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Detached proton auroral arcs are a newly discovered phenomenon at Earth by the IMAGE satellite. These events are characterized by IMAGE-FUV observations of subauroral arcs separated from the main oval and extending over several hours of local time in the afternoon sector. The emissions have been related to the precipitation of 20-30 keV protons measured by the FAST electrostatic analyzers and plasmaspheric plumes observed by the IMAGE-EUV instrument. We simulate the proton precipitation during two subauroral arc events which occurred on 23 January 2001 and 18 June 2001. During these periods the inner magnetospheric conditions were moderately disturbed with minimum $Dst = -25$ nT and $Dst = -61$ nT, and maximum $Kp = 5^-$ and $Kp = 5^+$, respectively. We use our global physics-based model, which calculates the temporal evolution of ring current H^+, O^+, and He^+ ion distributions including losses due to charge exchange, Coulomb collisions, and wave-particle interactions along adiabatic drift paths. Measurements from the geosynchronous Los Alamos satellites are used to simulate the time-dependent plasma inflow on the nightside and to compare with model results on the dayside. The growth rate of EMIC waves is self-consistently calculated and global images of precipitating ions are obtained and compared with IMAGE observations. The characteristics of the EMIC waves induced ion precipitation are investigated as a plausible mechanism for generation of the detached proton auroral arcs.

SM14A CC: 518 A Monday 1530h

Ground-Based Arrays for the 21st Century I *(joint with SA)*

Presiding: **M Connors,** Athabasca University**; B J Fraser,** Cooperative Research Centre for Satellite Systems

SM14A-01 1530h INVITED

The Application of Multiple Ground-Based Magnetic Observatories for Nowcasting and Forensic Analysis of Geomagnetic Disturbance Conditions

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Ground-based geomagnetic observatories have historically been used to derive local and planetary geomagnetic storm indices such as the K, Kp, Ap and various other indices which can cover broad 3 hour or longer time windows and broad geographic regions. Impacts to ground based infrastructures occur due to variations in geomagnetic field intensity which can exhibit rapid and complex regional and spatial variations. As a result, traditional geomagnetic storm indices do not provide sufficient details to interpret the severity of the environment and the storms ability to produce geomagnetically-induced currents in ground-based infrastructures. The application of multiple ground-based magnetic observatories when used with data assimilation modeling techniques can provide detailed spatial and temporal characterization of geomagnetic field disturbances caused by geomagnetic storms.

SM14A-02 1550h INVITED

MAGDAS/CPMN Observations for Space Weather Study

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An objective of the STP (Solar Terrestrial Physics) researches is to support human activities in the geospace in the twenty-first century from an aspect of fundamental study. In order to understand the Sun-Earth system and effects to human lives, the international LWS (Living With Star) and CAWSES (Climate and Weather of Sun-Earth System) programs start from 2004. The objective of CAWSES-WG 2 & 3 in Japan for the region from the solar surface through the solar wind, the magnetosphere, the ionosphere, and the thermosphere, to the atmosphere is a creation of new physics; (1) couplings of the complex and composite systems and (2) macro-and-micro-scale couplings in the Solar-Terrestrial system. The goals of CAWSES-WG 2 & 3 in Japan are to construct space weather stations (for observations) and modeling stations (for simulation/empirical modeling) during the period (2004-2008) of the international CAWSES program. Japanese STP groups will coordinate a research network to reach these goals for the space weather study. In order to study the complexity in the solar wind-magnetosphere-ionosphere-Earth's surface system, the Space Environment Research Center (SERC), Kyushu University, Fukuoka, Japan will carry out coordinated ground-based network observations for space weather studies, in cooperation with about 30 organizations in the world during the international CAWSES period (2004-2008). In the present paper, we will introduce a real-time MACnetic Data Acquisition System of Circumpan Pacific Magnetometer Network, i.e. MAGDAS/CPMN system in Kyushu University. By using this system, we will conduct the real-time monitoring and modeling of (1) the global 3-dimensional current system and (2) the plasma density variations for space weather researches and applications, in order to understand electromagnetic and plasma environment changes in the geospace.

