
W3ZZ

THE WORLD ABOVE 50 MHz

Extreme Distances on 6 Meter E-skip

In recent "World Above 50 MHz" columns Bob Cooper, ZL4AAA, has described a number of exotic long and skewed F2 propagation paths. Given the current state of sunspot Cycle 24, it is not clear whether such propagation will return this cycle. It should be noted that extremely long distance paths on E-skip (E_s) have been identified in recent years and in this column Jim Kennedy, KH6/K6MIO, the now retired Associate Director of the Gemini Observatory in Hilo, Hawaii, discusses just such E_s propagation that extends the equivalent of several E_s hops (>6800 km). As you will see, such propagation can and does occur during periods of low sunspot activity and can prove to be the means to support long distance communication even in years of low or minimal F2 ionization.

Jim Kennedy, KH6/K6MIO
k6mio@arrl.net

The very long short-path 6 meter propagation that has become almost commonplace for many locations in recent years, coincident with an unusually extended solar minimum, has rightly attracted a lot of attention. Many people have been wondering why it happens. This has led to a number of articles proposing answers to the questions.

Observationally, there appear to be two different, though perhaps related, phenomena. The most commonly observed version propagates largely east-west, between two points in the same "polar" hemisphere, either northern or southern. That is, the path never crosses the geomagnetic equator. Typical paths include EU-JA, JA-NA and NA-EU in the Northern Hemisphere. These are seen to extend out to about 10,000 km. The known paths in the Southern Hemisphere are from South America to Oceania, primarily VK/ZL-OA/CE. These paths reach out to about 13,000 km. Both the northern and southern paths open during their respective *local summer* E_s seasons.

The second version, a relative newcomer to the scene, has both a strong east-west component and a strong north-south component. Here the paths do cross the geomagnetic equator and also have long east-west extent. Those documented so far are paths between VK/ZL-NA. As observed so far, these events occur during the *overlap* of the Southern Hemisphere major E_s season and the Northern Hemisphere minor E_s season, typically from mid-December to mid-January. There is no apparent NA-ZS counterpart in the southern summer and no apparent corresponding north-south path, with long east-west propagation, to anywhere in the northern summer.

In 2006, Han Higasa, JE1BMJ, published an article in Japan's *CQ Ham Radio* calling the radio world's attention to the Northern Hemisphere east-west effect.[1] He proposed that E-layer chordal hops might be the cause allowing 10,000 km paths with adequate signal for communications. He labeled the phenomenon Short-path Summer Solstice Propagation (SSSP). This spawned a lively and healthy debate in ham radio publications about whether the process was ordinary multihop E_s (nE_s, where n = number of hops), chordal, E-layer "top-bottom" ducting or some combination of the three.

A Look at the Facts

With encouragement and help from Gene Zimmerman, W3ZZ, I presented a paper at the 2010 Central States VHF Society conference that showed an analysis of data from three specific Northern Hemisphere openings in 2000, 2006 and 2009.[2] The objective was to discern whatever real data could tell us about the actual events and explore the possibility of chordal (or ducting) hops. The 2000 and 2009 data were from my own logs from openings between KH6 and North America.

The first two questions were whether I had observed traditional multihop E_s and were there also instances of chordal/ducting. To be fair, the maximum distance from my KH6 location to eastern North America is about 8300 km, not 10,000 km (if it's nE_s, it's four hops). As it works out, past four hops on that azimuth it goes over the Atlantic to Morocco-at $7E_s$. Nevertheless, the 2000 and 2009 data showed convincingly that nE_s was the mechanism in the 2000 opening-1Es lands in the Pacific, but $2E_s$, $3E_s$ and $4E_s$ stations were all present at about the right distances in diminishing quantities as one moved farther east.

Also, the 2009 data showed a marked aberration in that the number of $2E_s$ stations was very small (and with weak signals), the number of $3E_s$ stations was somewhat larger and there was a very significant peak in activity right in the middle of the $4E_s$ range. The conclusion was that there was definitely something going on that allowed a path that passed substantially over the top of the $2E_s$ footprint and much of the $3E_s$ footprint, to land primarily in the $4E_s$ footprint.

