What to Expect at Solar Minimum

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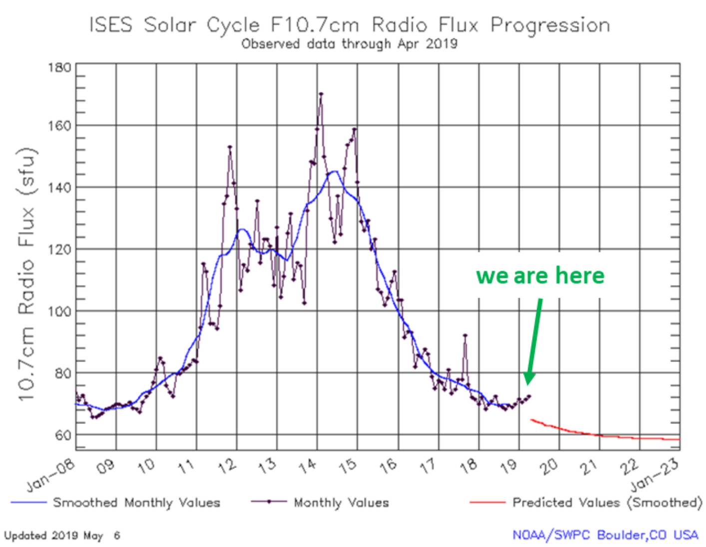
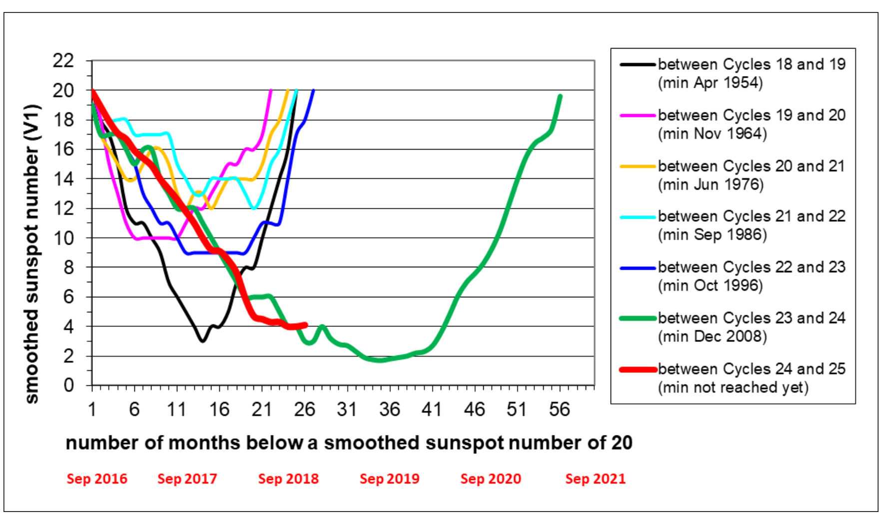
Here's the latest Cycle 24 data from the Space Weather Prediction Center (NOAA) in terms of the 10.7 cm solar flux. The black curve gives the monthly mean values (as can be seen, these values are spiky). The blue curve gives the smoothed values (essentially a 12-month running average of the monthly means). The red curve is the prediction out to the end of 2022.



A smoothed 10.7 cm solar flux of 70 (where we are now) is equivalent to a smoothed sunspot number of around 10. For all intents and purposes we are at solar minimum, although the prediction says we are headed to even lower 10.7 cm solar flux values. For the record, the lowest 10.7 cm solar flux ever measured was 61.6 (adjusted for 93 million miles).

A good question is "how is this solar minimum doing compared to previous solar minimums?" The following plot shows solar minimums all the way back to the minimum between Cycles 18 and 19. What's plotted is the number of months below a smoothed sunspot number of 20.



Let’s face it – we were spoiled by the short minimums between Cycles 18 and 19 through Cycles 22 and 23. Each of those minimum periods by my definition was only about 24 months (2 years) in duration. But the minimum between Cycles 23 and 24 (the green curve) was extremely long – almost 5 years. And it looks like the minimum between Cycles 24 and 25 (the red curve) is going to be another long one. The dates on the bottom of the plot indicate that official solar minimum could be around late 2019, but we’ll just have to wait and see what actually happens.

What can we expect on the HF bands during this solar minimum period? One approach is to look at worldwide F2 region MUF (maximum useable frequency) maps for winter and summer at a sunspot value of zero (no sunspots). This will show us which bands may be open.

The first worldwide map at the end of this paper is for a December month at 1800 UTC (local noon in middle North America). The contour lines are the F2 region MUF, and it assumes that any location is the midpoint of a 3000 km hop (which corresponds to radiation from our antennas at a low elevation angle). Being December, the overhead Sun (the yellow dot) is in the southern hemisphere. The MUFs are monthly medians (50% probability – half the days of the month), meaning that on a few days of December at zero sunspots the MUF could be 10-15% higher. That generally translates to one band higher. On a few days the MUF may be 20% or so lower.

