W3 to HS Via Long Path on 20-Meters

Carl Luetzelschwab K9LA August 2016

At the end of April 2015 I received an e-mail from Fred K3ZO about his long-running 20-Meter skeds with his friends in Thailand. The pertinent part of his e-mail said:

"*My friends in Thailand and I have been having regular weekly schedules on 20 and occasionally 15 meters for about 30 years now, every Wednesday at 1200 UTC. This year we have had unprecedented success with the grey line path (225 degrees bearing from here, 135 degrees bearing from Thailand) at that hour right through the whole month of April thus far. Normally that path is available to us for comfortable communications only from about mid-October to mid-February. We have never seen it to last this long into Spring before. Usually by this time of year short path is the only option.*

So I don't look on the coming downward trend of solar activity with doom and gloom. On the contrary, it may provide unexpected surprises which will continue to make a DX'ers life interesting."

First, I couldn't agree more with his comment in his second paragraph. We know a lot about the ionosphere, but it's mostly on a longer-term basis – essentially the average characteristics over a month's time frame. Our ability to predict shorter-term events (daily) is lacking. So stay active as Cycle 24 declines, and you may be pleasantly surprised – as K3ZO said.

Second, let's try to understand his first paragraph – specifically why mid-October through mid-February allows the W3-to-HS long path on 20-Meters. Maybe we can even offer an explanation with respect to why April 2015 was unusually good.

To start, let's look at the predicted maximum useable frequency (MUF – a monthly median value) and predicted signal power (also a monthly median value) for W3 to HS from VOACAP for each month at 1200 UTC at a constant smoothed solar flux of 100. This translates to a smoothed sunspot number of around 50, and represents a medium level of solar activity. I used 500 Watts and antennas with 14 dBi gain. Figure 1 gives these results.

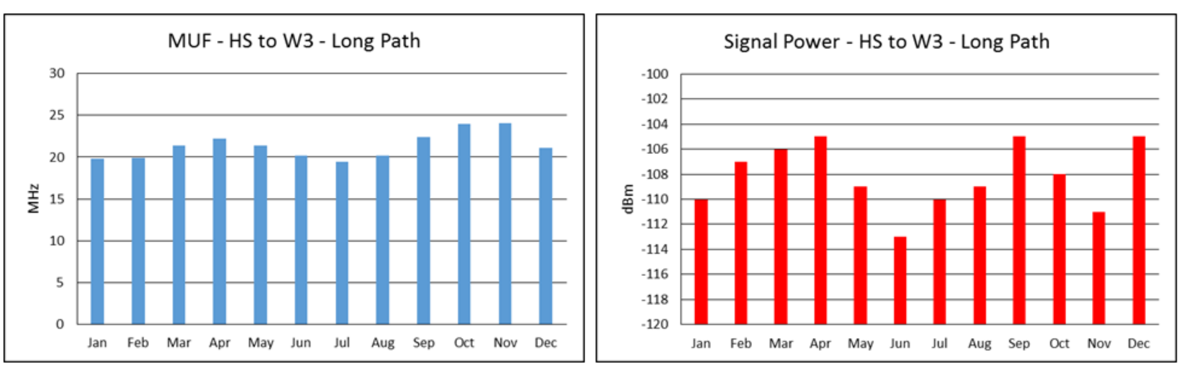

Figure 1 – Predicted MUF and Signal Power for HS-to-W3 20-Meter Long Path

VOACAP predicts the MUF to be at or above roughly 20 MHz for all months. So this doesn't help explain why K3ZO said mid-October through mid-February. Likewise, the signal power doesn't give a 100% clear advantage to mid-October through mid-February (by the way, -109 dBm is S3 assuming S9 is -73 dBm and an S-unit is 6 dB). So what's the problem?

The "problem" is that VOACAP (as do all our other propagation prediction programs) uses the control point method to predict propagation. VOACAP looks at the F2 region MUF at 2000 km from each end of the path (thus giving a 4000 km hop – it also looks at the E region control points 1000 km from each end – but the F2 region is the important player here). The lower of these two values is the reported MUF. This is based on empirical data suggesting that if the MUF is high enough at these control points, then propagation will be supported all along the path.