Whatever it was, it was consistent with at least some of the path being provided by a chordal or ducting mechanism. This was not the first time that my fellow KH6ers and I have noticed this. Here there were enough contacts to get useful statistics. The ultimate conclusion was that, out to about 8300 km, both nE_s and chordal/ductal propagation is actually observed on occasion.

The 2006 data were from Yoshi Miyamoto, JM1DTF, representing a typical JA-W *SSSP* opening. The data were consistent with chordal/ducting, but the case was not conclusive either way, because most of the intermediate-hop footprints were either in the ocean or in sparsely populated land areas, where it was hard to tell if the path came to earth.

The very clear point to emerge was that

[1]See H. Higasa, JE1BMJ, "SSSP: Short-path Summer Solstice Propagation," *CQ VHF*, Fall 2008, p 12, for an English translation of this article.

[2]Available at Bob Cooper's, ZL4AAA, website **www.bobcooper.tv/kh6-k6mio.htm**. Select the "Extreme Multihop 50 MHz Es" link.

This Month

April 11	144 MHz Spring Sprint
*April 16	Very good EME conditions
April 19	222 MHz Spring Sprint
April 27	432 MHz Spring Sprint
April 29-30	Southeastern VHF Society Conference, Huntsville, Alabama

*Degradation per EA6VQ

Gene Zimmerman, W3ZZ ♦ 33 Brighton Dr, Gaithersburg, MD 20877 ♦ w3zz@arrl.org; (301-948-2594)

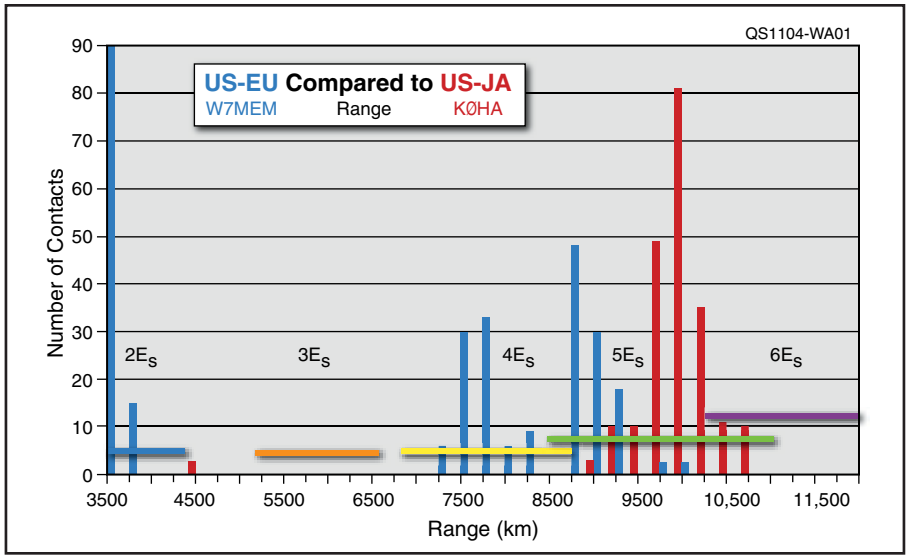

Figure 1 — Range comparisons between US-EU and US-JA contacts.

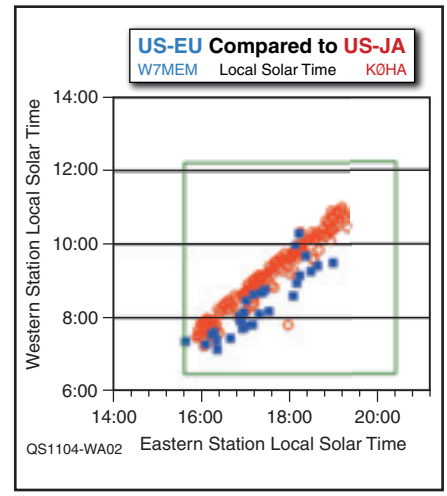

Figure 2 — Local Standard Time comparisons between US-EU and US-JA contacts.