URL: http://www.serc.kyushu-u.ac.jp/

SM14A-03 1610h

A Ground-Based Array to Observe Geospace Electrodynamics During Adverse Space Weather Conditions

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Geomagnetic Storms occur with surprising frequency and create adverse space weather conditions. During these periods, our knowledge and ability to specify or forecast in adequate detail for user needs is negligible. Neither experimental observations nor theoretical developments have made a significant new impact on the problem for over two decades. Although we can now map Total Electron Content (TEC) in the ionosphere over a continent with sufficient resolution to see coherent long-lived structures, these do not provide constraints on the geospace electrodynamics that is at the heart of our lack of understanding. We present arguments for the need of a continental deployment of ground-based sensors to stepwise advance our understanding of the geospace electrodynamics when it is most adverse from a space weather perspective and also most frustrating from an understanding of Magnetosphere-Ionosphere coupling. That a continental-scale deployment is more productive at addressing the problem than a realizable global distribution is shown. Each measurement is discussed from the point-of-view of either providing new knowledge or becoming a key for future real-time specification and forecasting for user applications. An example of a storm database from one mid-latitude station for the 31 March 2002 is used as a conceptual point in a ground-based array. The presentation focuses on scientific questions that have eluded a quantitative solution for over three decades and view a ground-based array as an "IGY" type of catalyst for answering these questions.

SM14A-04 1625h

Global and local equatorward expansion of the ion auroral oval before substorm onsets

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The temporal variation of the equatorward boundary of the proton aurora/high energy ion precipitation is a manifestation of diurnal, and seasonal (i.e., dipole tilt) effects as well as magnetic activity. In particular, during the substorm growth phase this boundary moves equatorward, an effect due primarily to thinning and Earthward motion of the cross-tail current in the inner magnetosphere as the field evolves towards a more stretched topology. Recent advances in monitoring this boundary using ground-based instruments have opened up the possibility of following its temporal evolution across several hours in local time. This in turn allows one to explore whether this magnetotail stretching is a global or local phenomenon. We have examined this boundary evolution during the growth phases of 68 substorms over the Canadian sector. We use the equatorward boundary of SuperDARN E-region echoes as a proxy for the proton auroral boundary as described in Jayachandran et al [10.1029/2001GL01484, 2002]. We find that in 21 of the 68 substorms the equatorward motion of the auroral boundary is restricted to only several hours of local time in the evening sector. In the remaining 47 substorms, the equatorward motion was global so that the boundary retained its shape throughout the growth phase. Our results indicate dramatically different growth phase phenomenology in two classes of substorms. In one, the growth phase involves stretching in the inner magnetosphere that is most pronounced around the onset meridian. In the other, the stretching extends many hours in local time away from the onset meridian.

SM14A-05 1640h

Multi-Satellite Studies of ULF Waves in the Outer Magnetosphere: GOES Results

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The GOES series of geosynchronous satellites offers an unique opportunity to study the azimuthal/local time spatial and temporal properties of Pc3-5 ULF waves in the outer magnetosphere. Since late 2001 four and sometimes five NOAA GOES satellites have been operating at geosynchronous orbit. For example, in September 2001 GOES 8 was located at 74.9 degrees West, GOES 12 at 89.9 degrees West, GOES 11 at 108.7 degrees West and GOES 10 at 134.5 degrees West. Other longitudinal spacings are also available since September 2003, including two spacecraft at 200-210 degrees West. This varying range in longitudinal coverage with adjacent satellite pair spacing varying over 15-125 degrees provides a unique geosynchronous satellite chain of magnetometers, ideal for the study of the azimuthal properties of Pc3-5 (1-100mHz) ultra-low frequency (ULF) waves. At synchronous orbit these waves may be observed as field line resonances, compressional cavity or waveguide mode resonances, or as propagating waves for the higher frequency Pc3 waves. Results will be presented on the spatial extent and azimuthal properties of various wave types seen, including harmonics, in order to identify modes seen at both storm and quiet times, and their relationship to cold plasma variability in the outer magnetosphere.

