at the Earth 3-4 days in advance. By detecting stream interfaces in the predicted velocity we obtain 2-3 days advance warning of a stream interface. We then use the climatology of an index relative to the predicted interface (the cdfs) to forecast the probability of enhanced activity. We will evaluate the quality of the predictions for the years 1995-1996 and apply it to current observations as we progress into the declining phase of the current cycle.

SM11D-05 1135h

Sun-to-Magnetosphere Modeling of Radiation Belt Electrons: Forecasting Using Linked Empirical Methods

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An important space weather threat is associated with very high energy electrons trapped in Earth's outer Van Allen zone. Past work has shown that radiation belt electron fluxes are highly dependent on the solar wind speed (V_{SW}). Generally, when V_{SW}. goes above 500km/s, the radiation belt electron fluxes increase substantially. We have used the Wang-Sheeley-Arge (WSA) method to predict the solar wind speed near Earth's orbit based upon solar surface measurements. This approach gives a predicted solar wind time series with a lead-time of two to three days. This forecasted solar wind speed is then convolved with linear and nonlinear filters in order to provide a predicted flux of electrons at various spatial locations throughout the outer radiation belt. We compare predicted and measured electron fluxes in order to assess the prediction efficiency and available lead times for this forecasting tool. We also compare forecasts based on the WSA method with results obtained by convolving filters with solar wind speeds measured by ACE sensors at the L1 point just upstream of the Earth.

SM11D-06 1150h

"Nudging" the Salammbo Code: First results of seeding a diffusive radiation belt code with in situ data: GPS, GEO, HEO and POLAR

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The Salammbo coded is a diffusive radiation belt code aimed at representing the dynamics of relativistic electrons in the inner magnetosphere. The code currently incorporates physics capturing the majority of the observed dynamics, but does not include all proposed mechanisms that could be responsible for some of the detailed dynamics observed - in particular, it does not include chorus acceleration. However, we do have at our disposal a range of data taken in situ. Traditionally diffusive models use data as boundary conditions only. We here use properly inter-calibrated data from a range of LANL geosynchronous and GPS particle instruments whenever they are available to seed or "nudge" the code, allowing the code in effect to act as a physics based interpolater of the data. This process yields a data/model global synthesis representation of the state of the relativistic electron belts that is better than any representation that can currently be achieved from models or data alone, in spite of some "missing physics". We present here the data ingestion methods used and first runs of this new synthesis model. We test this model against in-situ measurements of spacecraft not part of the assimilation process: In general the synthesis model is able to reproduce measured in-situ fluxes to within a factor of two, irrespective of activity level. This is of the same order as the fidelity of our spacecraft inter-calibration and thus as good as one can be expected to do. We are thus able to produce a high fidelity state of the global magnetosphere against which this and other physics based models may be compared.

SM11D-07 1205h

Role of Ion-drag Processes in the Nighttime, Low-latitude Thermospheric Wind and Temperature Structure

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The purpose of this study is to understand the role of the plasmasphere in equatorial electrodynamics, with a focus on the role of ion-drag processes in the nighttime low-latitude thermospheric structure. This study utilizes the Coupled Thermosphere-Ionosphere-Plasmasphere-Electrodynamics (CTIPe) model where the equatorial plasmasphere is self-consistently coupled to the electrodynamics and the global ionosphere and thermosphere system. Ion-drag processes play a significant role in the momentum and energy interactions between the ionized and neutral species. Comprehensive elucidation of the spatial and temporal variations of the 3-dimensional ion-drag, especially in the evening prereversal enhancement of the zonal electric field, requires a self-consistent plasmaspheric distribution together with the electrodynamics and polarization fields associated with the E- and F-layer dynamo. Furthermore, the impact of ion-drag parallel to the field-lines must be considered, since the parallel ion drag in the vicinity of a pronounced Equatorial Ionization Anomaly has a significant impact on the latitudinal structure of the equatorial thermospheric structure. In this study, the mechanism responsible for the latitudinal structure of neutral wind and temperature, such as Equatorial Temperature and Wind Anomaly, Midnight Temperature Maximum and superrotation of the Earth's upper atmosphere, is addressed. The model results indicate that the ion-drag variations derived from the interacting plasmasphere and electrodynamics is an important consideration in these phenomena.

SM12A MCC: Level 2 Monday 1330h

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

Presiding: **H U Frey,** Space Sciences Laboratory, University of California, Berkeley**;** **E Lund,** University of New Hampshire