Where this can fall apart is for extremely long distance paths that go to the high latitudes (where the MUFs are the lowest in the world). So what we need to do is plot the MUF at the midpoint of the HS-to-W3 long path. Figure 2 does this.

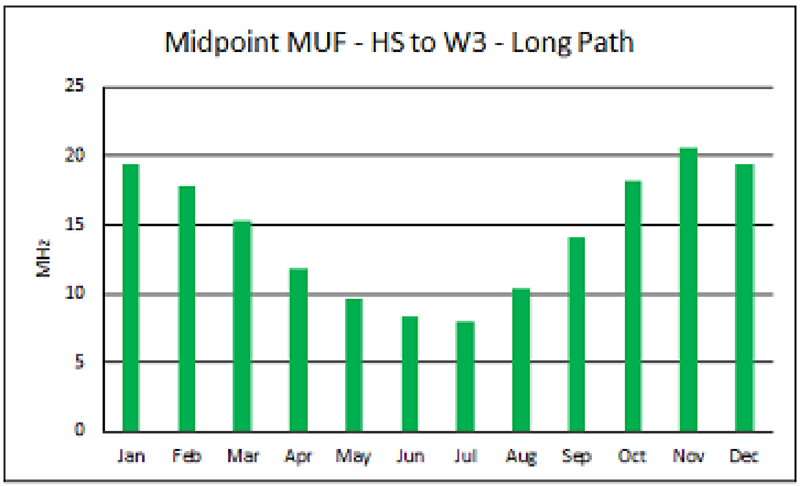

Figure 2 – MUF at Midpoint of Path

Now these results agree well with K3ZO's observations for 20-Meters. As a side note, the midpoint is at 77.0 degrees South latitude and 87.3 degrees West longitude. What this suggests is that this 20-Meter long path is mostly driven by the MUF at the high southern latitudes. Ionospheric absorption could be a secondary effect, of course.

Note that Figure 2 says that September and March are kind of "iffy" in terms of the MUF for 20-Meters. At a smoothed sunspot number of 50, the MUF at the midpoint would be high enough on only half the days of the month (remember these values are monthly medians – which implies 50%). Of course these values need to be corrected for the actual sunspot number. So this path being open in March and April could be highly variable – which might account for K3ZO's comment about "*never seen it to last this long into Spring before*" [note 1].

So the path being available is highly dependent on the MUF at the high southern latitudes. What drives the MUF up from mid-October through mid-February? The mapping feature in W6ELProp allows us to see the reason why. Figures 3a, 3b and 3c show this.