SM21A CC: 220 C-E Tuesday 0830h

Space Weather: Linking Research and User Needs I Posters *(joint with SA, SH)*

Presiding: **M W Liemohn,** University of Michigan**; C R Clauer,** University of Michigan

SM21A-01 0830h POSTER

Challenges in modeling the Sun-Earth System

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SM

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The transfer of mass, energy and momentum through the coupled Sun-Earth system spans a wide range of scales in time and space. While profound advances have been made in modeling isolated regions of the Sun-Earth system, minimal progress has been achieved in modeling the end-to-end system. Currently, end-to-end modeling of the Sun-Earth system is a major goal of the National Space Weather and NASA Living With a Star (LWS) programs. The uncertainty in the underlying physics responsible for coupling contiguous regions of the Sun-Earth system is recognized as a significant barrier to progress. Overarching questions remain such as: what are the primary problems that need to be resolved to enable significant progress in comprehensive modeling of the Sun-Earth system? and which model/technique improvements are required and what new data coverage is needed to enable full model advances? This poster highlights topics germane to modeling the Sun-Earth system and provides a top overview of barriers to making progress in those areas. The result of addressing these issues ultimately attends to fundamental space plasma processes; knowledge of which can be applied to space weather problems at Earth, to life sustaining activities elsewhere, and to understanding and predicting the environments of Earth-like planets and moons. Topics to be addressed include: corotating interaction regions, coronal mass ejections, energetic particles, system preconditioning, extreme events and super storms, and end-to-end modeling efforts. These topics will be addressed at length at the upcoming modeling workshop entitled "Challenges in modeling the Sun-Earth System" to be held in Huntsville, AL, October 18-22, 2004.

URL: http://science.nasa.gov/HSVWorkshop/

SM21A-02 0830h POSTER

The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS): A Potential Canadian Mission Contribution to ILWS

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The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS) mission is presently undergoing Concept Study as a Canadian Space Agency satellite mission contribution to ILWS. The ORBITALS will provide a unique view of the largely previously unexplored inner magnetosphere. Its mission goal to "understand the acceleration, global distribution, and variability of energetic electrons and ions in the inner magnetosphere" is perfectly aligned with the top geospace priority for the LWS and ILWS programs. Moreover, the ORBITALS would meet the plea from the LWS Mission Operations Working Group for the international provision of additional probe coverage to complement the Radiation Belt Storm Probes (RBSP) within LWS. ORBITALS will hence provide Canada with a unique leadership role at the forefront of the highest priority science goals for ILWS. In a 12 hour low inclination orbit (perigee L=2, apogee L=6), the ORBITALS will come into once daily apogee conjunctions with the extensive ground-based Canadian Geospace Monitoring (CGSM) instrumentation as well as with GOES East and West, the raised perigee providing both long outer radiation belt dwell times as well as coverage of the outer-most inner radiation belt. In combination, the ORBITALS-CGSM-GOES conjunctions will provide a unique data set with which to address fundamental radiation belt science questions, such as the competition between ULF and VLF acceleration processes, the role of EMIC and VLF waves in loss, and the relationship between these processes and plasmaspheric cold plasma dynamics. The ORBITALS will also address inter-related science questions about the structure of inner magnetosphere electric and magetic fields, the dynamics of the plasmasphere, including thermal ion injection and loss, and the dynamics of the ring current population in the inner magnetosphere during storms. In this poster we outline the motivating ORBITALS mission science, and highlight the concept mission orbit and strawman payload. In combination with the approved NASA LWS RBSP, the ORBITALS-RBSP constellation will have the necessary spatial coverage to resolve the spatio-temporal ambiguities and global dynamics and morphology of the Earth's radiation belts. Further satellite mission collaborations, perhaps bilaterally with ORBITALS, which would re-create the original ILWS mission goal of three-petal local-time coverage would represent an excellent additional mission infrastructure complement to the proposed contemporaneous ORBITALS-RBSP measurements.

