Propagation
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An Interesting Week on 160m

Last March a group of Germans went to Sudan, and they put STØRY on the air. I needed ST on 160m, and since they advertised a big low band effort, I did some advanced planning to improve my chance of adding a new one to my 160m DXCC total.

Using W6ELProp, I noted that my sunset was at 2354 UTC (just before 7PM local time here in Ft Wayne) and ST sunrise was at 0400 UTC (11PM local) for the mid-date of their DXpedition. That means the short path would be in darkness for about four hours. More importantly, there was the possibility of an enhancement in signal strength around my sunset and around ST sunrise. Historical observations have generally shown that the enhancement at sunrise is the most likely one and the most pronounced one, so that's where I was going to concentrate my effort. I also planned on not jumping in on the first couple nights – I'd wait until the pileups were down a bit. That turned out to be a big mistake.

On the first two nights of their operation, I was in bed at 10PM adhering to my "wait a couple days" plan. On the second night around 10:30PM I was awakened by a phone call from Jean, the wife of John K9UWA. She relayed that STØRY was real loud on 160m, and that John, Gary KD9SV, and Jim KR9U just worked them (the other 160m aficionados in the Ft Wayne area), and I better get down to the radio pronto.

I quickly went downstairs, turned everything on, and sure enough STØRY was very Q5 at my QTH. I threw my call into the fray, but no luck. About 5 minutes later they were down in the noise and I couldn't copy them. This is an excellent example of the old adage "you snooze, you lose."

This spurred me to listen in earnest every night thereafter at a little before my sunset (to catch any sunset enhancement on my end) and from 10PM on (to make sure I caught any sunrise enhancement on the ST end). I also kept an eye on Packet at all other times. They were there most every night as evidenced by the East Coast spots on Packet. But I couldn't hear them well enough to call. Finally, on March 28, the sixth night after my "you snooze, you lose" episode, STØRY came well out of the noise at 0320 UTC and they were very Q5 until around 0340 UTC, when they faded back into the noise. That twenty-minute period was a great example of sunrise enhancement. But unfortunately I came away empty-handed, as I couldn't get through the East Coast callers.

I kept checking every night afterwards until they ceased operating (which was four nights later), but their signal never came up as it did on the 28th. Was I disappointed that I didn't work them? Sure, but another old adage is "there's a silver lining in every dark cloud." On one of the nights when I was listening for STØRY, I caught 9L1BTB for a new one on 160m just as he was getting started on the band. With most everyone else calling STØRY, the 9L was very easy to work before the pileup got too big.

From my observations for this DXpedition, there were only two nights with a sunrise enhancement (the "you snooze, you lose" night and the night six days later). But this doesn't say there weren't any more. Perhaps there were enhancements of less magnitude every night – they just were not big enough for me to notice.

So what causes a sunrise (or sunset) enhancement? One of the most plausible explanations is the occurrence of a more efficient mode. If we assume that conventional multi-hop propagation was occurring prior to sunrise approaching the ST end, then we'd expect absorption on every hop (along with ground reflection losses). As an example, a seven E hop mode (a reasonable assumption for this 11,000km path) would have in the neighborhood of 9dB of absorption per hop, for a total of 63dB of absorption. This would take its toll on the received signal strength.

As sunrise approaches the ST end, the dawn tilt in the ionosphere (because the nighttime ionosphere is higher than the daytime ionosphere) begins to come into the picture. What this could do is instigate a ducting mode – a mode that doesn't incur ground reflection losses or absorption on transits through the absorbing region. Figure 1 is a ray trace from Proplab Pro (Solar Terrestrial Dispatch) from STØRY to K9LA at 0330 UTC on March 28 (the middle of my observed sunrise enhancement period noted previously) showing such a mode.

