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Electron number density measurements from IMAGE RPI are combined with ULF resonance-ground magnetometer derived mass density estimates during times of IMAGE and MEASURE ground magnetometer array conjunctions to determine the average composition of the plasmasphere during quiet times. Many studies have been performed to characterize the plasma density profile of the inner magnetosphere. The usual result is that the equatorial electron density decreases as a function of distance from the Earth. On the other hand, the mass density profile of the inner magnetosphere has not been extensively studied due to the difficulty of making direct measurements from spacecraft and the fact that ground-based techniques developed for remotely sensing mass density tend to be tedious to perform by hand. Recently, an automated process for estimating the mass density of the inner magnetosphere using pairs of ground magnetometers has been developed by Berube et al. The Radio Plasma Imager (RPI) on board the IMAGE spacecraft makes in situ measurements of magnetospheric electron density. By combining electron density measurements from RPI with mass density estimates obtained using ground techniques we are able to constrain the plasma composition of the inner magnetosphere for instances when IMAGE is in conjunction with the field lines spanned by ground stations.

SM51C-0556 0830h POSTER

Simulation study on how electron and proton whistlers appear for different latitudes

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Electron whistlers frequently excite proton whistlers. The proton whistlers appear on the dynamic spectrum as rising tones, which start after the reception of a short electron whistler, asymptotically approaching the local proton gyro-frequency. The proton whistlers are dispersed forms of lightning impulses and their dispersion can be explained by the effects of ions such as H^+ and He^+ on the propagation of an electromagnetic wave in the ionosphere. A wave propagating in the ionosphere changes polarization at the altitude where the frequency is close to a crossover frequency. This polarization reversal provides the mechanism by which an upgoing electron whistler can become a proton whistler. By adopting the multi-fluid numerical wave model, we investigate how the location of the lightning sources affects the electron and proton whistlers. The time histories of electric fields and the dynamic spectra are presented. We show that the polarization reversal occurs at mid- and low-latitudes where the geomagnetic field makes a large angle relative to vertical, while no polarization reversal occurs at high latitudes where the geomagnetic field is nearly vertical. We discuss how electron whistlers disappear when the frequency lies between the crossover frequency and the cutoff frequency in cold plasmas. We also compare our results with the previous theoretical and observational studies.

SM51C-0557 0830h POSTER

Observation of daytime Pc3-4 ULF waves near the plasmapause using SuperDARN TIGER radar

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SuperDARN radars are primarily designed to study large-scale long-period ionospheric plasma convection. However, these radars are also capable of monitoring much weaker and faster processes like ULF waves. Recently, we have shown that simple detrending together with utilization of sea/ground scatter echoes reveal on abundance of ULF waves in SuperDARN data. The basic radar sampling rate of 120 s limits ULF waves, which may be studied, to Pc4-5 frequency range. However, use of a special high time resolution mode shows regular appearance of band-limited daytime Pc3-4 waves. These waves are believed to be generated by ion-cyclotron instability in the reflected proton beams upstream of the Earth's bow-shock. Their propagation to the high-latitude ionosphere remains unclear. In this work we use SuperDARN TIGER radar (Tasmania) to investigate spatial characteristics of high-latitude daytime Pc3-4 waves in an attempt to clarify their propagation modes. Simultaneous ground magnetometer data were used for direct estimates of the ionosphere/ground transfer function in 10-100 mHz range, which was then compared with results of numerical and analytical modelling.

SM51C-0558 0830h POSTER

Monitoring the Ground-Based VLF transmissions from Space using IMAGE RPI

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Using the global network of ground-based VLF transmitters operating at frequency between 10 and 30 kHz, we have monitored the occurrence of whistler mode VLF signals with the RPI instrument on the IMAGE satellite. Our objective was to study the power and effective spatial scales of the whistler waves propagating trough the ionosphere into the magnetosphere. We have identified signals from 20 stations in the plasmasphere region with L shells ranging from 1.1 to 5.2. Ten of these stations have high radiated power, 200 kW to 1 MW. The spatial region where VLF signals were observed was significantly smaller during the dayside measurements than during the nightside ones. We also present azimuthal and radial characteristics of the VLF signal amplitude.

