Project Details

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Program Element: Focused Science Topic

Topic: Thermospheric wind dynamics during geomagnetic storms and their influence on the coupled magnetosphere-ionosphere-thermosphere system

Project Title:
Vertical winds: possible forcing and influence on the upper atmosphere

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Summary:
An accurate description of vertical winds in the thermosphere is essential to understand how the upper atmosphere responds to the geomagnetic storms. Even small vertical winds have a significant effect on the atmospheric density, composition, dynamics, electrodynamics and ionosphere because of the large vertical gradients. However, vertical winds have not been observed systematically and the simulations of effects on the upper atmosphere are very limited. Recent observation deployments and modeling developments now permit substantial progress on this problem. Observations from satellites and expanding ground-based networks, such as Fabry-Perot interferometers (FPIs) in Alaska and Brazil, are providing unprecedented coverage for understanding the role of vertical wind dynamics. Developments in first-principles models, such as the non-hydrostatic model, enable significant improvement on vertical wind simulations. Therefore, it is timely to investigate vertical winds and influence on the upper atmosphere through complementary data analysis and model simulations. In this project, the data sets from FPI ground-based observations along with DMSP and CHAMP satellites and the simulations from non-hydrostatic General Circulation Model(GCM) will be used to investigate F-region vertical winds due to different forcings at both high and low latitudes and to characterize their influence on the ionosphere and thermosphere. Specifically, we will:

(1) analyze FPI vertical wind observations at F-region altitudes in the aurora zone. The correlation of vertical wind with geomagnetic energy inputs will be investigated. The observations will be compared with simulations from the non-hydrostatic Global Ionosphere-Thermosphere Model (GITM). It will greatly improve our capability to describe the neutral wind responses to the magnetospheric energy inputs.

(2) Simulate vertical winds in the cusp during storm periods with GITM in high resolution. The term analysis of the neutral continuity equation will be conducted to study the relative significance of vertical wind to the neutral density. It will significantly advance our understanding of the neutral dynamics and its relationship to upper atmosphere storm time response.

(3) Process data of FPI observations at F-region heights from equatorial Brazil and conduct a climatological study of vertical wind at low latitudes for the first time. The climatology of vertical winds will be compared with the GITM simulations. It will give us a unprecedented view of the nighttime vertical wind at low latitudes, which is critical to specify the dynamics of the upper atmosphere.

(4) Investigate the influence of vertical wind caused by the perpendicular ion-drag force on the equatorial thermosphere anomaly (ETA) for the first time using the non-hydrostatic GITM. It will help us to unveil the ETA mystery and greatly advance the understanding of the momentum coupling between ionosphere and thermosphere.

The overall goal of this project is to substantially improve the description of the dynamics in the upper atmosphere associated with vertical winds and advance our understanding of the coupling between ionosphere and thermosphere. This investigation will make significant contributions to the scientific objectives of the NASA LWS Focus Science Topic: Thermospheric wind dynamics during geomagnetic storms and their influence on the coupled magnetosphere-ionosphere- thermosphere system.

Specifically, it will improve modeling and characterization of thermospheric wind processes during disturbed periods and to improve understanding of the role of winds in ionospheric storm time dynamics. Furthermore, this investigation will make important contributions to three science questions from the Heliophysics Roadmap. We would intend to interact with space physicists in the team to work on problems of overlapping interest that may be identified.

Publication References:

no references