Project Details

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

Project Title:
Variability of global electric field and its impact on the longitudinal structure of the ionosphere

PI Name: Liying Qian
PI Email: lqian@ucar.edu
Affiliation: University Corporation For Atmospheric Research
Project Member(s):
- McInerney, Joe M.;Co-I;University Corporation for Atmospheric Research
- Liu, Han-Li;Co-I;University Corporation for Atmospheric Research
- Burns, Alan G;Co-I;University Corporation for Atmospheric Research
- Wang, Wenbin;Co-I;University Corporation for Atmospheric Research

Summary:
The global ionosphere electric field varies considerably longitudinally and from day-to-day, but the causes of these changes are not well understood. The main processes that produce electric fields include: the neutral wind dynamo; the high-latitude electric fields of magnetospheric origin and the penetration of these fields to lower latitudes. Interactions between these processes, their longitudinal variability, particularly during geomagnetic storms, produce highly dynamic yet poorly-understood, longitudinal and day-to-day variations in the global electric field. At the low- and equatorial latitudes, the global electric field can rapidly raise or lower the ionosphere, and thus help create or suppress plasma instabilities, generate small-scale irregularities that are deleterious to global positioning system (GPS) and radio signal propagation. We propose to improve our understanding of the variability of the global electric field and its impact on the mid-, low- latitude and equatorial ionosphere, by addressing four specific questions:
1) How do the lower atmosphere tides/waves and magnetospheric inputs impact the global electric fields during geomagnetically quiet times?
2) How do the quiet-time global electric fields impact the longitudinal and day-to-day variability of the ionosphere and plasma instability at the mid-, low-, and equatorial latitudes?
3) How do geomagnetic storms impact the global electric fields?
4) How do the storm-time global electric fields impact the longitudinal and day-to-day variability of the ionosphere and plasma instability at the mid-, low-, and equatorial latitudes?

We will employ the Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension (WACCM-X) to carry out the proposed work. An upper atmospheric model uses empirical or specified lower atmosphere tidal forcing. This impairs the accurate determination of electrodynamic forcing from both below and above. WACCM-X treats the whole atmosphere as an integrated system, and employs realistic electrodynamic forcing from both below and above. Periods of geomagnetic activity that are suitable for this study will be identified. WACCM-X will be run with, and without, magnetospheric inputs to understand the interplay between the two forcing sources. Ionospheric Rayleigh-Taylor (R-T) instability growth rates will be calculated using model outputs. The WACCM-X runs will be compared with data from Incoherent Scatter Radars (ISRs), Communication/Navigation Outage Forecast System-Coupled Ion Neutral Dynamic Investigation (C/NOFS-CINDI), the Defense Meteorology Satellite Program (DMSP), Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC), and Total Electron Content (TEC), to understand longitudinal variations of the ionosphere and plasma instability from mid- to equatorial latitudes. Diagnostic analyses will be conducted to understand physical sources that drive this variability.

The project team will make the following contributions to the wider team effort. Model output and results from the proposed studies, including the calculated R-T instability growth rates, will be made available to all teams. We will attend team meetings and participate in team collaborative tasks.

The proposed studies directly address the LWS Focused Science Topic Mid-latitude and Equatorial Dynamics of the Ionosphere-Thermosphere System . It also addresses the Key Science Goal #2 outlined in the current NASA decadal survey: Determine the dynamics and coupling of Earth s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs . Furthermore, it is very relevant to interpreting the output from the current NASA flight mission, the Global-scale Observations of the Limb and Disk (GOLD). GOLD is seeing many structures in the equatorial anomalies after dark (R. Eastes, private communication), which can only be interpreted with a better understanding of the low latitude electric field.

Publication References:

no references