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USING BEACON SATELLITES TO ESTIMATE IONOSPHERIC DRIVERS DURING STORMY PERIODS

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Abstract: The storm-time dynamics of the ionosphere, including phenomena such as storm-enhanced densities (SED) and plasmaspheric plumes, are an active area of investigation. Comprehensively explaining these phenomena requires knowledge of the drivers of the ionosphere: production, loss, and especially electric fields and neutral winds. Direct measurement of the ionospheric drivers is usually rare and sparsely distributed in space and time. In contrast, measurements of TEC from beacon satellites such as GPS are available in abundance, even during stormy periods. This permits mature imaging algorithms such as Ionospheric Data-Assimilation 4-Dimensional (IDA4D) to routinely produce global three- dimensional, time-varying electron density estimates with 100 km resolution horizontally and 20 km resolution vertically[1,2].

We use the density specification produced by IDA4D with a new tool for deducing ionospheric drivers from 3D time-evolving electron density maps, called Estimating Model Parameters from Ionospheric Reverse Engineering (EMPIRE). Previous work on EMPIRE[3] has demonstrated its capability on simulated electron density data from the first-principles model TIMEGCM-ASPEN[4]. We apply this method to real IDA4D data from storm-time measurements, showing its capabilities during case study storms. We focus on the low- to mid-latitude F2 region. EMPIRE is used to estimate mid-latitude field-aligned and field-perpendicular drifts. Estimates of the drifts are computed hourly and at 20-minute intervals, to compare the effect of averaging estimates during highly dynamic periods.

The estimated drifts from EMPIRE are validated against measurements obtained from Arecibo and Millstone Hill incoherent scatter radars. The drifts are also compared to models, such as Assimilative Mapping of Ionospheric Electrodynamics (AMIE), which estimates drifts from independent data sources from those used in IDA4D. We show that the direction of the drifts (and therefore the electric fields) may be deduced from imaging based on beacon satellite data.

REFERENCES

[1] G. S. Bust and G. Crowley, "Tracking of polar cap patches using data assimilation," *J. Geophys. Res.*, 112, A05307, doi:10.1029/2005JA011597 (2007).

[2] G. S. Bust, G. Crowley, T. W. Garner, T. L. Gaussiran II, R. W. Meggs, C. N. Mitchell, P. S. J. Spencer, P. Yin, and B. Zapfe,Four Dimensional GPS Imaging of Space-Weather Storms, Space Weather, 5, S02003, doi:10.1029/2006SW000237 (2007).

[3] Datta‐Barua, G. S. Bust, G. Crowley, and N. Curtis, Neutral wind estimation from 4‐D ionospheric electron density images, *J. Geophys. Res.*, *114*, A06317, doi:10.1029/2008JA014004 (2009).

[4] R. G. Roble, and E. C. Ridley, A thermosphere ‐ ionosphere ‐ mesosphere ‐ electrodynamics general circulation model (time‐GCM): Equinox solar cycle minimum simulations (30–500 km), *Geophys. Res. Lett.*, *21*(6), 417–420 (1994).