SM21A-03 0830h POSTER

Dynamic Modeling of Solar Energetic Particle Cutoffs During Geomagnetic Storms and Comparison with Static Models

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We investigate numerically the relationship between time variations in the geomagnetic cutoff and prompt trapping of Solar Energetic Particles inside the prestorm cutoff, which form new radiation belt populations distinct from the CRAND-produced inner zone [Hudson et al. 2004]. Solar Energetic Particle (SEP) cutoffs are modeled using the Lyon-Feder-Mobarry (LFM) global MHD code, which is driven by measured solar wind parameters at the sunward boundary. This is done for several CME-shock initiated geomagnetic storms including the 6 Nov 2001, 24 Nov 2001, and 21-23 April 2002 storms. We show that SEPs may gain access to the inner magnetosphere through an MHD compression of the cutoff, caused by shock related enhancements in the solar wind dynamic pressure. Comparison are made with satelite data and with cutoffs calculated using several static field models. A dynamic model of the geomagnetic cutoff may be used as a space weather forcast tool, for predicting SEP injections such as those observed during the Nov 2001 storms.

SM21A-04 0830h POSTER

Real-time Upstream Monitoring System: Predicting interplanetary shock arrivals using energetic particle data from ACE

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We have created a system for predicting the arrival times at Earth of interplanetary (IP) shocks that originate at the Sun. Our prediction algorithm uses the real-time data stream from the Electron, Proton, and Alpha Monitor (EPAM) instrument on NASA's Advanced Composition Explorer (ACE) spacecraft. Most IP shocks are accompanied by locally accelerated energetic storm particle (ESP) events; signatures of ESP events can be used to predict the arrival of IP shocks. We have previously reported on the development and implementation of an algorithm to forecast the arrival of IP shocks. This prediction capability is combined with a web-based system that uses real-time ACE/EPAM data provided by the NOAA Space Environment Center (http://sd-www.jhuapl.edu/UPOS/RISP/index.html.) The most recent ACE data is continually processed and when an event is approaching, predictions of shock arrival time are updated every five minutes. Tests on the algorithm show an average error of 9 hours for predictions made 24 hours before the shock arrival and 5 hours when the shock is 12 hours away. This can provide significant lead-time and deliver critical information to mission planners, satellite operations controllers, and scientists. As of February 4, 2004, the ACE real-time stream has been switched to include data from another detector on EPAM. We are now processing the new real-time data stream and have made improvements to our neural network based on this data. In this paper, we report prediction results from this new network.

URL: http://sd-www.jhuapl.edu/UPOS/RISP/index.html

SM21A-05 0830h POSTER

An overview of solar events and ground responses in 2003

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An overview of solar events, solar wind disturbances and geomagnetic activity for the entire year of 2003 is presented with an emphasis on ground geomagnetic and technological effects across Canada. The most pronounced space weather event occurred on October 29-31 with maximum geomagnetic indices of Kp=9 and Dst=-401 on October 30. This famous event was initiated on October 28 by active Solar Region 486, which produced a X17/4B flare associated with a full halo CME with speed of about 2000 km/sec. The same active region produced the most powerful flare of X28 on November 4, but this flare was not geo-effective. Two other solar events with high geo-effectiveness were identified. Strong geomagnetic activity on May 29 with Kp=8+, Dst =-130, was due to two halo CMEs associated with X1 and X3 -flares accompanied by IMF Bz =-30 nT and solar wind speed of 800 km/sec. Geomagnetic storm on November 20 with Kp=9- and Dst=-453 was produced by a halo CME on November 18. The relative size of the geomagnetic disturbances in three zones (polar, auroral, subauroral) varied from event to event as shown by the hourly ranges of geomagnetic field at different observatories across Canada. Power systems experienced very strong geomagnetically induced currents during the October 29-31 event.

