Project Details

ROSES ID: NNH06ZDA001N
Selection Year: 2007
Program Element: Focused Science Topic

Topic: Investigate the Global Distribution, Sources and Effects of Large Electron Density Gradients at Middle and Low Latitudes

Project Title:
Characterizing the composition of large mid-latitude topside-ionospheric/plasmaspheric gradients

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Summary:
The overall goal will be to characterize the latitude and altitude dependence of large mid-latitude ionospheric electron and ion density gradients associated with outer-plasmaspheric structures. Specific objectives are to (1) delineate the differences between the sharp low-latitude walls of mid-latitude ionospheric Ne, H+, and He+ trough structures and the gradients of isolated plasma patches, (2) determine the altitude variations in these gradients from the O+ dominated ionospheric F region up to higher altitudes where lighter ions can dominate, and (3) relate these ionospheric Ne and ion boundaries to magnetospheric plasmapause observations during the same time period. Achieving these objectives will provide an understanding of the basic physics associated with these boundaries. This understanding requires knowledge of the ion composition that determines the underlying structure of the vertical Ne profiles.

The approach will be to use latitudinal cuts of topside sounder vertical Ne profiles, from both archived digital files and recently-produced digital topside ionograms, which can be used to infer ion composition changes from scale heights, in conjunction with archived satellite ion-spectrometer measurements to determine the altitudinal dependence of latitudinal structures in the midlatitude trough region for Ne and each of the important ion species. The rationale for using early archived data is to be able to subject a time interval when there were coincident vertical ionospheric Ne profiles, and a wealth of ionospheric and magnetospheric ion-composition data and magnetospheric electric-field data, to current analysis techniques based on a better understanding of ionospheric/magnetospheric physics. The structures of the low-latitude boundaries of the He+, H+ and Ne troughs, and the boundaries of detached narrow plasma enhancements, will be compared day and night as well as under differing geomagnetic storm conditions to quantify their interrelationships. Searches will be made for the composition signatures of ionospheric plasmatails and the conditions under which they occur. Physical models will be used to undertake detailed case study comparisons to understand the physical processes that control the ion densities along multiple magnetic field lines from the ionosphere to the plasmasphere. The topside Ne profiles and ion information will be used to include a representation of large gradients in the International Reference Ionosphere (IRI) in the mid-latitude topside ionosphere where it is in great need of improvement.

Our objectives support the LWS goal "to develop the scientific understanding ... to effectively address those aspects of the Heliophysics science that may affect life and society" in that a knowledge of mid-latitude topside ionospheric structures is needed to mitigate the ionospheric impacts on advanced technological systems, such as GPS positioning, where the ionospheric effects on trans-ionospheric radio propagation is often the limiting factor on overall system performance. It supports the LWS TR&T Focused Science Topic "a" (Investigate the Global Distribution, Sources and Effects of Large Electron Density Gradients at Middle and Low Latitudes) in that it aims to "produce an improved scientific understanding and characterization of large electron density gradients in the Earth's middle and low latitude ionosphere, leading to improved models that can generate predictions of societal value." Since the investigation (1) exploits the data analysis of large mid-latitude gradient features, (2) includes theoretical analysis of how these features are generated, (3) improves a physical model to relate ionospheric and magnetospheric features, and (4) enhances the IRI empirical model by providing more data that will lead to improved prediction capabilities, it addresses all four of the "types of solicited objectives" listed under the LWS TR&T Focused Science Topic "a".

Publication References:

Summary: no summary

Reference: Grebowsky, Joseph M.; Benson, Robert F.; Webb, Phillip A.; Truhlik, Vladimir; Bilitza, Dieter; (2009), Altitude variation of the plasmapause signature in the main ionospheric trough, Journal of Atmospheric and Solar-Terrestrial Physics, Volume 71, Issue 16, p. 1669-1676, doi: 10.1016/j.jastp.2009.05.016