SM12A-1190 1330h POSTER

Slow, Fast and Mixed Compressible Modes near the Magnetopause

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We motivate and illustrate a new technique to certify time variations, observed in spacecraft frame of reference, as compressible slow or fast magnetosonic waves. Like the Walén test for Alfvén waves, our method for identifying compressible modes requires no Galilean transformation. Unlike the Walén test, we use covariance techniques with magnetic field time series to select three special projections of $\mathbf{B}(t)$. The projections of magnetic fluctuations are associated with three, usually non-orthogonal, wavevectors that, in principle, contribute to the locally sampled density fluctuations. Wavevector directions ($\hat{\mathbf{k}}(CoV)$) are derived from eigenvectors of covariance matrices and mean field directions, $\mathbf{B}_o$. Linear theory for compressible modes indicates that these projections are proportional to the density fluctuations. Regression techniques are then applied to observed density and magnetic field profiles to specify coefficients of proportionality. Signs of proportionality constants, connecting the three projections of $\delta\mathbf{B}$ and $\delta\rho$, determine whether the compressional modes are of the fast (+) or slow (-) type. Within a polytropic-closure framework, the proportionality between magnetic and density fluctuations can be computed by relating $\hat{\mathbf{k}}$, the polytropic index, γ, and the plasma β. Our certification program validates the direct interpretation of proportionality constants comparing their best-fit and error values with the directions of wavevectors required by the dispersion relation, $\hat{\mathbf{k}}(Disp)$ inferred from experimental measurements of β and γ. Final certification requires that for each mode retained in the correlation, the scalar product of wavevectors determined through covariance and dispersion-relation analyses are approximately unity $\hat{\mathbf{k}}(CoV) \cdot \hat{\mathbf{k}}(\mathrm{Disp}) \approx 1$. This quality check is the compressible-mode analogue to slope-one tests in the Walén test expressed in Elsässer [1950] variables. By products of completed certification include the assignment of various portions of time-domain data streams to the compression or rarefaction phases of fast/slow modes structures, the directions of wave-power propagation in the plasma frame and relative to the magnetic field direction as well as their phase speeds with respect to the background plasma. These certifications also imply temporal trains of electric fields of the ambipolar type, including spatially varying $E_{\parallel}(t)$, that may be the cause of some of the structured observations of $E_{\parallel}$ that have recently been detected near the diffusion region. Along with Walén tests the new procedures enable surveys for the presence and roles of non-dispersive fast, intermediate, and slow MHD waves in geospace. Geophysical examples from the Polar satellite illustrate fast, slow and even admixtures of fast and slow magnetosonic waves retrieved through our analysis. On this experimental basis, we discuss the roles of compressible-mode structures in boundary layers associated with the magnetopause.

SM12A-1191 1330h POSTER

Dayside Auroral Morphology During Southeast IMF Orientation:Spatial Structure and its Implications for Magnetopause Reconnection

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In a case study we elaborate on the spatial structure of the dayside aurora within 0800-1600 MLT and discuss its implications for magnetopause reconnection topology. The detailed 2D auroral morphology is obtained from continuous ground observations at Ny Ålesund (76° MLAT), Svalbard during days when the interplanetary magnetic field (IMF) was oriented in the southeast direction ($B_y > 0$; $B_z < 0$). The major auroral features consist of sequential activations of latitudinally separated, sunward moving, arcs/bands (dayside BPS precipitation) in the prenoon (0800-1100 MLT) and postnoon (1200-1600 MLT) sectors which are separated by a deep minimum in activity/intensity within the 1100-1200 MLT sector. The latter "midday gap" aurora is attributed to the presence of component, steady state reconnection at the subsolar magnetopause where the stagnant magnetosheath flows lead to field-aligned currents (FAC) which are of only moderate intensity. The much more active and intense aurorae in the prenoon (0800-1100 MLT) and postnoon (1200-1600 MLT) sectors originate in magnetopause reconnection events that are initiated well away from the subsolar point, presumably in the form of antiparallel merging taking place near-simultaneously at high magnetopause latitudes in the southern/prenoon and northern/postnoon hemispheres, respectively, where the stronger boundary layer flow shears give rise to more intense FACs and aurorae.

SM12A-1192 1330h POSTER

Cluster Electron Cusp Dispersions and IMAGE Proton Auroras as Evidence for Continuous Merging at the Magnetosphere

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Whether magnetic reconnection at the earth is intrinsically non-steady is still a controversial question. Some authors have made a case for a pulsed merging process, with 1 minute of active reconnection followed by 8 minutes without merging. To pursue this issue, we examine Cluster cusp crossings for evidence of ongoing electron dispersion. Because electrons disperse very rapidly before becoming trapped with dispersing ions, their dispersion indicates contact with a field line that is still actively reconnecting. The detection of electron dispersions on multiple satellite cusp crossings, during periods of steady IMF and ideal inter-spacecraft spacing (less than 8 minutes and greater than 1 minute), would support a more continuous merging process. A statistical estimate of the number of Cluster cusp crossings with electron dispersions may serve as a proxy, in the absence of ideal inter-spacecraft spacing and extended periods of steady IMF. Moreover, SI-12 proton aurora data supplement Cluster electron and ion data in tracking the presence of an active merging sight.

SM12A-1193 1330h POSTER

Cluster Survey of the Occurrence of Poleward-of-Cusp Reconnection and its Dependence on the IMF

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We survey the occurrence of reconnection jets at the poleward edge of the cusp detected by Cluster as a function of the interplanetary magnetic field (IMF) clock angle. The survey covers 3 years (2001-2003) of data and is restricted to periods of relatively stable IMF. Our survey indicates that these jets occur only when the IMF clock angle is within 50 degrees of the GSM z direction. We will discuss this finding in relation to component versus anti-parallel merging models.

