# Two Topics
## 1) ZD7FT on 10m SSB
## 2) The Cycle 24 Termination Date

Carl Luetzelschwab K9LA

Rev 1 added more predictions and Rev 2 corrected typos

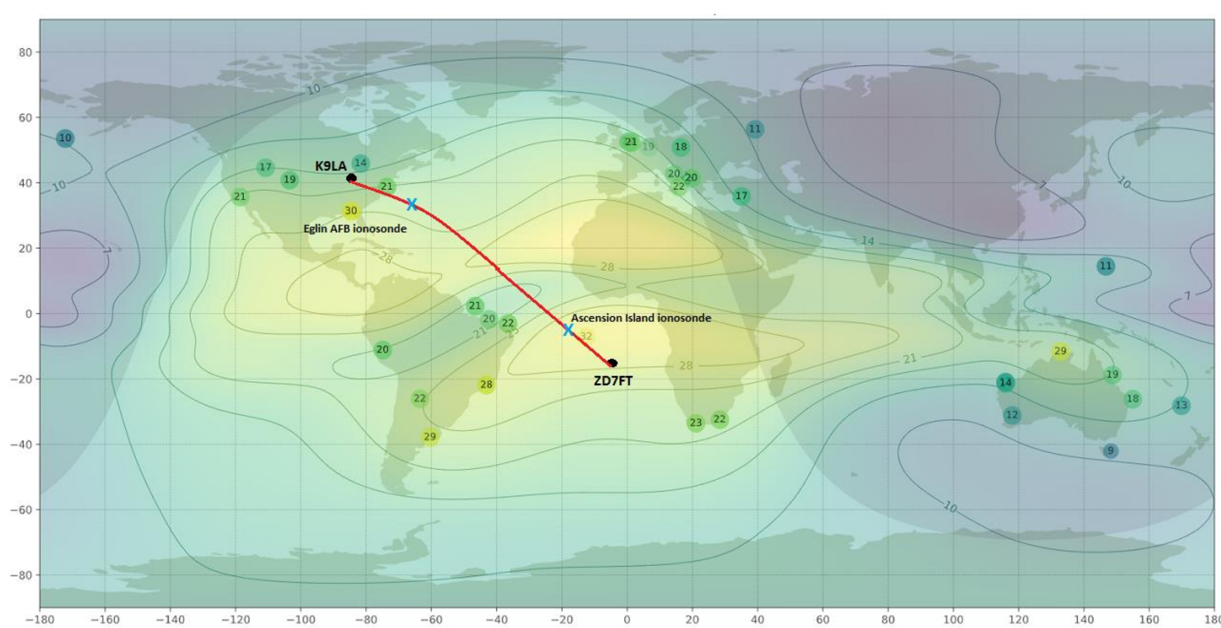
This month's feature consists of two topics:

1) ZD7FT on 10m SSB on November 20 – what enabled this QSO at solar minimum?
2) The Cycle 24 termination date and the McIntosh, et al, prediction of a big Cycle 25

