SM32A-1141 1330h POSTER

Substorm Growth Phase, Onset and Dipolarization

C. Z. Cheng[1] (609-243-2648; fcheng@pppl.gov)

Sorin Zaharia[2] (szaharia@lanl.gov)

[1]Princeton University, Princeton Plasma Physics Laboratory, Princeton, NJ 08543, United States

[2]Los Alamos National Laboratory, Los Alamos, Los Alamos, NM 87545, United States

Our 3D quasi-static solutions of magnetosphere show that as the plasma pressure gradient increases in the near-Earth plasma sheet region during the substorm growth phase, a current sheet with enhanced cross-tail current density is formed around the local midnight in a finite radial (7 - 10 R_E) and azimuthal domain. In the ionosphere the Birkeland current moves equatorward, the current density is enhanced, and its latitudinal width shrinks. This is consistent with the observed ionospheric growth phase signatures that the polar cap region expands equatorward, both the electron and proton aurora emissions move equatorward and brighten, and the auroral oval shrinks in width. In the current sheet the plasma beta becomes about 50 or larger and the magnetic field curvature is enhanced, and we find that the kinetic ballooning instability (KBI) can be excited with amplitude localized at the maximum plasma beta region. The KBI explains the low frequency (in Pi 2 frequency range and about 1 min period) instability observed by AMPTE/CCE excited at about 2-3 minutes before the substorm onset. The KBI is responsible for substorm onset because as it grows to a large amplitude with $\delta B/B \geq 0.2-0.5$, it causes enhanced ion drift in the westward or eastward direction. During the explosive growth phase that lasts about 30 sec before onset, the enhanced ion drift is in the westward direction. The eastward-westward oscillating ion drift caused by KBI then excites higher frequency instabilities in Pi 1 frequency range during the expansion phase, and the plasma and magnetic field become strongly turbulent. The plasma transport in both radial and azimuthal direction caused by the turbulence relaxes the steep plasma pressure profile during the expansion phase. As the plasma pressure profile relaxes in the plasma sheet, the magnetic field configuration dipolarizes and eventually returns to the pre-substorm more dipole-like geometry. Theories of growth phase magnetospheric configuration, KBI mechanism and dipolarization will be presented.

SM32A-1142 1330h POSTER

Energy Storage and Release at the Inner Edge of the Plasma Sheet.

Igor O Voronkov[1] ((780) 492-6568; igor@space.ualberta.ca)

Victor I Prosolin[1] ((780) 492-6568; victorp@space.ualberta.ca)

Peter Dobias[1] ((780) 492-0721; pdobias@space.ualberta.ca)

John C Samson[1] ((780) 492-4127; samson@space.ualberta.ca)

[1]University of Alberta, Department of Physics University of Alberta, Edmonton, AB T6G 2J1, Canada

The inner edge of the plasma sheet, as a region of transition from the dipolar to stretched magnetic field topology, may stay in the equilibrium for long lasting periods. At the same time, relatively slow energy storage, and its release at pseudo-breakups and substorm onsets, occur in this region. We use three complimentary MHD models, full nonlinear MHD, Lagrangian approach, and the Grad-Shafranov equation based model, to study the balance between the pressure gradient, stretched magnetic field, and convection velocity gradients. We show that the main energy is stored in the stretched magnetic field. Convection may play both stabilizing and destabilizing parts. The latter can trigger fast release of energy via the interchange (or low-beta ballooning) magnetic curvature instabilities. In this case, the modeling reveals the initial linear stage lasting for several minutes followed by the fast (tens of seconds) nonlinear instability. We suggest that at breakups, the linear stage is responsible for the equatorward arc intensification and auroral vortex formation whereas the nonlinear part brings about an explosive burst of pulsations, vortex expansion, and dipolarization in the region. We present samples of CANOPUS, Geotail, and geosynchronous data supporting the model constraint.

SM32A-1143 1330h POSTER

Substorm Injection Electron Flux

Manish Mithaiwala[1] ((512) 471-9676; mithaiwa@physics.utexas.edu)

Wendell Horton[1] (horton@physics.utexas.edu)

[1]The University of Texas at Austin Institute for Fusion Studies , 1 University Station C1500, Austin, TX 78712-0262, United States

One of the main questions concerning radiation belt research is the origin of radiation belt particles. Under the hypothesis that the plasma sheet electron population is the source of radiation belt electrons which are convected to the outer radiation belt region during substorms, we estimate the flux of particles generated at geosynchronous orbit. These electrons then serve as a source population for other energization mechanisms which accelerate the electrons to Mev and greater energies (i.e. killer electrons). The model fields are based on the *Li et al.* substorm particle injection model [1]. The flux is computed using the Hamiltonian guiding center equations in which the phase space density is conserved.

[1] Li, X., D. N. Baker, M. Temerin, G. Reeves, R. Belian, Simulation of Dispersionless Injections and Drift Echoes of Energetic Electrons Associated with Substorms? Geophys. Res. Lett., 25, 3763, 1998.

This work was supported by the National Science Foundation Grant ATM-0229863.

SM32A-1144 1330h POSTER

CLUSTER Measurements of Substorm Electric Fields at the Near-Earth Plasma Sheet Boundary

R B Torbert[1] (1-603-862-1638; roy.torbert@unh.edu); G Paschmann[2] (gep@mpe.mpg.de); J Quinn[1] (jack.quinn@unh.edu); L Kistler[1] (lynn.kistler@unh.edu); C Mouikis[1] (Chris.Mouikis@unh.edu); P Puhl-Quinn[2] (ppq@mpe.mpg.de); E Georgescu[2] (eg@mpe.mpg.de); J Raeder[1] (J.Raeder@unh.edu)

[1]University of New Hampshire, Space Science Center, Durham, NH 03824, United States

[2]Max Planck Institute for Extraterrestrial Physics, Postfach 1603, Garching 85741, Germany

The four-satellite CLUSTER mission offers the opportunity to look at the time sequence and spatial pattern of electric field intensification at times near substorm onset. Using data from the Electron Drift Instrument (EDI), the Flux-Gate Magnetometer(FGM), and the Composition instrument (CODIF), intense perpendicular flows (40 km/s) towards the neutral sheet can often be seen around the time of onset, followed by expansion of the plasma sheet. Comparisons of these observations with MHD simulations of substorms will be presented.

