Long Path / Short Path Switching on 15-Meters – Part 2

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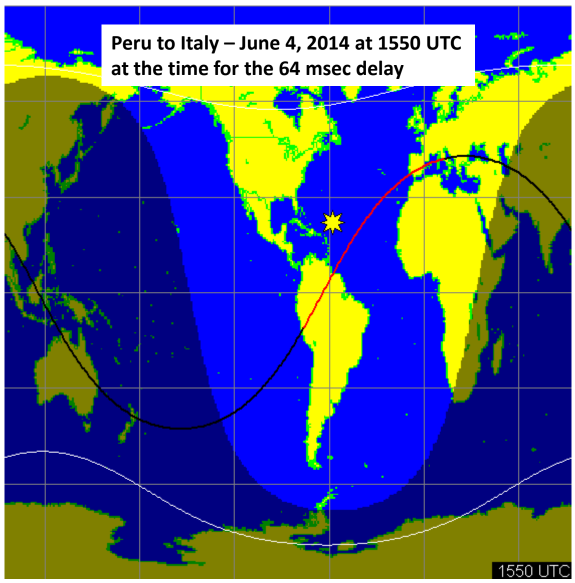
Last month we looked at short path and long path propagation between the OA4B IARU/NCDXF beacon in Peru and Flavio IK3XTV's QTH in Italy during the month of June 2014. The analysis showed why only long path was available around 1400 UTC and why only short path was available around 2100 UTC. It all has to do with ionization (for MUF) and ionospheric absorption (for signal readability above the noise). Now let's investigate the two instances of 64 msec delay seen on the Faros software screen shot (the first figure in Part 1) around 1550 UTC.

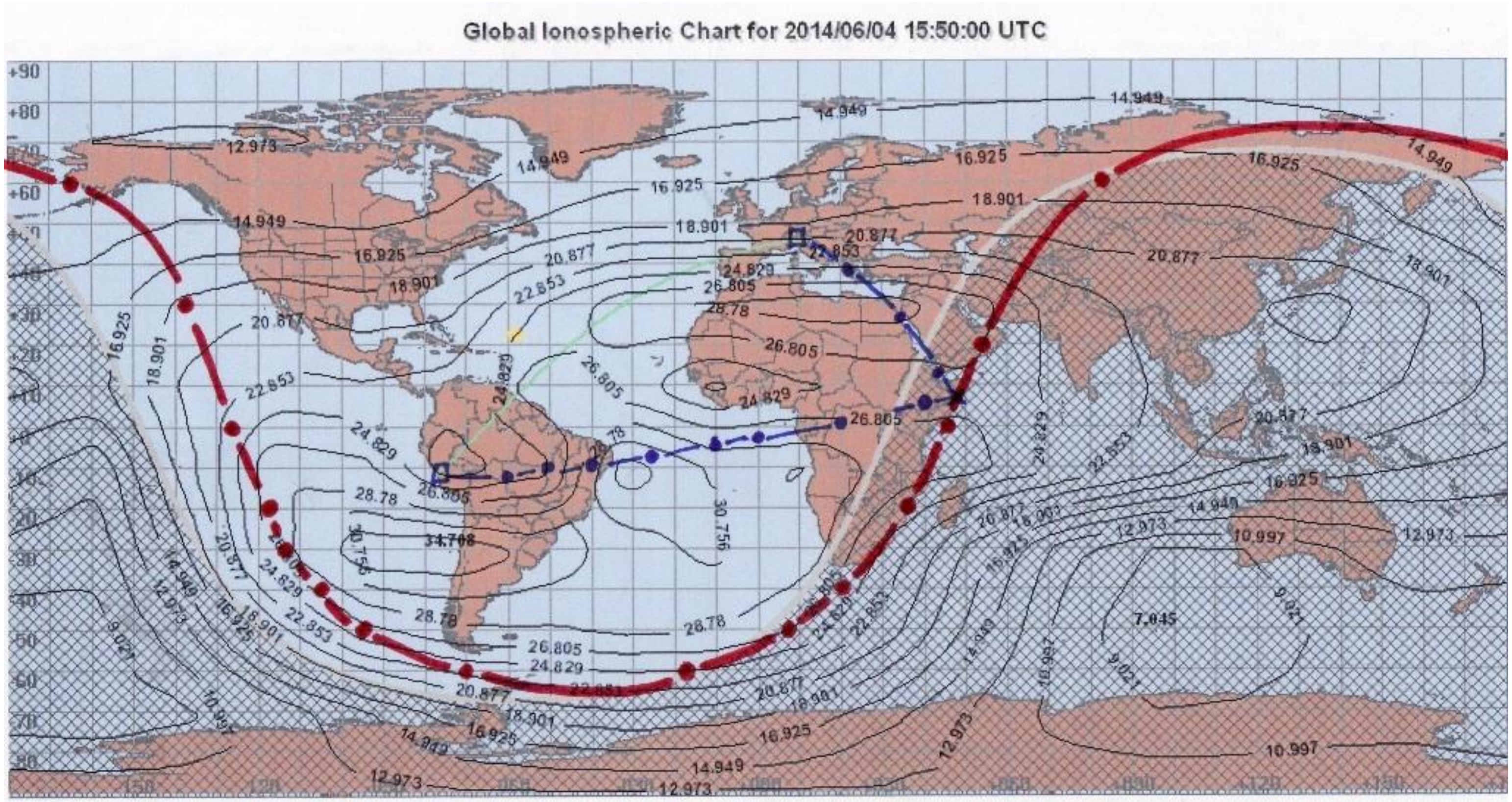
We'll start by looking at the 'big picture' as we did for the 1400 UTC scenario and the 2100 UTC scenario. From W6ELProp, we have the following for 1550 UTC.



