SM11D MCC: 124 Monday 1000h

Planetary Magnetospheres I *(joint with P, SH)*

Presiding: **K K Khurana,** University of California, Los Angeles**; F Bagenal,** Laboratory for Atmospheric and Space Physics, University of Colorado

SM11D-01 1000h

Temporal variability of Io plasma torus sources and sinks

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Plasma conditions in the Io torus are compared for Voyager 1, Voyager 2, Galileo and Cassini epochs. We find considerable changes in density and composition over time scales of days to years. These changes in plasma conditions are compared with models of physical and chemical processes in the torus. We vary the five main parameters of the chemical model (neutral source strength, oxygen/sulfur ratio of the source, radial transport time, fraction of hot electrons and hot electron temperature) to explore how the resulting equilibrium torus conditions (densities and temperatures of the main species plus the total emitted UV power) depend on the model input. Comparing the model output with observed torus conditions indicate Voyager 1 conditions are intermediate between Voyager 2 (when the source was high and the transport time short) and Cassini observations in January 2000 (when the source appears to be low and the transport time long). Cassini observations between October 1999 and April 2000 reveal variations in composition (of the order of a factor of 2) over time scales of weeks-months.

SM11D-02 1015h

A New Model of the Structure of the Neutral Current Sheet of the Jovian Magnetosphere

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We have used magnetic field data from the magnetometer instrument(MAG) onboard Galileo to build a new model of the current sheet of Jupiters magnetosphere. We identified 3,330 plasma sheet crossings from the MAG data obtained from all 33 Galileo orbits as well as the Voyager 1 and 2, Pioneer 10 and Ulysses spacecraft to develop this model.

We account for the delay of the current sheet both in terms of the bend-back of the magnetic field lines and the delay caused by wave travel time effects. The hinging of the current sheet caused by the influence of solar wind forcing and centrifugal force effects is also included. These effects are seen to be functions of local time as well as radial distance from Jupiter. The bend back, which results in a delay in the prime longitude of the neutral current sheet, appears to be strongest on the dawn side and weakest on the dusk side.

We next model the thickness of the current sheet by using the Harris neutral sheet equations. The best fits show that the thickness varies both as a function of local time and radial distance. A comparison of the model with the observations is provided.

SM11D-03 1030h

Plasma Dynamics Observed Near Local Noon in Jupiter's Magnetosphere With the Galileo Spacecraft

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During January 18-21, 2002, the Galileo spacecraft achieved a marvelous series of thermal plasma measurements in the local noon sector at Jovian radial distances in the range of about 10 to 50 R_J. Intense electron beams aligned along the magnetic field at two current sheet crossings by the spacecraft were found at radial distances of 24 and 29 R_J. These field lines thread the main auroral ring in Jupiter's atmosphere. The electron fluxes were detected at energies ranging from 3.7 to 14.8 keV and were sufficiently high to account for typical auroral luminosities. As the spacecraft moved outwards large departures from rigid corotational flow began at a radial distance of about 16 R_J. A stagnant region for flows was centered at about 26 R_J which was followed by a return of the plasma flows to nearly corotational values for the current sheet crossing at 29 R_J. Field-aligned heavy ions with $M/Q = 16$ and also protons were often observed at locations away from the position of the current sheet at Jovian radial distances in the range of about 18 to 32 R_J. These beams are examined in terms of their possible role in resolving questions of radial force balance in the outer magnetosphere. A remarkable feature of the ion densities in the local noon sector is a System III longitude effect at radial distances in the range of 32 to 44 R_J.

SM11D-04 1045h

Local and Global Jovian Plasma Sheet Characteristics Observed by the Galileo Energetic Particles Detector

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The Energetic Particles Detector (EPD) onboard Galileo has been measuring the three-dimensional intensity distributions of energetic ions and electrons throughout the Jovian magnetosphere from 10 R_J to beyond 140 R_J into the distant magnetotail. Spherical harmonic analysis of the distributions yields 8 of the 9 coefficients for the zeroth, first, and second order harmonics, and by estimating the final missing coefficient, parameters describing the streaming properties of the energetic particles may be derived. Specifically, plasma flow velocities are measured independently for three ion species (H, O, and S) at energies 20-100 keV/nucl, and spectral indices and partial pressures of both ions and electrons are obtained. These parameters are used to investigate both the local structure of the Jovian plasma sheet, which the spacecraft encounters once or twice every planetary rotation period, as well as variations throughout the Jovian magnetosphere on a global scale. Plasma sheet crossings are characterized by a systematic reversal of the magnetic field direction and enhancement in energetic particle intensities. Although the spatial structure of the plasma sheet cannot be determined directly by a single spacecraft, the organization of the measured streaming parameters with respect to the local magnetic field configuration, particularly the radial component, may be used as a reliable proxy for its local structure and motion. Local sheet structure is investigated for 85 individual encounters with the plasma sheet in the inner and middle Jovian magnetosphere. Well ordered variations of the observed streaming parameters across the plasma sheet are a persistent, yet sometimes puzzling, feature of the observations, which often show a dependence on local time and radial distance from the planet. For example, the center of the plasma sheet at small radial distances is commonly characterized by a significant hardening of the ion and electron spectra, while at larger radial distances, the spectra soften at the center of the sheet. Also, the edges of the sheet feature sharp changes in the azimuthal velocity, indicative of velocity shear at the plasma sheet boundary. In addition to studying the local plasma sheet structure, the measured parameters are used to investigate variations on a global scale. Evidence for a dependence on local time and/or radial distance from the planet is observed for several energetic particle parameters, including spectral index, partial pressure, and the direction of the plasma flow. Although the plasma sheet characteristics are remarkably consistent from one crossing to the next, the observations are not consistent with any simple model of Jovian plasma sheet structure and motion of which we are aware.