SM32A-1145 1330h POSTER

Vorticity Change in the Magnetosphere: A Study with Particle Guiding Center Motion

Tian-Sen Huang[1] (ts_huang@pvamu.edu)

Philippe Le Sager[1] (philippe_lesager@pvamu.edu)

[1]Prairie View A&M University Prairie View Solar Observatory, PO Box 307, Prairie View, tx 77446, United States

The generation of field-aligned current in the magnetosphere has been ascribed to dynamic changes of vorticity for at least two cases: the quiet time aurora of region R1 (Sato and Iijima, 1979) and the substorm onset (Hasegawa and Sato, 1979). From the point of view of particle guiding center motion the temporal change of vorticity is directly related to the polarization drift. In the guiding center formalism, it consists of five terms. We examine the contribution of each term to the change of vorticity. A distorted dipole (Stern, 1976) is adopted to model the magnetic field in the magnetosphere. This field is easily made time-dependent to simulate a dipolarization of the field, and its Euler potentials have an analytic expression. For numerical calculations, typical values of electric field and plasma density are used.

SM32A-1146 1330h POSTER

Effects of the interplanetary magnetic field and substorms on nightside upward field-aligned currents during storm-time inferred from geomagnetic data at mid-latitudes

Shin'ya Nakano[1] (+81-75-753-3953; shiny@kugi.kyoto-u.ac.jp)

Toshihiko Iyemori[1] (iyemori@kugi.kyoto-u.ac.jp)

[1]Graduate School of Science, Kyoto University, Department of Geophysics, 4-gokan, Graduate Scool of Science, Kyoto University, Kyoto 606-8502, Japan

Mid-latitude east-west geomagnetic disturbances on the nightside are attributed to field-aligned currents at high-latitudes. In order to discuss storm-time variations in field-aligned currents on the nightside, we examined east-west geomagnetic disturbance fields at mid-latitudes on the nightside for some geomagnetic storms. The results indicate that upward field-aligned currents are developed on the nightside (esp. in the post-midnight) under the condition that the interplanetary magnetic field (IMF) is directed southward. It is also suggested that substorm expansions have a secondary effect on the upward field-aligned currents on the nightside. We will discuss some possible mechanisms of substorms on the upward currents in the post-midnight.

SM32B MCC: Level 2 Wednesday 1330h

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

Presiding: **J U Kozyra,** University of Michigan**; L Goncharenko,** MIT Haystack Observatory

SM32B-1147 1330h POSTER

Magnetospheric response to solar wind pressure during strongly southward IMF: MHD simulations

Ramon E Lopez[1] (915 747-7534; relopez@utep.edu)

Michael Wiltberger[2] (wiltbemj@ucar.edu)

John G Lyon[3] (lyon@tinman.dartmouth.edu)

[1]Dept. of Physics, University of Texas at El Paso, El Paso, TX 79912, United States

[2]NCAR/HAO, 3450 Mitchel Lane, Coulder, CO 80301, United States

[3]Dept. of Physics and Astronomy, Dartmouth College, Hannover, NH 03755, United States

The solar wind energy input to the magnetosphere is generally controlled by the solar wind magnetic field, with significant energy transfer occurring during periods of southward IMF. In fact, empirical expressions of the energy coupling tend to be functions of solar wind speed, magnetic field, and the orientation of the field, but do not include the density or dynamic pressure as a factor. Recent investigations, both observational and theoretical, have suggested that the dynamic pressure can play a significant role in coupling solar wind energy to the magnetosphere during periods of strongly southward IMF. In the paper, we present results of global MHD models using idealized solar wind conditions as controlled experiments. We find that for moderate driving levels there is little influence of dynamic pressure, but during strong IMF driving the pressure is a major, or even dominant, factor in controlling the dayside merging rate and magnetospheric energy dissipation. We will discuss these results in the context of determining the geoeffectiveness of extreme solar wind conditions like magnetic clouds arising from CMEs.

SM32B-1148 1330h POSTER

Magnetospheric Response to Pulsed Variation in Solar Wind Dynamic Pressure: A Case Study

Suk-Kyung Sung[1] (+82-31-201-2690; sksung@spacelab.khu.ac.kr)

Khan-Hyuk Kim[1] (+82-31-201-2689; khan@khu.ac.kr)

Dong-Hun Lee[1] (+82-31-201-2449; dhlee@khu.ac.kr)

[1]Department of Astronomy and Space Science, Kyung Hee University, Yongin, Kyunggi 449-701, Korea, Republic of

On September 3 (day 247), 2000, ~0408-0417 UT, a pulsed geomagnetic signature was observed at the low-latitude dayside ground stations. The magnetic field strength at geosynchronous orbit also showed this single pulse variation. Using solar wind observations, we confirmed that the pulsed geomagnetic field was due to the change in the solar wind dynamic pressure, which indicates that the external source is in the form of the single pulse signature. Unlike the dayside feature at low-latitudes, mid- and high-latitude ground stations on the nightside(local time ~4-5 hours) recorded latitude-independent geomagnetic perturbations with a period longer than 700 s during about three cycles. These perturbations simultaneously occurred with the

pulse at the dayside low-latitude stations. This indicates that the dayside and nightside geomagnetic perturbations are excited by a common source, but that their generation mechanisms may be different. In this study, we discuss the generation mechanism of the latitude-independent pulsations observed at the mid- and high-latitudes on the nightside. In addition, we observed transient transverse perturbations by the POLAR spacecraft in the nightside magnetosphere while the magnetosphere was driven by the external pulse. This may be attributed to the transient response of the field lines to externally applied pressure disturbance.

