Project Details

ROSES ID: NNH18ZDA001N
Selection Year: 2018
Program Element: Focused Science Topic

Topic: Mid-latitude and Equatorial Dynamics of the Ionosphere-Thermosphere System

Project Title:
Stormtime Longitudinal Variability in the Ionosphere-Thermosphere System

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Summary:
Science Goals
The primary science goal is to determine the longitudinal variability in the 3-D ionospheric density from equatorial to mid latitudes before, during, and after geomagnetic storms and to elucidate its relationship with associated changes in the neutral and ionospheric dynamics. A second goal is to determine the impact of longitudinal variations in the plasma and neutral environment on low-latitude ionospheric irregularities and plasma instabilities, and its relationship with their climatological occurrence and their occurrence during specific cases.

Objective 1: Collect a value-added database of global space- and ground-based I-T observations before, during, and after selected geomagnetic storms, including the entire year of 2012. The datasets will include TEC from ground and space receivers, occultation data from satellites , measurements of ionospheric irregularities from ground and space, ground-based ionosonde, Fabry-Perot, magnetometer, and radar observations, space-based wind, plasma density, and UV measurements.

Objective 2: Conduct ensemble simulations with our physics-based data assimilation (DA) models to determine the I-T response before, during and after geomagnetic storms. Our focus will be to specify the longitudinal variability of the low- and mid-latitude plasma density during geomagnetic quiet and disturbed times as well as the associated longitudinal differences in the neutral winds and plasma drifts, including longitudinal variations of disturbance dynamo and penetration E-fields.

Objective 3: Specify the relative roles of neutral and plasma dynamics at low and middle latitudes during varying storm phases in generation of longitudinal variability of the storm-time plasma distribution. The investigation will utilize MEPS model specifications of the electric fields, neutral winds and composition, together with our suite of physics-based Ionosphere-Plasmasphere Models (IPMs).

Objective 4: Evaluate the effect of longitudinal variations in the plasma and neutral environment that enhances or suppresses low-latitude ionospheric irregularities and plasma instabilities, and compare with climatology as well as specific cases.

Methodology
We will use a Multimodel Ensemble Prediction System (MEPS) for the I-T system. MEPS will incorporate selected members of the six data assimilation models with different physics, numerics and initial conditions. MEPS will provide specifications of the plasma density as well as the neutral and plasma dynamics, which will be used to identify the longitudinal structure of the I-T system. MEPS specifications of the plasma drift and neutral wind and composition will be used in our physics-based models to evaluate their relative role in the generation of longitudinal variations in the plasma density. This methodology is based on the success of the MEPS DA models that have been used in simulations and publications, including studies of SEDs, the deduction of lunar tides, the Weddell Sea anomaly, global-scale mid- and low-latitude ionospheric disturbances during storms, etc.

Uncertainties
The MEPS approach will identify which outcomes are model independent together with estimates of the model uncertainty provided by the spread of the individual model runs about their mean value. Furthermore, detailed validation efforts will be undertaken to establish the uncertainties of our results by comparing with independent data using various metrics.

Proposed Contributions to the Focus Team Effort
Our investigation to elucidate the longitudinal variability in the I-T system from equatorial to mid latitudes before, during, and after magnetic storms along with the associated changes in the neutral and ionospheric dynamics is relevant to the I-T science topic and directly addresses several goals of this FST. The value-added storm- and quiet-time global I-T datasets and the output from our ensemble DA runs will be made available to all Focus Team members.

Publication References:

Summary: Blah

Reference: Molina, I., and L. Scherliess, 2023, “Longitudinal variability of thermospheric zonal winds near dawn and dusk”, Frontiers of Astronomy and Space Sciences, 2023.

- **Investigation Type:** Other Investigations
- Blah

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