## ZD7FT on 10m SSB on November 20

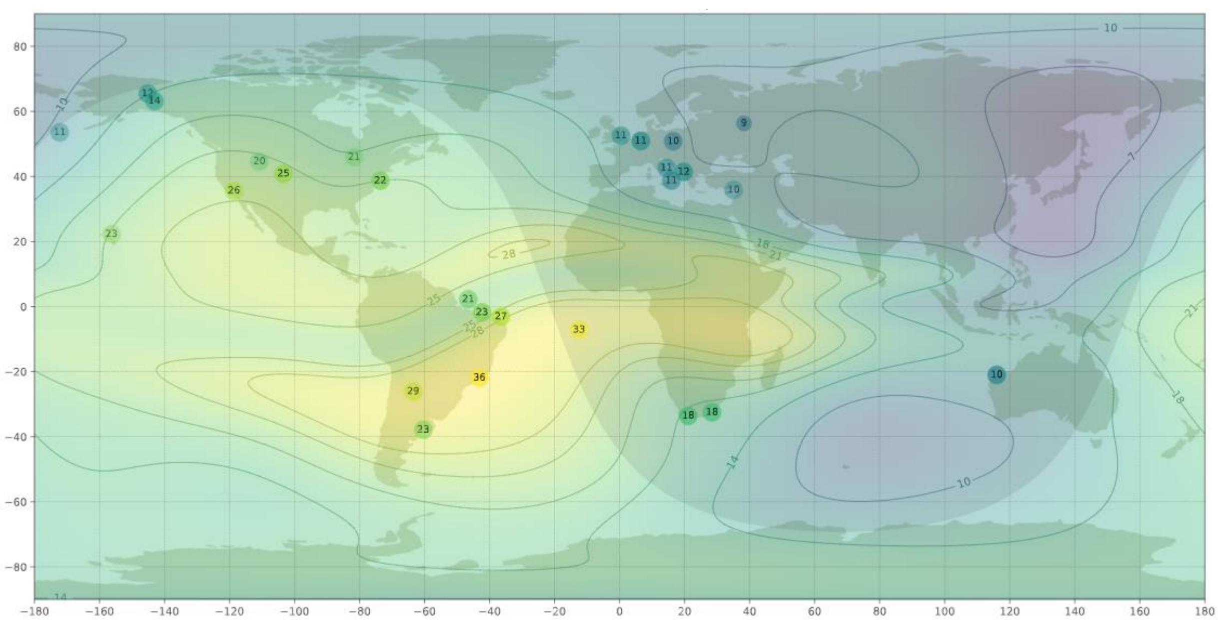
Around 1500 UTC (9:00 AM local time here in Ft Wayne, IN) on November 20, I wandered into the shack and saw some North American spots for ZD7FT on 28490 KHz. I turned on the AL-811H amplifier, turned my Tennadyne T6 LPDA (log periodic dipole array) to the heading for ZD7 (109°), turned on the Ten-Tec OMNI 7 and dialed up 28490 KHz. ZD7FT had a decent signal (around S6) and soon was in the log at 1501 UTC.

Here we are at solar minimum, with Cycle 25 just now showing signs of life. Why was propagation so good between ZD7 and North America on November 20? We might get a hint as to what was going on in the ionosphere by looking at the MUF (maximum useable frequency) map from Andrew Rodland, KC2G, at http://prop.kc2g.com/ at 1530 UTC on November 20. It would have been nice for me to get the 1500 UTC map, but I didn't think of doing that until a half hour later – old age is setting in! The contour lines of the 3000 km MUF (assuming it's the midpoint of a 3000 km path) are derived from ionosonde data, which are the dots with numbers. The short path from my location to ZD7 is shown in red.



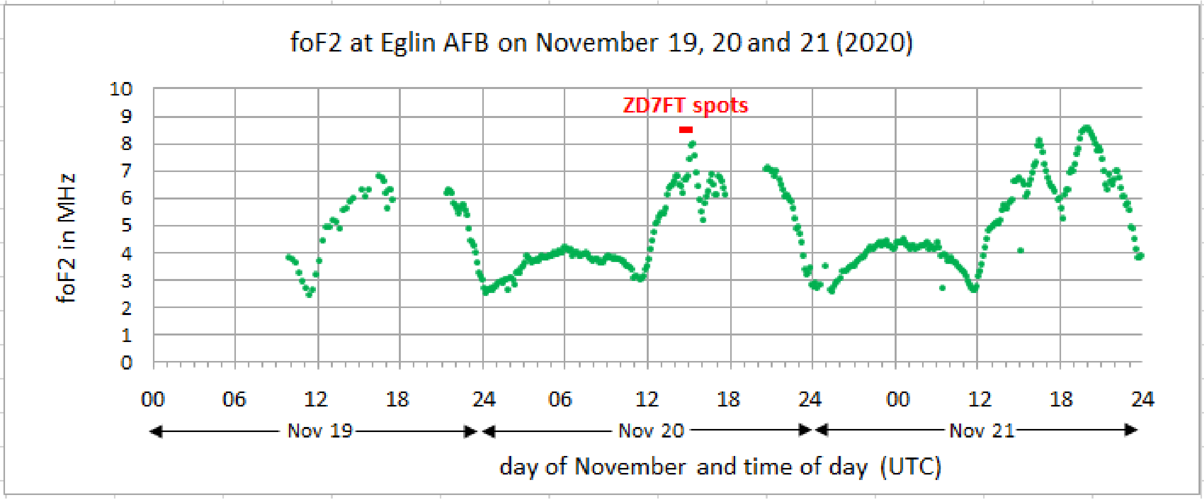
Note that the Eglin AFB ionosonde in Florida (the yellow dot with 30) and the Ascension Island ionosonde (the yellow dot with 32) both have MUFs that could support 10 meters at 1530 UTC (as mentioned earlier, a half hour past my QSO time).