SM32B-1149 1330h POSTER

Sawtooth Oscillations Directly Driven by Solar Wind Dynamic Pressure Enhancements

Dae-Young Lee[1] (dylee@ast.chungbuk.ac.kr)

Larry Lyons[2] (larry@atmos.ucla.edu)

[1]Chungbuk National University, Dept. of Astronomy and Space Science,, Cheongju 361-763, Korea, Republic of

[2]UCLA, Department of Atmospheric Sciences 405 Hilgard Ave., Los Angeles 90095-1565, United States

We have examined four well-defined events of sawtooth oscillations in energetic particle flux and magnetic field at geosynchronous orbit. During all four events, nearly simultaneous energetic particle flux enhancements and magnetic field variations occurred at all MLTs for each sawtooth cycle. Geomagnetic H component data at low-to-mid latitude also show a global H-increase simultaneously with the geosynchronous responses at all MLTs. These global simultaneous occurrences are what is expected from a response of the magnetosphere to solar wind dynamic pressure enhancements. By directly checking the solar wind data, we indeed find that there exist a series of solar wind dynamic pressure enhancements for each sawtooth event. We show that each cycle of the sawtooth oscillation can be associated in timing with a corresponding solar wind dynamic pressure enhancement. Furthermore, details of solar wind variations are sometimes well seen in the corresponding responses in geosynchronous particle flux, geosynchronous magnetic field, and geomagnetic H-component on the ground. Variations in the orientations, structure, and propagation speed of solar wind discontinuities prevent a one-to-one correspondence with each sawtooth oscillation from being determined with precise temporal accuracy. However, the global H-component increases as well as northern and southern PC index enhancements indicate that the solar wind pressure enhancements did indeed impact the magnetosphere at appropriate times. Therefore we suggest that the sawtooth oscillations studied in this paper are directly driven by series of solar wind pressure enhancements, and are not successively occurring substorms.

SM32B-1150 1330h POSTER

Effect of Solar Wind Pressure Enhancement on Ring Current Asymmetry During Strong Storms

Yong Shi[1] ((310)-794-9273; yongshi@atmos.ucla.edu)

Eftyhia Zesta[1] (ezesta@atmos.ucla.edu)

Larry Lyons[1] (larry@atmos.ucla.edu)

[1]UCLA Dept.of Atmospheric Sciences, 405 Hilgard Ave, Los Angeles, CA 90095, United States

During storms, solar wind dynamic pressure enhancements can significantly increase the Chapman-Ferraro, ring current and other magnetospheric and ionospheric current systems. The effect of the compression on the ring current could be asymmetric due to the ring current being stronger on the dusk side than on the dawn side. Variations of these current systems can be evaluated from the response of ground magnetometers. Typical response to compressions at low-latitude ground magnetometers is a positive increase of the horizontal magnetic field component, known as the main impulse (MI). In this study, a few strong storms (with Dst<-200nT) have been selected to investigate the effect of pressure enhancement on ring current asymmetry. We examined IMF data, ground geomagnetic data, and the ASY-H and SYM-H indices for each event. All cases studied show negative bays at low latitude over a large MLT sector around the dayside and dusk side, which is opposite to the typical MI response. This implies that the magnetic effect of the enhanced ring current exceeded that due to the enhanced Chapman Ferraro current. Only on the dawn side do we find the typical MI positive increase, which implies that the Chapman-Ferraro current effect there exceeded the ring current effect. This finding suggests that solar wind pressure enhancements asymmetrically increase an already asymmetric storm-time ring current. Consistent with this, the ASY-H index shows that the ring current, which has become asymmetric at the beginning of the storm, becomes even more asymmetric following a sudden increase in solar wind dynamic pressure. A moderate storm has also been investigated for comparison with the strong storms. For this storm, the effect of the enhancement of Chapman-Ferraro current at low latitudes is everywhere stronger than that of the ring current, although we also found enhancement of the ring current and its asymmetry. Therefore, we conclude that the storm-time ring current gets enhanced and more asymmetric due to the compression by solar wind dynamic pressure enhancements, and the stronger the storm, the more the ring current is enhanced.

SM32B-1151 1330h POSTER

Effect of Multiple Substorms on the Ring Current

Kristi A Keller[1] (301 286-2935; kakeller@pop600.gsfc.nasa.gov); Ayris Falasca[1]; Mei-Ching Fok[2]; Michael Hesse[1]; Lutz Rastaetter[1]; Maria Kuznetsova[1]; Tamas Gombosi[3]; Darren DeZeeuw[3]

[1]NASA/Goddard Space Flight Center, Code 696.0, Greenbelt, MD 20771, United States

[2]NASA/Goddard Space Flight Center, Code 692.0, Greenbelt, MD 20771, United States

[3]University of Michigan, Space Physics Lab 2455 Hayward, Ann Arbor, MI 48109, United States

The effect of magnetospheric substorms on the ring current is not completely understood. Using a combination of the University of Michigan's BAT-S-RUS Model and Mei-Ching Fok's Ring Current Model, we will study how substorms can affect the ring current. Using simulated solar wind to drive substorms, we will study the effects of multiple substorms on the ring current. In particular we will study how the symmetry and energy of the ring current are different for multiple substorms as compared to a single substorm. We will also study how multiple substorms can drive injections into the ring current.

