116 -- 2017-03-09 11:48:58
Session 1A Paper 3
Groves, Keith: Boston College Institute for Scientific Research
Paznukhov, Vadym: Boston College Institute for Scientific Research
Carrano, Charles: Boston College Institute for Scientific Research
Decker, Dwight, Boston College Institute for Scientific Research;

Characterization of HF Perturbations and Drift Velocity with GPS

Many have considered the use of high frequency (HF) signals for communications and remote sensing to be obsolete in the modern era of satellite-based services. Yet the utilization and investment in HF technologies around the globe continues to grow. A large number of HF applications involve over-the-horizon (OTH) propagation for which the ionosphere serves as a primary component of the propagation channel. The channel is thus modified by changes in the ionosphere.

Although the mid-latitude ionosphere is generally stable, a variety of phenomena generate variations in the electron density that can cause dramatic changes in HF radio wave paths. These changes are typically difficult or impossible to quantify using the HF signal itself and dedicated active HF sensors, such as an ionosonde, are typically used to diagnose propagation conditions. Here we attempt to employ passive GPS receivers to extract similar information on the amplitude and propagation speed of TIDs.

Our approach is based on the recently demonstrated capability of GPS sensors to detect medium-to-large perturbations in the ionosphere that we believe are associated with TIDs. TIDs represent one of the most challenging sources of HF propagation errors and are unfortunately equally challenging to model and predict. Combining GPS and oblique HF link observations allows us to unambiguously quantify the correlation between GPS TID signatures and HF propagation perturbations.

Moreover, we attempt to infer the phase velocities of the disturbances which facilitates a predictive capability for nearby regions. Velocities are estimated using a combination of techniques including the statistical angle of arrival and Doppler method (SADM) of Afraimovich (1998) and a more deterministic method based on temporal cross-correlations.

The combined method mitigates some of the instantaneous uncertainty in the SADM technique while still providing near continuous coverage. Given that GPS measurements are the most ubiquitous space environment data in the world, the potential pay-off for HF prediction applications is substantial.

References

E. L. Afraimovich, K. S. Palamartchouk, and N. P. Perevalova, “GPS radio interferometry of travelling ionospheric disturbances,” Journal of Atmospheric and Solar-Terrestrial Physics, vol. 60, no. 12, pp. 1205–1223, 1998.