Project Details

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Program Element: Focused Science Topic

Topic: Plasma Neutral Gas Coupling

Project Title:
Global Ionospheric Electric Field Variations in Response to Changes in Geophysical Conditions

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Summary:
We propose to undertake a comprehensive study of the variations of the penetration electric fields and the mechanisms causing these variations under various geophysical conditions. Ionospheric electric fields play a crucial role in ion-neutral coupling in the thermosphere and ionosphere system. They redistribute the ionospheric plasma through transport process, affecting not only global structures of the ionosphere, but also those of the thermosphere by the nonlinear, dynamical coupling between the ions and neutrals. Our understanding of the penetration electric fields and the total ionospheric electric fields is still very limited despite the studies done over the years. Furthermore, the variations of these fields in response to changing driving conditions, and the processes that lead to these variations have not been fully characterized. Thus, we propose to carry out a comprehensive investigation of the behavior of ionospheric electric fields and their effects on thermospheric and ionospheric structures using combined model simulations and data analysis. The model we will use is a state-of-art Coupled Magnetosphere Ionosphere Thermosphere (CMIT) model. The data sets that will be used in this study include electric fields measured by the Jicamarca incoherent scattering radar and the ROCSAT-1 satellite, ionospheric total electron content (TEC) observed by GPS receivers, thermospheric mass density from the CHAMP satellite, and neutral composition obtained from the TIMED/GUVI observations. Four scientific investigations will be undertaken:

1) A study of the longitude variation of the penetration electric fields, the cause of this variation, and the dependence of this variation on solar cycle, season and other geophysical conditions using the CMIT model. The effect of ionospheric pre-conditioning on this variation will also be studied.

2) A study of the cause of the early morning eastward electric field at the geomagnetic equator, and its correlation with solar wind/IMF conditions.

3) An investigation of the effects of corotation interaction regions on the penetration electric fields and thermospheric and ionospheric structures, and the change of this effect with geophysical conditions.

4) A study of the behavior of penetration electric fields and the neutral wind dynamo during the main and recovery phases of storms. Emphasis will be on the changes of the penetration efficiency of high latitude electric fields during storms and the way ionospheric electric fields recover after storms.

The proposed work is directly relevant to the NASA-LWS objectives, in specific, to the NASA LWS Targeted Research and Technology Program Focused Science Topics 1.2.1 d: plasma-neutral gas coupling . The proposed work will use both ground- and space based observations and a first-principles, self-consistent numerical model of the coupled magnetosphere, ionosphere and thermosphere to investigate the interactions between ionospheric plasma and neutral gas, and the responses of these interactions to changing geophysical conditions. The proposed study will advance our understanding of both the variations of penetration electric fields and the cause mechanisms of these variations, and thus our knowledge of the behavior of the T-I system under various geophysical conditions. The proposed work will help improve physics-based models of the coupled magnetosphere ionosphere and thermosphere system and thus our capability of space weather forecast.

Publication References:

Summary: no summary

Reference: Ma, Ruiping; Xu, Jiyao; Wang, Wenbin; Lei, Jiuhou; Liu, Han-Li; Maute, Astrid; Hagan, Maura E.; (2010), Variations of the nighttime thermospheric mass density at low and middle latitudes, Journal of Geophysical Research: Space Physics, Volume 115, Issue A12, CiteID A12301, doi: 10.1029/2010JA015784