Propagation column
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Alaska to Europe on 6m

The following news item was in the June 22 issue of The Daily DX (edited and published by Bernie W3UR):

Yesterday (June 21, 2006) a historic 6 meter opening took place between Alaska (KL7) and Europe. The band opened up between 1130 and 1230 UTC with seven EU QSOs in Kevin NL7Z's log. "PA4PA was first to work Kevin, other contacts followed with SM, OZ, & DL," reports 6 meter enthusiast Kerry G0LCS.

Kevin NL7Z followed up this news item with some comments about these 6m QSOs:

Working Europe on 6M from [Wasilla] Alaska was a real thrill. I have been watching several indicators since the beginning of June, and this time it paid off. Starting at about 11:30 UTC (3:30 in the morning local time) I first heard a very weak beacon, but I couldn't get the call. Come to find out it was OZ7IGY running 30 Watts! Also, being 3:30 AM and I wasn't quite awake yet, I had to fumble for a few seconds before I realized that what I was hearing was the "other side" of the FSK keying on it. Shortly thereafter I called CQ and about fell out of my chair when I heard PA4PA (Netherlands) coming up out of the noise. After working Ray, I worked the following stations over a 35-minute period: DL9USA, OZ1DJJ, OZ1LO, OZ8RW, DL3DXX, DL2DXA, SM6CMU, and DL7CM. I did not hear any polar flutter, no aurora, just QSB at a fairly steady rate.

The purpose of this month's column is to try to determine the likely propagation mode(s) for these QSOs. This is always tough to do for incidents of propagation that are extremely rare (happening for the first time classifies these QSOs as extremely rare!). First, our monthly median model of the ionosphere doesn't capture extremely low probability events. Second, we usually don't have ionosondes in the right place to see what the ionosphere was doing. So be forewarned – we'll probably never really know with 100% certainty how these 6m QSOs happened. The best we can do is to compare the observations (the QSOs) with the statistical patterns of various modes – and then make our best educated guess.

The modes of propagation we'll look at are normal F_2 propagation, an unusual F_2 propagation mode that was discussed in a previous column, summer-like sporadic E propagation, and auroral-E propagation.

The first order of business is to look at the path. Figure 1 is from DXAID (from Peter Oldfield) with additional annotation added.

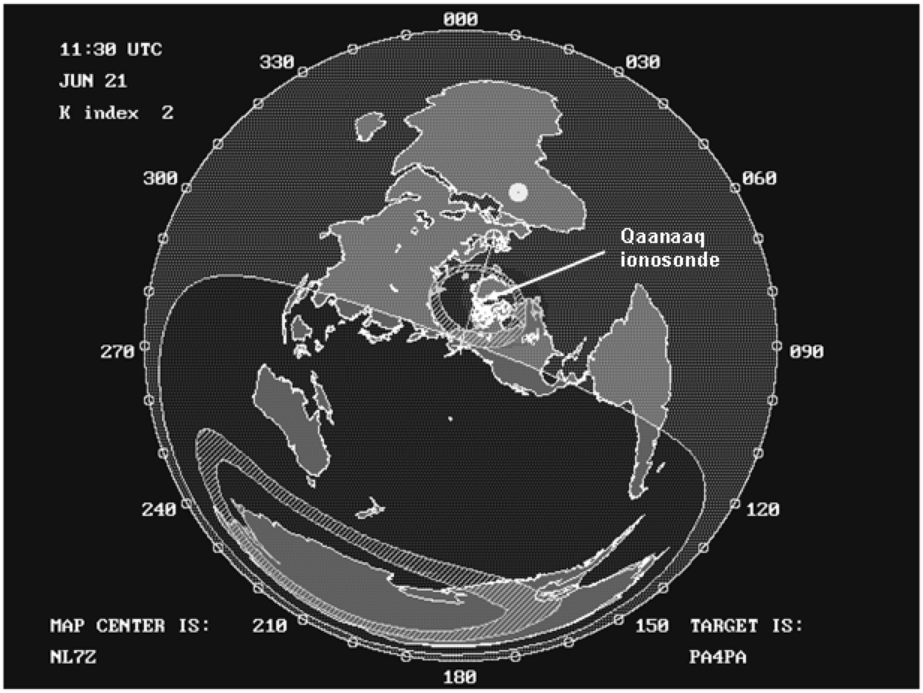

Figure 1 – NL7Z to PA4PA

The center of the map (indicated with a +) is NL7Z. The short path to PA4PA is the straight line from NL7Z ending with a circled + at PA4PA. The white disk over northwest Africa is the overhead Sun. The entire path was in sunlight at the time of the QSOs (1130 UTC is around NL7Z sunrise in June). The northern auroral oval depicted (the smaller cross-hatched annular ring) is for a K index of 2.