SM51D MCC: 2006 Friday 1020h

The Electrodynamics of the Cusp and the Open/Closed Field Line Boundary Region III *(joint with SA)*

Presiding: **R Pfaff,** NASA Goddard Space Flight Center**; T Yeoman,** University of Leicester

SM51D-01 1020h INVITED

Combined Sounding Rocket and SuperDarn/EISCAT Radar Observations of Plasma Convection, Shear, Irregularities and other Phenomena in the Cusp and Boundary Layer during IMF Bz Negative and By Negative Conditions

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On December 14, 2002, a NASA Black Brant X sounding rocket was launched equatorward from Ny Alesund, Spitzbergen (79 deg. N) into the dayside cusp and subsequently cut across the open/closed field line boundary, reaching an apogee of 771 km. The launch occurred during Bz negative conditions with strong By negative that was changing during the flight. SuperDarn (CUTLASS) radar and subsequent model patterns reveal a strong westward/poleward convection, indicating that the rocket traversed a rotational reversal in the afternoon merging cell. The payload returned DC electric and magnetic fields, plasma waves, energetic particle, suprathermal electron and ion, and thermal plasma data. We provide an overview of the main observations and focus on the DC electric field results, comparing the measured E x B plasma drifts in detail with the CUTLASS radar observations of plasma drifts gathered simultaneously in the same volume. The in situ DC electric fields reveal steady poleward flows within the cusp with strong shears at the interface of the closed/open field lines and within the boundary layer. We use the observations to discuss ionospheric signatures of the open/closed character of the cusp/low latitude boundary layer as a function of the IMF. The electric field and plasma density data also reveal the presence of very strong plasma irregularities with a large range of scales (10 m to 10 km) that exist within the open field line cusp region yet disappear when the payload was equatorward of the cusp on closed field lines. These intense low frequency wave observations are consistent with strong scintillations observed on the ground at Ny Alesund during the flight. We present detailed wave characteristics and discuss them in terms of Alfven waves and static irregularities that pervade the cusp region at all altitudes.

SM51D-02 1040h

Observations of Highly Structured Precipitating Electrons in the Dayside Cusp/Boundary Layer Ionosphere

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Observations of electrons precipitating in the dayside entry region are presented. The measurements were gathered using instrumentation carried on a sounding rocket launched into the cusp region from Ny Ålesund, Svalbard on 14 December 2002. The electron fluxes were highly structured and patchy and correlated with the electromagnetic signatures measured by the fields experiment on the rocket. The electron signatures are interpreted in terms of wave-particle interactions involving the large scale fields including Alfvénic fluctuations as well as the inferred open-closed field line geometry. Mapping of the electrons up the field lines using time-of-flight techniques is used to help understand the coupling between the fields and the waves.

SM51D-03 1055h INVITED

Determining the Open Flux Content of the Magnetosphere From Observations of the Polar Ionosphere

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We employ observations from several sources to determine the location of the polar cap boundary, or open/closed field line boundary, at all local times, allowing the amount of open flux in the magnetosphere to be quantified. These data sources include global auroral images from the Ultraviolet Imager (UVI) instrument onboard the Polar spacecraft, SuperDARN HF radar measurements of the convection flow, and low altitude particle measurements from Defense Meteorological Satellite Program (DMSP) and

National Oceanographic and Atmospheric Administration (NOAA) satellites, and the Fast Auroral SnapshoT (FAST) spacecraft. Changes in the open flux content of the magnetosphere are related to the rate of magnetic reconnection occurring at the magnetopause and in the magnetotail, allowing us to estimate the day- and nightside reconnection voltages associated with different IMF orientations and the occurrence of substorms. In addition, we discuss the ramifications for the magnetotail of changes in open flux content of the magnetosphere.

