turn, leads to confidence in determining the electron density N_e to within a few per cent even in space plasmas with $N_e < 10\ cm^{-3}$ where determinations to this accuracy are difficult to achieve.

SM42C-0628 1330h POSTER

Critical Temperature for the Onset of Spacecraft Charging, An Update

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The onset of spacecraft charging at geosynchronous altitudes occurs at a critical value of the space plasma electron temperature for a given spacecraft surface. We review the theoretical formulation and computational results and compare the results with the Los Alamos National Laboratory spacecraft charging obervations. It is amazing that the observational data show that the onset of charging occurs at a critical temperature in almost every charging event, no matter which satellite, which year and which month. It is equally amazing that the theoretical critical temperature values remain the same no matter in Maxwellian plasma or in kappa plasma, in eclipse or even in sunlight. We also offer a full theoretical formulation of critical temperature in cut-off Maxweliian distributions and a good reason why spacecraft charging seldom occurs in the dusk sector.

SM42D MCC: 2008 Thursday 1340h

Sun-to-Earth Elements and Linkages That Drive Geoeffectiveness V *(joint with SA, SH, NG)*

Presiding: **R L Kessel,** NASA Goddard Space Flight Center**; M Henderson,** Los Alamos National Laboratory

SM42D-01 1340h

A Taxonomy of the Magnetosphere's Reaction to Solar-Wind Driving

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By statistically examining the properties of the solar wind during various types of magnetospheric phenomena, we have produced a suggested taxonomy of the magnetospheric phenomena resulting from various properties of the solar-wind driver. These phenomena include periodic substorms, steady-magnetospheric-convection (SMC) events, storms with global sawtooth oscillations, storms without sawtooth oscillations, quiet periods with viscous convection, quiet periods without viscous convection. Periodic substorms tend to be found in times of modest southward vBz and normal to high amplitudes of upstream MHD turbulence. SMC events tend to be found in times of modest southward vBz and low-amplitude upstream turbulence. Global sawtooth oscillations tend to be found in times of big B, modest n, and low-amplitude upstream MHD turbulence. The geomagnetic indices are well correlated with the amplitude of upstream solar-wind turbulence. Under northward vBz this correlation is very clear, suggesting that (in analogy with fluid dynamics experiments) a viscous driven convection in the magnetosphere is being controlled by the amplitude of the solar-wind turbulence. A single diagram is presented summarizing the hypothesized taxonomy in vBz (reconnection) turbulence (viscosity) space. If the solar-wind-driver parameters are maintained for a sufficient amount of time, the predicted magnetospheric phenomena should occur.

SM42D-02 1355h

Plasmaspheric Dynamics: Solar-Wind/IMF and Sub-Auroral Coupling

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The images produced by the IMAGE extreme ultraviolet (EUV) imager have provided the first global view of plasmaspheric dynamics, including the process of erosion and the formation and evolution of drainage plumes. The traditional picture holds that the zero-order behavior of the plasmasphere is described by superposition of corotation and solar-wind-driven sunward convection. We test this long-standing hypothesis by comparing EUV images and the output of a plasmapause evolution model driven by a time-varying Volland-Stern electric potential field. Volland-Stern simulations of two June 2001 erosion events reproduce the EUV plasmapause position on the dawnside, but place it too far from Earth near dusk, implying strong duskside flows not in the model. Low-altitude DMSP data show that duskside flows are often enhanced by the sub-auroral polarization stream (SAPS) phenomenon which couples the ring current, ionosphere and plasmasphere together. Our simple ad-hoc SAPS model corrects the duskside plasmapause position in the model. Thus, both convection and SAPS play a significant role in the global dynamics of the plasmasphere during geomagnetic disturbances. Analysis of DMSP data and model results indicate that SAPS flows may be responsible for a duskside "undulation" of the plasmapause observed on 17 April 2002. There is also evidence that SAPS plays a significant role in the creation of "tongue"-like regions of enhanced ionospheric/plasmaspheric total electron content (TEC) observed by the GPS network to extend poleward from low latitudes.