Note that the path transits the auroral oval on the Alaska end, crosses the polar cap (the area inside the auroral oval), again transits the auroral oval, and then proceeds into Europe. Thus this path stays entirely at high latitudes.

Let's first consider normal F_2 propagation. Being at high latitudes, the F_2 region electron densities are lowest – especially around solar minimum (where we are). So it's not likely that normal F_2 propagation was the mode (we'll confirm this with some subsequent data).

The fact that the path goes across the polar cap rings a bell for a more unusual F_2 region mode – patches of dense F_2 region ionization that drift across the polar cap. This was discussed in the August 2000 column. But the statistical pattern of drifting patches of F_2 region ionization across the polar cap does not fit these QSOs – these patches have been observed to occur during the winter months when the polar cap is in darkness. So it's not likely that drifting patches of F_2 ionization was the mode (again, we'll confirm this with some subsequent data).

With F_2 modes most likely out of the picture, that leaves E region modes. Let's first look at summer-like sporadic E. The statistical pattern of summer-like sporadic E sure fits – it's best in the summer months and best in the late morning and early evening hours. Now let's look at some ionosonde data to see if summer-like sporadic E was a possibility (this data will also test our assumption that F_2 wasn't involved).

We'll look at the Qaanaaq ionosonde in Greenland. Its location is indicated in Figure 1. Although it isn't exactly along the path, it can give us a general idea of what was happening in the area around the time of the QSOs. Figure 2 shows foF_2 data (F_2 region critical frequency) and foE_s data (sporadic E critical frequency) at Qaanaaq from June 1 through 21. Note that Qaanaaq is in the polar cap, so what it reports as foE_s is most likely not auroral-E.

