Estimating Model Parameters from Ionospheric Reverse Engineering (EMPIRE)

G. S. Bust, S. Datta-Baruah, G. Crowley and A. Reynolds

ASTRA

One of the current limitations to the community's understanding of ionospheric processes is knowledge of the local physical drivers responsible for the distribution of ionospheric electron density. Direct measurement of these drivers is infrequent and spatially scarce. Our ongoing goal has been to use measurements that are plentiful, such as TEC-based density specification, to infer the drivers. This technique we call Estimating Model Parameters from Ionospheric Reverse Engineering (EMPIRE).

Previously, we have presented results demonstrating the validity of the EMPIRE algorithm using simulated ionospheric data from the Thermosphere-Ionosphere Mesosphere Electrodynamics General Circulation Model (TIMEGCM-ASPEN) physics-based model. The EMPIRE weighted least squares estimates of the field-aligned neutral winds in the equatorial region from were in reasonable agreement with the TIMEGCM background model "true" winds. The other drivers, such as production, loss, diffusion, gravity, and drifts, were modeled as known quantities.

Here we present results, based upon an improved algorithm, that estimate corrections to other physical drivers, such as diffusion, ExB drifts, production and loss, simultaneously with estimating the neutral winds. The new algorithm allows for correcting all driver terms in the continuity equation including production, loss, diffusion, ExB and winds. The corrections can be additive or multiplicative. We apply the new algorithm to actual estimates of the 4D electron density field, obtained from the ionospheric data assimilation algorithm IDA4D. The EMPIRE estimates of the field-aligned velocity terms in the continuity equation are compared to Arecibo incoherent scatter radar measurements, when available, for validation. We will investigate results for the low-latitude super-storm of November 2004, as well as quiet mid-latitude cases.