SM32B-1152 1330h POSTER

Solar Wind Driving of the Storm-Time Ring Current

Niescja E Turner[1] (915-747-7547; neturner@utep.edu)

Ramon E Lopez[1] (relopez@utep.edu)

Elizabeth J Mitchell[1] (ejmitchell@utep.edu)

Demetrio S Corralez[1] (dscorralez@utep.edu)

[1]University of Texas at El Paso, Dept. of Physics, El Paso, TX 79968, United States

We use ring current observations, along with MHD simulation results, to investigate the magnetospheric response to different types of solar wind energy input. The MHD simulations show that the dissipation of energy in the magnetosphere-ionosphere system is very sensitive to solar wind density variations during time of strong driving, with large density pulses during southward Bz exhibiting significantly greater geoeffectiveness than strong Bz without such pulses. This suggests that solar wind kinetic energy flux may play a significant role during southward Bz. We compare this behavior with the behavior of ring current ions (using particle measurements and Dst) and show that ring current ions exhibit a similar response to different types of solar wind energy coupling. We present observations showing the overall magnetospheric effect of these different solar wind drivers. We also pay particular attention to the type of solar wind drivers at work, whether high speed streams, coronal mass ejections, etc., to determine whether this difference has a significant effect on energy coupling into the magnetosphere.

SM32B-1153 1330h POSTER

ENA Images of Ring Current Ion Precipitation 14-24 April 2002

R DeMajistre[1] (4437788756; robert.demajistre@jhuapl.edu)

E C Roelof[1] (ed.roelof@jhuapl.edu)

P C:son Brandt[1] (Pontus.brandt@jhuapl.edu)

D G Mitchell[1] (Don.Mitchell@jhuapl.edu)

[1]The Johns Hopkins University Applied Physcis Laboratory, 11100 JOHNS HOPKINS RD, LAUREL, MD 20723-6099, United States

The High Energy Neutral Atom (HENA) camera on the IMAGE spacecraft images ion precipitation from the ring current through the upward ENA albedo of the downward ion precipitation. A newly developed ion/neutral transport theory predicts that an appreciable fraction of the incident ions will emerge from the exosphere (albeit at a lower energy due to inelastic collisions). These emerging intensities register dramatically in the HENA images during perigee passes, yielding about 6 images with excellent pixel statistics in each 2-minute exposure. The viewing aspect during the STORMS2002 period (14-24 April) was excellent at approximately 1500 km altitude over the southern polar cap. Almost the entire sub-auroral precipitation region falls within the images at some time during the passes. The emission from precipitation is also imaged at higher altitudes when IMAGE is between about N40°-N60° magnetic latitude, but at greatly reduced spatail resolution at the larger radial distances of 4-7 R_E. Our analysis techniques are still in the early stages of development, but even so, the ENA images can indicate when and where ring current precipitation is occurring. Thus they promise a new measure of geoeffectiveness of magnetic storm activity.

SM32B-1154 1330h POSTER

Conductivity Depdendence of Cross-Polar Potential Saturation

Tsutomu Nagatsuma (+81-42-327-6095; tnagatsu@crl.go.jp)

Communications Research Laboratory, 4-2-1 Nukuikita, Koganei 184-8795, Japan

The cross-polar potential tended to be saturated when the value of the merging electric field (Em) was high. Using data from the Wind and ACE satellites and the northern polar cap index (PCN) as a proxy for cross polar potential, Nagatsuma [2002] have shown that the degree of saturation does not depend on the intensity of the interplanetary magnetic field on GSM Y-Z plane (BT) but depends on that of Em. This result supports the idea that the enhancement of Region 1 current plays a significant role for regulating the efficiency of solar wind - magnetosphere interaction [Hill,1976; Siscoe et al.,2002]. If the enhancement of the Region 1 current plays a significant role for regulating solar wind - magnetosphere interaction, the intensity of ionospheric conductivity controls the degree of saturation since the Region 1 current system is a voltage generator. We have examined that the solar zenith angle (SZA) dependence of PCN saturation. Our statistical results show that the degree of saturation is increasing with decreasing solar zenith angle under the sunlit condition, and opposite trend is seen during the darkness period. These characteristics can be explained as a SZA dependence of total ionospheric conductivity in northern and southern polar caps. This result confirms that the development of Region 1 currents plays a significant role for regulating solar wind - magnetosphere interaction. Further, it is suggested that this conductivity dependence of solar wind - magnetosphere interaction produces diurnal and seasonal changes of geomagnetic activity.

SM32B-1155 1330h POSTER

Penetration Electric Fields and Magnetospheric Convection During the April, 2002 Geomagnetic Storms

Phillip C. Anderson (310-336-2244; phillip.c.anderson@aero.org)

The Aerospace Corporation, Box 92957 M2/260, los Angeles, CA 90009, United States

We analyze the magnetospheric electric field strength and penetration electric fields during the series of geomagnetic storms in April, 2002 using measurements of the ion drifts in the ionosphere by the DMSP spacecraft. The cross-polar-cap potential drop (Ψ_{PC}) is seen to begin increasing at the beginning of the storm growth phases, maximizing near the beginning of the recovery phases, and exceeding 180 kV for three of the storms. The subauroral potential drop (Ψ_{SA}) in the evening sector exceeds 60 kV during three of the storms and can be a substantial fraction of Ψ_{PC} - up to 78%. The largest Ψ_{SA} values are seen in the dusk sector and diminish with increasing MLT. This is attributed to the greater separation between in the dusk sector between the inner edge of the electron and ion plasmasheets where the Region 2 field-aligned currents (FAC) flow into a region of low subauroral ionospheric conductivity, driving large electric fields. There is a good correlation of Ψ_{PC} and Ψ_{SA} with both Dst and AE - greater than 0.7. The best correlation with both potential drops occurs with no time delay for AE and with a 45 minute delay for Dst with Ψ_{PC}. However the best correlation for Dst with Ψ_{SA} occurs well into the recovery phase with a time delay of 4 hours. This is attributed to the movement of the inner edge of the electron plasmasheet/aurora to higher latitudes exposing a broader region of low ionospheric conductivity to the Region 2 FAC still being maintained by the equatorial ion pressure gradients as the ring current/ion plasmasheet decays.