SM21A-06 0830h POSTER

GIC Effects on Power Systems: March 1989 and October 2003

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In March 1989 one of the largest magnetic storms of the 20th century caused widespread problems to power

systems including the blackout of a major power system. Across the province of Quebec, industries were forced to shut down and residents woke up to find themselves without power. In October 2003 another major magnetic disturbance occurred without causing as much damage. This presentation examines the effects on power system produced by the two storms. Power system observations plus GIC simulations are used to present a picture of the storm impacts on different power systems. This is used to illustrate how system changes have influenced their vulnerability to GIC, and how the characteristics of the storms determined their impact on the ground.

SM21A-07 0830h POSTER

A Report on the Effects Caused by the October 28-31 2003 Space Weather Event.

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The space weather event at the end of October 2003 was one of the largest events of the current solar cycle prompting further investigation into the effects that it caused. With an ever increasing societal dependence on technology, understanding the effects of space weather events is becoming more necessary. These effects include charging on satellite surfaces, HF degradation, and increased levels of radiation at aviation altitudes. On the ground, power systems and pipelines experienced large geomagnetically-induced currents and azimuth errors occurred during directional drilling. Examination of the effects experienced as a result of this storm plays an important role in improving our understanding of these effects and developing better tools for forecasting and mitigation.

SM21A-08 0830h POSTER

AF-GEOSPACE Version 2.1

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AF-GEOSpace is a graphics-intensive software program with space environment models and applications developed and distributed by the Space Weather Center of Excellence at AFRL. A review of current (Version 2.0) and planned (Version 2.1) AF-GEOSpace capabilities will be given. A wide range of physical domains is represented enabling the software to address such things as solar disturbance propagation, radiation belt configuration, and ionospheric auroral particle precipitation and scintillation. The software is currently being used to aid with the design, operation, and simulation of a wide variety of communications, navigation, and surveillance systems. Building on the success of previous releases, AF-GEOSpace has become a platform for the rapid prototyping of automated operational and simulation space weather visualization products and helps with a variety of tasks, including: orbit specification for radiation hazard avoidance; satellite design assessment and post-event anomaly analysis; solar disturbance effects forecasting; frequency and antenna management for radar and HF communications; determination of link outage regions for active ionospheric conditions; scientific model validation and comparison, physics research, and education. Version 2.0 provided a simplified graphical user interface, improved science and application modules, and significantly enhanced graphical performance. Common input data archive sets, application modules, and 1-D, 2-D, and 3-D visualization tools are provided to all models. Dynamic capabilities permit multiple environments to be generated at user-specified time intervals while animation tools enable displays such as satellite orbits and environment data together as a function of time. Building on the existing Version 2.0 software architecture, AF-GEOSpace Version 2.1 is currently under development and will include a host of new modules to provide, for example, geosynchronous charged particle fluxes, neutral atmosphere densities, cosmic ray cutoff maps, low-altitude trapped proton belt specification, and meteor shower/storm fluxes with spacecraft impact probabilities. AF-GEOSpace Version 2.1 is being developed for Windows NT/2000/XP and Linux systems.

SM21A-09 0830h POSTER

The Importance of Surface Condition on Photoemission in Spacecraft Charging

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Much attention has been paid in recent years to the effect of surface conditions on secondary emission, which plays an essential role in spacecraft charging. In comparison, little or no attention has been paid to the effect of surface condition on photoemission, which plays a dominating role in spacecraft charging. In this paper, we present theoretical reasoning why highly reflective surfaces generate substantially reduced photoemission. We have calculated by using the Langmuir orbit-limited current balance equation the different surface potentials of various surface materials under typical space plasma conditions, satellite surface reflectivity values, and sunlight incidence angles. We have found that with substantially reduced photoemission in sunlight, highly reflective surfaces would often charge to negative potentials as if almost in eclipse. For spacecraft featuring many surfaces with different smoothness or reflectivity, this result has implication of differential charging. We warn that satellites with surfaces of widely different reflectivities are susceptable to differential charging, especially shortly after eclipse exit in the early morning. Differential charging is already known to be an important space hazard, especially in energetic space plasmas. After an eclipse exit, the time of development of the space hazard depends on the capacitances involved.