SSSP propagation happened only during the times that the western station (JA) was in the local morning E_s peak window and the eastern station (W) was in its local afternoon-evening E_s peak window. Due to the innate same-hemisphere longitude difference, this *early-on-late* local solar time (LST) condition occurs for east-west paths from about 9500 km to more than 14,000 km. Basically, the first and last geographical skip points were ideally located for optimum ionization to ensure that the signal started and ended skipping toward the other station. The propagation rarely, if ever, occurred at other times of day. This early-on-late effect is strong evidence supporting it as being an E_s phenomenon (at least at the first and last hops).

Using the past north and south E seasons, Gene and I have teamed up to explore the east-west phenomenon for the 2010 season. This time we paid particular attention to the NA-EU paths that were not included in the 2009 study. We also took a look at the 2010-2011 ZL/VK-NA paths crossing the geomagnetic equator. While still a work in progress, what follows is a preview of what we found.

2010 — A Preliminary Analysis

The first priority was to compare the propagation characteristics between the NA-JA paths westward and the NA-EU paths eastward. We picked one US station actively working the JAs and another single US station actively working EUs, gleaning data from various sources. This was to determine who else a single station was working along the direction of the path in order to see if any intermediate hops were open at the same time (ie, is it nE_s or chordal/ductal?).

We chose data from the operations of KØHA for the JA paths and W7MEM for the EU paths, in part because both had multiple contacts and some distances were at 10,000 km or more. So far we have looked at two parameters, the range distances between the stations and the LST of each contact at each end of the circuit. The purpose of the distance distributions was to assess whether or not any intermediate hops were observed. The purpose of the LST comparisons was to see how it fit with the known diurnal E_s propagation pattern.

Figure 1 shows the EU (blue) and JA (red) distance comparisons. The colored horizontal bars represent the classical nE_s skip distances for reference. The total number of contacts has been normalized, some to make the graphic more visually useful (there were well over 100 contacts for each station).

The figure shows that there is very little evidence of intermediate hops for the NA-JA path. There is one lonely KL7 contact at 4500 km (2Es). All of the JAs fell into a nice statistical distribution in the 9000-10,750 km range.

By contrast, the NA-EU plot shows that there was a lot of two-hop activity (we ignored single hop), no three hop and then there is clear evidence of both 4Es and 5Es, with even a small gap in between them. Before jumping to conclusions there are important factors to consider. Starting in the US, both paths cross over vast amounts of largely uninhabited territory before getting to the destinations; there are few stations at 3Es.

At multiple hop range, KØHA looks northwest over western Canada and Alaska, and then the Bering Sea and the Pacific Ocean, until arriving at JA. W7MEM looks northeast across Hudson Bay (although W1, W2 and other east coast stations were in and being worked in between the EU stations). The path then crossed central Greenland and Iceland before reaching EU.

The point is that, while the JA data are consistent with chordal/ducting hops, they are *not definitive*. It could just as well be ordinary nE_s multihop. The EU data leads to a somewhat stronger conclusion. Whatever happened before the third hop, the evidence strongly supports nE_s for the fourth and fifth hops.

Figure 2 shows a comparison of the LST at each end of each contact for both the JA (red) and EU (blue) paths. The green box shows the classical boundaries of the early-on-late E_s time frames. In both cases, the timings of the contacts are excellent matches to the usual pattern. This strongly supports the notion that these were E_s-related events.

There were a very few Southern Hemisphere contacts made by OA4TT and OA4B into the ZL/VK environs again during the southern summer. We are still interested in knowing about more such contacts, so there will be enough data to draw some conclusions. At this point there is every reason to believe that these Southern Hemisphere events are simply the southern version of what is happening in the Northern Hemisphere summer.