SM51D-04 1115h

Interhemispheric conjugate observations of ionospheric convection flows in the dayside high-latitude regions

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Interhemispheric conjugate observations of ionospheric convection flows are essential for understanding the electrodynamics in the dayside high-latitude regions, particularly in the cusp and the open/closed field line boundary region. We investigate the SuperDARN data for this purpose. Merged vectors obtained from pairs of radars are calculated using the common program data during the 8-year period of 1995-2002. We select 29 events in which a large number of merged vectors are obtained by coverage of pairs of conjugate radars. Most events occurred near equinox under the southward IMF conditions. This is consistent with a fact that the generation of ionospheric irregularities is affected by daylight high diffusion rates and enhancements of convection electric field. Interhemispheric convection patterns are consistent with the Heppner-Maynard pattern when the IMF is stable for >30 min. It is found that convection flows and vorticities tend to be weak in the sunlit region in the vicinity of the open/closed field line boundary. This may reflect an asymmetry of the cusp properties in the northern and southern hemispheres due to ionospheric conductivity differences. Considering these result, we discuss the three dimensional current system producing the interhemispheric convection patterns in the dayside high-latitude region.

SM51D-05 1130h

Does the IMF High Latitude Convection?

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One of the paradigms of present day magnetospheric physics is that the interplanetary magnetic field at the dayside magnetopause controls the shape of the high-latitude convection pattern and the magnitude of the cross polar cap potential. From this viewpoint, IMF-derived statistical models of high-latitude convection can readily be used to carry out studies of plasma transport and evolution in both the ionosphere and magnetosphere. While there appears to be underlying structure to the convection patterns that is well represented by IMF orientation, studies being carried out with the SuperDARN radar network indicate that the IMF magnitude and orientation does not provide a good measure of the instantaneous cross polar cap potential. Rather the cross polar cap potential exhibits sharp transient increases in a manner discussed by Lockwood and Cowley in the early 1990s. The effects are most apparent in the vicinity of the cusp, but can be observed at other local times. Transient latitudianlly-confined regions of strong convection are the most obvious feature of these potential enhancements. In this paper, we present examples of this phenomena as observed with SuperDARN and discuss its implications.

SM51D-06 1145h INVITED

Numerical modelling of observed cusp characteristics for spatial and temporal variations in magnetopause reconnection rate

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Using the Cowley-Lockwood theory of ionospheric flow excitation, a numerical model of the response to generalised variations of the magnetopause reconnection rate, in both space and time, has been developed for times when the Y-component of the IMF is small. This model allows the motion of all reconnected field lines to be monitored and maps of time-elapsed since reconnection can be generated. Because the characteristics of the ion precipitation spectrum can be characterised as a function of this elapsed time and the site of the reconnection, we can use this model to generate time series of maps of parameters such as the sheath ion flux, the mean energy, the low-energy cut-off, and the proton aurora intensity, as well as the convection patterns and maps of the consequent ion heating. Comparison with observations shows very good agreement with observations by the IMAGE spacecraft and the SuperDARN network of HF radars. The model reproduces observed stepped and sawtooth signatures, depending on satellite altitude and pass orientation, as predicted for pulsed reconnection. Using the maintenance of quasi-neutrality, first-order predictions of features produced by sheath electron precipitation can also be modelled. For example, we show how poleward-moving 630 nm auroral transients and patches of enhanced plasma concentration can also result from the pulsed reconnection.