Remember we're dealing with a path delay of 64 msec, which equates to 19,200 km distance. This is a path that is longer than short path (10,850 km at 36 msec) but shorter than long path (29,174 km at 97 msec). Not knowing the exact path at the moment renders the above figure kind of useless. So we need to figure out what the path might have been.

What should be obvious is this could be a skewed path – a great circle path out of Peru and a great circle path out of Italy joined by a skew point (or area). The great circle path out of Peru to this point and the great circle path out of Italy to this point must add up to 19,200 km. Also both paths must have enough ionization for 21 MHz, have low enough ionospheric absorption for 21 MHz and offer a sufficient electron density gradient around the skew point to refract the signal off one great circle path and onto the other great circle path. How's that for a tall order!

Using great circle maps, we can come up with a worldwide line on which the skew point could exist to give the 19,200 km total path length between Peru and Italy. This is the red-dotted line shown on the following page on a worldwide map of 3000 km MUFs (maximum useable frequencies) at 1550 UTC on June 4, 2014.



Monthly median map for a 3000 km hop via the F2 region at 1550 UTC centered on June 4, 2014
Green line is short path from Peru to Italy
Yellow dot is overhead Sun
Red-dotted line gives possible skew-points for 64 msec delay (see text)
Blue line is one possible skewed path for 64 msec delay (see text)

Note that I've included a possible skewed path (the blue lines) to show the concept here. I was hoping it would be obvious where the skew point would be, but nothing is working out correctly. The skew point from both Peru and Italy must encounter an increasing electron density. But none of the available paths provides this critical condition.

I considered the southern and northern auroral zones as the skew point, but the K index for all day on June 4 was less than or equal to 2. With the amount of refraction (skewing) inversely proportional to the square of the frequency, it just doesn't seem possible that 21 MHz could be skewed from the auroral zone with K indices less than or equal to 2.

Thus the skewed path shown on the map was selected because the skew point is on the eastern coast of Africa in the equatorial ionosphere where the highest electron densities occur and where electron density gradients can be significant. Also, the MUF appears to be high enough to support 21 MHz all along this skewed path and the overhead Sun is far enough away from this path to dispel any concern about ionospheric absorption.

We do have to remember that the map is a monthly median map. In other words, it's kind of an average of the 30-day period centered on June 4. It is very possible that the ionosphere, being very dynamic on a day-to-day basis, provided the desired skew point. After all, this 64 msec delay only occurred twice on June 4. That's a very low probability that our monthly median model of the ionosphere simply did not capture since it was such a short-term event (note 7).

There's another possible explanation that's a little more exotic. Perhaps there was an area of very high electron density along the short path to significantly reduce the group velocity (note 8) so that it took an extra 28 msec to get to Italy. For that to happen, the plasma frequency would have to be near 21 MHz, which just doesn't show up on the map (remember the map shows the MUF, which is the F2 region critical frequency foF2 times the F2 region M-factor). But again, there were only two instances of the 64 msec reception, so again the monthly median model may not have caught this.

So here's one of these "what happened?" moments. There's no hard evidence of what caused the 64 msec delay. We made some estimated guesses, but this one will likely remain unresolved.

Notes

Note 7 – If a skewed path can exist on 10-Meters as explained in my July 2014 Monthly Feature titled "Skewed Path to FT5ZM on 10-Meters", then it should be possible on 15-Meters.

Note 8 – This concept comes from my MSEE research paper of 1972. Gee, it only took 45 years to apply that work to the real-world!