SM21A-10 0830h POSTER

Cumulant-Based Characterization of Nonlinear Magnetospheric Dynamics

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Understanding magnetospheric dynamics and predicting future behavior of the magnetosphere is of great practical interest because it could potentially help to avert catastrophic loss of power and communications. In order to build good predictive models it is necessary to understand the most critical nonlinear dependencies among observed plasma and electromagnetic field variables in the coupled solar wind/magnetosphere system. In this work, we apply a cumulant-based information dynamical measure to characterize the nonlinear dynamics underlying the time evolution of the Dst and Kp geomagnetic indices, given solar wind magnetic field and plasma input. We examine the underlying dynamics of the system, the temporal statistical dependencies, the degree of nonlinearity, and the rate of information loss. We find a significant solar cycle dependence in the underlying dynamics of the system with greater nonlinearity for solar minimum. The cumulant-based approach also has the advantage that it is reliable even in the case of small data sets and therefore it is possible to avoid the assumption of stationarity, which allows for a measure of predictability even when the underlying system dynamics may change character. Evaluations of several leading Kp prediction models indicate that their performances are sub-optimal during active times. We discuss possible improvements of these models based on this nonparametric approach.

URL: http://w3.pppl.gov/∼jrj/cumulant.html

SM21A-11 0830h POSTER

Kp forecast models

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Magnetically active times, e.g., Kp > 5, are notoriously difficult to predict, precisely when the predictions are crucial to the space weather users. Taking advantage of the routinely available solar wind measurements at Langrangian point (L1) and nowcast Kps, Kp forecast models based on neural networks were developed with the focus on improving the forecast for active times. In order to satisfy different needs and operational constraints, four models were developed: (1) model that inputs nowcast Kp, solar wind parameters, and predict Kp 1 hr ahead; (2) model with the same input as (1) and predict Kp 4 hr ahead; (3) model that inputs Kp for 2 hrs ago, solar wind parameters, and predict Kp for 1 hr ahead, and (4) model that inputs only solar wind parameters and predict Kp 1 hr ahead (the exact prediction lead time depends on the solar wind speed and the location of the solar wind monitor). Extensive evaluations of these models and other major operational Kp forecast models show that while the new models can predict Kps more accurately for all activities, the most dramatic improvements occur for moderate and active times. The evaluations of the models over 2 solar cycles, 1975–2001, show that solar wind driven models predict Kp more accurately during solar maximum than solar minimum. This result, as well as information dynamics analysis of Kp, suggests that geospace is more dominated by internal dynamics during solar minimum than solar maximum, when it is more directly driven by external inputs, namely solar wind and IMF.

SM21A-12 0830h POSTER

Assessing the Performance of Space Weather Models Using Metrics

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Metrics are one tool for assessing the progress of scientific models in space weather predictions. A scientific metric as defined by the National Space Weather Program has three elements: 1) An output parameter from the model such as density, 2) A satellite or ground-based measurement that can be used for comparison, and 3) A quantifiable parameter that can measure the difference between the model parameter and the measurement. We will present results for heliospheric, inner magnetospheric and ionospheric models. For the heliospheric models, we will compare results to ACE plasma data. For the inner magnetosphere, we will compare the results of the models to LANL geosynchronous satellite data. In the ionosphere, we will compare the computed magnetic perturbations of the ionospheric models to measured values in the Greenland magnetometer chain.

SM21A-13 0830h POSTER

Skill Score Analysis of MHD Simulation Global Magnetic Fields

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We examine the ability of the Lyon-Fedder-Mobbary (LFM) MHD simulation to reproduce the global magnetic field and current systems in the inner magnetosphere during both quite times and over a range of storm conditions. Using the semi-empirical Tsgyanenko storm model (Tsyganenko, 2003) as a baseline, we quantify the strength and weakness of the MHD simulation through objective comparison with observations. This study extends on our previous related work that focused on the comparison of a single storm event (Huang et al., 2003, Fall AGU meeting). Here, we explore the global magnetic field configuration at various storm phases and as a function of local time, using formal skill score computation as a quantitative measure of model performance.

