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Ionospheric Data Assimilation with SAMI3/IDA4D and DINEOFs

Sarah E. McDonald*[(1)], Robert Schaefer[(2)], Roy Calfas[(3)], Russell Stoneback[(4)], Alex Chartier[(2)], Gary Bust[(2)], Angeline Burrell[(1)], Christopher Metzler[(1)], Katherine Zawdie[(1)], Jennifer Tate[(5)], Giuseppe Romeo[(2)], Patrick Dandenault[(2)], Dustin Hickey[(1)], Manbharat Dhadly[(1)]

(1) Space Science Division, Naval Research Laboratory, Washington, DC, email: sarah.mcdonald@nrl.navy.mil, angeline.burrell@nrl.navy.mil, Christopher.metzler@nrl.navy.mil, kate.zawdie@nrl.navy.mil, dustin.hickey.ctr@nrl.navy.mil, manbharat.dhadly@nrl.navy.mil
(2) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD
(3) The Applied Physics Laboratories at the University of Texas at Austin, Austin, TX
(4) University of Texas at Dallas, Dallas, TX
(5) Computational Physics, Inc., Springfield, VA

The ionosphere is a highly driven region of the atmosphere that exhibits considerable variability in response to solar as well as lower atmospheric forcing. Variations in solar irradiance, interaction of the solar wind with Earth's atmosphere, and modulation of thermospheric winds and temperatures by upward propagating tides all contribute to day-to-day and longitudinal variability of the large-scale structure of the ionosphere. Understanding and predicting the global structure of the ionosphere is important for navigation and communication systems that require accurate ionospheric nowcasts and forecasts.

In this talk, we highlight our efforts to investigate the day-to-day and longitudinal variability of the mid- and low-latitude ionosphere using hindcasts generated by a physics-based model of the ionosphere that uses data assimilation tools to correct the model trajectory. Specifically, we use SAMI3 (SAMI3 is Another Model of the Ionosphere) as the background state for the Ionospheric Data Assimilation 4-Dimensional (IDA4D). IDA4D assimilate datasets that can be related to electron density, including ground-based GPS receivers, radio occultation data, ultraviolet sensors, in-situ data, and ionosondes. In addition, we assimilate ion drift velocities into SAMI3 using Data Interpolating Empirical Orthogonal Functions (DINEOFs), a machine-learning data-based interpolation method to fill gaps in sparse observational coverage. For the time period of this study, we use measurements from the Coupled Ion Neutral Dynamics Investigation (CINDI) Ion Velocity Meter (IVM) instrument aboard the Communication/Navigation Outage Forecasting System (C/NOFS). Ion drifts are potentially an important measurement to incorporate into data assimilation systems as this dataset will be plentiful in the low-latitude region with the recent launch of the Constellation Observing System for Meteorology, Ionosphere, and Climate-2 (COSMIC-2).

We have performed hindcasts of the ionosphere during the solar maximum conditions between January and April 2014. We assess the performance of SAMI3 data assimilation system with respect to state-of-the-art empirical models comprised of truth data sets, as well as vetted ground- and space-based measurements. We also discuss our efforts to select suitable metrics for verification and validation of the model.