Also note the blue X southeast of K9LA along the path and the blue X northwest of ZD7 along the path. These are points that are 1500 km from each end – where the RF would encounter the F2 region on the first hop out of each end for a 3000 km hop. The MUF on the K9LA end is in the vicinity of 28 MHz and the MUF on the ZD7 end is well above 28 MHz. Now let's look at the same MUF map at 1950 UTC on November 20.



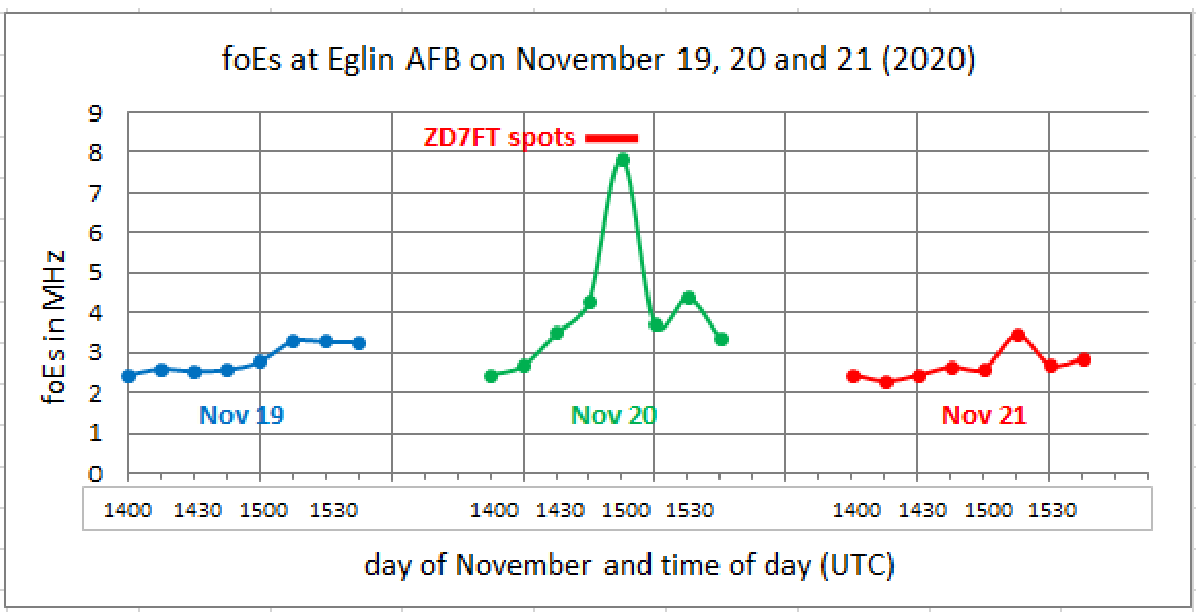

There are no data from Eglin AFB at this time. In fact, there were no data at all between 1745 UTC and 2000 UTC. Data from the ionograms before 1745 UTC and after 2000 UTC show the MUF to be from the low 20s to the mid 20s – not enough to support 28 MHz. The MUF near the first hop out of ZD7 is still well above 28 MHz. Thus North America was the critical end. If the MUF supported 28 MHz on the K9LA end, then the path was likely to be open.

Let's now look at more detailed data from the Eglin AFB ionosonde data on the day before, the day of the ZD7FT spots and the day after. **First**, here's the plot for foF2 – the F2 region critical frequency. Multiplying foF2 by 3 gives an approximation for the MUF for a 3000 km F2 path. The MUF for a 3500 km path (that works out to 3 hops from ZD7FT to K9LA) would be a bit higher at about 28 MHz. The 3500 km MUF is higher because the wave is at a bit more of a grazing angle on the F2 region of the ionosphere.