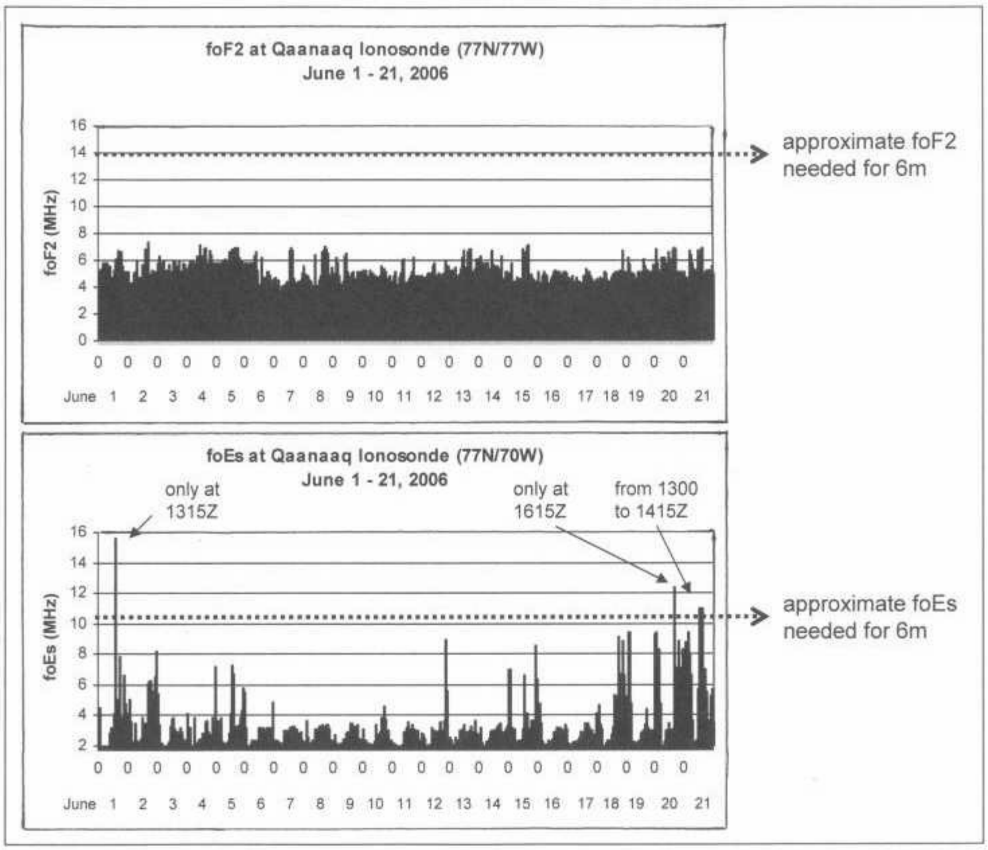

Figure 2 - foF2 and foEs in the Polar Cap

Let's first address the top plot – foF_2. I added a dotted line indicating the approximate value of foF_2 needed to refract 6m RF. Obviously the normal F_2 region was not ionized enough to be involved (as expected). And no drifting patches of sufficiently dense F_2 ionization were seen, either (also as expected due to the polar cap being in summer daylight). This data tends to confirm our earlier assumption that the F_2 region was not the likely mode for these QSOs.

Now let's look at the bottom plot – foE_s. Again I added a dotted line indicating the approximate value of foE_s needed to refract 6m RF. On June 1 at 1315 UTC, foE_s was high enough to refract 6m RF. Likewise, on June 20 at 1615 UTC foE_s was high enough to refract 6m RF. But since these two instances only occurred at one sample time, it suggests that areas of sporadic E ionization weren't widespread enough to propagate 6m from KL7 to Europe across the polar cap.

But on June 21 (the day of this historic 6m event), foE_s was high enough for more than an hour over Qaanaaq. This suggests a more widespread area of sporadic E ionization in the polar cap, and the possibility of enough E_s to propagate 6m in the polar cap.

What about auroral-E? Could it have contributed to this path? Figure 3 shows the northern Statistical Auroral Oval map at 1113 UTC on June 21, 2006 (from the Space Environment Center in Boulder – thanks to Dave Evans).

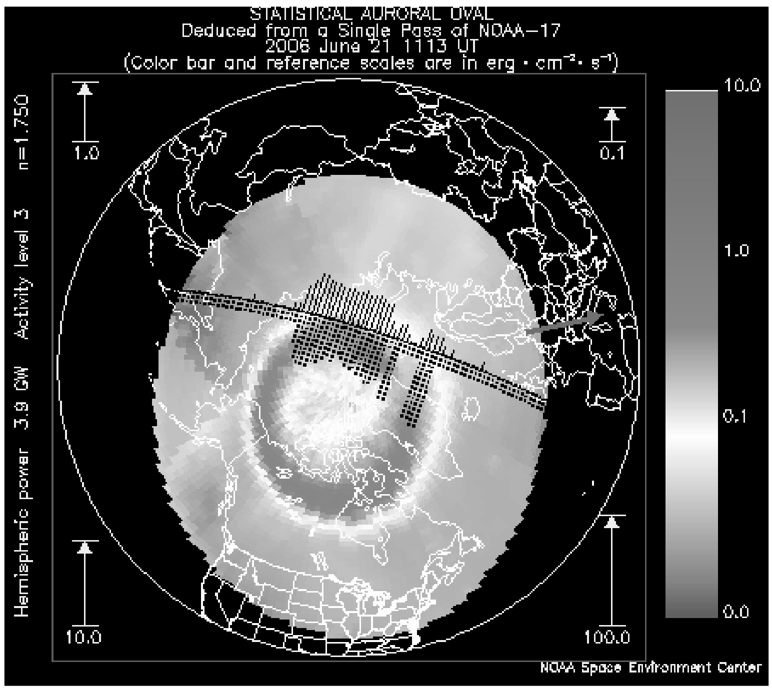

Figure 3 – PMAP for 1113 UTC on June 21, 2006

Although the geomagnetic field was quiet around the time of the QSOs (as expected since the high latitude K indices for June 21 were 0, 0, 0, 0, 0, 1, 0, 1), there were some low energy electrons precipitating at the time. An analysis of the energy of these electrons (from the number of dots perpendicular to the satellite track) and the flux of these electrons (from the length of the solid line perpendicular to the satellite track) indicates that there might have been some auroral-E occurring of sufficient density to refract 6m RF.

In summary, the best match we have between the observations and propagation modes is an initial hop on each end of the path via auroral-E and a summer-like sporadic E hop in the polar cap. It should be noted that this summer-like sporadic E in the polar cap may be ionization from Sun-aligned auroral arcs (seen in the daytime polar cap during quiet magnetic periods – also called theta aurora). Stay tuned for more about summer-like sporadic E in the polar cap and Sun-aligned auroral arcs in future columns.