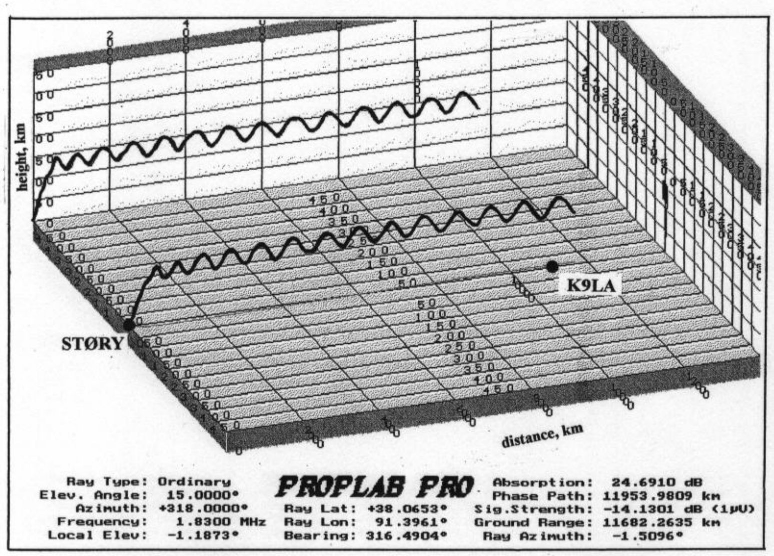

Figure 1 A Duct Mode from ST to W9

The premise is that the dawn tilt helped STØRY's RF get into the duct (by the way, there's a tilt at dusk, too). With only 25dB of absorption to get to K9LA (from the data in the lower right corner of Figure 1) and no ground reflection losses, the duct mode signal strength would be significantly greater than the aforementioned conventional multi-hop mode. As sunrise got closer to ST, the tilt would disappear and the duct would also go away. Note that the height scale in Figure 1 starts at 0km and is in 50km increments – I mention this as the actual height values are truncated in the Proplab Pro image.

Is there a physical reason for a duct to occur? Yes there is, and Figure 2 (also from Proplab Pro) shows the electron density profile along the STØRY to K9LA path at a point well away from sunrise.

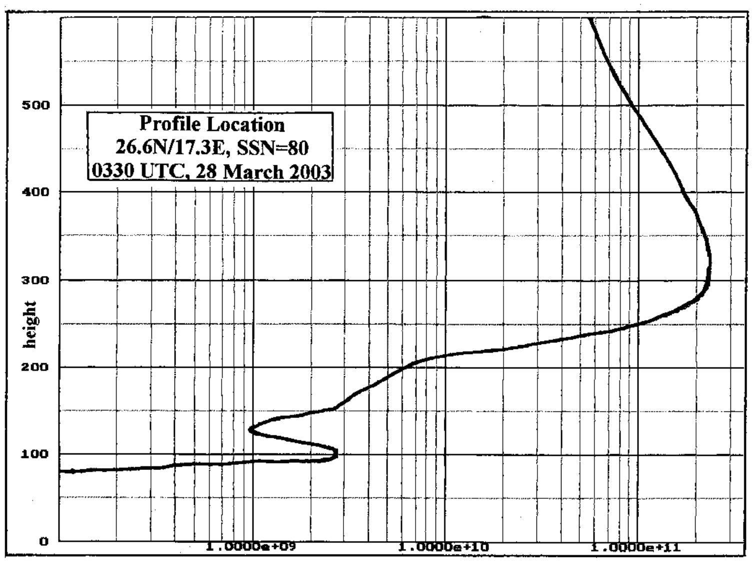

Figure 2 Electron Density Along the ST to W9 Path

We're looking along the path, and we're looking at the electron density versus height in km. Note the valley above the E region peak (the peak being at 100km). This is a typical profile in the dark ionosphere under quiet geomagnetic conditions. What this forms is a natural upper and lower boundary for successive refractions to occur. If you compare the apogee and perigee of the ray trace in Figure 1 (around 150km and 110km, respectively) to the electron density profile in Figure 2, you'll see that the ray is refracting between the topside of the E region and the higher F region.

Although a duct mode being the root cause of low band enhancements is an interesting hypothesis, it has its problems. One problem is seen in Figure 1: what brings the ray down into K9LA? Fortunately this isn't too hard to answer. Our model of the ionosphere is a monthly median model, which means it's essentially an average of the ionosphere during the desired month. Thus it doesn't show the daily variation of the ionosphere, and more importantly it doesn't show the irregularities that are known to exist in the ionosphere – even in the dark ionosphere when things are generally more stable. It could be that an irregularity in the electron density refracted the signal out of the duct. What helps here is that refraction is inversely proportional to the square of the frequency. Thus of all our bands, 1.8MHz RF would be refracted the most from a given irregularity (gradient).

A more troubling problem deals with getting into the duct. Is the tilt the only way to get into a duct on 160m? Based on ray tracings with Proplab Pro along the ST to W9 path at 0200 UTC (well before sunrise at the ST end) and from many other previous ray tracings on other paths, the answer to that question is NO. Ducts can start in the dark ionosphere (the extent to which they occur appears to depend on magneto-ionic issues), so it's not real obvious why a duct instigated by approaching sunrise would be any better than a duct away from sunrise.

Please realize that this hypothesis is speculation. But it's interesting to think about it and try to match the physics of the ionosphere to observations, and vice versa. When we have a good match, we'll probably know the answer to sunrise (and sunset) enhancements on 160m.