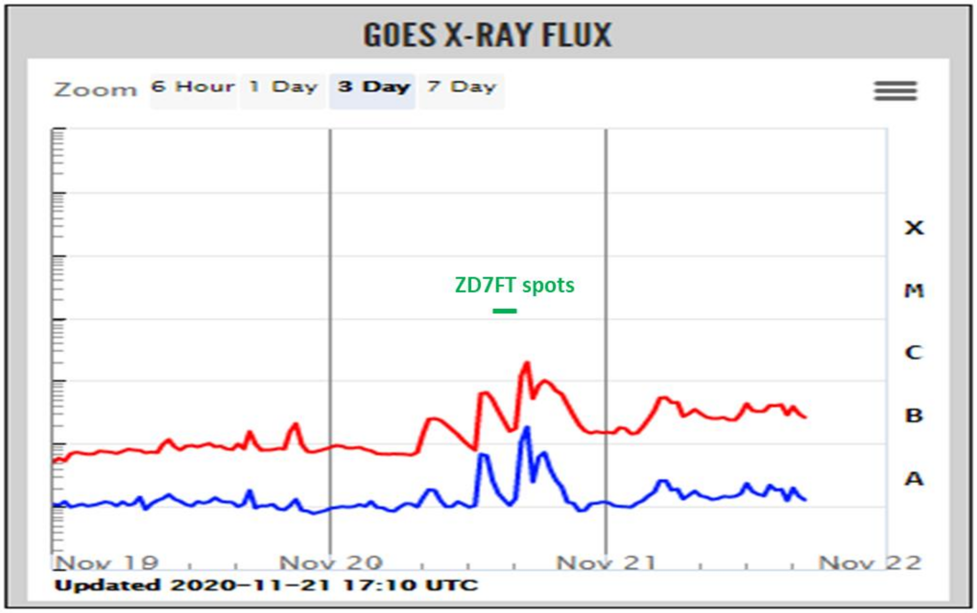

The short horizontal red line in the plot is the time period over which there were ZD7FT spots (1438 UTC to 1505 UTC per PacketCluster). What's noticeable is the short-term spike of foF2 during the ZD7FT spotting period. But there were even higher foF2 spikes on the next day. What we're seeing on the 20th may be the start of an F2 region traveling ionospheric disturbance (TID) in the Eglin area that was instigated by a gravity wave propagating up from an event in the lower atmosphere. Was the spike in foF2 on November 20 the enabler for my QSO?

**Second**, let's look at E region data from Eglin (both the normal foE data and the sporadic E foEs data) for the day before, the day of the ZD7FT spots and the day after. The normal E region data didn't show anything unusual – the MUF was way too low for 28 MHz propagation. But foEs was a different story. Here's that plot. Multiplying foEs by 5 gives an approximation for the MUF for a 2000 km Es path of around 40 MHz.



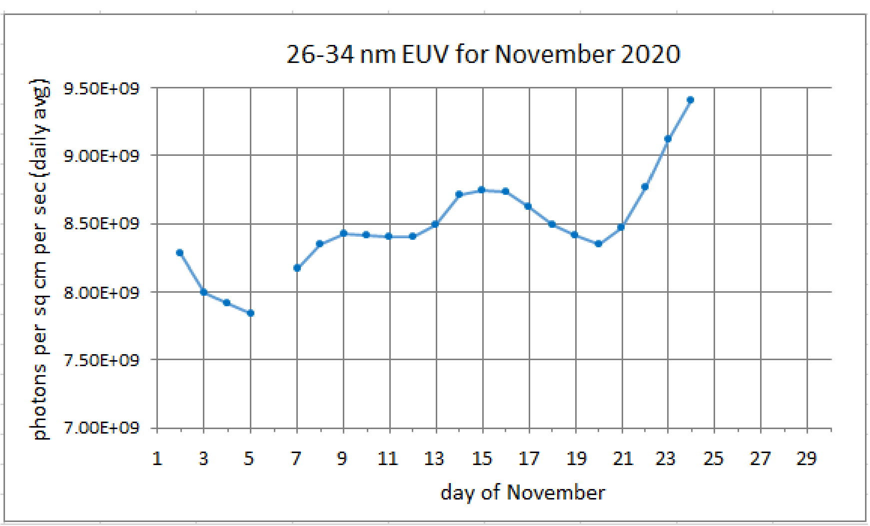
The spike in foEs occurs only on the 20th at the time of the ZD7FT spots. It suggests that 28 MHz could have been supported on the K9LA end for a short time. Was the spike in foEs on the 20th be the enabler for my ZD7FT QSO?

**Third**, some minor solar flaring occurred on November 20. The following is a plot of X-ray flux for November 19 and 20 (and partial data for November 22) from https://www.swpc.noaa.gov/.



