Project Details

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Program Element: Focused Science Topic

Topic: Studies of the Global Electrodynamics of Ionospheric Disturbances

Project Title:
Quantifying the variability of equatorial electrodynamics during disturbed geomagnetic conditions using first-principle models

PI Name: Tzu-Wei Fang
PI Email: tzu-wei.fang@noaa.gov
Affiliation: University Of Colorado, Boulder
Project Member(s):
- Maruyama, Naomi ; Co-I; University of Colorado at Boulder
- Matsuo, Tomoko ; Co-I; University of Colorado, Boulder
- Richmond, Arthur D; Collaborator; NCAR
- Fedrizzi, Mariangel ; Co-I; NOAA/SWPC-CIRES/University of Colorado
- Heelis, Rod ; Collaborator; University of Texas at Dallas
- Makela, Jonathan J.; Collaborator; University of Illinois at Urbana-Champaign
- Welling, Daniel ; Co-I; University of Michigan
- Nair, Manoj C; Collaborator; NOAA/NGDC E/GC2
- Toth, Gabor ; Co-I; University of Michigan
- Singer, Howard J; Collaborator; NOAA Space Environment Center
- Fuller-Rowell, Tim ; Co-I; University of Colorado

Summary:
Studies have suggested that the tides and waves associated with terrestrial weather can significantly contribute to the day-to-day variability of the equatorial electric field under low solar activity and quiet geomagnetic conditions. When geomagnetic activity increases, the electrodynamics is further influenced by the disturbance wind dynamo and a penetration electric field originating in the magnetosphere. The temporal and spatial variations of storm-time equatorial electrodynamics strongly depend on the evolution of geomagnetic disturbance, the nature of the energy inputs to the ionosphere and thermosphere and the response of the thermospheric dynamics. The corresponding changes in the ionosphere-thermosphere (I-T) system become much more complex and with the temporal and spatial variations of equatorial electric fields reflecting different physical processes occurring during geomagnetic storms.

Science goals and objectives: To better understand the I-T responses under storm conditions and their impact on the equatorial electrodynamics, four specific science questions are identified:

1) What are the temporal and spatial variations in equatorial electrodynamics under the impact of geomagnetic storms?

2) What is the contribution of changes in ionospheric conductivity and thermosphere neutral winds in driving the storm-time equatorial electrodynamics?

3) How does the lower atmosphere variability modulate the electrodynamic response to a geomagnetic storm?

4) How well can we forecast the storm-time responses of the system using state-of-the-art models?

Methodology: We will utilize a fully coupled Whole Atmosphere Model (WAM) and the Ionosphere Plasmasphere Model (IPE) to quantify the relative roles of the disturbance dynamo and prompt penetration electric field. The magnetospheric drivers used in WAM-IPE will be derived from the combinations of AMIENextGen, Michigan Geospace Model (MGM), and Prompt Penetration Equatorial Electric Field Model (PPEEFM1). The responses of equatorial electric fields and I-T changes at mid- and low-latitudes under moderate and strong storms will be simulated and validated. The WAM-IPE will also be run with the NOAA-SWPC operational Geospace model, which is driven by real-time solar wind data, to examine the forecast capability of predicting the I-T conditions when geomagnetic activity increases. Running WAM under disturbed geomagnetic activity, the contributions of the disturbance dynamo and tides/waves from the lower atmosphere will be better estimated and their impact on the equatorial electric field will be quantified. Simulated storm-time I-T changes and equatorial electrodynamics will be compared with observations from multiple satellites (DMSP, C/NOFS, GOCE), and ground-based measurements (incoherent scatter radar, Fabry-Perot Interferometer, ionosondes, GPS-TEC). Simulation results will provide a good estimation of the storm-

time electrodynamics and yield to a better understanding of the physics that connects the high-latitude drivers and low-latitude electrodynamics.

Contributions to the Focus Team Effort: The proposed study aims to expend our current understanding on the equatorial electrodynamics, ionospheric changes, and neutral wind perturbation during geomagnetic storms, which fits into the Focus Science Topic of Studies of the Global Electrodynamics of Ionospheric Disturbances that is targeted for the 2016 Heliophysics Living With a Star program. The investigation will provide state-of-the-art models as powerful simulation tools to the focus team members. The comprehensive whole atmosphere-ionosphere model, combined with the well-described high-latitude electric field and energy inputs, will enable us to systematically analyze and quantify the impact of geomagnetic storms on the I-T system.

Publication References:

no references