The task was to look at the very recent flurry of very long contacts across the geomagnetic equator between NA and the ZL/VK environs. Figure 3 shows a plot of the distances observed and some labels identifying the endpoints. To an even higher degree than the strictly Northern Hemisphere events, this is still a work in progress and it

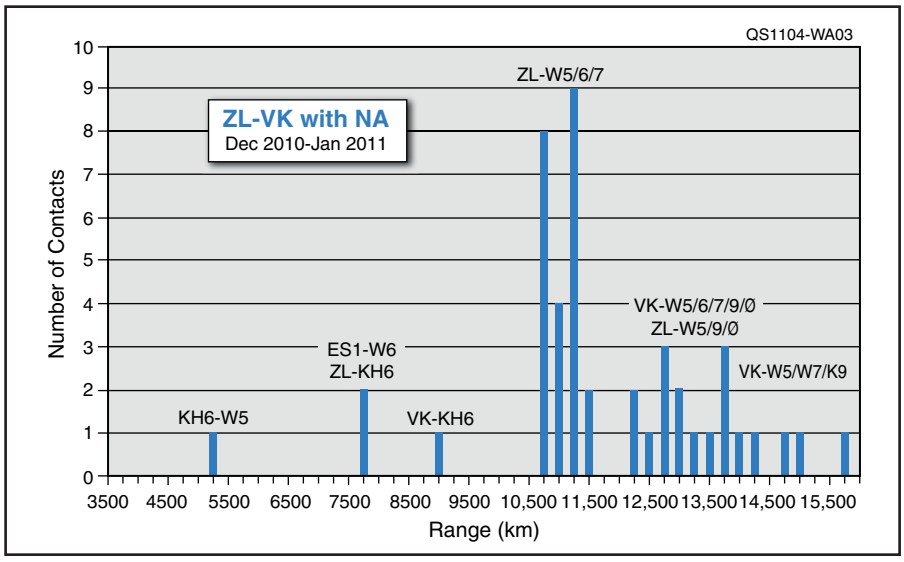

Figure 3 — Range distribution for ZL/VK-North America contacts.

will be the subject of another report but, the distances are phenomenal and the propagation processes are not at all clear.

At this point, all we can say is that they are occurring during the southern-northern E_s season overlap. Moreover, *virtually all* of the LSTs at the east end (NA) fell squarely in the E_s afternoon-evening peak. This strongly suggests that E_s was a factor on the east end. Going west, the path comes out of afternoon or twilight into full sunshine over the US west coast and stays in daytime until it reaches ZL/VK. There on the west end, about half arrive in the E_s morning peak and half fall where you would expect a *valley* in E_s ionization (1300-1500 LST).

It is tempting to suggest that some sort of F-layer TEP might be carrying the path across the geomagnetic equator. But in December/January only the southern branch of the Equatorial Anomaly has any substantial ionization (otherwise TEP would be common then). If there were enough ionization for a single chordal hop from the energized southern anomaly, the math says that an 11,000 km E_s path linked to a single 4000 km chordal F-hop would take you the required 15,000 km. On the other hand, one could postulate the (normally daytime) equatorial E_s might take a handoff from the temperate zone E_s somewhere over the Pacific and bring it on down. Resolving this will require further examination of ionospheric data. Stay tuned.

ON THE BANDS

6 meters. The Christmas bonus continues unabated. Bob, K6QXY (CM88) reports ZL video Jan 1 and 2. He worked ZL1RS on Jan 7 and again on Jan 10. He also worked ZL3NW early on Jan 11. The latter contacts were on JT65a. Peaking on Jan 11, major E_s links at both ends of the paths yielded widespread contacts of extremely long distances. Steve, VK3OT (QF12ag) first heard the K6FV/B beacon (CM87) and then worked WØOGH (DM43) in AZ. He then worked several others including K9HMB (EN52), his ODX, N7CW, W7KNT and AA7A. The same day Bob, ZL1RS (RF64vs) also worked K9HMB, KCØCF (EN32), NØLL (EM09), N5JEH, K7VAY, WØGNE, N7KA, W7RCS and N7CW. ZL2TPY (RF72) reports WØOGH and N7CW.

