A second order semi-implicit code is used to model radial diffusion of relativistic electrons in the outer radiation belt with electron lifetime as a specified parameter. To isolate the controlling effect of electron lifetime we make a number of assumptions: dipole field model, constant boundary conditions, and idealized variations of the Kp index. Phase space density and 1.0 MeV electron fluxes are computed for both constant lifetime and Kp dependent values. We demonstrate that knowledge of lifetimes is crucial for both idealized steady-state and time dependent cases. Comparison of steady-state and time dependent profiles shows that steady state is never attained during a storm, and radial diffusion should be modeled with a time dependent code. Comparison of our results and data suggest that lifetimes are on the order of days, much shorter than that of expected plasmaspheric losses. Results and possible limitations of the model are discussed.

SM11A-07 0935h INVITED

The Education Program of the Center for Integrated Space Weather Modeling

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The Center for Integrated Space Weather Modeling (CISM) is a Science and Technology Center (STC) funded by National Science Foundation whose goal is to produce space weather models that extend from the Sun to the Earth. Like all STCs, CISM has an extensive education program that ranges from precollege to graduate education. A key educational goal is to communicate the idea of a coupled space weather system involving the Sun, interplanetary space, the magnetosphere, and the ionosphere. In this talk I will review the set of CISM education activities and discuss the implications for space science education in general.

SM11B MCC: 3009 Monday 0800h

Solar Wind-Magnetosphere Coupling: Comparative Magnetospheres I *(joint with P, SH)*

Presiding: **J Saur,** Applied Physics Laboratory, Johns Hopkins University**;** **C Paranicas,** Applied Physics Laboratory, Johns Hopkins University

SM11B-01 0800h

Ionospheric Effects on the Paleomagnetosphere

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Paleomagnetic studies indicate that the strength of the Earth's internal magnetic field has varied over the range 0.1 to 3 of the present value. Consequently the paleomagnetosphere, which results from the coupled interaction of the solar wind, the Earth's internal magnetic field and the conductive paleoionosphere, must have undergone severe changes, especially during the so-called polarity transition epochs, when the Earth's internal dipole moment reversed. Different transition scenarios can be conceived, none of which is excluded in the present state of our knowledge: The dipole moment could decay to zero and quickly build up again in the opposite direction; or a much reduced dipole moment could turn around, staying close to the equatorial plain for a significant time; or the dipole moment could completely vanish and higher order multipoles could dominate during the transition epoch. In a paleomagnetosphere with reduced internal magnetic field the ionospheric conductivity is expected to be higher, which implies stronger ionosphere-magnetosphere coupling, i.e. stronger ionospheric and field aligned magnetospheric currents. Although several scaling relations have been found to scale different parameters of a dipolar paleomagnetosphere to the dipole moment, no theoretical scaling relations exist for the magnetospheric-ionospheric current systems that control the inner magnetospheric convection. In the first part of this paper, we present some theoretical considerations and new scaling relations related to the current systems in the paleomagnetosphere. In the second part, we test the effect of different ionospheric boundary conditions and conductivity models on different types of paleomagnetospheres by means of the Michigan BATS-R-US MHD code. Namely, we study the inner magnetospheric plasma convection patterns and the equivalent ionospheric electric potential patterns. In general, we conclude that the ionosphere plays a more important role in the paleomagnetosphere during polarity transition epochs.

SM11B-02 0815h

Magnetic Reconnection and Magnetospheric Dynamics as a Function of Dipole Tilt and the IMF By Component