SM12A-1194 1330h POSTER

Magnetospheric Cusp Observed by Cluster on 18 April 2002

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Results are presented from a study of the northern magnetospheric cusp crossed by the 4 Cluster satellites during 16:25-17:55 UT on 18 April 2002 when the solar wind dynamic pressure was rather low and IMF Bz was suitable (southward) for reconnection at subsolar magnetopause. The satellite orbit and data from the FGM, CIS, PEACE, STAFF and WHISPER instruments reveal that the satellites have crossed through the edge of a structured exterior cusp. Three distinct anti-sunward ion flow events of duration about 1.5, 17.5 and 19.0 minutes, with bulk flow roughly parallel to the magnetopause surface, are detected in the cusp region. The ion density in the events measured by one of the satellites (C3) is up to 10 times less than that measured by other satellites (C1 and C4, no data from C2), which seems to arise from the low northward-westward flow encountered by C3 compared to C1 and C4. The magnetic field fluctuations in By ($\approx$ 50 nT) associated with the anti-sunward ion flow events are nearly twice as strong as those in Bx and Bz, suggesting strong field-aligned currents. The sharp inward/outward walls in all directions of the anti-sunward flow events are detected with expected/reversed time sequence by the 4 satellites, with time delays of up to 10 sec./4 sec. That suggests reversed and accelerated plasma flows in all directions inside the events (faster acceleration closer to the walls) compared to the flows outside the events.

SM12A-1195 1330h POSTER

A FIELD LINE TOPOLOGY TRACER – CLUSTER ENERGETIC ELECTRONS OBSERVATIONS IN THE HIGH LATITUDE BOUNDARY / CUSP REGIONs

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Energetic electrons (e.g. 50 keV) travel along field lines with a high speed of around 20 $R_E s^{-1}$. These swift electrons trace out field lines in the magnetosphere in a rather short time, therefore, can provide nearly instantaneous information about the changes in the field configuration in the geospace regions. The energetic electrons in the high latitude boundary regions (including the cusp) have been examined in detail by using Cluster/RAPID data for four consecutive high latitude/ cusp crossings between 16 March to 19 March 2001. Energetic electrons with high and stable fluxes were observed in the time interval when the IMF had a predominately positive Bz component. These electrons appeared to be associated with a lower plasma density exhibiting no obvious tailward plasma flow ($<$ 20 keV). On the other hand, no electrons or only spike -like electron events have been observed in the cusp region during southward IMF. At this time, the plasma density was as high as that in the magnetosheath and it was associated with a clear tailward flow. The fact that no stable energetic electron fluxes were observed during southward IMF indicates that the cusp has an open field line geometry. The observations indicate that both the south and north high latitude magnetospheric boundary regions (including both north and south cusp) can be energetic particle trapping regions. The energetic electron observations provide new evidences to understand the dynamic cusp processes. Finally, the trajectory tracing of test particles have been performed by using the Tsyganenko 96 model which demonstrates that energetic particles (both ions and electrons) could be indeed trapped in the high latitude magnetosphere.

SM12A-1196 1330h POSTER

Cluster Observations During a Slow Crossing of the Duskside LLBL and Conjugate Observations in the Topside Ionosphere with FAST

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On 7 December 2000, the Cluster spacecraft were trailing a slowly expanding moagnetopause near dusk, remaining within $1R_E$ of a model boundary for more than three hours. This orbit allows a detailed probing of the structure of the low latitude boundary layer (LLBL). During this time the IMF trended from south to north, a rotation punctuated by several sharp southward excursions. The aim of the paper is threefold: (1) using twin-satellite observations to find the effect of this IMF behavior on the LLBL; (2) to compare the observations with theoretical predictions of the layered structure of the LLBL and its field-aligned currents (Sonnerup and Siebert, 2003); and (3) to find the ionospheric imprints this boundary layer leaves at FAST altitudes. This work is supported in part by NASA's Living with a Star program. Sonnerup, B. U. Ö., and K. D. Siebert, Theory of the low latitude boundary layer and its coupling to the ionosphere: A tutorial review, in *Earth's Low-Latitude Boundary Layer*, *Geophys. Monogr. Ser.*, vol. 133, edited by P. T. Newell and T. Onsager, p. 13, American Geophysical Union, Washington, DC, 2003.

SM12A-1197 1330h POSTER

Cusp Region as Viewed by Energetic Electrons and Ions:A Statistical Study Using Cluster Rapid Data

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We present statistical results from the energetic electron and ion data set obtained by the RAPID experiment on Cluster when these satellites were in the vicinity of the dayside cusp and magnetopause.The energy range of RAPID for ions extends from 30 to 1500 keV and for electrons from 20 to 400 keV.The data used were obtained from Jan.1 to Apr.30, 2001 and Mar.1 to Apr.30,2002 to identify the cusp, to study its longitudinal extent in magnetic local time, to study its dependence on the solar wind velocity and the Interplanetary Magnetic Field(IMF) and to determine the relationship of energetic particles to this region. Furthermore, the relation between the energetic particles and local plasma and magnetic field is explored in detail for two events. The criteria used to identify the cusp region are: 1. High density(comparable to that in the sheath) 2. Small or stagnant plasma flow($<$ 60 km/s) 3. Turbulent magnetic field Energetic ions are essentially present on each pass (80% of such opportunities)through this region.The energetic electron behavior observed in the cusp region was significantly more structured and variable than the ions. The location of cusp is affected by IMF By and/or solar wind Vy(solar wind dynamic pressure on Y-direction). The particle spectra are characterized by a power law and the power law index is found to be closely related to solar wind velocity.

