The Future of Propagation Predictions

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I've been working on a project that got me thinking about what's in the future for propagation predictions. I've broken my thoughts into two issues: the ionospheric model in our propagation predictions and how propagation predictions will be used.

Model Issues

The F2 region model

Much effort is currently underway to better understand the day-to-day variability of the F2 region. Our present understanding of this short-term variability is statistical in nature, and that's why our propagation predictions give us monthly median values (usually MUF and signal strength) versus a smoothed solar index (either smoothed sunspot number or smoothed 10.7 cm solar flux).

The problem is that this short-term variability depends on more than just solar radiation. Yes, solar radiation instigates ionization, but geomagnetic field activity can modify the amount of ionization at any given point on Earth. But that's still not the whole story. The third variable is events at ground level and in the lower atmosphere that can couple up to the ionosphere to possibly further modify the amount of ionization at a given location.

As research into this third variable continues, parameters to define these events need to be defined. Then a model relating these parameters to the effects on the ionosphere needs to be developed. Eventually this will lead to daily propagation predictions – in other words, what is the ionosphere really doing right now.

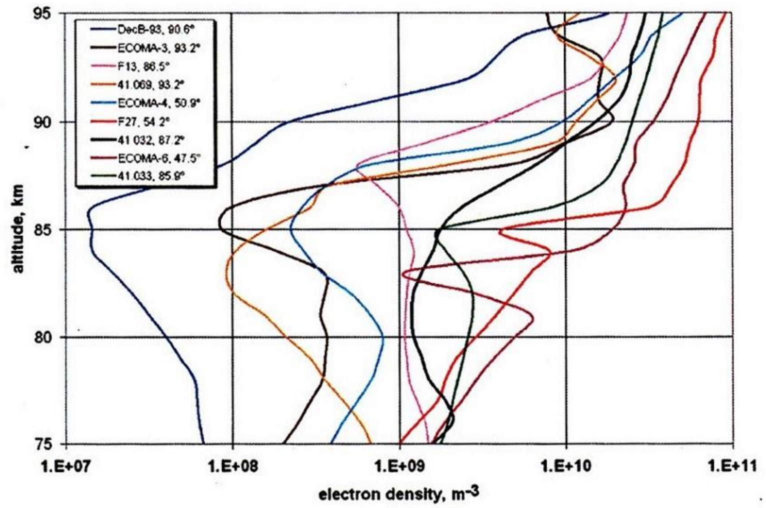
Assimilation of ionosonde/TEC data

Until events at ground level and in the lower atmosphere are well understood and characterized, assimilative models of the ionosphere will be further developed. Real-time ionosonde data and/or real-time TEC (total electron content) data will be used to make our monthly median predictions closer to real-time conditions.

The Committee on Space Research (COSPAR) and the International Union of Radio Science (URSI) is working towards this goal with the International Reference Ionosphere (IRI). It is called the IRI Real-Time model. For more information on this, see reference 1.

The D region model

The part of the ionosphere that we know the least about with respect to short-term variability is the D region. The model of it in our prediction programs is based on a limited number of rocket flights, a limited amount of incoherent scatter radar data and theoretical considerations. The model assumes a smooth electron density profile versus D region height. In the following figure, compare that smooth model to what the D region can look like in the real world from actual measurements.

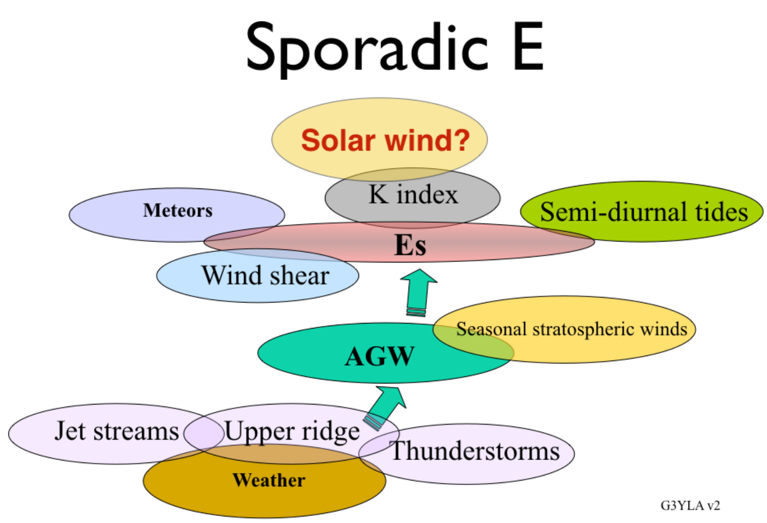


Experimental and theoretical research into the lower atmosphere and lower ionosphere is needed to give us a better understanding of the region that is most important on our lower HF bands (due to ionospheric absorption).

Sporadic E

Our understanding of sporadic E still isn't complete. We know the basic drivers of sporadic E, and experimental data (most recently from occultation data from GPS frequencies) has given us the most likely times and locations for sporadic E. But we can't predict exactly when and where it will occur. It would be nice to have this in our propagation predictions.

Jim Bacon, G3YLA, a professional meteorologist in the United Kingdom, is investigating the tie between sporadic E and underlying "weather" phenomena per the following sketch [reference 2].



How propagation predictions will be used

The current SDR radios, and even some analog radios (like my Ten-Tec OMNI 7), have screens that could be used to display propagation predictions and related information.

The particulars of your station could be input to the prediction software. This could include antenna gains (from antenna modeling software such as EZNEC or 4nec2), your man-made noise environment, transmit powers and even receiver MDS (minimum discernible signal) for analysis on the higher HF bands and 6-Meters where man-made noise may not be the limiting factor.

With assimilative ionospheric models, turning on the radio could display a worldwide MUF (maximum usable frequency) map that represents near real-time conditions. With a full model that includes the three variables, current space weather data and current terrestrial "weather" data could be downloaded to give the same information. Sporadic E predictions could also be included.

For DX chasers, your DXCC status could be input to the software. Propagation predictions to your needed entities (by band and even by mode) could be displayed – not only predictions for right now, but also when the best time might be. And if the time is right now to work a new entity on one of our bands, the prediction software could change your radio to the right band, turn on the amplifier and turn your antenna to the DXCC entity.

For contesters, the predictions could display the best band to be on right now to maximize your score per the contest rules. These predictions would include your station specifics so you're not getting predictions for legal limit power when you're QRP.

I'm sure there are other innovations coming. We'll just have to wait to see what happens.

Summary

One thing I haven't discussed is a fully-automated station. That can be done now with the digital modes, and advancing technology will allow it to happen with the other modes (if it already hasn't!).

References

1) Bilitza, D., D. Altadill, V. Truhlik, V. Shubin, I. Galkin, B. Reinisch, and X. Huang (2017), International Reference Ionosphere 2016: From ionospheric climate to real-time weather predictions, *Space Weather, 15*, 418-429, doi:10.1002/2016SW001593.

2) https://www.youtube.com/watch?v=wn5as91ndG4