S M

SM32B-1156 1330h POSTER

Seasonal Variation of Auroral Electron Flux

Charles A. Barth[1] (303-492-7502; charles.barth@lasp.colorado.edu)

Scott M. Bailey[2] (907-474-7741; scott.bailey@gi.alaska.edu)

Daniel N. Baker[1] (303-492-4509; dan.baker@lasp.colorado.edu)

[1]Laboratory for Atmospheric and Space Physics, University of Colorado 1234 Innovation Drive, Boulder, CO 80303, United States

[2]Geophysical Institute, University of Alaska 903 Koyukuk Drive, Fairbanks, AK 99775-7320, United States

The deposition of energy by auroral electrons precipitating into the polar lower thermosphere is deduced from observations of nitric oxide at 110 km. Precipitating electrons in the 3-4 keV range deposit their energy in the thermosphere between 100 and 120 km. The interaction of these energetic electrons with the molecules and atoms in the atmosphere produces ionization, auroral emissions, and nitric oxide. We use a thermospheric photochemical model to calculate the nitric oxide density in this altitude range at 60 degrees north and south latitude. This model takes into account all the processes producing nitric oxide including electron precipitation. We compare the model calculations with observations of nitric oxide made with the Student Nitric Oxide Explorer (SNOE) for the two and a half year period from March, 1998 until September, 2000. We iterate the model calculation many times, varying the auroral energy input, in order to achieve a self-consistent determination of the flux of precipitating electrons. The results of this analysis show that the electron flux is larger during the fall/winter season than in the spring/summer season in each hemisphere. These results support the idea of sunlight suppression of auroral activity which leads to a lower flux of precipitating auroral electrons in the illuminated hemisphere.

SM32B-1157 1330h POSTER

Empirical Modeling of Global Electron Energy Input During the April 2002 Storms

James R Sharber[1] (210-522-3853; jsharber@swri.edu)

Rudy A Frahm[1] (210-522-3855; rfrahm@swri.edu)

Martin P Wuest[2] (41-81-423-388-3270; Martin.Wuest@inficon.com)

Geoff Crowley[1] (210-533-3475; gcrowley@swri.edu)

J Kevin Jennings[1] (210-522-5573; kevin.jennings@swri.org)

[1]Southwest Research Institute, P O Drawer 28510 Department of Space Science, San Antonio, TX 78228, United States

[2]INFICON Limited, Alte Landstrasse 6 FL-9496 Balzers, Princ. Liechtenstein, LIE FL-9496, Liechtenstein

We employ an empirical model to study the effects of the energy released into the atmospheric system during the course of the storms of April 14-24, 2002. The NOAA-Data Climatology is a statistical model of precipitating electrons based on 10 years of NOAA-12 Space Environment Monitor (SEM) data. For each hour of UT, the electron spectral shape is defined for solar activity (using F10.7), geomagnetic activity (using Dst, Kp, and PC), invariant latitude (40° to 90°N and -40° to -90°S), and magnetic local time. The climatology includes the precipitating differential fluxes determined from the integral high-energy telescopes of SEM and its low-energy differential measurements. In addition to total global energy input, the spectral information contained in the model enables computations of ionization rate profiles and Hall and Peterson conductivities. We compare these quantities with measurements from low altitude spacecraft and ground-based observatories; and, with global circulation modeling, we obtain height profiles of reactive constituents at selected intervals during the storm.

SM32B-1158 1330h POSTER

High Energy Precipitation and Consequences During the April 2002 Storms

Xiaohua Fang[1] (1-734-647-3370; xhfang@umich.edu)

Janet Kozyra[1] (1-734-647-3550; jukozyra@engin.umich.edu)

Michael Liemohn[1] (1-734-763-6229; liemohn@umich.edu)

David Evans[2] (1-303-497-3269; david.s.evans@noaa.gov)

Stanley Solomon[3] (1-303-497-2179; stans@ucar.edu)

[1]University of Michigan, 2455 Hayward St., Ann Arbor, MI 48109-2143, United States

[2]SEC/NOAA, 325 Broadway, Boulder, CO 80305, United States

[3]National Center for Atmospheric Research, 3450 Mitchell Ln, Boulder, CO 80301, United States

Hemispheric maps of high energy proton and electron precipitation were created to characterize more accurately the energy inputs to the ionosphere-atmosphere system by interpolating NOAA-POES observations over 3-hour intervals during the April 2002 geomagnetic storms. The 3-hour cadence needed to achieve the required coverage is assumed to provide useful information, because of the relatively longer growth and development time scales for the ring current and the slow variation in long-duration solar particle events. These two populations probably account for most of the precipitation in the energy range >30 keV covered by the maps. The maps reveal interesting changes in the precipitation pattern with solar wind conditions and also a more isotropic in local time input during the intervals of sawtooth oscillations. Ring current ion precipitation is thought to be mainly a result of ion scattering in stretched geomagnetic fields as their gyroradii and the scale length of the field curvature become comparable near the equatorial plane. During the sawtooth activity, GOES observed tail-like fields to extend into the geosynchronous orbit region from midnight to dayside local times. Numerical results of our 3D Monte Carlo model will be presented for representative locations in the global particle precipitation. The transverse particle beam spreading effect is considered to be the result of the charge exchange and electron stripping collisions with the Earth's atmosphere. Initial comparisons between our model calculations and data will be provided as well.