SM12A-1198 1330h POSTER

Dynamic Features of the High-Altitude Cusp:IMAGE/LENA Observations

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IMAGE low energy neutral atoms (LENA) imager responds to the neutral atoms formed by the magnetosheath interactions with the hydrogen exosphere during periods of high solar wind dynamic pressure. Detailed analyses of the LENA data have shown that the high-altitude cusp can be monitored because the cusp indentation structure makes the emission have a distinct direction. Most of the cusp emission events include a sudden impulse on the ground, created by the contact of a rapid increase in the solar wind dynamic pressure to the dayside magnetopause. When the sudden impulse timing is compared with the change of the dynamic pressure at ACE spacecraft, the time delay of the solar wind to the magnetosphere can be obtained. Our extensive survey for the cusp emission from near-noon orbits during 2001 has identified a significant number of events. We mapped the motion of the cusp emission on the modeled magnetopause considering the corresponding solar wind conditions, and examined how the high-altitude cusp responds to the variations of the solar wind with a time resolution of 2 min. Results of analyses show that the equatorward/poleward motion of the cusp is prominent as expected, and that the displacements usually do not exceed 1 Re per 2 min. Several events have larger displacements, e.g., 2 Re per 2 min, i.e., about 100 km/s. One such rapid motion event was observed at April 12, 2001, when POLAR/TIDE also measured the corresponding motion of the cusp simultaneously. Our events also include simultaneous observations of IMAGE and SuperDARN radar on April 11, 2001. The ionospheric cusp measured by the radar, and the LENA high-altitude cusp show correlated variations in latitudes. Detailed characteristics of the motion of the high-altitude cusp, including its connection to the ionosphere, will be presented, and discussed in terms of the corresponding variations of IMF and solar wind dynamic pressure.

SM12A-1199 1330h POSTER

Magnetosheath Neutral Atom Observations and the Relationship With Radar Backscatter in the Cusp: Combined Observations From IMAGE LENA and SuperDARN

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In this study we present preliminary observations showing the relationship between charge exchanged neutral atom emissions from the magnetosheath and the appearance of cusp-like signatures in the ionosphere. The Low Energy Neutral Atom imager on IMAGE can be used to detect the magnetosheath neutral atom signature during strong southward IMF conditions. Correspondingly, under such conditions, dayside reconnection is enhanced and the ground based SuperDARN radars monitor the increase in the flow and backscattered power associated with enhanced activity in the cusp. We present data from the SuperDARN radars, showing typical cusp signatures during the period of enhanced neutral atom emissions observed by LENA. We show that there is a significant correlation between the backscattered power at high latitudes detected by the radar and the ENA emission recorded at LENA. As the magnetopause is eroded due to the increased reconnection activity, the neutral density near the reconnection site will be higher than under normal conditions, resulting in a higher flux of charge exchanged neutral atoms observed by LENA. Also there may be a greater influx of magnetosheath particles which can charge exchange in the magnetosphere resulting in an increase in neutral atom emissions observed by LENA. The particle precipitation also ionizes the high latitude ionosphere producing irregularities resulting in an increase in the radar backscattered power. We present the observations showing the relationship between the ENA emissions and the radar backscatter in the cusp region.

SM12A-1200 1330h POSTER

Global Flow Rates of 15-eV to 33-keV Ions Away From Earth Near the Polar Satellite Apogee Versus Perigee

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As previously reported, the southern hemispheric outflow rates of 15-eV to 33-keV H^+, O^+ and He^+ ions observed 1996-98 by the TIMAS instrument on the Polar satellite about two R_E geocentric distance, near perigee, are significantly less than rates observed by instruments at somewhat higher altitudes, especially the H^+ rates. In this paper a comparison is made with TIMAS observations in the northern hemisphere, at 4-9 R_E, by scaling local flow densities along magnetic field lines in the combined IGRF-95 internal and Tsyganenko-95 external field models. The northern hemispheric outflow rates are indeed substantially greater within the given energy range, indicating continued acceleration of lower-energy ions above the Polar perigee altitude. Specifically, the northern rates for O^+ and He^+ ions are, respectively, about 3-5 and 6-10 times greater than their southern counterparts, the larger multiplier associated with summer season (April-September). In absolute numbers, in units of 10^{25} s^{-1}, the northern outflow rates are in the range of 1-3 for the O^+ and 0.3-1 for the He^+, the larger numbers in the summer of 1998, about two years past solar minimum. The average Kp is about 2. The northern hemispheric outward flow rate of H^+ ions is as much as 30-100 times greater than the southern counterpart, but that is largely due to solar origin ions with net flow away from the cusp region. Unlike the ionospheric H^+ ions, the solar ions have much enhanced flow rate during the summer season (by almost a factor of three), presumably because the northern cusp is then tilted more toward the solar wind source.