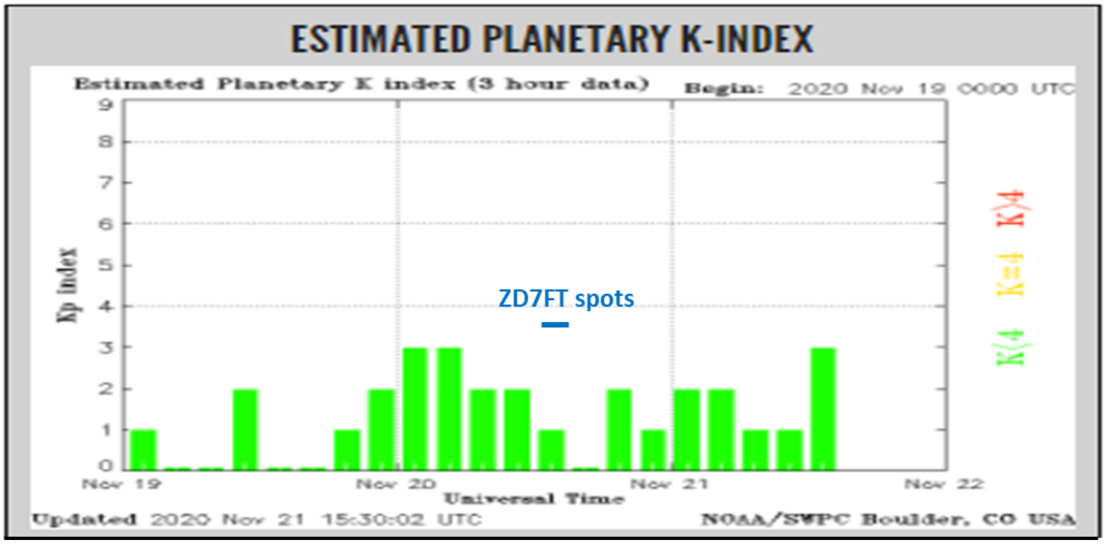

The blue curve is radiation from 0.05-0.4 nm. The red curve is radiation from 0.1-0.8 nm (the wavelength band that determines the class of the flare). Did this flaring enhance the F2 region?

The F2 region, which is responsible for most of our long distance QSOs, is ionized by EUV (extreme ultraviolet) radiation from about 10-100 nm. About 60% of the F2 region is the result of radiation around 30 nm. The above X-ray data does not tell us directly anything about EUV radiation. So I downloaded 26-34 nm EUV data and plotted it for the month of November.



On November 20, the EUV radiation, if anything, took a minor dip. Thus the flaring doesn't appear to be the cause of the spike in foF2 (or even the spike in foEs). Of course the generally increasing EUV radiation likely helped with the background F2 region ionization.

**Fourth**, the Kp index decreased around the time of the ZD7FT spots. Here's the Kp index plot from https://www.swpc.noaa.gov/.



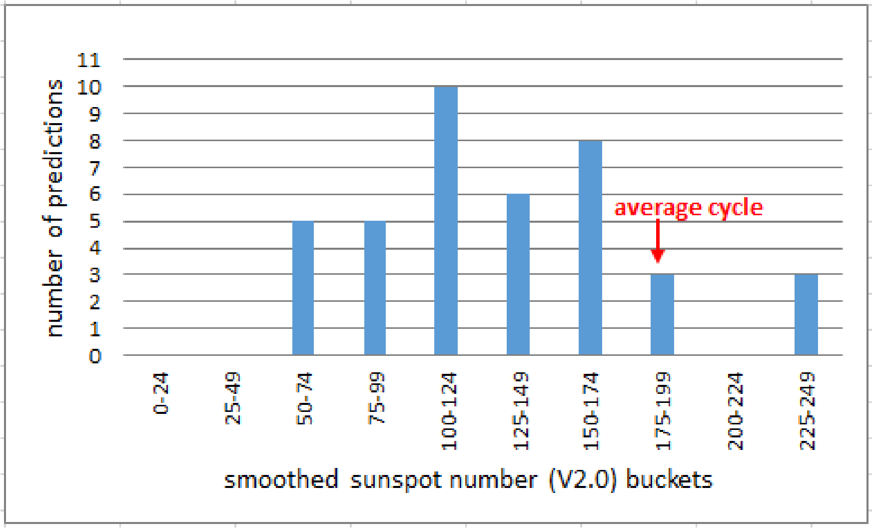

The Kp index was 2 in the 09-12z period, 1 in the 12-15z period and 0 in the 15-18z period. Could this decrease in geomagnetic field activity have helped the F2 region?