SM11D-05 1100h

Electron Flux Variability and Diffuse Auroral Precipitation in the Jovian Magnetosphere

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The energetic electron population in the middle Jovian magnetosphere is subject to pronounced, episodic flux enhancements. A study has been made of the effects of such electron injections into the Jovian magnetosphere and of their ability to provide the source population for variations in diffuse auroral emissions. To identify the source region of precipitating auroral electrons, we have investigated the pitch-angle distributions of high-resolution Galileo Energetic Particle Detector (EPD) data that indicate strong flux levels near the loss cone. The equatorial source region of precipitating electrons has been extrapolated from the locations of Galileos in-situ measurements by tracing magnetic field lines using the KK97 model. The primary source region for Jupiters diffuse aurora appears to lie in the magnetic equator at $15 - 40$ RJ, with the predominant contribution to precipitation flux (tens of ergs-cm-2-s-1-sr-1) stemming from < 30 RJ. The average diffuse auroral precipitation flux has been shown to vary by as much as a factor of eight at a given radial location. This variability appears to be associated with electron injection events that have been identified in high-resolution Galileo Energetic Particle Detector data. These electron flux enhancements are also associated with enhanced whistler-mode waves that cause pitch-angle scattering and isotropization through resonant wave-particle interactions.

SM11D-06 1115h

Consequences of OH observations at Saturn

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Observations of OH in Saturn's magnetosphere have been combined with a Monte Carlo model of neutrals sputtered from Saturn's satellites and rings. We have found that a large source of water near Enceladus is required to match the observations. Other consequences of this model are that most of the neutrals are molecular and that the neutral cloud has a large latitudinal extent. Since the neutrals are the plasma source, the composition of the plasma is altered from earlier results. We show the density and composition of the neutral gas near Saturn and use this gas as a source for a model of plasma chemistry and transport. We then derive contours of the density of each ion which are consistent with the neutral cloud.

SM11D-07 1130h

Early Observations of Saturn Kilometric Radiation by Cassini

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One of the primary objectives of the Cassini radio and plasma wave science investigation at Saturn is the study of Saturn kilometric radio emissions (SKR). Based primarily on Voyager observations, these emissions are believed to be analogous to auroral kilometric radiation at Earth, generated via the cyclotron maser instability near the electron cyclotron frequency on field lines threading Saturn's aurora. Beginning in early 2002, Cassini has observed Saturn's most prominent radio emission on numerous occasions with signal to noise ratios exceeding 10 dB, even though the spacecraft is still more than two astronomical units from Saturn. One specific objective involving SKR is to develop the relationship between the timing and intensity of the radio emissions as a function of solar wind input; strong correlations with various solar wind parameters are already known on the basis of Voyager studies. A second objective is to measure spectral and temporal variations in the SKR emissions at high resolution. The observations acquired by Cassini to date already allow such studies to begin. Simple ballistic projections of high density regions in the solar wind observed at 1 AU have been used successfully to predict the intensification, hence detection, of SKR by Cassini. Also the first high-resolution frequency-time spectrograms of SKR have been acquired; these show a wealth of spectral and temporal structure one would expect on the basis of observations of terrestrial auroral kilometric radiation.

SM11D-08 1145h

A Global Three Dimensional Hybrid Simulation of the Interaction Between a Magnetized Obstacle and the Solar Wind

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We present results from the numerical modeling of the interaction between the solar wind and a conductive obstacle with a dipole magnetic field using a three dimensional hybrid code where electrons are treated as a massless fluid and ions are treated as particles. The results show that the hybrid approach is capable of describing most of the structures formed due to the interaction between the solar wind and a magnetized planet such as the bow shock, proton foreshock, magnetopause, magnetosheath, northern and southern cusps, current sheath, and reconnection sites. We discuss the applicability of the model for different planets in the Solar System. Results from the hybrid simulation model will be compared with the results from a global MHD simulation model.

