

Sunspot Number Confusion  
 Carl Luetzelschwab K9LA April 24, 2020

Recently Frank W3LPL (of Multi-Multi contest fame) reviewed NOAA's official updated Solar Cycle prediction. He also commented that the International Sunspot Number is typically about one third lower than the SWPC (Space Weather Prediction Center) sunspot number.

Why is that? Well, there's a good reason for this discrepancy, and it should be resolved in the near future. Let's look at how we got into this confusing situation and what the solution is.

We have sunspot records back to Cycle 1 (and even earlier). The official sunspot number originally came out of Zurich, and now it comes out of the Royal Observatory of Belgium. In 1848, Rudolph Wolf devised the equation for the sunspot number. It involves the number of sunspot groups, the total number of individual spots in all the groups, and a variable scale factor. We were happy with this until 2011, when the first of four workshops were held to review the sunspot data because there were concerns that the scale factor may be skewing the true data.

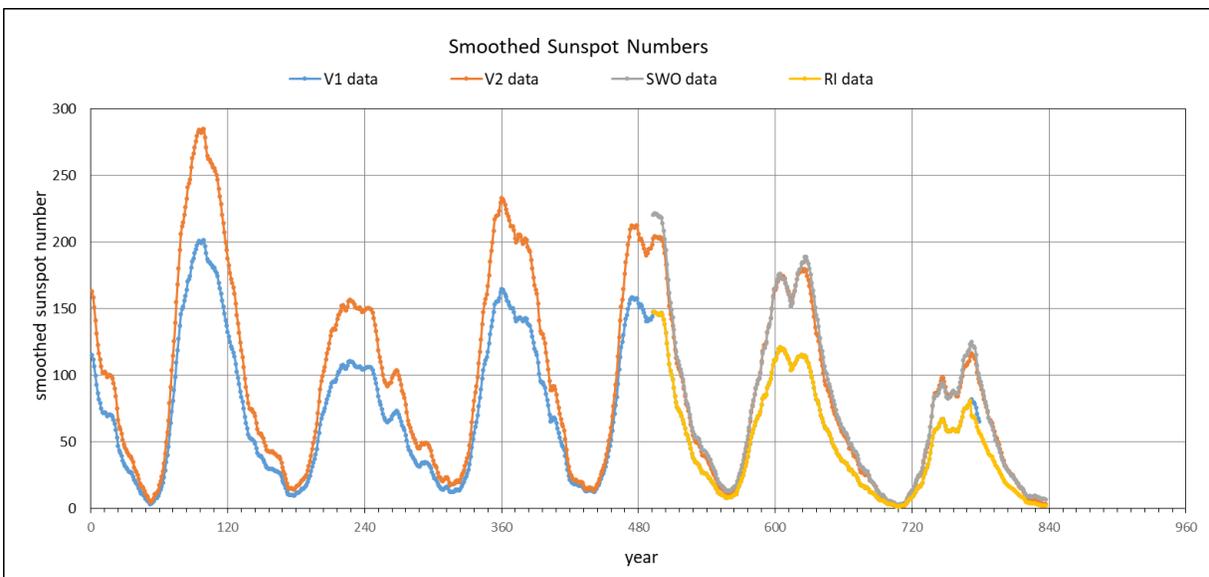
The result of the four workshops was an entirely new sunspot record. The biggest difference was the scale factor of 0.6 that was in use. It is not considered valid any more based on corroborating data, and thus that raised the V2.0 data over the V1.0 data by 1/0.6. To distinguish between the old and new sunspot numbers, the old sunspot numbers are designated V1.0 (version 1.0) and the new sunspot numbers are designated V2.0 (version 2.0). The Royal Observatory of Belgium started reporting V2.0 sunspot numbers on July 1, 2015 (and remember that the V2.0 record all the way back to Cycle 1 changed, too).

Now if we go to <https://www.swpc.noaa.gov/products/solar-cycle-progression> and download the .txt file 'Table of Recent Solar Indices (Preliminary) of Observed Monthly Mean Values' in the Data tab, we'll see the following SWPC predictions (just an excerpt of the entire data is shown).

Recent Solar Indices of Observed Monthly Mean Values										
-----Sunspot Numbers-----										
---Observed--- Ratio --Smoothed- Observed Smoothed ---Geomagnetic---										
# YR MO SWO RI RI/SW SWO RI 10.7cm 10.7cm Observed Smoothed										
#-----Ap Ap-----										
2019 01	16.0	4.6	0.29	9.0	3.2	71.6	70.0	6	6.8	
2019 02	-1.0	0.5	-1.00	8.7	3.0	70.6	69.8	7	6.7	
2019 03	14.8	5.6	0.39	8.3	2.8	71.5	69.7	6	6.6	
2019 04	11.5	5.5	0.48	7.9	2.6	72.4	69.6	6	6.7	
2019 05	18.1	5.9	0.34	7.4	2.3	71.3	69.6	7	6.7	
2019 06	11.6	0.7	0.06	7.3	2.2	68.1	69.6	5	6.5	
2019 07	1.6	0.5	0.31	7.0	2.1	67.1	69.7	6	6.3	
2019 08	2.5	0.3	0.16	7.0	2.1	67.0	69.8	7	6.2	
2019 09	2.6	0.7	0.27	6.8	1.9	68.1	69.7	10	6.2	
2019 10	1.8	0.2	0.11	-1.0	-0.6	67.4	-1.0	8	-1.0	
2019 11	1.1	0.3	0.27	-1.0	-0.6	70.2	-1.0	4	-1.0	
2019 12	7.2	0.9	0.14	-1.0	-0.6	70.9	-1.0	4	-1.0	
2020 01	9.2	3.8	0.41	-1.0	-0.6	72.3	-1.0	5	-1.0	
2020 02	5.5	0.2	0.04	-1.0	-0.6	71.0	-1.0	6	-1.0	
2020 03	3.0	0.9	0.30	-1.0	-0.6	70.1	-1.0	6	-1.0	

The first two columns (columns 1 and 2) are the year and month. The next three columns (columns 3, 4 and 5) are the monthly mean sunspot numbers per SWO (Space Weather Operations – they're with the SWPC), per the Royal Observatory of Belgium (RI is also known as the International Sunspot Number) and the ratio between the two. The next two columns (columns 6 and 7) are the smoothed sunspot numbers per SWO and per the Royal Observatory of Belgium (RI). Note that the smoothed sunspot numbers are 6 months behind the monthly mean sunspot numbers – that's because of how the smoothed sunspot number is determined.

So the discrepancy that W3LPL talked about is between the SWO values and the RI values. What's going on is the SWO group never applied the 0.6 scale factor to their sunspot count, and thus the SWO values are essentially the Royal Observatory of Belgium V2.0 data. The RI values reported by SWO are the Royal Observatory of Belgium V1.0 data. All of this can be seen in the following plot. The V1.0 data is in blue and the V2.0 data is in orange.



The SWO data (in gray) indeed follows the V2.0 data. And the RI data (in yellow) indeed follows the V1.0 data.

To resolve this discrepancy as we go forward, SWO plans to change RI over to the V2.0 data at solar minimum since at solar minimum the V1.0 data should be equal to (or extremely close to) the V2.0 data.

Thus the SWO data will for all intents and purposes be equal to the RI data. That should resolve the confusion with sunspot numbers (except for the fact that our old sunspot numbers, to which our propagation predictions were correlated, are deemed incorrect!).