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SM21A-14 0830h POSTER

Estimating Atmospheric Neutral Density Using Joule Heating Proxies

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Currently, neutral density models that are used to estimate the atmospheric drag on low-earth orbiting satellites use F10.7 as a proxy for solar EUV input, and the ap index as a proxy for the geomagnetic input. Recent work has shown that the neutral density at a 450-km altitude as estimated by the CHAMP satellite is much better correlated to the polar cap index than the ap index. In this study, we use a portion of the CHAMP data set to develop parameters for estimating the atmospheric neutral density at 450 km, and then use those parameters to estimate the neutral density during a different portion of the CHAMP data set. We develop a skill score to determine how well we are able to predict neutral density.

SM21B CC: 518 A Tuesday 0830h

Ground-Based Arrays for the 21st Century II *(joint with SA)*

Presiding: **M Connors,** Athabasca University**; R E Denton,** Dartmouth College

SM21B-01 0830h INVITED

The Super Dual Auroral Radar Network (SuperDARN): A ground-based array of HF radars for global-scale studies of ionospheric and magnetospheric processes

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Radars have been utilized since early in the 20th century for remote investigations of Earth's upper atmosphere. Many of the terms used to describe the ionosphere in particular were derived from the characteristics of radar soundings. It is now appreciated that the ionosphere also provides a portal for viewing processes in the magnetosphere, including the impact of variability in the solar wind. Beginning in the 1970s, efforts were made to construct small systems of ionospheric radars for research at high latitudes (e.g., STARE, SABRE). These efforts culminated in the last decade with the realization of the SuperDARN concept. An international consortium of researchers and funding agencies assembled networks of HF radars that provide large-scale coverage of the high-latitude ionosphere in both hemispheres. The northern component comprises 9 instruments with sites that extend westward from Scandinavia to Alaska while the southern component consists of 6 instruments with fields of view that converge over Antarctica. The radars observe coherent backscatter from ionization irregularities in the E and F regions and measure their motions. Synthesis of the velocity data sets results in global-scale images of the convection of ionospheric plasma that are analogous to images of auroral luminosity obtained with spaced-based instruments. The radars operate continuously with a cadence of 1 or 2 minutes. Summary information is downloaded from the northern radars via real-time internet links to JHU/APL where they are combined into a nowcast of the ionospheric space weather. Further expansion of SuperDARN is planned for both hemispheres and may include sites that will extend the coverage higher into the polar cap and to mid-latitudes. The range of studies pursued with SuperDARN includes convection dynamics, M-I coupling, atmospheric gravity waves, substorm processes, ionospheric modeling, and ULF pulsations. New areas for development include estimation of the global Poynting flux with the Iridium satellite network, coordinated studies of the polar cap ionosphere with AMISR, and the exploitation of meteor scatter to study the global distribution of mesospheric winds. In this talk we will review the status of SuperDARN, describe some of the scientific and technical accomplishments to date, and discuss the application of the data to the solution of current research problems.