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Magnetospheric dynamics are controlled by magnetic reconnection between the geomagnetic field and the interplanetary magnetic field (IMF). Dayside magnetic reconnection is often described by two different models: antiparallel merging which occurs preferentially where the magnetosheath magnetic field is antiparallel to the Earth's magnetic field and subsolar point merging which is sometimes called component merging. Observationally it is not clear which of these two models better describes the reconnection process at the magnetopause. Observations of flux transfer events (FTEs) at the dayside magnetopause are usually explained by subsolar merging, while observations of ionospheric convection are usually explained by antiparallel merging. In global magnetohydrodynamic (MHD) simulations antiparallel merging frequently dominates. A study of magnetopause reconnection as a function of IMF By and dipole tilt should help us determine which model best describes dayside merging. We have studied magnetic reconnection and magnetospheric dynamics by using a full 3-D MHD simulation for finite dipole tilt, IMF By and Bz components. We find that antiparallel reconnection is dominant at the dayside magnetopause during intervals with southward IMF, a finite IMF By component and finite dipole tilt. Under these conditions reconnection near the magnetic equator and noon-midnight meridian is suppressed because of increased magnetosheath flow. For IMF $By > 0$ and finite tilt the reconnection site splits as it moves from the subsolar point. The reconnection sites separate into northern dusk and southern dawn parts for $By > 0$, and the sites shift sunward in the summer hemisphere and tailward in winter hemisphere for finite tilt. There are observable changes in the ionospheric configuration that can help us determine if the antiparallel reconnection pattern in the simulation is correct. The convective flow in the ionospheric throat region where the flow changes from sunward to tailward becomes more dawnward/duskward in the summer hemisphere and more poleward in the winter hemisphere.

SM11B-03 0830h

3-D, MHD Studies of the Effects of the Crustal Magnetic Field and Corona on the Solar Wind Interaction with Mars.

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We present the most recent results from our continuing studies of the interaction of the solar wind with Mars. In our 3D multi-species MHD model, the Martian ionosphere is assumed to consist of O2+, O+ and CO2+ ions, while the solar wind is represented by protons. Chemical reactions involving these ions, such as photoionization, charge exchange and recombination are included in the model self-consistently. The effects of the crustal magnetic field and the hot oxygen and thermal hydrogen corona are evaluated by using a spherical co-ordinate system, which allows an altitude resolution of 10 km within the ionospheric region.

SM11B-04 0845h

Localized and Continuous Nature of the Ionospheric Plasma Cloud Ejection: Solar Wind-Venus Global Hybrid Simulation Perspective.

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Plasma cloud ejection, the signatures of which were often detected just above the Venusian ionopause by the Pioneer Venus Orbiter, is investigated using a comprehensive global hybrid (particle ion/massless fluid electron) simulation model of the solar wind-Venus interaction with a planetary ionosphere included. The model reveals that the ejection region of plasma clouds is not smoothly distributed as that is expected from previous local simulations of the Kelvin-Helmholtz (K-H) instability, but instead is rather localized and travels tailward as time goes on. The tailward traveling of the ejection region is accompanied by the co-moving of the background field structure, and the ejected clouds carry farther away from the ionopause than those in the local K-H simulation. These results suggest that the ejection may not be controlled by the local Kelvin-Helmholtz process but affected by the other processes related to the global stream around the planet.

SM11B-05 0900h

Transport of Angular Momentum in the Magnetosphere of Jupiter

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The subcorotation of plasma in the Jovian magnetosphere is attracting renewed interest. In Hill's classical theory, as plasma injected deep within the magnetosphere is transported outward, corotation can only be maintained as long as Birkeland currents supply sufficient angular momentum from the ionosphere and atmosphere. These Birkeland currents are now widely viewed as primarily responsible for the main auroral emissions at Jupiter. Mathematical models for calculating the radial profiles of mean angular velocity and associated Birkeland currents have been developed by Hill, Cowley and coworkers, and others. In all these models, angular momentum is assumed to be simply convected outward by a (zonally averaged) mean flow. The dependence of angular velocity on radial distance is then determined (given a model of the magnetic field and of the ionospheric conductance) by a first-order differential equation (Hill-Pontius equation), subject to the single boundary condition of corotation at the inner boundary. In the region where the magnetic field lines are closed, however, there can be no mean MHD outflow, and the outward transport must be described as a diffusion process, averaging over inward and outward flows. Here I apply the mathematical description of diffusion, familiar from mass transport, to angular momentum transport. The Hill-Pontius equation generalizes to a differential equation of second order (thus requiring an additional boundary condition), which in the limit of long acceleration time reduces to a diffusion equation for flux tube content of angular momentum, of the same form and with the same diffusion coefficient as the equation for flux tube mass content. Physical implications and simple examples of solutions will be discussed.