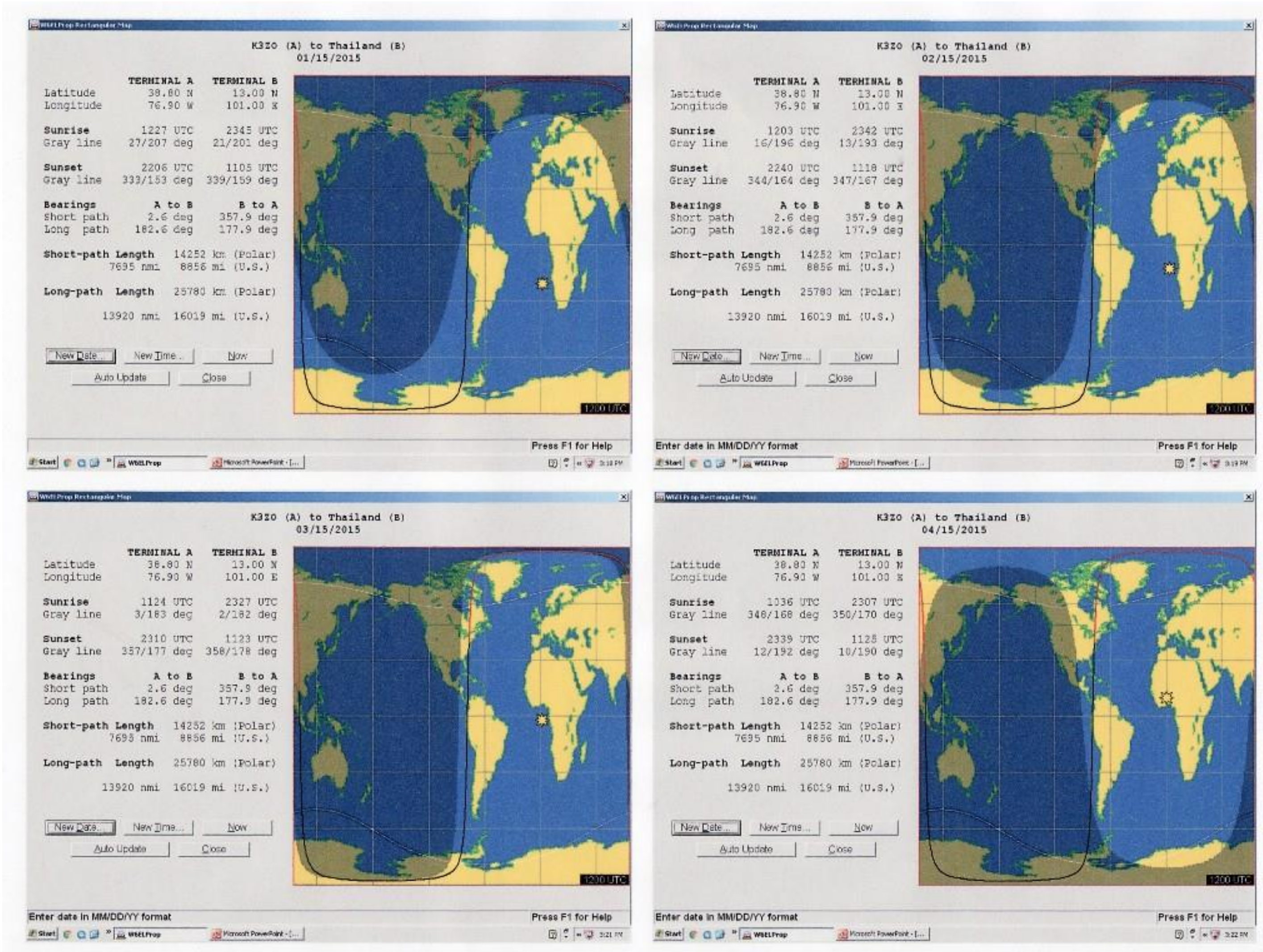

Figure 3a – January, February, March, April

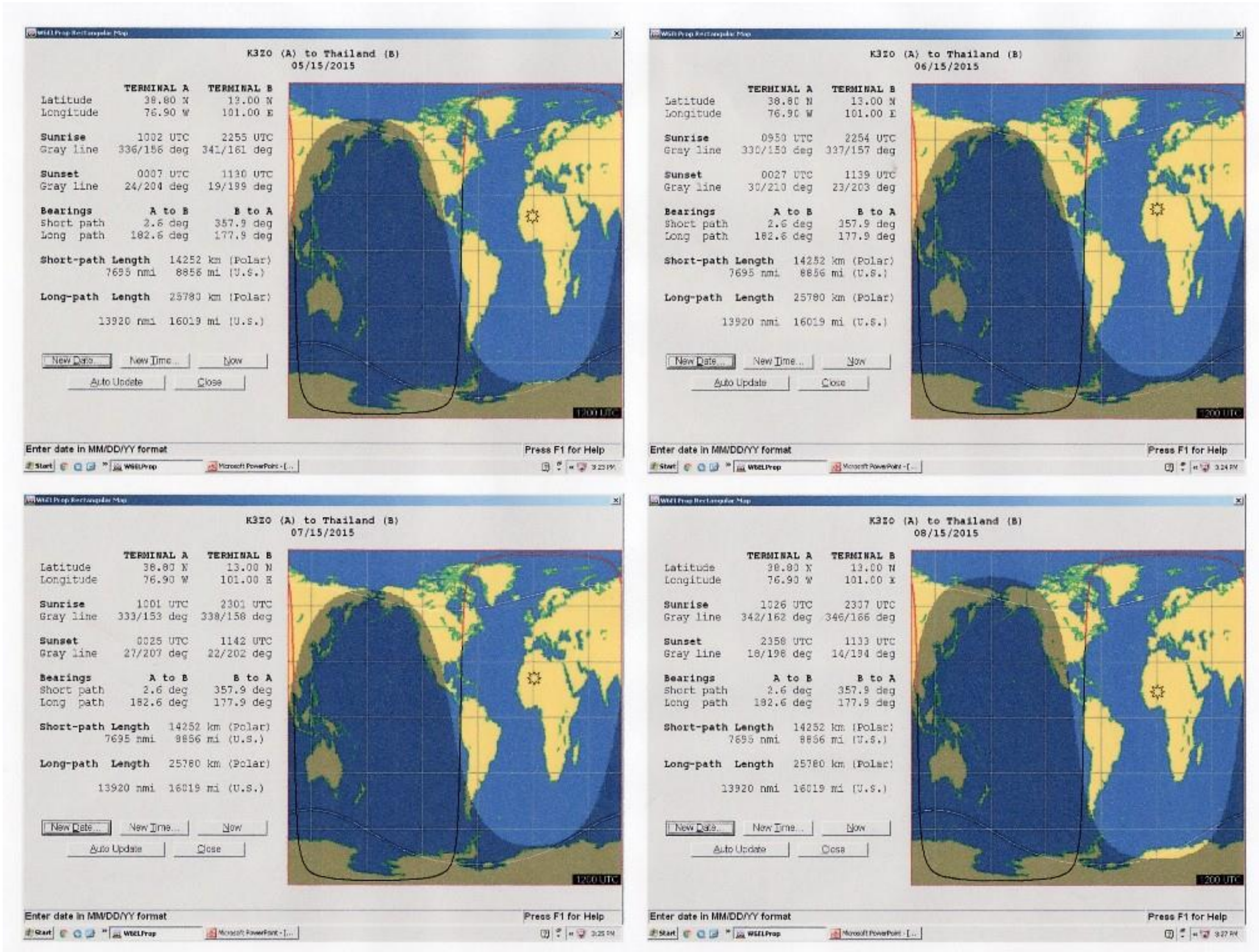

Figure 3b – May, June, July August

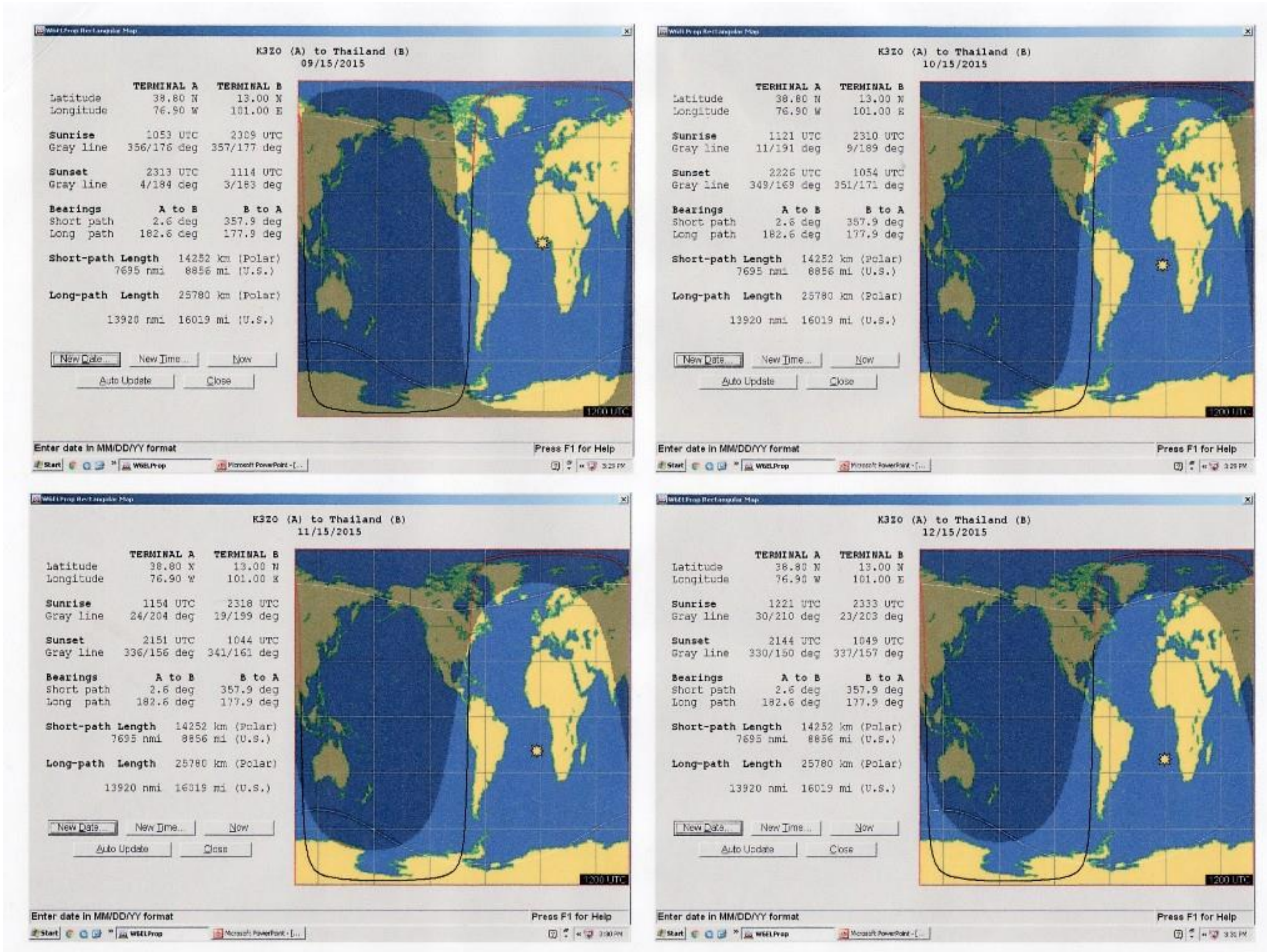

Figure 3c – September, October, November, December

Each figure is for four months. The long path between HS and W3 is the black line (the short path is red). As can be seen, the only months when the high southern latitude part of the long path is definitely in daylight are October, November, December, January and February. With the high southern latitudes being in daylight, the MUFs will be higher in that area – allowing propagation.

The last nagging issue is K3ZO's comment about the grey line path (225 degrees out of K3ZO and 135 degrees out of HS). The true great circle paths are more on the order of 180 degrees out of each end. So did the RF travel via the true great circle path, or did it travel along the terminator? I favor the true great circle path, as the grey line headings cited by K3ZO would put the high southern latitudes closer to darkness – which would result in lower MUFs. Also, for the RF to travel along the terminator at 1200 UTC would require one (or even two) skew points to kick the RF off the true great circle path onto the great circle path aligned with the terminator and vice versa. Identifying the necessary gradients in the ionosphere to do this is tough.

In summary, we understand this long path fairly well. The issues that were discussed could be applied to any path and any band – namely, look at the MUF and absorption. Usually the MUF is only important on the higher bands (17-Meters through 10-Meters), while absorption is only important on the lower bands (160-Meters through 40-Meters). 30-Meters and 20-Meters can be considered to be transition bands, where both MUF and absorption could be important.

Note 1 – This analysis assumes simple multi-hop propagation (successive refractions from the ionosphere and reflections from the ground). It could very well be that chordal hops are involved – especially at the higher southern latitudes. In this case, the conventional MUF is not truly applicable, and thus ionospheric absorption could be the determining factor for this path. But to reiterate, Figure 2 matches the observations well – suggesting that multi-hop is indeed the major player.