SM21B-02 0845h

Transionospheric HF Propagation Experiments at Auroral Latitudes

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High-frequency (HF) propagation experiments are planned as part of the Enhanced Polar Outflow Probe (ePOP) satellite mission to be launched for the Canadian Space Agency in 2007. Ground transmitters such as the CADI ionosondes and the SuperDARN radars will be operated collaboratively to emit waves for detection by the Radio Receiver Instrument of ePOP during passes in the vicinity. The scientific goals include improved understanding of F-region morphology and dynamics, wave scattering and microphysical plasma processes. Partly as preparation for ePOP, transionospheric HF propagation data recorded by the receivers of the ISIS-I and ISIS-II spacecraft are being analyzed. The measurements were made in spring-summer 1978. A ground transmitter was built in Ottawa especially for the project. Some of the ISIS data were obtained in digital form from http://nssdc.gsfc.nasa.gov/space/isis/isisstatus.html. These digital data are being surveyed in an attempt to establish repeatable propagation characteristics. From these characteristics, the goal is to understand the processes experienced by waves passing through the ionosphere. Several tens of ISIS-II passes recorded at a fixed frequency of 9.303 MHz have been examined. Swept-frequency ionograms interleaved with these fixed-frequency measurements allow two-dimensional electron density distributions to be modeled in altitude and latitude. Computer code has been developed for three-dimensional ray tracing. The computed latitudinal extent of the zone irradiated at the ISIS-II altitude is approximately as observed. Within this "iris" of accessibility, the peak intensity of waves recorded at the spacecraft is within about 10 dB of what is computed with a link calculation. This calculation is based on a model for the 1-kW transmitter, a radiant-transfer calculation that follows the focusing/defocusing of rays using a three-ray pencil between ground and the satellite, and the orientation of the sounder receiving dipole. Poleward rays result in dispersed pulses, indicating quasi-perpendicular propagation that is forward scattered. Equatorward pulses are comparatively sharp and occasionally exhibit periodic fades with beat frequencies between 1 and 4 Hz.

SM21B-03 0900h

Mid-continent Magnetoseismic Chain (McMAC): A Ground-based Magnetometer Chain for Magnetospheric Sounding

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The Mid-continent Magnetoseismic Chain (McMaC) is a National Science Foundation (NSF) project that conducts research in magnetospheric sounding using ground magnetic field observations. We refer to the methodology used in this research as "magnetoseismology," reflecting its similarity to terrestrial seismology and helioseismology. The magnetoseismic research consists of two parts: the normal mode analysis that deduces the plasma density along a field line from its resonant frequencies, and the travel-time analysis that infers the density distribution in an extended region by timing the arrival of impulsive signals at multiple locations. To provide necessary data for employing magnetoseismic methods, 9 new magnetic stations will be installed in the United States and Mexico roughly along the 330° magnetic longitude meridian. These new stations will be equipped with highly sensitive fluxgate magnetometers synchronized by GPS signals. The McMAC stations and the "Fort Churchill Line" of the CANOPUS will be on the same meridian, and together they form a long north-south chain of magnetometers whose L-values range from 1.3 to 11.7. A database of the mass density of magnetospheric plasma derived from magnetoseismic methods will be established to investigate magnetospheric dynamics under different solar wind and ionospheric conditions.

SM21B-04 0915h

Plasmaspheric mass density response to geomagnetic storms determined from ULF resonance data

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The equatorial mass density the plasmasphere shows a systematic depletion in response to geomagnetic storms. A superposed epoch study of plasmaspheric mass density determined using ULF resonance data from the MEASURE magnetometer array shows a clear and systematic decrease in mass density in the day following the main phase onset of a storm. The average mass loss for $L < 3$ is roughly 35 percent of the prestorm mass density based on 81 events. The mass density typically returns to pre-storm levels within days of the storm onset. Specific storms are studied in detail to examine the variability of the plasmaspheric response to changing geomagnetic conditions.

SM21B-05 0930h

Plasmaspheric Depletion, Refilling and Plasmapause Dynamics: Coordinated Ground-Based and IMAGE Satellite Studies.

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Ground-based magnetometer and IMAGE satellite RPI and EUV instrument data have been employed in order to monitor the magnetospheric plasma density and thus plasmapause dynamics which occurred throughout a prolonged moderately active interval between the 5th and 17th May 2001. The ground-based results derived using the cross-phase technique were compared to in-situ satellite measurements, as well as model and observed plasmapause location, during both depletion and refilling intervals. The results of the ground-based and satellite techniques show excellent agreement, thus validating the ground-based technique and verifying its usefulness for monitoring global plasmaspheric dynamics. Comparison of cross-phase determined plasma density and RPI determined electron number density also enabled heavy ion dynamics to be examined, the results suggesting the presence of an enhanced heavy ion population in the inner plasmatrough region during the refilling interval. An observationally elusive reverse cross-phase signature was also identified in the vicinity of a very steep plasmapause. Using the excellent combined RPI and cross-phase coverage we compare our reverse cross-phase observations to those expected theoretically.