Initial Observations of Plasma Waves in the Sub-Auroral Polarization Stream with the Van Allen Probes

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Abstract

The Sub-Auroral Polarization Stream (SAPS) is a geospace boundary layer phenomenon associated with the interaction of the warm plasma of the magnetospheric ring current with the cold ions and electrons of the outer plasmasphere [1]. Driven by ring current enhancements during magnetospheric disturbances, SAPS location, intensity, and characteristics are greatly influenced by the underlying ionosphere. Strong M-I coupling by means of field-aligned currents creates a high-speed (>1000 m/s) westward plasma flow channel in the ionosphere at pre-midnight/post-noon local times which is readily observable by incoherent scatter [2] and HF radars and in plasma drift observations by low-altitude spacecraft (e.g. DMSP). The fast ionospheric flows generate E-region irregularities providing for additional diagnostics using coherent backscatter techniques [3].

SAPS plays a significant role in the redistribution of cold plasma through the geospace system at both ionospheric and magnetospheric heights. Where the SAPS flow channel overlaps the mid-latitude ionosphere and outer plasmasphere, streams of cold plasma are carried westward and sunward as plumes of storm enhanced density (SED) in the ionosphere and as plasmasphere erosion plumes at high altitude. Ground-based maps of GPS total electron content (TEC) serve to visualize the spatial extent and evolution of the SAPS and SED. Mapping these features to magnetospheric altitudes along magnetic field lines permits direct intercomparison with in situ spacecraft observations.

The recently launched Van Allen Probes twin satellites (RBSP-A & RBSP-B) are in near-equatorial orbits well suited for studies of the SAPS and related phenomena at the apex of field lines threading the plasmasphere boundary layer. Simultaneous near magnetic field aligned observations of SAPS at DMSP altitude (~800 km) and by RBSP-A at ~20,000 km show close correspondence of SAPS location and characteristics between the ionosphere and magnetosphere. In highly elliptical orbits with apogee near 5.5 Re, the RBSP spacecraft often spend hours at a time skimming the outer plasmasphere within the SAPS region. A great variety of wave phenomena are observed. Here we describe long-duration large amplitude (+/- 5 mV/m) electric field oscillations with 3 min – 5 min period seen in the magnetospheric equatorial plane within the SAPS/erosion plume region.

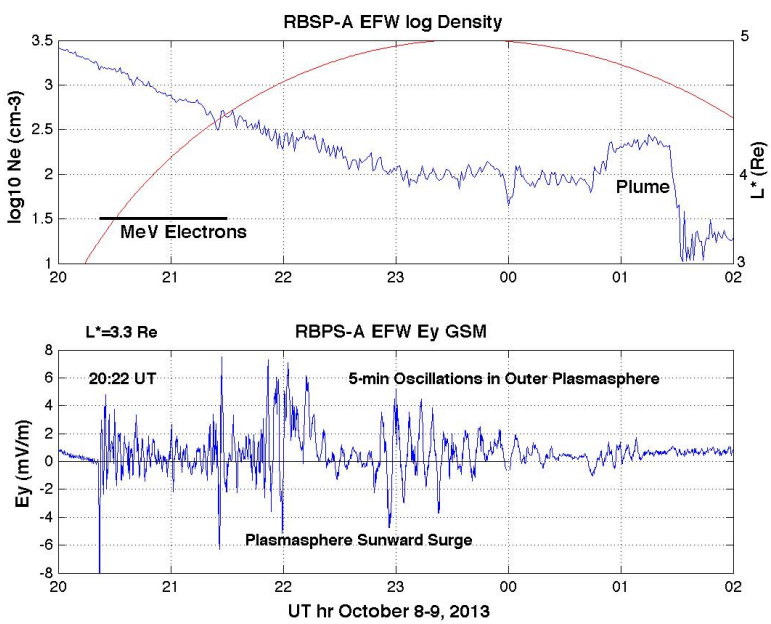

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Figure 1. The RBSP spacecraft often spend hours at a time skimming the outer plasmasphere within the SAPS region. In the example shown RBSP-A remained near apogee at L*~5 Re just inside the outer edge of the plasmasphere and the erosion plume for ~90 min. Large amplitude (+/- 4 mV/m) electric field oscillations were observed with ~ 5 min period.

In prior work, similar +/- 25 mV/m ionospheric electric field variations with ~5-min periodicity within the SAPS channel have been reported in Millstone Hill UHF radar E-region coherent backscatter observations [4].

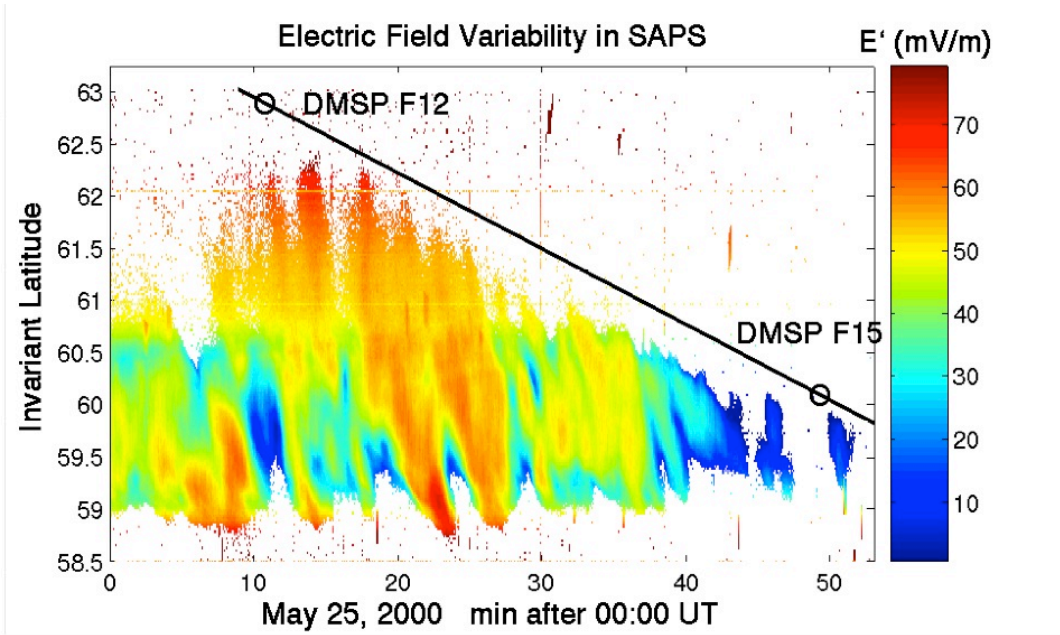

Figure 2. Coherent backscatter observations of ~5-min period large amplitude waves within the SAPS ionospheric flow channel often are observed with the high power, narrow beam Millstone Hill UHF radar. One hour of observations are shown with the radar beam held stationary crossing the latitude span over which the beam is near perpendicular to **B** at E region heights. The equatorward extent of auroral electron precipitation is indicated at two times as observed by the DMSP satellites.

References

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