SM12A-1201 1330h POSTER

Latitudinal variation of the electron density over the northern polar cusp from RPI/IMAGE observations

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When IMAGE flew through the northern polar region near 04 - 14 MLT, on March 4, 2003, the Radio Plasma Imager (RPI) on IMAGE satellite measured 10 electron density profiles along the satellite track, each from the satellite to lower altitudes along the magnetic field. The IMF was predominantly southward and the kp index was 5- during the event. An enhancement in the density is observed near dayside 73°- 82° invariant latitude. The Tsyganenko 1996 (T96) magnetospheric model shows that the topological separation between closed and open field lines is near 70°. The enhancement may have occurred poleward of the dayside cusp as a result of heating and ionization due to reconnection and precipitation particles with some convection time delay.

SM12A-1202 1330h POSTER

Modeling Polar Cap Field-aligned Electron Density Profiles Measured with IMAGE Radio Plasma Imager

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A dynamic fluid semi-kinetic (DyFK) model is used to simulate the ion field-aligned flows within flux tubes drifting along a model specified convection line across the polar ionosphere. In this DyFK model, the collision dominated portion of the flux tube is treated with a moment-based fluid model for altitudes from 120 to 1100 km, while the generalized semi-kinetic model is used for 1100 km to 3 RE region. The effects of auroral soft electron precipitation, centrifugal acceleration, wave-driven transverse ion heating and parallel potentials are incorporated into the simulation of the ion field-aligned transport. The modeled field-aligned electron density profiles in the polar cap are compared with several field-aligned density profiles measured by the Radio Plasma Instrument (RPI) on the IMAGE satellite on March 4, 2003, in a weak magnetic storm (minimum Dst value of -58 nT). The electron densities were substantially elevated during the magnetic storm, with electron density reaching 10 cm-3 at 2.8 RE altitude. It is found that reasonable parameters for the indicated aurora processes could raise the modeled electron densities to the level of the densities measured by the IMAGE/RPI. The simulation results indicate that the O+ becomes the dominant ion species in the altitude range considered for high density cases.

SM12A-1203 1330h POSTER

The O+ Density Trough at 5000 km Altitude in the Polar Cap

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At altitudes near 5000 km over the Southern polar cap region of the terrestrial magnetosphere/ionosphere, the Thermal Ion Dynamics Experiment (TIDE) onboard the Polar satellite has observed O+ ion density trough regions, in which the O+ densities were at least one order of magnitude lower than the surrounding O+ densities. In the O+ density trough regions, the estimated O+ densities were generally lower than 0.01 per cc. From December 1, 1997 to November 30, 1998, polar cap O+ troughs in Polar/TIDE observations occurred at a frequency of about 48%. Statistical examination of the Polar perigee observations from December 1, 1997 to November 30, 1998 shows that the Polar perigee passes evenly covered the southern polar cap region, while the O+ density trough was always located on the nightside portion of the polar cap magnetosphere/ionosphere, and that invariant latitude spans of such troughs could be as large as 23o in extent. The trough occurrence displayed strong seasonal dependence; in the winter season (e.g. for July in the southern hemisphere) the O+ ion density trough occurrence frequency ranged up to 92%, while in the summer season (e.g. for January in the southern hemisphere) it decreased to as infrequent as 15%. The O+ ion density trough occurrence appeared relatively independent of the geomagnetic Kp index, and IMF Bz, By conditions, although it generally anti-correlated with the solar wind dynamic pressures in the solar wind dynamic pressure range 0.8 - 2.6 nanopascal. However, as suggested by the seasonal dependence, the O+ ion density trough occurrence was strongly related to the

solar zenith angle (SZA). In the SZA range 50o to 125o, the trough occurrence increased monotonically with SZA. Also, case-by-case examinations of near-simultaneous O+ densities and vertical velocities observed by the DMSP satellite group orbiting at 840 km altitude indicate that the O+ density troughs observed at 5000 km altitude exhibit moderate correlation or anti-correlation with topside ionosphere density or velocity features at 840 km altitude for approximately half of the near-conjunction cases examined.

SM12A-1204 1330h POSTER

Measurements of Polar Cap Absorption (PCA) Events at Very High Geomagnetic Latitudes in the Antarctic

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The availability of imaging riometer data from the Automatic Geophysical Observatories (AGOs) P5 and P6, located a few degrees on either side of the southern geomagnetic dipole provides an unprecedented opportunity to study polar cap absorption (PCA) events at the highest latitudes to date. Of equal importance is the opportunity provided by these imaging instruments, together with similar instruments at other AGO sites and South Pole, for investigations of the spatial structure with time of the absorption events. The imaging riometer data are used together with interplanetary charged particle measurements from the EPAM instrument on the ACE spacecraft to provide new understanding into the effects of solar particle events on the very high latitude ionosphere. Results from studies of three events in 2000 (February 18, November 8, November 24) will be discussed in some detail.