SM42D-03 1410h

Global Observations of O/N_2 in Earth's Thermosphere During the April 2002 Sun-Earth Storms

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During the period of April 14-24, 2002, a series of solar disturbances began several chains of events that influenced geospace. Earth's thermosphere is one endpoint for these chains. The Polar spacecraft was in a unique position to observe the end effects on the thermosphere. During April 2002, the 8 R_E apogee altitude of the Polar orbit was near the equator at approximately 1015 local time. The ultraviolet sensitive Earth Camera of the Visible Imaging System on the Polar spacecraft acquired global images of Earth's dayglow through a broadband filter at FUV wavelengths. For this filter, percentage variations in dayglow intensity relative to quiet times across the dayside hemisphere are related to variations in the O/N_2 column density ratio of the thermosphere. An initial small decrease in the O/N_2 ratio was observed on April 17, 2002. The O/N_2 ratio reached a maximum depletion of 45% during the magnetospheric storm on April 19, 2002 at 1907 UT. Full recovery of the O/N_2 ratio followed in less than 36 hours. The O/N_2 depletions were located in the polar regions and extended to mid-latitudes in both the northern and southern hemispheres. These depletion regions were highly structured and differed significantly between the hemispheres. The variability of the solar EUV photon flux can be observed in the hemisphere-integrated dayglow intensities and must be taken into account in order to obtain accurate retrieval of the O/N_2 ratios. Discussion will concentrate on the north-south asymmetry of the depletion regions and the variations of the observed O/N_2 ratio in the thermosphere as compared with the model results from the TIMEGCM.

SM42D-04 1425h

Interplanetary-Ionospheric Coupling: The 6 November 2001 Magnetic Storm Event

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The effects of the intense southward interplanetary magnetic fields of the 6 November 2001 event is studied using ground-based GPS receiver data, satellite (vertical) GPS receiver data, satellite altimeter data and Brazilian near-equatorial ionosonde data. Strong dawn-to-dusk directed interplanetary electric fields are generated by shock compression of an upstream slow magnetic cloud southward Bz magnetic fields. The electric field reached an unusually high approx. 55 mV/m intensity. Immediately after shock impingement, there were strong dayside and nightside ionospheric effects. The CHAMP GPS data plus ground based GPS data indicate that the dayside ionosphere was lifted to altitudes above the satellite (approx. 430 km). The vertical ionospheric TEC increased by 50-100 %. Nightside ionosonde data indicate strong decreases in TEC. During the intense interplanetary electric field event, an unusual plasma feature is noted. Enhanced midlatitutde densities occur with a sharp drop-off of densities at higher latitudes. The latitude of the drop-off decreased with storm development, similar to plasmaspheric erosion during magnetospheric convection electric field events. Finally large decreases in the dayside TEC are noted approx. 6 hrs after shock passage. This decrease is approx. 40 % below quiet daytime values. These interesting ionospheric features will be discussed in terms of prompt penetration of interplanetary electric fields, shielding fields, and neutral winds and composition.

SM42D-05 1440h

Non-uniform precipitation of solar energetic particles across the Earth's polar caps

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The Earth's magnetic field has a complex influence on the precipitation of solar energetic particles into the atmosphere at high latitudes. Besides the time-dependent cutoff latitude, one often observes large (> factor of 4) changes in the intensity of solar particles particles as a low-altitude satellite traverses the polar caps. These features were first observed in low-Earth orbit and modeled in the 1970's (e.g. Scholer 1972). Factors such as delayed particle access from deep in the magnetotail, favored access to one pole or the other due to the polarity of the interplanetary magnetic field; and quasi-trapping just above the cutoff latitude were thought to play a role. We revisit these phenomena using the high-sensitivity instruments on the SAMPEX satellite at 600km altitude. We will test the previous

concepts and models of solar particle access across a wider range of particle rigidity (10's to 100's MV) and with better statistics than has been done in the past. At the meeting we will quantify non-uniform particle illumination in many events from 1992-2003, including the 14-24 April 2002 interval, and discuss its impact on calculations of the solar particle energy deposit into the atmosphere. M. Scholer, J. Geophys. Res. 77, 2762-2769, 1972.