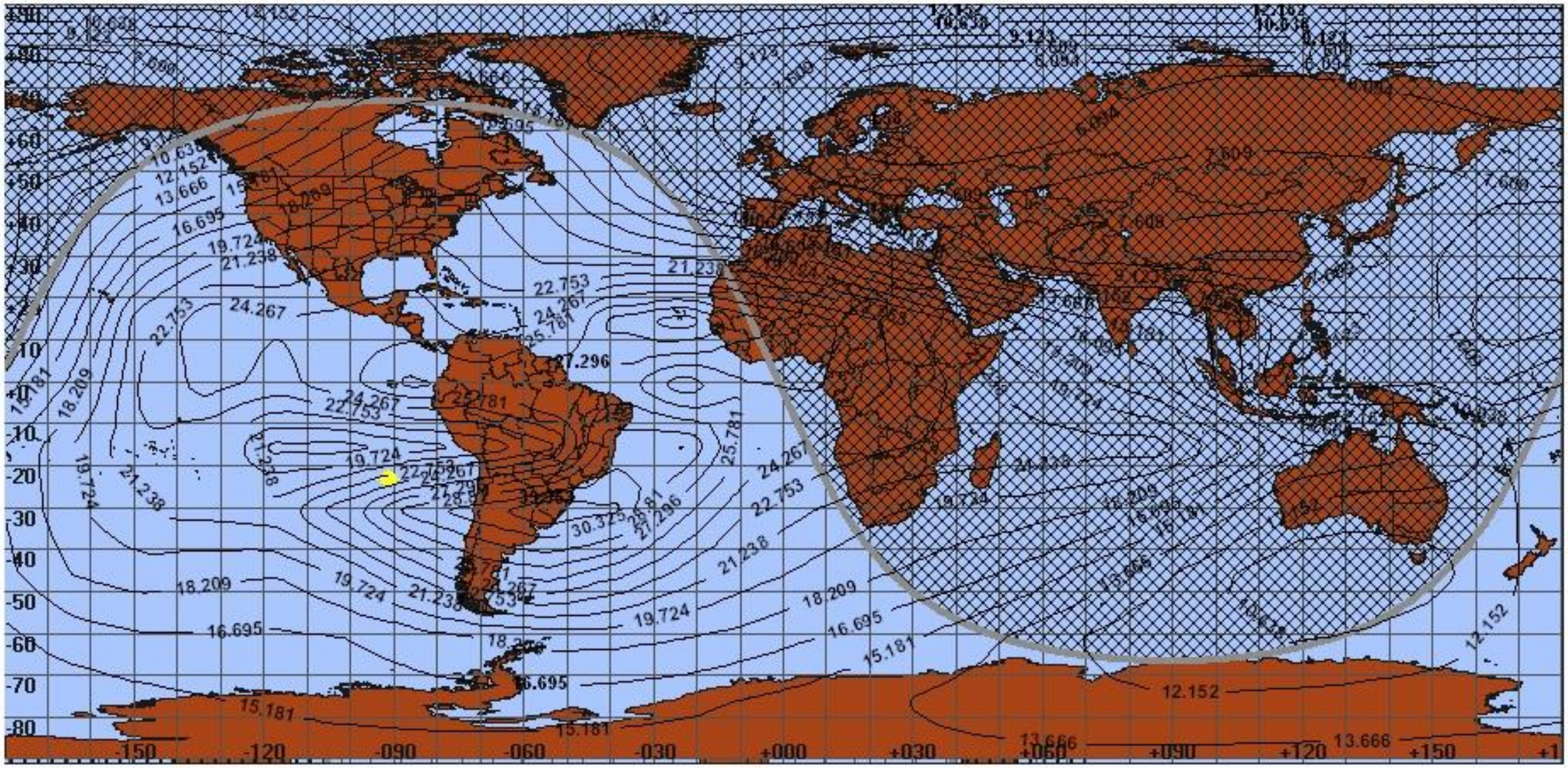
During the late afternoon and into the early evening, the MUFs should allow worldwide 20m contacts on most days, with 17m at a lower probability. Openings to South America, Central America and the Caribbean on the higher bands may occur occasionally. Of course the low bands should be good at night. And as expected, the equatorial ionosphere has the highest MUFs.

The second worldwide map at the end of this paper is for a July month at 1800 UTC. Being July, the overhead Sun (the yellow dot) is in the northern hemisphere. Again we see the highest MUFs in the equatorial ionosphere, but generally the MUFs in the northern hemisphere are about 6 MHz lower during the day in July compared to during the day in December. This is due to a change in the atmosphere from winter to summer. These lower MUFs at solar minimum at solar minimum critically impact the ARRL Field Day and the IARU contest. But don’t forget sporadic E in the summer.

Having said all the above, remember that our understanding of the ionosphere is on a monthly median basis – in other words, kind of an average over the month. We don’t fully understand short-term events, so always keep an eye out for unusual space weather (for example, a spike in the K index or a small solar flare) that may result in short-term enhancements in propagation. If you’re in the right place at the right time, you may be rewarded with an unusual QSO.

One last comment – the correlation between how long solar minimum is and the magnitude of the next cycle suggests Cycle 25 will be another small one. I believe most solar scientists agree on this, but again we’ll just have to wait and see what actually happens.

December, 1800 UTC, zero sunspots



July, 1800 UTC, zero sunspots