SM12A-1205 1330h POSTER

Ground based OI 630.0 nm Observations of Sunlit Cusp from Sondrestromfjord, Greenland

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We have used a high resolution (0.01 nm)imaging spectrograph to measure auroral emissions along the magnetic north-south meridian from Sondrestromfjord, Greenland (67° N, 51° W; 74.5° N Mag. Lat.). The red line (OI 630.0nm) emission intensities during a magnetically disturbed day (January 21, 2001) showed significant enhancement near local noon (SZA 86°). Salient characteristics of the observations include (1) a gradual buildup in column emission rates of up to 3000 R, which is a four-fold increase above the normal dayglow emission rates, (2) a sharp equator-ward boundary, and (3) a poleward moving form following the emission peak. These are characteristic signatures of emissions of magnetospheric cusp origin. Simultaneous incoherent scatter radar measurements show a significant increase in Te (up to 4500 K) in the directions of optical emission enhancement. Model intensities using the radar measurements of Ne, Te, and Ti are consistent with our observations.

SM12A-1206 1330h POSTER

Plasma Density and Temperature Measurements in the Cusp Ionosphere

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A Black Brant X sounding rocket (NASA 35.033) was launched on December 14th, 2002 at 11:16:48 UTC from Ny Ålesund, Norway to study the electrodynamics of the cusp ionosphere and the open/closed field line boundary region. The launch was coordinated with satellite measurements and with optical and radar ground-based observations. The rocket was launched during Bz southward conditions and reached an apogee of 771 km, well above the F-layer peak. Measurements by a fixed-bias (ion) Langmuir probe and a swept Langmuir probe on the rocket payload provide plasma density, density fluctuations, and electron temperature, as well as the plasma potential. The swept Langmuir probe used a 2.5 cm diameter titanium nitride coated spherical electrode whereas the fixed bias probe used a 10 cm diameter, 6.4 mm thick ring as the active element. On the upleg of the rocket trajectory, a very disturbed ionosphere was encountered, with large amplitude (>20%), large scale (typically 10 m-10 km) irregularities superimposed on the background, indicative of the open magnetic field line cusp environment. By contrast, the downleg profile shows a smooth density profile without irregularities that is consistent with the dayside ionosphere on closed magnetic field lines. Elevated electron temperatures were observed coincident with regions of energetic precipitations. These may have been due to instrumental effects, however, and a detailed analysis is still underway. We compare both the density and temperature measurements gathered with the rocket instruments with those measurements simultaneously gathered with the EISCAT radar, and with temperatures derived from the Calgary Suprathermal Ion Imager, that was also part of the rocket payload.

SM12A-1207 1330h POSTER

Main Characteristics of the VLF Magnetic Field Waves Recorded by the Search Coil Magnetometer Experiment Onboard the CUSP Sounding Rocket

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The CUSP rocket is a NASA Black Brant X sounding rocket dedicated to the exploration of the electrodynamic coupling, pulsations, and acceleration processes in the dayside cusp and the boundary layer interface. The launch occured on December 14, 2002, from Ny Ăleysund, Spitzbergen (79° N) during Bz negative conditions. We present the magnetic field waves measurement collected in the frequency range [10 Hz - 10 kHz] by the three axis Search Coil Magnetometer (SCM) experiment onboard CUSP. The observations reveal the presence of intense field fluctuations corresponding to ELF hiss which is only seen on closed field lines and hence can be used to define the magnetic boundary of the cusp. Several data analysis techniques were applied to the 3 components of the magnetic field fluctuations associated with the ELF hiss to obtain information regarding the wave polarization and the wave vector directions. The magnetic field wave data are compared with simultaneous observations of electric field wave data to further enhance our understanding of these wave phenomena. The main results coming from this detailed study are presented and discussed.

SM12A-1208 1330h POSTER

Multi-station Scintillation Observations at Spitzbergen During the NASA Cusp Rocket Campaign

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The plasma density irregularities and their turbulent motion in the cusp following the launch of the NASA Cusp Rocket on December 14, 2002, were studied by the Air Force Research Laboratory (AFRL) from ionospheric scintillation observations by using transmissions from a quasi-stationary satellite at 250 MHz and GPS at 1.5 GHz. The multi-instrumented rocket was launched from Ny Alesund at 11h 16m 48s and the rocket attained 300 km altitude after 2m 27s into the flight and reached its apogee at 760 km after 8m 8s. At this time the 300 km sub-ionospheric locations of UHF scintillation measurements from Ny Alesund (75 MLAT) and from Longyearbyen (74.1 MLAT) on Spitzbergen corresponded closely to the rocket flight path. Scintillations were in a quiescent phase earlier that day, becoming suddenly enhanced to saturation levels prior to 1100 UT and maintaining this increase up to 1250 UT. The rocket was launched during this active phase when a burst of GPS phase fluctuations was also observed. The most significant result was the broadening of the scintillation spectrum at 250 MHz that exceeded 2 Hz indicating at least a 5-fold increase in the turbulent motion of plasma density irregularities compared to that prior to the scintillation enhancement. The enhancement of scintillation was coincident with the enhanced plasma convection and radar backscatter recorded by the SuperDARN radars at Iceland and Finland. The increased spectral width of the backscatter return from these two radars indicating turbulent electric fields agreed very well with that obtained from the broadening of the power spectrum of scintillations. The rocket in-situ observations of electric field fluctuations and plasma density irregularities are being studied in relation to the magnitude of scintillations and their spectra.

