Topic: Storm effects on the global electrodynamics and the middle and low latitude ionosphere

Project Title:
Storm-time sub-auroral electric fields: Ionospheric and magnetospheric control

PI Name: Pontus Brandt
PI Email: pontus.brandt@jhuapl.edu
Affiliation: The Johns Hopkins University Applied Physics Laboratory
Project Information:
The role of electric fields in the sub-auroral ionosphere have been underestimated for a long time largely due to the lack of understanding of their origin and global behavior. Solar irradiation, Joule heating and the ring current cause ionospheric electric fields. Separation of their different origins is inherently difficult due to limited spatial coverage of measurements (radars, low-latitude satellites).

We propose to provide a realistic model of the sub-auroral electric field, produced by the ionospheric closure of the ring current, using observations and modeling, and investigate how it is controlled by magnetospheric activity and ionospheric conductance. The output electric fields is intended to be used as input by other thermospheric models investigating the transport and density of the ionosphere/thermosphere. Our work can be divided into the following tasks.

TASK I - Perform a correlative statistical study of ionospheric electric fields. Three types of electric fields will be investigated: (1) Penetration (or undershielding) electric fields; (2) Sub-auroral Polarization Streams (SAPS); (3) Midnight-dawnside, sub-auroral flow reversals. Observational parameters will include solar wind conditions, ionospheric conductance, Region-2 current intensity.

TAKS II - The sub-auroral, ionospheric electric field of selected storm events will be modeled using the Comprehensive Ring Current Model (CRCM), which computes the electric field, self-consistently arising from the closure of the ring current through the ionosphere.

TAKS III - The results from the observational and model study will be combined into a climatological model of the behavior of the sub-auroral, ionospheric electric fields.

The most outstanding ionospheric effect is the uplift of plasma through penetration electric fields on the low-latitude dayside, causing storm enhanced densities (SED) in the F-layer. The SEDs corotate into the duskside ionosphere where ring-current driven electric fields transport plasma to mid-latitudes and sunward. The SEDs have far reaching consequenses for a number of technological systems over our heavily populated continent. For example, the Wide Area Augmentation System (WAAS) assists positioning of civil aircraft by providing time delay of Global Positioning System (GPS) signals from geosynchronous satellites. However, WAAS can only provide time delays from about a two dozen of stations over the North American continent, forcing aircraft to interpolate the time delay value between stations. At disturbed times, the ionosphere display very high densities in very confined regions which makes the position determination by interpolation invalid.

The proposed work fulfills the NASA National Objective: ``Study the Earth system from space and develop new space-based and related capabilities for this purpose.'' and all of its sub-objectives. As recommended by the LWS TR\&T Science Definition Team, the proposed work relies on large-scale modeling work that addresses the coupling between the two traditional domains of the storm-time magnetosphere and ionosphere and offers to provide its output (large-scale, sub-auroral electric fields driven by the magnetosphere) to be used further by thermospheric models. We therefore believe that the proposed work will be a useful strategic capability in understanding the storm-effects on the global electrodynamics and the mid- and low latitude ionosphere/thermosphere system.

ROSES ID: NNH05ZDA001N
Duration:
Selection Year: 2006
Program Element: Focused Science Topic

Citations: