Ionospheric Disturbances Observed with the VLA Low-band Ionospheric and Transient Experiment (VLITE)

Joseph Helmboldt[(1)], Paul Ray[(1)], Tracy Clarke[(1)], Namir Kassim[(1)], Tony Mroczkowski[(1)], Emil Polisensky[(1)], and Simona Giacintucci[(1,2)]
(1) U.S. Naval Research Laboratory, Washington, DC 20375, USA
(2) Computational Physics Inc., Springfield, VA 22151, USA

A new backend has been implemented for the Very Large Array (VLA) low-band system (<500 GHz) to specify mid-latitude ionospheric disturbances (the VLA is at 107.7°W, 34.1°N) with great precision and to monitor for transient cosmic sources. Dubbed the VLA Low-band Ionospheric and Transient Experiment (VLITE), the backend began science operations in November 2014 on 10 of the VLA's 27 dish antennas, continually observing in the 320-384 MHz range during all normal science observations (~13 hours per day, on average). Observations of cosmic sources at these frequencies with the VLA are sensitive to the horizontal gradient in total electron content (TEC). At VLITE frequencies, these observations can be used to characterize ionospheric fluctuations to a precision as good as 0.0002 TECU km^{-1}. An automated, real-time processing pipeline applies a specialized spectral analysis method to these TEC gradient measurements to characterize the observed fluctuations on fine spatial (as small as ~1 km) and temporal (≥2s) scales. When a single, dominant wavelike fluctuation is detected, a "drift-scan" image of this traveling ionospheric disturbance (TID) can also generated. In addition, a separate and complementary pipeline analyzes data from 20 continuously operating GPS receivers in the region around the VLA to contemporaneously characterize larger-scale disturbances.

We will present the details of the ionospheric pipeline, initial results, and future applications of this system and the database it is generating. Included within this discussion will be the nature of the power spectrum of TEC gradient fluctuations up to an oscillation frequency of 0.25 Hz as functions of time of day and season from Fall 2014 to the present. These are compared with similar fluctuation spectra derived from a nearby seismograph (in Albuquerque, NM) and from satellite-based (GOES) observation of solar X-ray irradiance to assess the roles forcing from below and above may play in driving dynamics on these relatively small temporal and spatial scales. Examples of serendipitous findings enabled by VLITE will also be presented, including a joint detection and characterization of the impact of a solar flare on both the ionosphere and plasmasphere as observed with VLITE, GPS receivers, and an oblique HF sounder.