SM32B-1159 1330h POSTER

Quantifying the Extraction Efficiency of Ion Upflows Using ISR-FAST-POLAR Common Volume Observations

Ennio R Sanchez[1] (6508594021; ennio.sanchez@sri.com)

Joshua Semeter[1]

Anja Stromme[1]

[1]SRI International, 333 Ravenswood Avenue, Menlo Park, CA 94025, United States

A vast research of radar and spacecraft observations and models has established that the magnitude of the ion flux of ionospheric origin is a consequence of an intricate relationship between the ionosphere and external forcing from the magnetosphere and the Sun. Ions that flow upward from the polar ionosphere fall into two categories: bulk ion flows with energies up to a few eV, and the suprathermal ion flows. Suprathermal ion flows include transversely accelerated ions, upwelling ions, ion conics, and ion beams. These flows have been observed at altitudes ranging from 500 km to several thousand km. Different extraction mechanisms have been proposed to account for the suprathermal ion flux observed by spacecraft at different altitudes. However, it is still unclear how ions are accelerated with altitude in each region of the polar ionosphere for different external forcing conditions. Incoherent-scatter radar and polar orbiting spacecraft measurements have shown that prior to their extraction from the ionosphere, ions are energized locally at topside F region altitudes. The amount of energy gained in the ionosphere due to this preconditioning, however, cannot account for the magnitude of escaping fluxes observed at higher altitudes. The ion extraction process must be a combination of processes that couple the ionosphere source (the F region) to acceleration mechanisms at high altitudes. Simultaneous measurements of ion populations at different altitudes are useful to understand how the ion upflows evolve with altitude. We use conjunctions between Incoherent scatter radars and FAST to explore the height evolution of ion upflows. First, we explain how we define a conjunction in terms of spatial proximity, similarity of particle precipitation or lack of precipitation, and azimuthal extent of auroral precipitation at or adjacent to the topside F-region ion upflow measurement. Then we present the results of a group of conjunctions between FAST and the Sondrestrom and EISCAT radars to show how the efficiency of extraction of ionospheric ions (measured as the ratio of ion flux at FAST with energy of at least 10 eV and pitch angles of at least 90 degrees and bulk ion flux at the topside F-region) can vary from a few percent to several tens of percent, depending on the magnitude of various magnetospheric input parameters such as electron precipitation flux, convection, field-aligned potential drop, and Alfven wave amplitude.

SM32B-1160 1330h POSTER

Variability in the Mesosphere/Thermosphere/Ionosphere System During the Quiet Time of April 2002

L. P Goncharenko[1] (781-981-5622; lpg@haystack.mit.edu); J. Salah[1] (jsalah@haystack.mit.edu); A. Coster[1] (ajc@haystack.mit.edu); W. Rideout[1] (brideout@haystack.mit.edu); S. R. Zhang[1] (shunrong@haystack.mit.edu); L. Paxton[2] (larry.paxton@jhuapl.edu); Y. Zhang[2] (yongliang.zhang@jhuapl.edu); G. Crowley[3] (gcrowley@swri.edu); V. Taran[4] (iion@kpi.kharkov.ua); B. Reinisch[5] (Bodo_Reinisch@uml.edu); R. Clark[6] (ron.clark@unh.edu); A. Manson[7] (manson@dansas.usask.ca); N. Mitchell[8] (N.J.Mitchell@bath.ac.uk); Y. Murayama[9] (murayama@crl.go.jp); D. Riggin[10] (riggin@colorado-research.com); W. Singer[11] (singer@iap-kborn.de)

[1]MIT Haystack Observatory, Off Route 40, Westford, MA 01886, United States

[2]John Hopkins University, APL, 11100 John Hopkins Rd., Laurel, MD 20723, United States

[3]Southwest Research Institute, P.O. Drawer 28510, San Antonio, TX 78228, United States

[4]Institute for Ionosphere, 16 Chervonopraporna Str, Kharkiv 61002, Ukraine

[5]University of Massachusetts Lowell, 600 Suffolk Street, Lowell, MA 01854, United States

[6]University of New Hampshire, Kingsbury, Durham, NH 03824, United States

[7]University of Saskatchewan, 116 Science Place, Saskatoon SK S7N 5E2, Canada

[8]University of Bath, Department of Electronic Electrical Engin., Bath BA2 7AY, United Kingdom

[9]Communications Research Lab., 4-2-1, Nukui-kita, Tokyo 184-8795, Japan

[10]Colorado Research Assoc. Inc., 3380 Mitchell Lane, Boulder, CO 80301, United States

[11]Rostock University, Schloss Str. 6, Kuhlungsborn 18225, Germany

We investigate the structure of the global mesosphere-thermosphere-ionosphere system using multi-instrument observations during the April 2002 period, with focus on geomagnetically quiet periods. Large variations in electron density were observed at midlatitudes by the array of incoherent scatter radars, ionosondes and GPS receivers. On April 16, 2002, electron density decreases to 50-70% of the level observed on Apr 15, 2002. This depletion far exceeds commonly observed 10-20% quiet-time variations. At the same time, the observations from the array of MF and meteor radars show global presence of planetary wave disturbances, and a westward offset in the zonal wind of 15 m/s was noticed at locations coincident with the area of large variations in the electron density. We find that variations in ionospheric parameters have a strong relationship with neutral density, and show that an extensive area of depleted electron density as observed by GPS receivers, ISR radars and ionosondes is coincident with the area of large decrease in the column integrated O/N2 ratio measured by the GUVI instrument on board of TIMED satellite. Similar variations are also predicted by the TIMEGCM/ASPEN model in both O/N2 ratio and electron density, though the magnitude of the variations in the model is significantly smaller.

