of the F2 region. From the tabular results above, it's on the order of one band. At solar minimum, though, there will essentially be no difference since V2 is very similar to V1.

But we have to watch it here. Not only have we changed sunspot numbers, there are two other issues that might affect our predictions nowadays compared to many decades ago.

First, the magnetic poles are moving. The ionosphere contains charged particles, and as such it is ordered about magnetic coordinates, not geographic coordinates. Thus our worldwide data base of ionospheric parameters may be off from when they were created decades ago.

Second, there are noticeable changes in the ionosphere due to global warming over the past several decades. In general the height of the peak F2 electron density has decreased [note 4], along with changes in the peak F2 electron density itself [note 5]. These changes are admittedly small, but they are changes nonetheless.

The bottom line is all these changes may add in-phase to maximize the error. Or some may counter others, essentially putting things back to "near normal". This would be an interesting topic for a future Monthly Feature.

Notes

1. This Monthly Feature is available at https://k9la.us/Apr16_NEW_Sunspot_Numbers.pdf

2. Of course the 10.7 cm solar flux doesn't have this version issue as it is a measured parameter – there is no human interpretation. But the 10.7 cm solar flux only goes back to

1947, and it can’t distinguish in which solar hemisphere sunspots emerge. Additionally, the 10.7 cm solar flux will not tell us if it’s solar flux from old or new active regions.

3. When we input a smoothed sunspot number into our propagation prediction programs, the outputs are monthly median MUF and monthly median signal strength. This is how our propagation prediction programs were developed since the correlation between a daily solar index and the daily MUF is extremely poor.

4. This general decrease results in a slightly higher MUF and a shorter hop.

5. In general an increase in electron density is seen in the lower ionosphere and a decrease in electron density is seen in the upper ionosphere.