SM51D-07 1205h

Plasma Dynamics in the Vicinity of a Cusp-Like Magnetic Configuration

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The magnetospheric cusps are an important structural element of the Earth's magnetosphere. Magnetic flux from the magnetospheric boundaries converges into the cusps and the magnetic field in the vicinity of the cusps rotates by 360 degrees. The magnetic field and plasma flow configuration allows for magnetic reconnection and Kelvin Helmholtz instabilities in the vicinity of the cusps. In addition plasma flow can become turbulent due to boundary layer separation as a result of the plasma flow over the cusp indentation. However, there are very few models based on first principles and with good numerical resolution which address the cusp physics. Here we will present first results based on MHD simulations with an initial condition which includes a cusp-like magnetic field indentation. The initial conditions particularly address cases with a magnetic field and plasma flow aligned and perpendicular to each other. The results consider a variation of the velocity on the magnetosheath side as well as the influence of viscosity on the the flow structure in and adjacent to the cusp.

SM51E MCC: 3014 Friday 1020h

Radiation Belts and the Inner Magnetosphere III

Presiding: **T P O"Brien,** The Aerospace Corporation**; A A Chan,** Rice University

SM51E-01 1020h

SAMPEX Observations of the Inner Radiation Belt Over a Complete Solar Cycle

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The Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) satellite was launched into low Earth orbit in July 1992, and has been measuring energetic protons and heavy hydrogen isotopes during several traversals of the inner radiation belt each day since then. We have now accumulated a data set covering a full 11-year cycle of solar activity (from declining phase of Cycle 22 to the declining phase of the current Cycle 23), and have assembled it into time-varying maps of several parameters of the radiation belt. We will describe the variations of energy spectra, pitch-angle distributions, scale height, and isotopic composition as the solar activity level changed during the mission. The scale height (measured through gradient anisotropy, the "East-West effect") at the lower edge of the radiation belt responds to changes in the upper atmosphere over the solar cycle. Varying isotopic composition, especially considering the 12-year half-life of tritium, reflects the differing sources and losses for the CRAND protons and secondary deuterium and tritium. Time variations at the upper edge of the radiation belt at energies of tens of MeV respond to geomagnetic injections of these high-energy particles as well as to the relatively steady CRAND source and atmospheric losses. This data set is being incorporated into models of the low-altitude inner zone that seek to improve on the two-state (solar max, solar min) AP8 model by including continuous response to changes in solar activity.

SM51E-02 1035h

Coordinated Energetic Particle Measurements Using Chandra, Cluster, and Polar

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It is not well known in the magnetospheric physics community that the Chandra spacecraft carries a multi-element energetic particle telescope called EPHIN (Electron Proton Helium Instrument) fielded by the University of Kiel. For present purposes we are interested in electrons that are measured from greater than 30 keV to greater than 10 MeV. Chandra is in a highly elliptical orbit with a perigee of 16000 km, and apogee of 133,000 km and an inclination of 28 degrees. Fortuitously the line of apsides is relatively close to that of the Cluster constellation. A first use of the Chandra data has been a further examination of a substorm onset that occurred = 0408 UT on 27 August 2001, discussed in a publication by Baker et al. (2002). At that time the s/c coordinates in GSM were Chandra (-6.64, 16.15, 12.82); Cluster 3 (-19.15, -1.40, 1.54); Polar (-7.71, -4.50, 3.32). It can be seen that whereas Cluster and Polar were a bit post midnight and roughly radially aligned, Chandra was well pre-midnight at around 20 hrs. Yet the onset time of energetic electrons at Chandra was very close to that observed at Cluster and Polar. Furthermore, some pre-substorm bursts were also seen to be closely time coincident at Chandra and the other spacecraft. These observations give additional evidence about the scale size of the phenomena and will be discussed in detail along with other coordinated measurements. Baker et al. GRL 29, no. 24, 2190, 2002

SM51E-03 1050h

Global flux isotropization and in-situ Pitch angle evolution during relativistic electron energization in the outer zone.

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Energization of outer zone electrons to relativistic energies in the Earth's magnetosphere is fundamentally caused by high solar wind velocity and the southward turning of the interplanetary magnetic field. However, details of all the physical processes involved, are ill

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