Propagation column
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160m Propagation from Amsterdam Island to Colorado

In the August and September 2007 columns, VOACAP was used to look at antipodal propagation from Amsterdam Island (FT5Z) in the Indian Ocean to its antipode in Colorado (W0). The VOACAP results on 20m, 15m, and 40m agreed very favorably with the general characteristics of antipodal propagation seen during actual measurements on a VK6-to-VP9 antipodal path. This month we'll look at actual QSOs on 160m on the FT5Z-to-W0 path to determine how much effect antipodal propagation had on this path.

During the period December 1987 through February 1988, Bill W4ZV (then W0ZV in Colorado) reported that Dany FT5ZB was very regular at his sunrise (around 1400 UTC) on 160m, with Dany's 80-90 W signal Q5 most of the time. In addition to working Dany numerous times, Bill heard him many other times during this period. Bill noted that Dany peaked at S7-8 once on his TS-930 S-meter. Bill also noted that he only heard Dany on his 310^{o} Beverage – never on his 250^{o} or 210^{o} Beverages, which were typically useful for other sunrise openings. The short path heading from Bill to Dany is 308^{o}, and this important observation will be discussed in a bit.

On the other end of the path, Dany noted more than 20 dB improvement in Bill's signal for 10 to 15 minutes for the QSOs they had on 40m, 80m, and 160m (I do not know if the 'more than 20 dB improvement' is applicable to all bands or just certain bands). He attributed the signal strength enhancement to antipodal focusing.

Those are interesting comments from Bill and Dany. Let's use what we learned in the August and September columns, along with some new insights, to try to answer two basic questions: Was the signal strength enhancement (seen by FT5ZB) due to antipodal focusing? And was the regularity of their QSOs over this 3-month period (noted by W4ZV) due to their path being antipodal?

Let's start by looking at the VOACAP predicted signal strengths on 160m on the eight paths out of FT5Z (as we did in the August and September 2007 columns). Since VOACAP was only intended to go down to 2 MHz, we'll use this frequency for our 160m results (that's close enough for our analysis). The assumptions and methodology for 160m are the same as for the predicted signal strengths on 20m, 15m, and 40m given in the August and September 2007 columns, but with two exceptions. First, the level of noise assumed on 160m is different. I assumed a quiet rural noise environment, which says that a signal must be above -102 dBm to give a signal-to-noise ratio (SNR) greater than 0 dB in a CW bandwidth (500 Hz) at 2 MHz. Second, the "improved" model of the lower ionosphere from the December 2007 column has been factored into the results.

As a refresher, the eight paths out of FT5Z (see the appropriate figure in the August 2007 column) start at 270^{o} (Path A) and step clockwise in 45^{o} increments (Paths B through H).

Figure 1 plots the 160m results, but with the headings defined out of W0 to make it easier to compare to W4ZV's observation of which Beverage he heard FT5ZB on.

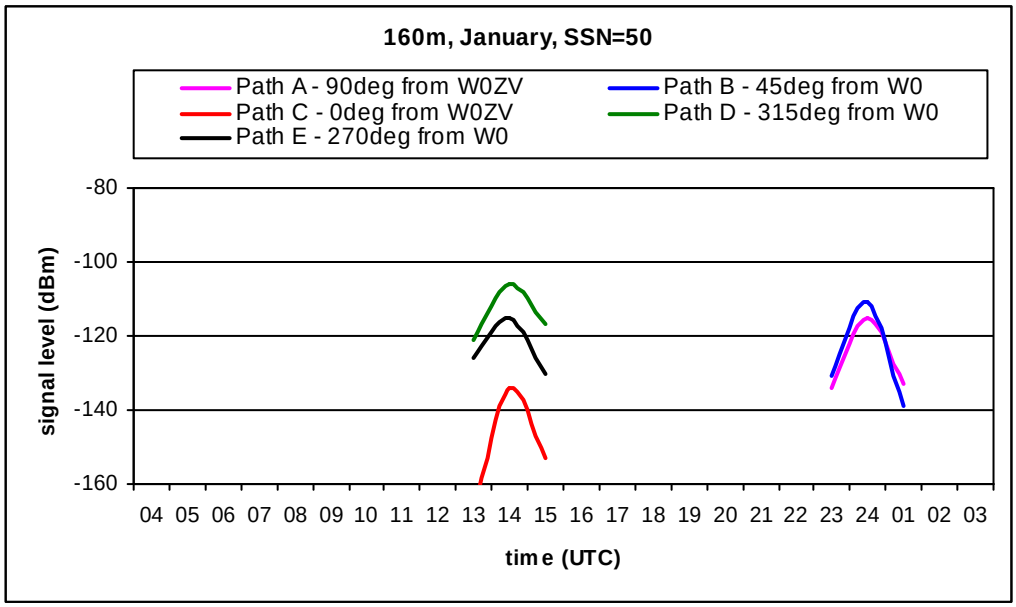

Figure 1 – Signal Powers on 160m (using improved D-region model)

Note that the predicted signal levels peak near our -102 dBm target for a short duration on only five of the eight paths. Path A and Path B (90^o and 45^o out of W0, respectively) peak around 2400 UTC. Paths C, D, and E (0^o, 315^o, and 270^o out of W0, respectively) peak around 1400 UTC. These two times correspond to sunrise and sunset at both ends of the path – 1400 UTC is around W0 sunrise and FT5Z sunset, and 2400 UTC is around W0 sunset and FT5Z sunrise.

These results on 160m are an extension of the 40m results from the September 2007 column – the opportunity for antipodal propagation on the lower frequencies tends to be short duration around sunrise and sunset. Interestingly, the best opening predicted by VOACAP in terms of signal strength is around 1400 UTC on the 315^o heading (Path D) out of W0 – that is in excellent agreement with what W4ZV reported. Two comments are in order about this specific path.