SM12A-1209 1330h POSTER

HF Radar Measurements of the Ionospheric Footprint of the Cusp During the December 2002 Rocket Campaign

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The NASA Cusp rocket Campaign of December 2002 provides a unique combination of in situ and ground-based instrumentation for the investigation of the Earth's cusp. The CUTLASS HF radars provided 2-D convection measurements over the rocket trajectory region during launch from Ny Alesund on December 14. The radars ran in a special mode with high spatial and temporal resolution. Stereo operations allowed a full 16 beam scan to be generated every 48 s, whilst simultaneously a restricted 6 beam scan localized over the trajectory was generated every 18 s. Excellent data coverage was obtained from both radars over almost the entire rocket trajectory, allowing 2-D convection information to be recovered. The remaining SuperDARN array provided the global convection solution at a resolution of 2 min. The spatial and temporal variations of the ionospheric convection flows under the influence of transient magnetopause reconnection processes will be presented, along with an examination of the location and motion of geophysical boundaries derived from radar spectral width.

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SM12A-1210 1330h POSTER

Small-Scale, Field-Aligned Currents at the Top-Side Ionosphere

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High-precision vector magnetic field observations from the Ørsted satellite are used to investigate small-scale, field-aligned currents on spatial scales down to 600 m. Placed in a low-Earth, polar orbit, the slowly drifting orbit plane has covered all local times since launch in 1999 with more than 25000 polar passes.

Small-scale currents are primarily found in the cusp with densities of 10-100 μAm^{-2}, reaching more than 1000 μAm^{-2} during disturbed conditions. These values are 1-2 orders of magnitude larger than large-scale region 1 and 2 currents. Current densities are 2-4 times larger when the ionosphere is illuminated than when in darkness. While the location of currents follows the changes in cusp location with changing IMF, the intensity of the currents seems to depend on the level of solar wind turbulence. The data suggest that small-scale currents may be associated with significant local heating of the ionosphere and thermosphere.

SM12A-1211 1330h POSTER

Return Current Region Aurora: Dayside Parameterization of Ion Conics and BBELF Activity at FAST Altitudes

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We consider auroral ion heating associated with broadband ELF (BBELF) wave activity in downward current, downward electric field regions on the pre-noon dayside at altitudes of 2000-4000 km, using data gathered from the FAST spacecraft. Statistics from 11 dayside passes are collected, and parameters including ion and electron distribution function moments, BBELF wave activity indices, and field aligned current density are indexed. Relationships between these parameters are quantified and compared to a larger similar study on the nightside (Lynch et al., 2002). We wish to determine whether the observed qualitative similarity between return current regions on the dayside and the nightside is backed up by a quantifiable parameter relationship. On the nightside it is found that the BBELF wave activity in these regions is highly correlated with a specific combination of parameters from the ion and field aligned current density data. This empirical relationship has guided theoretical developments in modelling of the return current region (see the related talk by Jasperse et al.)

SM12B MCC: 3009 Monday 1340h

Jovian Magnetospheric Environment Science for the Jupiter Icy Moons Orbiter (JIMO) I *(joint with P, SA)*

Presiding: **J F Cooper,** Raytheon Technical Services Company, LLC**; K K Khurana,** Institute of Geophysics and Planetary Physics, University of California, Los Angeles

SM12B-01 1340h INVITED

Vision of the Future: Exploring Moons and Magnetospheres with Magnetometers

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In recent months, planetary scientists have been offered a Jupiter Icy Moons Orbiter (JIMO) mission that "will provide unprecedented opportunities for investigation of the Jovian magnetosphere and its interactions with icy surfaces of Galilean moons, putative subsurface oceans of these moons, . . . and the interplanetary solar wind." In the spirit of never saying no to temptation, we will consider some of the questions that can be investigated by JIMO, focusing on problems whose investigation requires fields and particle measurements. The primary targets of the mission are the icy moons, Europa, Ganymede, and Callisto. Galileo measurements provided compelling evidence that all three respond inductively to the time-varying magnetic field of Jupiter and that Ganymede has a stable intrinsic magnetic field. Additional magnetometer measurements from a spacecraft dwelling in a highly inclined orbit around one of these moons will provide invaluable insight into the properties (depth of burial, spatial extent, conductivity) of the conducting layer, a subsurface ocean or a soft ice layer. Such measurements will also provide stronger bounds on the strength of the internal magnetic moments of Callisto and Europa and will identify the properties of the higher order moments of Ganymede. Such constraints are needed for models of the interiors. Two magnetospheres (Jupiter's and Ganymede's) will be probed in new ways. Extensive dwells at roughly fixed radial distance from Jupiter offer opportunities to monitor substorm-like dynamics in a systematic manner and to probe asymmetries of particle and field structure. At Ganymede, a long interval within the magnetosphere will offer opportunities to learn how steady reconnection affects a magnetosphere and to map out the details of the interior and the boundary. It does sound irresistible.