SM12A MCC: Hall D Monday 1330h

Magnetosphere-Ionosphere Coupling III Posters *(joint with SA)*

Presiding: **H U Frey,** University of California, Berkeley**; L Andersson,** University of Colorado

SM12A-0457 1330h POSTER

Wave Propagation Through the Collisional Ionosphere

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Under the assumption of a vertical magnetic field, the wave dispersion for plasma waves splits into right- and left-hand circularly polarized waves. At frequencies above 0.1 Hz the waves have a profile consistent with the Alfvén resonator, with the transmission efficiency through the ionosphere depending on frequency, and further being different for the two wave modes. Below this frequency (< 0.01 Hz) the mode structure is the same for both modes. However, the actual mode structure depends on the boundary conditions at the bottom of the surface-ionosphere waveguide, being different for open or perfectly reflecting boundary conditions. One feature missing for parallel propagation is the "Hughes rotation," where the wave magnetic field below the ionosphere is rotated by 90° with respect to the wave magnetic field above the ionosphere. This appears to be a result of oblique propagation, with the fast mode being evanescent in the vertical direction when the mode is assumed to propagate across the ambient field. While some consideration must be given to the differences between parallel and oblique propagation, the results for the parallel case indicate that only low frequency waves would maintain consistent polarization through the ionosphere. The differences in attenuation and polarization as a function of frequency argue against the surface-ionosphere waveguide as being the path for transmitting signals such as changes in magnetospheric convection to lower latitudes.

SM12A-0458 1330h POSTER

Ionospheric Electric Field Perturbations at the Nightside Equator Associated With a Geomagnetic Sudden Commencement

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Ionospheric electric field perturbations associated with a sudden commencement at 1640 UT Apr. 6, 2000 were observed by the FM-CW HF radar at the dip equator station Cebu, Philippine. Ionograms were obtained from the FM-CW HF radar at intervals of 5 minutes. The zonal electric field can be estimated from the time variation of the height profile of ionograms. A sudden increase in the westward electric field of 1.6 mV/m was observed simultaneously with the sudden increases in the H component magnetic field of 250 and 110 nT at the dayside dip equatorial station Ancon, Peru and the dayside off dip equatorial station Eusebio, Brazil, respectively. The amplitude enhancement of the magnetic variation at the dip equator suggest that an eastward electric field was imposed at the dayside equatorial ionosphere. Both the dayside and nightside electric field perturbations show that the dawn to dusk electric field of DP(MI) was imposed globally on the equatorial ionosphere.

The HF Doppler frequency shift was observed at the nightside low latitude station Sugadaira, Japan. From the frequency deviation, it is found that a westward electric field of 2.0 mV/m was suddenly imposed at the beginning of the sc. The amplitude of the westward electric field observed at the nightside equator is 0.8 times that at the nightside low latitude station. It can be caused by the geometrical attenuation [Kikuchi et al., 1978, Nature].

The direction of the zonal electric field observed at Cebu was reversed from westward to eastward and returned westward again. The electric field at Sugardaira shows similar temporal variations. These variations were well correlated with fluctuations of solar wind number density. The eastward electric field may be caused by the over shielding effect of the region 2 field-aligned current [Kikuchi et al., 2000, JGR].

Acknowledgement. The HF Doppler data was provided by Sugadaira Space Radio Observatory, Univ. Electro-Comm.

SM12A-0459 1330h POSTER

The Electrodynamics in the Ionosphere During Substorms

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From the observations by the PIXIE and UVI cameras on board the Polar satellite, we derive global maps of the precipitating electron energy spectra from less than 1 keV to 100 keV. Based on the electron spectra, we infer the height profiles of the resulting ionization. Photoionization by solar illumination is also included in these calculations. We then generate instantaneous global maps of the Hall and Pedersen conductances. The UVI camera provides good coverage of the lower electron energies contributing most to the Pedersen conductance, while PIXIE captures the high energetic component of the precipitating electrons affecting the Hall conductance. A study by Aksnes et al. [Ann. Geophysicae, 20, 1181, 2002] shows that the Hall to Pedersen conductance ratios from combined PIXIE and UVI measurements are larger than those given by existing statistical conductance models. While most statistical conductance models have derived conductances from electron precipitation data below approximately 30 keV, PIXIE measurements provide us with the electron fluxes at higher energies needed to derive an accurate Hall conductance. The instantaneous global conductance maps derived from combined PIXIE and UVI measurements have been implemented in the Assimilative Mapping of Ionospheric Electrodynamics (AMIE) procedure to provide global instantaneous distributions of ionospheric electrodynamical parameters. In this study, we present the electrodynamics in the ionosphere during substorms. We also investigate the possible effects of the PIXIE data on the AMIE outputs.

SM12A-0460 1330h POSTER

Statistical Behavior of Proton and Electron Auroras During Substorms

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The IMAGE FUV imager can provide global maps of electron and proton precipitation and it is possible to observe how these maps change as a result of substorms. The large body of IMAGE FUV data permits the performance of a superimposed epoch analysis for many substorms. For each substorm the onset locations and times were determined from the Wideband Imaging Camera (WIC) images which represent

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