SM42D-06 1455h

Energetic and dynamic impact on the upper atmosphere during the April 2002 geomagnetic storm

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The April 2002 geomagnetic storm has been associated with a wide range of disturbances that occurred on the Sun, including high-speed coronal mass ejections, and several M- and X-class flares. This event therefore offers a unique opportunity to define and unravel the geoeffectiveness of various energy inputs originating from the Sun. This talk focuses on the impact of precipitating particles on the upper atmosphere. Numerical experiments are carried out to study the response of the thermosphere and ionosphere to the different particle inputs, such as the auroral electrons and energetic protons, and the intense high-energy polar rain that was observed during the storm. We also show the generation and propagation of the large-scale traveling atmospheric and ionospheric disturbances (TADs and TIDs) and their relation to the impulsive magnetospheric energy inputs via precipitating particles and Joule heating. Storm-time changes in neutral temperature, neutral winds and composition, as well as electron density will be discussed in light of the model simulations.

SM42D-07 1510h

Energization of Ionospheric Plasma During the April 17, 2002 Storm

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Statistical studies as well as recent multi-fluid simulations have demonstrated a correlation between the outflow of ionospheric plasma with the solar wind conditions and especially with the sign of the interplanetary magnetic field (IMF). This paper investigates the energization of ionospheric and solar wind plasma during the April 17, 2002 storm. This storm provides an excellent means of not only investigate the size of the ionospheric outflows but also the energization of these outflows as a function of solar wind conditions. It is show that will ionospheric outflows are enhanced by the arrival on the magnetic cloud at Earth, much of the ionospheric plasma remains relatively could for the first couple of hours during the event. Variability in the IMF conditions produces some local heating of heavy ions, but during the first part of the event it is the light ions that experience the bulk of the heating. It is only after a few hours when there is a prolonged period of southward IMF, that there is significant depletion of light ions in the magnetotail and the preferential heating of heavy ions occurs. These results demonstrate that conditions between storms and substorms can be very different in the magnetotail, and that this difference will lead to changes in the characteristics of the energetic populations in the tail even for very similar IMF conditions.

SM42D-08 1525h

Atmospheric Effects of Solar/Geomagnetic Disturbances: the Role of Initial Atmospheric States

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This paper will investigate how the initial atmospheric composition, temperature, and wind and dynamic states affect the extent and duration of the neutral atmosphere and ionosphere response to various solar and geomagnetic disturbances. The variable energy inputs during solar and geomagnetically disturbed times drive important chemical reactions involving energetically-important minor species such as O and NO throughout the high-latitude mesosphere and lower thermosphere. These changes are transported in latitude and altitude, affecting the global thermal structure and composition. Changes in the thermal structure will ultimately result in changes in the circulation pattern that provide feedback to the time-varying atmospheric effects. In addition the disturbed wind patterns can affect the distribution of ionospheric density, such as contributing to variations in the Appleton anomaly. As a result, it is anticipated that the extent of the responses will depend on the initial atmospheric condition. For example, the season during which the disturbance(s) occur, at what point in the 11-year solar cycle, and whether the disturbance is an isolated event or part of a series, such as the recent April 2002 storms, will affect the magnitude and structure of the changes in the O/N2 ratio, ionospheric density, etc. In this paper we investigate the response at these various atmospheric conditions using mechanistic runs of first principle general circulation models of the upper atmosphere.