SM32B-1161 1330h POSTER

Auroral zone GIC proxy dependence on solar wind speed

Brian J Jackel[1] (403-220-4271; bjackel@phys.ucalgary.ca)

Eric F Donovan[1] (eric@phys.ucalgary.ca)

Gregory J Baker[1]

Don D Wallis[2]

David H Boteler[3]

[1]University of Calgary, Institute for Space Research, Physics and Astronomy Dept. University of Calgary 2500 University Drive, Calgary, AB T2N 1N4, Canada

[2]Magnametrics, 2340 Briar Hill Drive, Ottawa, ON K1H 7A9, Canada

[3]Geological Survey of Canada, Geomagnetic Laboratory 7 Observatory Crescent, Ottawa, ON K1A 0Y3, Canada

Dynamic changes in the geomagnetic field provide useful information about the coupled earth-sun system. They also produce ground induced currents (GIC) that can have a profound impact on artificial systems such as pipelines, communications networks, and power transmission grids. Recent work has established that the time derivative of the horizontal magnetic field (dH/dt) is a good proxy for GIC. For this study we analyzed 15 years of data from the CANOPUS magnetometer array, which has 13 sites located primarily in the auroral zone. Most results (ie. weak 11-year and 27-day dependencies, strong latitudinal and local time dependence) are similar to those obtained in other studies. However, we also found a strong quasi- periodic variation in dH/dt with time scales of 7-14 days. This led to the discovery of a strong correlation between dH/dt and solar wind speed. We will present these results, and show how they can be used to predict GIC risks.

SM32B-1162 1330h POSTER

Ground induced currents incorporated to the model for direct and simultaneous simulations of the heliosphere-magnetosphere-ionosphere interactions

Igor V Sokolov[1] (734-647-4705; igorsok@umich.edu)

Tamas I Gombosi[1] (734-647-764-7221; tamas@umich.edu)

Aaron Ridley[1] (734-764-7221; ridley@umich.edu)

[1]University of Michigan, 2455 Hayward Ave, Ann Arbot, MI 48105

The performance of the modern supercomuters allows us to simulate the space weather phenomena and/or the distinct events in the heliosphere-magnetosphere-ionosphere interaction. More and more complicated and extensive models may be incorporated into the global simulation system (framework) to simulate the more complicated in interesting physical phenomena, on one hand, as well as achieve the predictive features of the space weather framework. Among the new features which are being added to the Space Weather Model Framework (University of Michigan) now is the ground induced current model. Being based on more or les detailed information about the ground condictivity, this tool allows us to predict the inductive voltage between any pair of the (grid) points at the Earth surface, on one hand, and estimate the effect the ground induced currents on the ionospheric electric currents and electric fields as well as on the measurements of the magnetic feild variations

SM32B-1163 1330h POSTER

The Effect of Joule Heating on Neutral Density

Francis K Chun[1] ((719) 333-2601; Francis.Chun@usafa.af.mil)

Matthew G McHarg[1] ((719) 333-3510; Matthew.McHarg@usafa.af.mil)

Delores J Knipp[1] ((719) 333-3510; Delores.Knipp@usafa.af.mil)

Frank Marcos[2] (Frank.Marcos@hanscom.af.mil)

[1]Department of Physics, USAF Academy, 2354 Fairchild Drive, Suite 2A31, USAF Academy, CO 80840, United States

[2]Air Force Research Laboratory, AFRL/VSBX, Hanscom AFB, MA 01731, United States

The amount of Joule heating in the upper atmosphere is known to be affected by solar radiation and geomagnetic activity. This heating can lead to an expansion of the upper atmosphere and increase the drag on low-earth orbiting satellites. Currently, the ap index is used as a geomagnetic proxy for neutral density. However, recent studies have shown that Joule heating in the upper atmosphere, and presumably neutral density, can be estimated fairly well by the polar cap (PC) and Dst indices. In this study, we present correlations of neutral density data from the CHAMP satellite to Joule heating spatial distributions from the Assimilative Mapping of Ionospheric Electrodynamics (AMIE) as parameterized by the polar cap index. The CHAMP densities are from days 134 to 182 for the year 2001 at a normalized altitude of 450 km. Preliminary results have shown that in regions of enhanced Joule heating, the neutral density at 450 km as determined from CHAMP data also increases. Further analysis will focus on identifying a temporal relationship between neutral density and Joule heating.

SM32B-1164 1330h POSTER

Global Thermosphere Density Response During the May 27 - June 4, 2003 Storm Interval From CHAMP Accelerometer Measurements

Eric K Sutton[1] (303.492.7061; Eric.Sutton@colorado.edu)

R S Nerem[1] (303.492.6721; nerem@colorado.edu)

J M Forbes[1] (303.492.4359; Forbes@colorado.edu)

[1]Colorado Center for Astrodynamic Research, University of Colorado Campus Box 431, Boulder, CO 80309, United States

Measurements of atmospheric density from the CHAMP satellite near 410 km are used to illustrate the dependence of seasonal, latitudinal, and day/night response of the thermospheric region to elevated levels of magnetic activity. The latitude vs. time evolutions of total mass density at local times near 03:00 and 15:00 hours are elucidated from accelerometer measurements on the CHAMP satellite. These results are compared with density predictions from the NRLMSISE-00 empirical density model. Zonal winds near the equator along with polar north/south winds are analyzed using cross-track accelerometer measurements from CHAMP. The time period considered includes a significant geomagnetic storm from May 27 to June 4, 2003, which exhibits elevated magnetic activity of approximately Kp $\sim$ 5-8. Response during this storm is compared to typical quiet-time behavior during May and June (Kp $\sim$ 1-2). This time interval provides an opportunity to examine the equatorward penetration of storm-induced disturbances under conditions where the mean solar-driven summer-to-winter solstitial circulation, and the circulations driven by high-latitude heating, reinforce and oppose each other in opposite hemispheres. We find a number of orbits to be characterized by 100-1000 km-scale structures, suggesting the presence of aurorally-generated waves. Day/night differences in the equatorward penetration of both global-scale and small-scale density perturbations are also examined in terms of diurnal variations in the solar-driven meridional flow.

