magnetosphere. In this plasma sheet the magnetic-field strength is weakened and the magnetospheric field lines are distorted into a "stretched" configuration that extends from the nightside well sunward of the dawn and dusk terminators. (4) An equatorial current system associated with this stretching forms a horseshoe around the nightside of the dipole. (5) The field lines poleward of the flattened plasma sheet are open to the magnetosheath; dipole tilt and the twisting of this plasma sheet by the IMF can bring lobe field lines to the equator in the middle magnetosphere. (6) If the IMF is not steadily southward, the field lines in the dipole are not stretched. (7) If the strength of the solar-wind magnetic field is not high, the field lines in the dipole are not stretched. (8) If the solar-wind density is too high, the field lines in the dipole are not stretched. (9) Dipole tilt does not prevent the stretching of field lines in the dipole. None of the simulations make known sawtooth oscillations in the magnetosphere. Reasons are suggested as to why the magnetosphere does not undergo sawtooth oscillations in the MHD simulations.

SM13A CC: 518 A Monday 1330h

Magnetosphere-Ionosphere Coupling at Subauroral Latitudes *(joint with P, SA)*

Presiding: **P L Rothwell,** Air Force Research Laboratory**; M Wiltberger,** National Center for Atmospheric Research High Altitude Observatory

SM13A-01 1330h

Electrical currents from global ENA images

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Plasma pressure gradients in the plasmasheet and ring current are in force balance with electrical currents. Energetic Neutral Atom (ENA) images obtained by the HENA imager on board IMAGE can be inverted to retrieve the proton pressure, and to some extent the O^+ pressure, in the ring current region. Assuming a magnetic field model and isotropic pitch-angle distributions (PADs), or assimilating PADs from in-situ measurements, the electrical currents can be computed by using the force balance equation $\mathbf{J} \times \mathbf{B} = \nabla \mathbf{P}$, where the inertial term has been neglected for the inner magnetosphere. We present results from several geomagnetic storms and compare the ionospheric end of the currents with the field-aligned current (FAC) patterns obtained from Iridium magnetometer data. At present the HENA-derived currents are about a factor of 5 below the current densities derived from Iridium, and the Iridium FAC pattern is often at lower latitudes than that derived from HENA. While a slight underestimation of the intensities are expected due to HENA's energy and mass range, we investigate some possible reasons for these discrepancies: (1) HENA only obtains a part of the total pressure; (2) The choice of magnetic field model; (3) The choice of constraints in the inversion algorithm; (4) Unwanted effects at the edges of the field-of-view of HENA. We also compare the results to runs of the Comprehensive Ring Current Model (CRCM) in order to investigate how the most intense ionospheric FACs relate to the morphology of the plasma pressure in the plasma sheet and ring current.

SM13A-02 1345h

Influence of Ionosphere Conductivity on Ring Current

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Using the Comprehensive Ring Current Model (CRCM), which self-consistently solves the kinetic equation of ring current protons and the closure of the electric current between the magnetosphere and ionosphere, we have studied how ionospheric conductivity controls injection of the storm-time ring current. By changing ionospheric conductivity artificially, we found the corresponding effects of the ionospheric conductivity on the ring current. The conductivity for F10.7=250 (solar maximum condition) produces about 29% stronger ring current than for F10.7=70 (solar minimum condition), and the conductivity at equinox produces about 5% stronger ring current than at solstice. That is because the two-hemisphere conductivities at equinox are higher than at solstice. This would be a new mechanism for probably explaining the semi-annual variation of Dst. Simulation with a realistic auroral conductivity estimated from the IMAGE/FUV auroral imager data reveals the fact that the auroral brightening does not significantly change the intensity of the ring current. The overshielding condition is found to be produced when the auroral conductivity decreases abruptly near the Dst minimum, triggering a rapid decay of the ring current. The ring current is shown to be influenced by not only IMF and the solar wind, but by solar radiation and morphological feature of the auroral electron precipitation as well.

SM13A-03 1400h

Dynamical coupling of ionosphere, plasmasphere and ring current.