So what enabled this QSO on the K9LA end of the path? A TID in the F2 region? Some sporadic E? Or a decrease in geomagnetic field activity? That's a tough question to answer with the data we have. I would likely go with a traveling ionospheric disturbance causing a spike in foF2. It is highly likely that we will never know what really enabled this path. All we can do is list the possibilities and hope that one of them (or a combination of them?) was the enabler.

## More comments about the McIntosh, et al, prediction of a big Cycle 25

The August 2020 Monthly Feature on my website titled "Cycle 25 Predictions" looked at the many predictions for Cycle 25, and then looked at the smallest prediction (by Javaraiah) and the biggest prediction (by McIntosh, et al) in more detail.

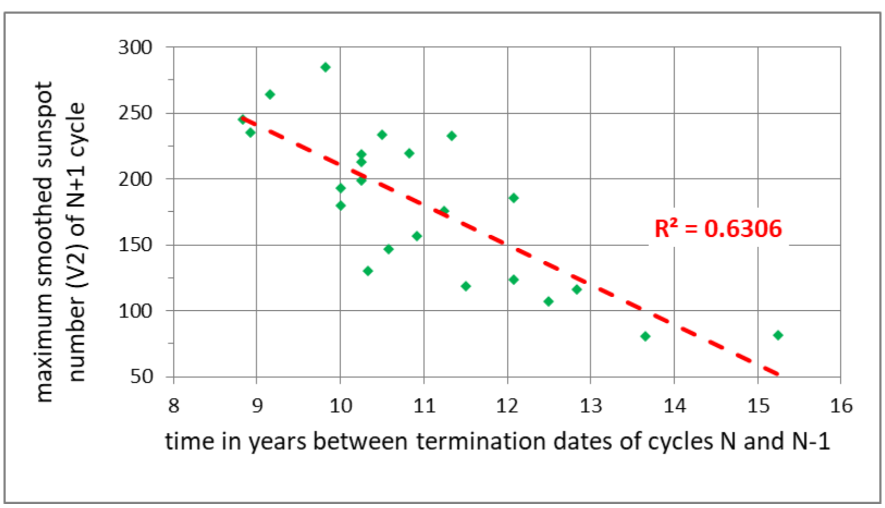
At the time I wrote that Monthly Feature in July 2020, I was aware of 27 predictions for Cycle 25. After that Monthly Feature I became aware of 40 predictions (from a presentation by W. Dean Pesnell of NASA'a Goddard Space Flight Center). Here's the distribution of those 40 predictions.




34 of the 40 predictions (85%) are for a below-average cycle. 3 predictions are for an average cycle. And 3 predictions are for a big cycle – the McIntosh, et al, prediction is one of these.

Very recently, I attended a presentation by Doug Biesecker of NASA/NOAA. He identified 53 predictions (13 more than Pesnell). All but three of these 53 predictions are at or below the average smoothed sunspot number of 179. Thus the distribution of the predictions hasn't changed much with the 13 new predictions.

As discussed in the August Monthly Feature, the McIntosh, et al, prediction is based on the assumption that the termination date for Cycle 24 occurred in April 2020 (2020.37). The termination date for Cycle 23 was in January 2011 (2011.08). From the scatter diagram from the August 2020 Monthly Feature (my Excel plot from McIntosh, et al, data and reproduced below), that gave the McIntosh, et al, smoothed sunspot prediction of 229 (V2 data set).



But per Dr. Scott McIntosh's presentation of November 11, 2020, the termination date for Cycle 24 did not occur in April 2020. As the date moves out, the predicted magnitude of Cycle 25 goes down.

An update from Steve McDonald, VE7SL, in early December on the topband reflector indicates that Dr. McIntosh believes the termination date for Cycle 24 was in early November. Thus the difference between the Cycle 23 termination date and the Cycle 24 termination date would be 9 years and 10 months. From the figure above, that still gives a larger-than-average solar cycle – around 210.

On a personal note, I'm cheering for a big Cycle 25. Why? I have a little homebrew QRP 10 meter DSB (double sideband) transmitter (250 milliwatts PEP out on USB) and a direct conversion receiver that needs sunspots! The transceiver is pretty simple – an ON/OFF-volume control and a frequency knob. During the peak of Cycle 22, I worked US, Caribbean and South American stations using a 4-element 10m Yagi at 72 feet. Here's a picture of it.