SM42E MCC: 2008 Thursday 1600h

Exploring the Digital Geospace: Modern Methods of Spatial Data Analysis I *(joint with SA, SH, NG)*

Presiding: **L Scherliess,** Utah State University**; R S Weigel,** CISM/KT

SM42E-01 1600h INVITED

Analysing structures and interfaces using spatially-distributed data

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Cluster has provided fully co-ordinated, spatially-distributed data for the first time. A number of multi-spacecraft techniques which measure, for example, boundary orientation, thickness and motion, and deviation from planarity, have been developed. In addition, the data allows the electric current structures, both within the boundary layers and associated with other structure, to be probed. We investigate and compare boundary crossings arising from spacecraft encounters with discontinuities in the solar wind, the bow shock, the magnetopause and the magnetotail, which are observed by Cluster on multiple scales (ranging from 6000-100 km). Behaviour of the interfaces, such as distinguishing strong acceleration and thickness variations, can be made. Knowledge of boundary orientation and motion can accurately scale the plasma and field signatures across the boundary layer.

SM42E-02 1620h

Plasma Wave Identification in Multi-Spacecraft Data Using the Eigenstructure of the Cross Spectral Density Matrix

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Data from multi-spacecraft missions offer the possibility to study plasma processes by means of, both, their temporal and spatial characteristics. This is of particular importance in plasma wave analyses where good frequency and wave vector estimates are needed to test dispersion relations. Here we focus on data from ESA's Cluster-II mission. Analysis methods like the wave telescope or k-filtering technique originally developed for seismic arrays have been generalized and applied to Cluster-II data. This report presents a wave identification method based on the eigendecomposition of the cross spectral density matrix. The method is expected to facilitate the detection of plasma waves and should be well suited for routine analyses of large data sets. Furthermore, the eigenstructure of the cross spectral density matrix allows to compare the method presented here with already existing techniques, and to construct performance measures. Estimation of the complete set of parameters of plane wave sources helps to reconstruct wave fields and to carry out polarization analyses.

SM42E-03 1635h INVITED

Data Assimilation in Ionospheric and Magnetospheric Models

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In this talk we present a review of ionospheric and magnetospheric data assimilation models which are currently in use or under development. This is a very challenging field because of the the sparseness of data and the vastness of the volume. Even though it is challenging, researchers have made tentative steps in the development of region and global data assimilation models. We attempt to discuss a variety of models using different methodologies and complexities. These models cover the ionospheric electrodynamics, radiation belts, ring current, global magnetosphere, thermosphere, and ionosphere.

SM42E-04 1655h

The USU GAIM Data Assimilation Model for the Ionosphere

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Although data assimilation techniques have been successfully used by the meteorologists and oceanographers for several decades, the space physics community has been slow in implementing data assimilation techniques, primarily because of the lack of a sufficient number of measurements. However, this situation is changing rapidly for the ionosphere. Within ten years, it is anticipated that there will be millions of ionospheric measurements per day from a variety of sources, and these data will be available for assimilation into specification and forecast models. A physics-based data assimilation model of the ionosphere is under development as the central part of a DoD MURI funded program called GAIM (Global Assimilation of Ionospheric Measurements). The Utah State University GAIM model will use a physics-based ionosphere-plasmasphere-polar wind model and a Kalman filter as a basis for assimilating a diverse set of real-time (or near real-time) measurements. The new physics-based ionosphere-plasmasphere-polar wind model (IPM/IPWM) includes 6 ion species (O_2^+, N_2^+, NO^+, O^+, H^+ and He^+) and covers the low and mid latitudes from 90 km to about 20,000 km altitude and the high latitudes from 90 km to 10,000 km altitude. The Kalman filter is based on a reduced state approximation combined with a segmentation of the model domain into geographical sectors. These approximations not only lead to a dramatic reduction in the computational requirements but also make the model more easily adaptable for global, regional, or local applications. Several real data types, including in situ electron density measurements from DMSP satellites, bottomside electron density profiles from the Air Force network of digisondes, GPS-TEC from a global network of more than 160 ground stations, and occultation line-of-sight TEC measurements from three low Earth orbiting satellites are currently assimilated into the model. In this paper we will briefly review the Kalman filter technique including the applied approximations and then present results from a 3-day model run using data from the four different data types.