Selective Propagation on 10-Meters

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Let's start this month's column with a trip in the Way-Back machine (remember this from the Sherman and Peabody segment in the old Rocky and Bullwinkle TV show?). We're going back to December 1986.

In conjunction with a short vacation, I was doing the ARRL 10-Meter Contest from the Cayman Islands. My ZF call at that time was ZF2AY (no ZF2LA vanity call yet). I operated from our hotel room that was right on Seven Mile Beach on the west side of Grand Cayman, which gave me a clear shot over water to the south, southwest, west, northwest and north. I was running 100 Watts to a small 2-element 10-Meter Yagi.

December 1986 was just starting to come out of solar minimum between Cycles 21 and 22. The smoothed sunspot number for December 1986 was only 16, so I didn't expect to work many stations. And I didn't. I made a total of 42 QSOs, with each green x in Figure 1 indicating the location of a W/VE QSO.

Figure 1 – ZF2AY W/VE QSOs in the December 1986 10-Meter Contest

If you count the x's on the map, you'll come up with 35 – the number of QSOs with W/VE stations. Where were the other 7 QSOs? I made 2 QSOs with ZF stations, and 5 QSOs with TI (Costa Rica) stations.

Note that those 35 W/VE QSOs were at distances from about 2700 km (the shortest) to about 4250 km (the longest). Why were they in this range of distances? That's not too difficult to answer. Figure 2 shows the relationship between the distance covered and the resultant elevation angle for a typical parabolic F2 region. Figure 2 is Figure 4.10 in Ionospheric Radio Propagation (1965) by Kenneth Davies.

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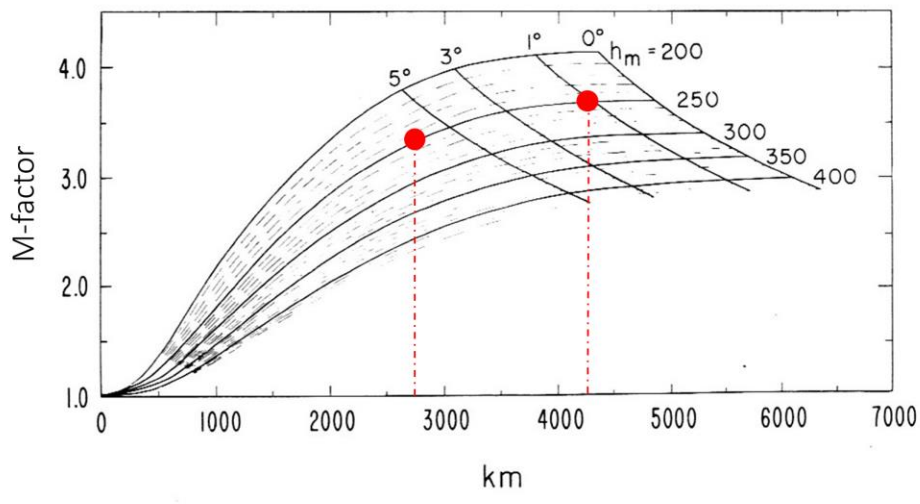

Figure 2 Relationship between Distance and Elevation Angle for 1 Hop in the F2 Region

The horizontal axis in Figure 2 is the skip distance in km. The vertical axis is the F2 region M-factor, which is what the critical frequency foF2 is multiplied by to determine the MUF (maximum usable frequency). The various curves that start in the lower left are the heights of the maximum electron density of the F2 region. The curves that slant from top left to bottom right are the elevation angles.

Using VOACAP with the solar conditions for December 1986 gives us a predicted monthly median value of 250 km for the height of the maximum electron density at the times of the QSOs. On the 250 km height curve, I’ve added a dot at 2700 km and at 4250 km. From these two dots, we determine that the required elevation angles are about 6 degrees for the 2700 km shortest distance and about 1 degree for the 4250 km longest distance. Remember these are for 1 hop via the F2 region.

From Figure 2 we also note that the M-factor for the 2700 km distance is around 3.4 and is around 3.7 for the 4250 km distance. This tells us that the MUF is highest for the lowest elevation angles. So the only way 10-Meters would open to the north from ZF would be at very low elevation angles. And that’s why all the W/VE QSOs are in the distance range of 2700 km to 4250 km around solar minimum. If you’ve been a follower of my columns in the various publications, you already knew this.

As for the 5 QSOs with TI, the distance from ZF to TI is about 1140 km. How were these QSOs made, realizing that they would be at higher elevation angles? The answer is that the midpoint of these TI QSOs was much farther south of the midpoints of the W/VE QSOs. This puts the midpoint of the TI QSOs much nearer the equatorial ionosphere, where ionization is the highest in the world. Thus higher angles could be supported.

Now let’s fast-forward to December 2015. Joe W6VNR/ZF2AH, my wife Vicky AE9YL/ZF2YL and I (K9LA/ZF2LA) participated in the 2015 ARRL 10-Meter Contest last December as ZF1A from the Cayman Islands. Since Cycle 24 is on the decline, we expected to see a fewer number of QSOs than in previous years. And we did. In 2013 we made just over 2900 QSOs, in 2014 we made about 2250 QSOs and in 2015 we made about 1750 QSOs. Unfortunately the next running of the 10-Meter Contest in December 2016 will likely see even fewer QSOs as Cycle 24 marches towards solar minimum.

In addition to a fewer number of QSOs, we expected more selective propagation on 10-Meters. In other words, in 2015 we didn’t expect worldwide propagation as in previous years – in fact, we didn’t work a single JA station. We also didn’t expect to work all the US states – and we missed Louisiana and Mississippi. We did expect to take a step towards more selective propagation as I saw in the December 1986 contest at solar minimum. Indeed, this pattern began to emerge. Figure 3 shows our W/VE QSOs.

Figure 3 – ZF1A W/VE QSOs in the December 2015 10-Meter Contest

The green values are the eleven US states and Canadian provinces with the highest number of QSOs. Minnesota led the pack with 137 QSOs. Colorado and Michigan were tied at second with 86 QSOs each. Massachusetts was eleventh with 55 QSOs. The red values are all the other W/VE QSOs. Of course population density with respect to the numbers of hams comes into play here, too.

Included on Figure 3 are dashed green lines bounding the distances covered for these eleven states and provinces. The shortest distance for the high number of QSOs is about 2350 km and the longest distance is again about 4250 km. Thus the process of selective propagation on 10-Meters has begun as we head towards solar minimum. Next year’s contest will likely show fewer QSOs outside of these low elevation angle 1 hop distances.

Although this column focused on ZF, it is applicable to any location. Of course the characteristics of the ionosphere out to 4000 km or so at other locations will be different than ZF, and may not allow any 10-Meter F2 QSOs at solar minimum.