SM12B-02 1400h

A New Jovian Magnetospheric Field Model for Galileo and Jupiter Icy Moon Orbiter (JIMO) Missions

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Global magnetic field models are required to interpret field and plasma observations collected by Galileo in Jupiter's magnetosphere. Accurate models would also be needed to define the changing magnetic field in the rest frames of the icy satellites for the JIMO mission. Previous models have been inadequate because of simplifying assumptions or inadequate data coverage. We have recently developed a new model of Jupiter's magnetospheric field which borrows from techniques and methods developed by modelers for the earth's magnetospheric field. The model uses observations from all of the six spacecraft that have traveled through Jupiter's magnetosphere. The model incorporates an internal spherical harmonic model (VIP4), new modules for ring and magnetotail currents and shielding fields from an axially symmetric magnetopause. The structural model of the current sheet incorporates the delay and hinging of the current sheet observed at large distances. The thickness of the current sheet is modeled as a sinusoidal function of local time such that the current sheet is at its thinnest in the dawn sector and is the thickest in the dusk sector. The model also correctly includes the effect of the 3.2 degrees tilt between the Jovian orbital and equatorial planes We use Tsyganenko and Peredo [1994] models of disk-shaped current sheets to model the magnetic field of Jupiter's current sheet. The delay and hinging of the current sheet is introduced by using the general deformation technique [Tsyganenko, 1998]. The shielding field from the magnetopause for the equatorial current sheet and the internal field is specified by Cartesian and cylindrical harmonics, respectively. Comparisons of the model with observations are presented from various local times in Jupiter's magnetosphere.

SM12B-03 1415h INVITED

Radio and Plasma Wave Science Opportunities Afforded by the Jupiter Icy Moons Orbiter

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The Galileo mission demonstrated the extensive and varied interactions between the Jovian magnetosphere and the icy Galilean satellites. In particular, the Galileo plasma wave investigation showed the surprisingly complex array of plasma and radio wave phenomena accompanying Ganymede's magnetosphere, evidence of an extensive magnetospheric interaction at Europa, and a weaker yet highly variable interaction at Callisto. The plasma wave observations showed that all three moons were sources of plasma for the Jovian magnetosphere. Furthermore, the Galileo observations of Jovian radio emissions extended those of earlier Voyager and Ulysses and provided unique insight into the dynamics of the Jovian magnetosphere. The Jupiter Icy Moons Orbiter (JIMO) offers important extensions to the Galileo studies mentioned above. Primarily, the ability to orbit each of these moons will enable much more complete maps of the magnetospheric interactions than possible with even the multiple flybys provided by Galileo. More importantly, however, the additional power and data volume promised by the JIMO spacecraft means that the microphysics of these interactions can be addressed, given an accompanying set of fields and particles instruments. JIMO also provides the possibility of actively sounding the ionospheres of the moons to obtain complete ionospheric profiles along the orbit and down to the surface. In addition, JIMO provides the opportunity to make important advances in the study of the Jovian magnetosphere and its extensive array of radio emissions. The resources available on this platform would enable extensive direction-finding and polarization studies of the radio emissions from anywhere along the orbit as has been demonstrated by the Cassini Radio and Plasma Wave Science instrument. The periods in orbit about the moons provide multiple occultations of the higher frequence radio emission sources (decametric and hectometric) so that direction-finding can be performed without complication from the complex antenna patterns usually found at the higher frequencies.

SM12B-04 1435h

Remote Radio Sounding Science For JIMO

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Radio sounding of the Earth's topside ionosphere and magnetosphere is a proven technique from geospace missions such as the International Satellites for Ionospheric Studies (ISIS) and the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE). Application of this technique to the Jupiter Icy Moons Orbiter (JIMO) mission will provide unique remote sensing observations of the plasma and magnetic field environments, and the subsurface structures of Europa, Ganymede, and Callisto. Spatial structures of ionospheric plasma above the surfaces of these bodies will vary in response to magnetic field perturbations from magnetospheric plasma flows, ionospheric currents from ionization of sputtered surface material, and induced electric currents in salty subsurface oceans. Radio sounding at 3 kHz to 10 MHz will provide globally-determined electron densities necessary for the extraction of the oceanic current signals and will supplement in-situ plasma and magnetic field measurements. Long-range magnetospheric sounding, pioneered by the radio plasma imager (RPI) instrument on IMAGE, has provided electron density distributions along magnetic field lines and in radial directions on time scales of minutes. RPI has also been able to measure the entire electron plasma density distributions (in the orbit plane) of the Earth's polar cap and the plasmasphere within one pass of the spacecraft. In a similar manner, a radio sounder orbiting an icy moon would be able to measure the electron density along the magnetic field into each hemisphere and provide information on the Jovian magnetospheric background, the magnetospheric influences on the moon's ionospheres, and distortions of magnetic field line geometry from model predictions. The higher-power source available