Bob, K6QXY, worked into KH7Y and KH6SX during this opening and had a partial contact with VK9NA on Norfolk Island. Other VKs reported to be working into the US included VK4MA (QG64kb), VK4WM (QG64jq), VK2KPP (QF55) and VK4DDC (QG62pb). Thus the opening appears to be the combination of widespread E_s links at both ends of the path with some kind of F2 linkage at mid-path. It is possible that the F2 linkage was TEP although a straight F2 link across the geomagnetic equator is equally or more likely, or perhaps an equatorial E link as described above. TEP at the solstices is reasonably uncommon especially during periods of low sunspot activity such as we are experiencing now.

Jack, OA4TT, worked ZL1RS on Jan 9 via JT65a. Jack says that JT65a digital is a very effective means of communication terrestrially on marginal paths. K6QXY worked ZL3NW on the 12th and ZL1RS on the 13th. On Jan 13 VK3DUT worked KH7Y. KH7Y is reported to have worked several other VK/ZLs including VK3OT, VK3AAU and ZL4AS. The ZLs report that their E_s season appeared to end abruptly on Jan 15. Lacking any E_s links these long distance contacts ceased at that point.

Microwaves. Adrian, VK4OX (QG63kf) writes that on Jan 27 at 0315Z he worked Steve, ZL1TPH/p (RF73hm) on 2304 SSB at a distance of ~2315 km. Adrian was running 20 W and Steve was running 100 W. Less than 24 hours later at 2130Z Adrian worked Brian, ZL1AVZ (RF73fd) at ~2318 km. Brian was running 15 W. Both these contacts easily broke the former Australian 13 cm record. Congratulations all!

EME. Lance, W7GJ, reports what is probably the first 6 meter EME contact from the new PJ2 country (Curaçao) with a contact with PJ2/W8WTS (FK52kg) at 1541Z Jan 27 on JT65a. This is Lance's DXCC #164 (113 via EME).

January VHF Contest. The January contest lived up to its midwinter reputation. Ice and snow, and temperatures much below normal caused poor tropospheric propagation and limited rover activities in many regions. I received almost no reports. The few scores I saw have not been stellar. The mid-Atlantic locals did worse than usual according to K1RZ and W8ZN. Ed, K6VNV (CM98) said he had a lot of fun using a newly acquired ICOM IC-271A transceiver and a small Yagi to make 4 contacts in his first VHF contest.

HERE AND THERE

Logbook of The World and VUCC. The ARRL Logbook of The World (LoTW) now works with VUCC Awards. Details can be found at the LoTW website at **p1k.arrl.org/lotwuser/default** *or* **www.arrl.org/vucc**. Thanks to the VHF community for continuing to ask for its implementation and to the ARRL IT people for making it happen.

Spring Sprints. Time to tune up your station for summer. The first three of these short duration Sprints are 144 MHz, Monday, April 11; 222 MHz, Tuesday, April 19, and 432 MHz, Wednesday, April 27. Each runs from 7-11 PM local time. Exchange six digit grid squares; distance scoring will be used for the 2011 Spring Sprints. Full details can be found at **sites.google.com/site/springvhfupsprints**.

Southeastern VHF Conference. The 2011 SVHFS Conference will be held at the Holiday Inn Downtown Huntsville in Huntsville, Alabama, April 29-30, 2011. This is always an excellent convention that brings together VHF enthusiasts from throughout the Southeast. More details can be found at the SVHFS website at **www.svhfs.org/conference.html**.

2011 Six Meters Marathon. The seventh annual Six Meters Marathon begins May 7, 2011 at 0000Z and runs through August 7 at 2400Z. The objective is to work as many DXCC entities as possible on 6 meters during this period. You can follow the progress of the contest at **6m.dy.fi**. Full details can be found at **www.tamrinki.fi/6m/mrules.php**.