SM32B-1165 1330h POSTER

The ISR World-Day Campaign: Review of the April 2002 Geomagnetic Storm With Comparisons to the TIMEGCM/ASPEN Model

Mario N Vigil[1] (719-576-3842; mailtovigil@yahoo.com); Joseph Salah[1]; Larisa Goncharenko[1]; Shunrong Zhang[1]; Geoff Crowley[2]; Anthony Van Eyken[3]; Jeff Thayer[4]; Boris Shpynev[5]; Vitaliy Taran[6]; Qihou Zhou[7]; Nestor Aponte[8]; Jorge Chau[9]

[1]Haystack Observatory, Off Route 40, Westford, MA 01886-1299, United States

[2]SwRI, 6220 Culebra Road P.O. Drawer 28510, San Antonio, TX 78228-0510, United States

[3]EISCAT Scientific Association, PO Box 432, Longyearbyen N-9171, Norway

[4]SRI International Center for Geospace Studies, 333 Ravenswood Avenue, Menlo Park, CA 94025, United States

[5]Institute for Solar-Terrestrial Physics, P.O.Box 4026, Irkutsk 664033, Russian Federation

[6]Institute for Ionosphere, 16 Chervonopraporna Str, Kharkiv 61002, Ukraine

[7]Miami University Manufacturing and Mechanical Eng. Dept., 141 Kreger, Oxford, OH 45056, United States

[8]Arecibo Observatory, HC3 Box 53995, Arecibo PR 00612, United States

[9]Instituto Geofisico del Peru Radio Observatorio de Jicamarca, Aparatado 13-0207, Lima LIMA 33, Peru

In this presentation, the results of the April 2002 world-day campaign are reviewed. Initiated by the Haystack Observatory, this campaign unites the efforts of eight incoherent scatter radars to collect ionospheric data during a major geomagnetic storm beginning on April 17, 2002. The participating ISRs are located along latitudinal and longitudinal sectors making this campaign unique and invaluable for studying spatial and temporal effects of ionospheric storms. Emphasis is given to describing pre-storm electron density depletions, storm-time ionospheric structure, and comparisons between the ISRs and TIMEGCM/ASPEN, a first principle physical model.

SM32C MCC: 2002-2004 Wednesday 1340h

Magnetotail and Plasma Sheet III

Presiding: **N E Turner,** University of Texas at El Paso**; J Buechner,** Max-Planck-Institut für Aeronomie

SM32C-01 1340h

Numerical Simulations of the Interchange Instability in the Plasma Sheet

Stanislav Sazykin[1] (713-348-3628; sazykin@rice.edu)

Richard A. Wolf[1] (713-348-3308; rawolf@rice.edu)

Robert W. Spiro[1] (713-348-3591; spiro@rice.edu)

Frank R. Toffoletto[1] (713-348-3641; toffo@rice.edu)

[1]Rice University, Physics and Astronomy Dept., MS-108, 6100 South Main St., Houston, TX 77005-1892, United States

Although the plasma sheet of the Earth is usually stable with respect to interchange motion, it has been long known that, under appropriate conditions, interchange-like instabilities are possible even in the ideal MHD approximation. For example, such conditions may exist during periods of strong sunward convection when there are sharp and significant decreases in the plasma sheet density. Previously, we have used numerical simulations to show that the inner (L<6) magnetosphere can be interchange-unstable if we take particle fluxes measured by LANL geosynchronous spacecraft as inputs to the Rice Convection Model (RCM). In this paper, we present new results from RCM numerical simulations with the modeling region expanded to 20-25 Re in the magnetotail, to include the central plasma sheet region. In these simulations, a global time-dependent magnetic field model, as well as a time-dependent distribution of particle fluxes in the plasma sheet, are used as inputs to the model. First, we analyze under what geomagnetic conditions the plasma sheet may be interchange-unstable by using a number of different empirical models of the plasma sheet plasma distribution and several magnetic field configurations (both theoretical and data-based). We then present time-dependent simulations of magnetospheric global particle fluxes, field-aligned currents, and electric fields computed self-consistently with the RCM that show growth and evolution of the interchange instability. Based on these results, we address the previously-published idea that interchange-instability motions in the plasma sheet may be related to the formation of auroral arc structures.

SM32C-02 1355h

Probability Distribution Functions for Magnetic Field Fluctuations Inferred From Cluster Measurements: Evidence for Intermittent Turbulence in the Plasma Sheet.

James M Weygand[1] ((310) 825-1995; jweygand@igpp.ucla.edu); Margaret G Kivelson[1]; Krishan K Khurana[1]; Robert L McPherron[1]; Lynn M Kistler[2]; Andre Balogh[3]; Scot Thompson[1]

[1]Insitute of Geophysics and Planetary Physics University of California, Los Angeles, 3845 Slichter Hall PO Box 1567, Los Angeles, CA 90034, United States

[2]University of New Hampshire, Department of Physics DeMeritt Hall, 9 Library Way, Durham, NH 03824, United States

[3]The Blackett Laboratory, Imperial College of Science, Prince Consort Road, London Sw7 2BZ, United Kingdom

Cluster fluxgate magnetometer data and ion spectroscopic data are employed to construct and interpret the probability distribution functions (PDFs) of magnetic field fluctuations. This technique, often used in analysis of laboratory plasmas, is used to look for intermittent plasma turbulence. We examined the distribution of the magnetic field fluctuations for a single spacecraft, and between pairs of highly correlated Cluster times series magnetometer data in both the plasma sheet and lobe regions. Because there are four Cluster spacecraft, one can examine up to 6 spacecraft pairs and because the separations change yearly, it is possible to examine for three different scale sizes (about 150 km, 1000 km, and 5000 km) relative to the turbulent eddy scales during Cluster's passages through the magnetotail regions in the summers of 2001, 2002, and 2003. The PDFs in the plasma sheet fall off more slowly for increasingly large fluctuations than do normal distributions. Furthermore, the distribution function for