SM11B-06 0915h

Influence of Magnetospheric Electrons on Titan's Interaction With Saturnian Magnetospheric Plasma

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On its orbit around Saturn Titan interacts with the magnetospheric plasma that is more or less corotating with Saturn. Titan's dense neutral atmosphere (and ionosphere) and the trans-alfvénic plasma environment form a challenging constellation from a plasma physical point of view. The approaching Cassini spacecraft gives us the opportunity to study this interesting situation in situ. In order to understand what Cassini is going to meassure we have to develop numerical models. Our recently developed 3D MHD model includes the following features that have crucial impacts on the interaction: (1) The model neutral atmosphere includes the two species CH4 and N2 which are known to be the major constituants of Titan's atmosphere. (2) Together with the solar euv spectrum and the two free parameters Saturnian local time (SLT) and sub solar latitude (SSL) we are able to calculate realistic 3D distributions of the photoionization rates for distinct condions (e.g. Cassini fly-by times). Although photoionization is the main source of ionospheric plasma production, ionization due to magnetospheric electrons plays also an important role at least on the nightside of Titan. (3) Our 3D time dependent flux tube model includes the effect of the magnetospheric electrons, calculates ionization rates by electron impact, and takes into account heat conduction along the magnetic field lines. All these features are embedded in the MHD model in order to come close to the conditions during the Cassini fly-bys.

SM11B-07 0930h

Pickup ions, plasma anisotropy and instability at Saturn: Predictions for Cassini

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Pickup ions are a primary source of plasma within Saturn's magnetosphere. These ions are initially in a strongly anisotropic ring distribution, but instabilities can rapidly cause them to evolve into a more isotropic distribution. Similar processes have been studied at length in the case of comets and Jupiter's moon, Io. Here, we apply these theories to Saturn's magnetosphere and predict that the Cassini spacecraft will frequently observe strongly anisotropic distributions. The important processes are the suppression of the ion cyclotron instability by a thermal background of a similar species, the limits to which ion cyclotron waves may reduce anisotropy (especially in a plasma where the pickup velocity is lower than the wave velocity) and the stability criteria for mirror mode instabilities.

SM11B-08 0945h

Modeling the electron and proton radiation belts of Saturn

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Results of a physical model for energetic electrons and protons trapped in the inner magnetosphere of Saturn are presented. This radiation-belt model is built in order to improve our understanding of the radiation-belt population as observed during the Pioneer and Voyager flybys, before being used to predict radiation-belt fluxes and emissions for the Cassini Mission. The radiation-belt particle spatial distribution has been determined by modeling the trapped particle interactions with different components of the Saturn system: moons, dust rings, neutral clouds, plasma and magnetic field. Our results suggest some explanations on the dynamics of the radiation belts of Saturn. Absorption by ring particles is dominant in the [1; 2.3] Rs region (inducing low trapped electron and proton populations) while moons. local losses act as the prominent physical process in the outer part of the inner magnetosphere ([2.3; 6] Rs). Concerning the proton radiation belts model, beyond 2.3 Rs, interactions with neutrals also cause significant losses in the outer part of the inner magnetosphere. Our simulations predict a strong production of energetic neutral hydrogen atoms, but it predicts also a very weak synchrotron emission confirming the weakness of this radiation for Saturn. Comparisons between Voyager data and model results are displayed, and trapped particle fluxes along Cassini spacecraft are discussed.

