A Possible Precursor to Good Propagation on 160m
Carl Luetzelschwab K9LA

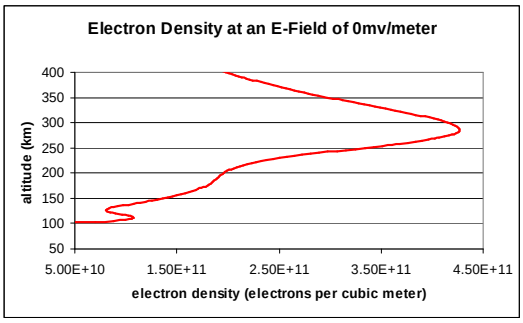
[*this article appeared in the Summer2006 issue of the Low Band Monitor*]

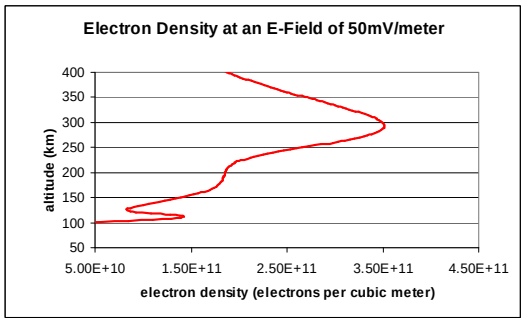
In my article "More Space Weather and the Recent Excellent Propagation on 160m" that appeared in the January 2004 issue of The Low Band Monitor, I looked at space weather parameters for the 160m opening to JA that John W1FV (and others) had around sunrise on January 16, 2004. The only parameter that stood out was a jump in the K index just before the opening. I made the following comment in that article:

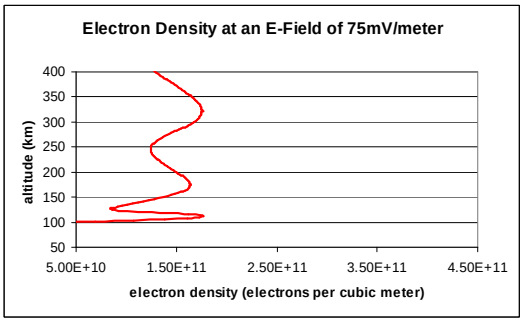
Good propagation just before the K index increases – This has been observed by many topband operators, and sometimes it is even concurrent with good 6m propagation. Fred K3ZO sent me an informative e-mail in late November 2002 with his observations of unusually strong AM broadcast stations before a short-lived G1-class geomagnetic storm hit on November 26, 2002. There's something afoot here, and an understanding of high latitude ionospheric physics may shed some light on these observations.

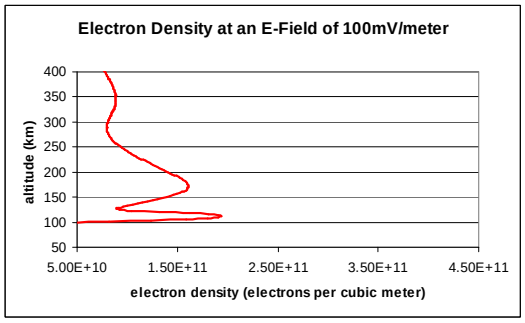
Thanks to an April 2004 paper in the Journal of Geophysical Research [*Zhang* et al, 1984], the "something afoot" comment may be able to be explained by electron density changes in the high-latitude E region due to an increase in the ionosphere's electric field. Increases in the electric field are a result of increasing geomagnetic field activity.

The following plots are modeled data (they're from the referenced paper and e-mails with Dr. Zhang). They show what can happen to a typical high-latitude electron density profile as the electric field increases from 0 mV/meter (minimal geomagnetic field activity – the top left plot) to 100 mV/meter (more geomagnetic field activity – the bottom right plot).









At 0 mV/meter, the electron density valley above the E region peak is not well formed. Propagation on 160m is likely to be via a lossy multi-hop mode. But as the electric field increases, the valley develops such that at 50 mV/meter and 75 mV/meter propagation via ducting may be possible. The electromagnetic wave would successively refract between the top of the E region and the bottom of the F region, thus avoiding lossy transits through the absorbing region. At 100 mV/meter the valley starts to disappear due to the loss of the upper (F region) boundary (the valley may also fill in due to increased electron precipitation). Thus ducting may occur only at the onset of the geomagnetic storm.

Note that the F2 region begins depleting as soon as the electric field begins increasing. This supports the often-observed loss of F2 propagation at high latitudes as geomagnetic field activity increases.

Although the "No E-Field" plot is representative of a daytime electron density profile, the same trend of a more developed valley because of an increased electric field is likely in the nighttime ionosphere, too – which may help those nights when the valley is not well-developed due to the night-to-night variation of the ionosphere.

The Tie to 6m

As stated earlier, the possibility of good propagation on 160m via ducting may occur only in the early stages of a geomagnetic storm. As the storm progresses, the duct may disappear – but auroral propagation may develop giving good 6m propagation.

The Tie to Marconi

This process may also explain how Marconi accomplished his trans-Atlantic feat on December 12, 1901. Many doubt that Marconi actually heard the signals from Poldhu because absorption on medium wave frequencies during daylight hours is prohibitive. Some have suggested that being at solar minimum (between Cycle 13 and Cycle 14) was the answer, but solar minimum only minimizes D region ionization by radiation at 'hard' X-ray wavelengths (0.1 – 1 nm). A second source of D region ionization is from radiation at a hydrogen spectral line at 121.5 nm ionizing nitric oxide, and the resulting absorption is still prohibitive. But if we look at geomagnetic activity on the day of Marconi's feat, we see a small jump in activity right before the reception. Who knows – maybe Marconi was the first benefactor of medium frequency propagation via a duct.

Summary

Ionospheric modeling data suggests that an increase in the electric field in the ionosphere may help develop the electron density valley above the E region peak that is conducive to ducting on 160m. So keep an eye out for pending geomagnetic storms – you may be rewarded with an unusual 160m opening.

Reference: Zhang, B. C., Y. Kamide, R. Y. Liu, H. Shinagawa, and K. Iwamasa (1984), A modeling study of ionospheric conductivities in the high-latitude electrojet regions, *Journal of Geophysical Research*, Vol. 109, A04310.