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The first unambiguous observations of drainage plumes by IMAGE EUV have verified the qualitative predictions of early convection-based MHD models, but quantitative agreement demands treatment of the physical processes that couple the plasmasphere, ring-current/plasmasheet, and ionosphere. The sub-auroral polarization stream (SAPS), a ring-current/ionospheric feedback process, forms a narrow flow channel that focuses the effects of convection in the premidnight and dusk MLT sectors, modifying plasmapause locations and contributing to the formation of narrow duskside plumes. There is a connection between drainage plumes and 'storm-enhanced density' (SED) or 'tongues of ionization' in the ionosphere that implies strong coupling between plasmasphere and ionosphere, perhaps especially during intervals of SAPS. We investigate the nature of the coupling between plasmaspheric plumes and ionospheric SED tongues using a variety of techniques. First IMAGE EUV data are used to provide the equatorial global shape and motion of plumes. From the motion of the plume boundary we can infer the component of the electric field tangent to this boundary; this allows study of some of the details of the erosion process, and also opens the door to investigation of the disturbance-time inner magnetospheric electric field. Second, we use GPS total electron content (TEC) measurements and DMSP in situ observations to gain insight into the structure and dynamics of the low-altitude ionospheric portion of the flux tubes occupied by the plumes. Third, we use IMAGE HENA measurements to examine the role of the ring current in the dynamical formation and development of plumes during times of plasmaspheric erosion. Finally, to help deconvolve the TEC and EUV 2D spatial maps, we employ a three-dimensional model of plasmasphere and ionosphere density. With these tools we examine the highly coupled inner magnetosphere system during geomagnetically active periods.

SM13A-04 1415h

Electric potential pattern in the inner magnetosphere derived by Cluster EDI: Dependencies on IMF B_Z, Kp index, and Dst index

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Electric potential patterns are derived in the inner magnetosphere at $4 < L < 10$ using data from the Electron Drift Instrument (EDI) on Cluster. First, we examine the relations between the electric field and the following three parameters to understand how the potential patterns are organized: B_Z component of the interplanetary magnetic field (IMF), Kp index, and Dst index. From these correlations, we can recognize the effect of the interplanetary electric field (IEF) on the inner magnetospheric electric field as measured by Cluster. Next, the electric field is related to the quantity proportional to the injection rate of the plasmasheet particles, $(dDst^*/dt + 0.13Dst^*)$, where the effect of the magnetopause current is removed in Dst^*. Then we develop a method to obtain potential patterns. An inverse problem is solved by adjusting a trade-off parameter for smoothness of the result. We discuss the following features from the potential patterns sorted by IMF B_Z, Kp index, and $(dDst^*/dt + 0.13Dst^*)$: 1. potential drop, 2. rotation of the direction of the convection electric field, 3. dawn-dusk asymmetry of the strength of the electric field, and 4. shape of the last closed equipotential (LCE) and its relation to the outflow of the plasmaspheric material. We find that the LCE for $Kp < 2$ is a typical tear-drop shape, while those for $2 \leq Kp < 4$ and $4 \leq Kp$ are distorted because of the inward shift of the LCE in the evening MLT.

SM13A-05 1430h

Do Region 2 Currents Affect the Cross Polar Potential?

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Global MHD simulations of the magntosphere tend to (1) have high values of the cross-polar potential(CPP) and (2) have weak or possibly non-existent Region 2 currents. Since the Region 1 current closes both across the polar cap and through the Region 2 system, Hill has suggested that strengthening the Region 2 system causes more current to close at lower latitude which may act as an added ionospheric conductance and, thus, reduce the cross-polar potential. We present a simple model of ionospheric convection to indicate why we believe this is unlikely. The basic idea is that an increase in the Region 2 current causes a corresponding increase in the Region 1 current. Assuming an ionosphere with constant Pedersen conductance, the total resistance (in a dynamic, not electrical sense) which the ionosphere presents to the solar wind depends on Σ_P and the CPP. The effect of the Region 2 currents is to shield the inner magnetosphere from the potential generated by the solar wind. However, the total amount of flux which must return from the nightside to the dayside is unaffected by this shielding. What the shielding does is constrict the channel available for the return. We present a simple model to show the relation between the Region 1 and Region 2 currents as a function of channel width that indicates that enhanced Region 2 current leads to enhanced Region 1 current. We will present results from global simulations to indicate whether this scenario holds for these calculations.

SM13A-06 1445h

Modeling the Proton Precipitation During Detached Subauroral Arc Events

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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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