SM11C MCC: Level 2 Monday 0830h

Polar Cap and Auroral Phenomena Posters *(joint with SA, AE)*

Presiding: **T Moretto,** NASA Goddard Space Flight Center**; E Zesta,** University of California, Los Angeles

SM11C-1164 0830h POSTER

Comparison of Dayside Reconnection Rate Measurements by HF and Incoherent Scatter Radar

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There are currently two techniques used to remotely sense magnetospheric reconnection using ground based radar. One technique uses High Frequency (HF) radar. The other uses incoherent scatter (IS) radar. In both cases, the reconnection rate is determined from the F-region plasma velocity in the rest frame of the separatrix. However, the identification of the separatrix and the measurement of the plasma velocity are based on physically different phenomena. Thus the two techniques produce independent measurements of the reconnection rate. In this study, we compare reconnection rate measurements made by the Super Dual Auroral Radar Network and the Sondrestrom IS Radar on four separate dates to determine the accuracy of the reconnection rate measurements. The previously reported finding that the position of the separatrix is poorly correlated between the two instruments when the reconnection rate is high is borne out by this study. However, we will also show that the reconnection rate is well correlated between the two instruments due to the high correlation in the plasma velocity measurements.

SM11C-1165 0830h POSTER

Evolution and Characteristics of Global Pc5 observations of ULF waves During a High Solar Wind Speed Event.

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We present an interval of long-lasting Global Pc5 oscillations during a high solar wind speed event, during which there is an excellent conjunction between the Cluster and Polar spacecraft on the dusk flank, and ground-based instrumentation. Virtually monochromatic large amplitude highly-polarised pulsations were observed by the CANOPUS magnetometer chain at dusk for many hours, which we identify as being a field line resonance. Many radars of the SuperDARN HF network observed clear pulsations of similar frequencies as these radars rotated into the dusk sector ionosphere. The pulsations are observed in geosynchronous data at all local times. We analyse the solar wind data to verify the source of these oscillations. Cluster field and plasma instruments indicate Kelvin-Helmholtz type activity on the magnetopause and Polar observed oscillations in both electric- and magnetic fields. We analyse these fluctuations in local field-aligned coordinates and calculate the poynting fluxes along and perpendicular to the field to fully understand the nature of these oscillations. We present these results in terms of previous studies and discuss possible source mechanisms.

SM11C-1166 0830h POSTER

Dependence of the electric field in the inner magnetosphere on the IMF B_Y component

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It is known that the electric field pattern at high-latitudes depends on the polarity of IMF B_Y. The potential cell at the duskside (dawnside) is larger than that at the other side for IMF $B_Y > 0$ ($B_Y < 0$) in the northern hemisphere. This asymmetry of the potential cell appears oppositely in the southern hemisphere. In this study we investigate the above problem by using the perigee data from Cluster passing through the magnetic equator. The data consist of both components of the electric field perpendicular to the magnetic field obtained by the electron drift instrument (EDI). These data are sorted by IMF B_Y and discussed in terms of the seasonal variation of the orbits and the possible locations of the reconnection at the dayside magnetopause.

SM11C-1167 0830h POSTER

The dynamic Behaviors of the Magnetosphere Based on A Laboratory Simulation

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We have performed a laboratory simulation of the magnetosphere. The main aim of this experiment is to understand the acceleration mechanism of the aurora. Our laboratory simulations are examined to satisfy the MHD scaling law. Electric field is measured on the sun-earth line in the nightside of the magnetosphere. The result has shown that the earthward electric field exists on the tail current sheet stably. The value is consistent with the predicted electric field in the magnetospheric current sheet. In this experiment, the dynamic pressure of the simulated solar wind is changed to investigate the dynamic behavior of the magnetosphere and the mechanism of the substorm. The measured electric field in the tail current sheet is modulated due to the change of the solarwind dynamic pressure. The experimental results also show that the magnetospheric current in the plasmapause exists rather longer time after the disappearance of the solar wind. It is found that the confinement time is consistent with the Bohm's magnetic field diffusion time.

SM11C-1168 0830h POSTER

The Relationship Between Proton Aurora and Trapped Ion Flux as Seen by IMAGE

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