Non-linear ionospheric retrieval of electron density profiles using FORTE broadband data

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We present results from a non-linear ionospheric removal algorithm applied to FORTE satellite- detected broadband signals. For these signals, the FORTE satellite detects frequency versus time in the 15 to 88- MHz frequency range. In this study, the received-FORTE data originates from two sources: the Los Alamos Portable Pulser (LAPP) and lightning strokes. We use these data in non-linear inversion algorithms to retrieve the electron density profile along the transmitter-receiver path. Non-linear inversion of these 2D data sets is motivated by the goal of being able to estimate the 2D (altitude versus horizontal satellite trajectory) electron density field directly from the FORTE data.

We present preliminary results for two separate non-linear techniques. The first technique uses the Appleton-Hartree equation to fit the dispersion of the signal by using a Levenburg-Marquardt non-linear fitting routine, and, thus, retrieves the electron density profile along the path. For this technique, we verify the fitted output parameters for FORTE signals detected from sources with known locations (LAPP pulses and located lightning strokes). We then use this non-linear ionospheric retrieval algorithm to determine electron density profiles in disturbed ionospheric regions. The second technique makes use of the ionospheric imaging algorithm Ionospheric Data Assimilation Four-Dimensional (IDA4D). IDA4D ingests a wide variety of data sets, both linearly and non-linearly-related to electron density, and applies the principles of data assimilation to retrieve the 4D global electron density field. IDA4D will use a 3D ray-trace forward model and apply iterative non-linear techniques upon the FORTE broadband data. IDA4D will be run in a mode in which the primary data set is FORTE, and also in a mode in which all available data sets, including FORTE, are ingested.