First, W4ZV's Colorado QTH was not exactly at the FT5Z antipode – it was about 360 km northwest of the FT5Z antipode. Combined with Bill's observation that he only heard Dany on the 310^o Beverage suggests Bill was far enough away from the antipode so that the direct short path was best. Second, the direct short path is opposite in direction from the overhead Sun. In other words, the direct short path is equally far away from the terminator as it makes its way to the other end of the path. I mention this as I've seen this latter comment in other technical papers analyzing low frequency reception. When you think about it, it makes all the sense in the world with absorption being inversely proportional to the square of the frequency – low frequencies generally want to be in the darkest portion of the ionosphere.

Now let's look at the first question posed earlier: Was the signal strength enhancement noted by FT5ZB due to antipodal focusing?

Although the VOACAP data at 1400 UTC in Figure 1 suggests that several paths could have propagated and thus given a signal enhancement, I think there's a much more plausible explanation for FT5ZB's observations of signal enhancement. Because antipodal stations are on opposite sides of the Earth, sunrise at one end occurs simultaneously with sunset at the other end. Figure 2 shows this for mid January for the W0-to-FT5Z path. In both images, the lighter line heading to the northwest out of W0 is short path, and the black line heading to the southeast out of W0 is long path. FT5Z is at the right-most end of the black line.

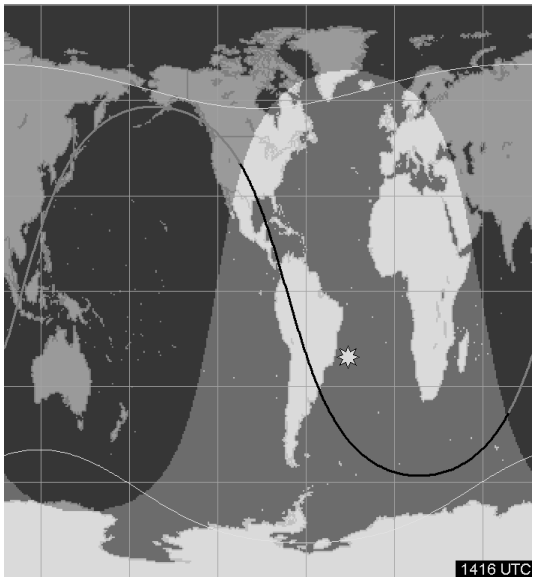

Figure 2a – W0 sunrise/FT5Z sunset

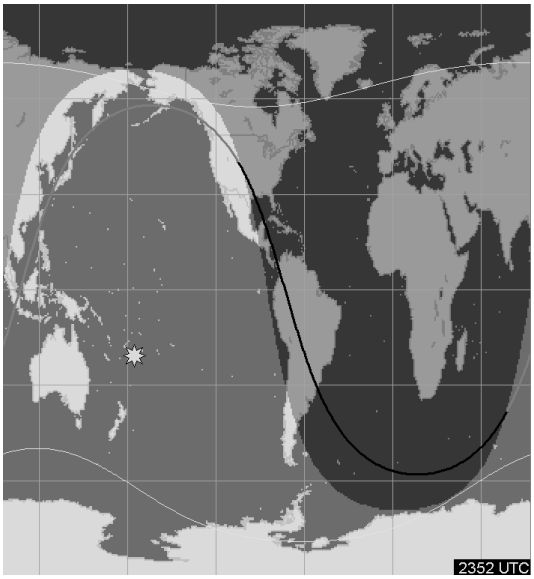

Figure 2b – W0 sunset/FT5Z sunrise

By mentally shifting the terminator to the left and then back to the right for both Figure 2a and 2b, it's easy to see that there isn't any long duration of the path to the northwest out of W0 being in darkness. Darkness along the entire path only occurs around sunrise/sunset times. Thus absorption is going to minimize (a signal enhancement) for a brief period only around these times. This is what I believe FT5ZB was seeing – the direct short path being entirely in darkness for a short duration, and not antipodal focusing.

Now let's look at the second question: Was the regularity of the QSOs over this 3-month period noted by W4ZV due to the path being antipodal? This is a tougher question to answer. All the antipodal literature that I'm aware of talks of longer duration openings over a 24-hour period, as more paths are available throughout the day (remember the 20m results from the August 2007 column?).

One thing we could look at is geomagnetic field activity over the period W4ZV worked (and heard) FT5ZB. Since 160m is generally best under quiet conditions, perhaps the December 1987 through February 1988 period was quieter than the same period the year

before and the year subsequent. I looked at planetary A index (Ap) data, and found that the year W4ZV and FT5Z worked each other on a regular basis (December 1987 through February 1988) wasn't as quiet as the previous year (December 1986 through February 1987), but was quieter than the subsequent year (December 1988 through February 1989). This is consistent with geomagnetic field activity on the rising portion of a solar cycle.

Thus the Ap data doesn't support or refute antipodal propagation being available over long term periods. Perhaps it was just a good year for whatever reason – that may not be surprising since our understanding of propagation on 160m even over shorter non-antipodal paths can be challenging to explain.

That's enough – it's time to summarize all of this. For the 160m QSOs between W4ZV when he was in Colorado and FT5ZB (which is pretty much an antipodal path) in the December 1987 – February 1988 period, antipodal propagation may have played a role in the regularity of the QSOs over this 3-month period – but the jury is still out on this issue. Furthermore, I suspect the improvement in signal strength seen by FT5ZB had more to do with darkness along the direct short path – and not with any antipodal focusing mechanism. That's my story and I'm sticking to it!