Project Details

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Topic: Pathways of Cold Plasma through the Magnetosphere

Project Title:
Midlatitude topside ionospheric variations associated with plasmaspheric erosion and refilling

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Summary:
The plasmasphere and ionosphere are a tightly coupled dynamic system. Plasmaspheric flows can produce nighttime midlatitude ionospheric anomalies. At storm main phase, plasmaspheric erosion temporarily depletes large regions due to enhanced sunward flow expanding equatorward, with subsequent refilling during storm recovery phase. Ionospheric storm-enhanced density, with
a magnetic dual in plasmaspheric plumes, appears to be uplifted and sometimes is situated within ion upflow regions. During the recovery phase, plasmaspheric refilling takes place principally via diffusion, established by balance between gravity and plasma pressure gradients. Ionospheric storm recovery creates a negative storm phase when reduced mid / low latitude thermospheric O/N2 changes occur. These ionosphere-plasmasphere mass exchange processes have significant geospace impact including alteration of ion trajectories in the inner magnetosphere in the presence of cold plasma, extending the reach of these influences into magnetospheric configuration. Frequency of storm occurrence keeps this process inherently dynamic. Throughout, the topside ionosphere is a key and dynamic region.
We will focus on the following science questions: (1) What are characteristic topside ionospheric variations associated with plasmaspheric erosion and refilling during geomagnetic storm main and recovery phases? (2) During plasmaspheric erosion and refilling, what is the influence of topside ionospheric dynamics on plasmaspheric and inner magnetospheric cold plasma populations? (3) What are controlling factors and physical processes in topside ionospheric recovery?
To address these questions, we propose 8 research tasks to analyze cold plasma density in the topside and other ionospheric altitudes, plasma temperatures, and thermospheric column O/N2 to gauge dynamic and chemical processes which are important for topside ionospheric recovery. We will study cold plasma state parameters in the plasmasphere and inner magnetosphere, and
establish linkage with topside ionospheric sources during the short-term storm main phase and long-duration recovery phase. We will also provide ionospheric upflow estimates in the topside, and gauge ionospheric storm recovery/plasmaspheric refilling. Primary 2012-2019 datasets (with maximum data overlap) include DMSP and Swarm density and velocity, GNSS topside TEC from LEO satellites GRACE, TSX, Swarm-A, Swarm-B, and MetOp-A, and GUVI column O/N2. This will be augmented by Millstone Hill incoherent scatter radar observations as well as GNSS TEC and ionosonde observations. We will also use Van Allen Probes A and B measurements of inner magnetospheric cold plasma density, electric field, and cold ion composition and THEMIS A, D, and E inner magnetospheric measurements of cold plasma density.
Our work will study topside ionosphere source plasma and in-situ cold plasma dynamics in the plasmasphere and inner magnetosphere, addressing FST SSA-V (Dynamics of the Global Ionosphere and Plasmasphere) and SSA-IV (Variability of the Geomagnetic Environment) and focusing on FST #2: the cold plasmasphere, drainage plume and refilling. Our LWS FST team contribution will include data and analysis of topside ionospheric recovery characteristics as a comparison basis for team validation of first-principle models with an ionospheric component. Joint analysis of topside ionosphere and inner magnetosphere cold plasma configuration and dynamics will provide coincident information for these same models on plasma sources and evolution within the coupled ionosphere and plasmasphere (and inner magnetosphere).

Publication References:

no references