SM21D-05 1120h

Filling and Emptying of the Plasma Sheet: Remote Observations With 1-70 keV Energetic Neutral Atoms

David J. McComas[1] (1-210-522-5983; dmccomas@swri.edu); Philip W. Valek[1] (pvalek@swri.edu); James L. Burch[1] (jburch@swri.edu); Craig J. Pollock[1] (cpollock@swri.edu); Ruth M. Skoug[2] (rskoug@lanl.gov); Michelle F. Thomsen[2] (mthomsen@lanl.gov)

[1]Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78238, United States

[2]Los Alamos National Laboratory, MS D466, Los Alamos, NM 87545, United States

This study shows the first energetic neutral atom (ENA) observations of the extended plasma sheet, taken with the Medium Energy Neutral Atom (MENA) imager on the IMAGE spacecraft. We show that ENA emissions can be routinely observed back to several tens of R_E deep in the magnetotail when IMAGE is in an appropriate orbital position. Enhanced emissions (high plasma sheet densities) are associated with high solar wind densities and with super dense plasma sheet observations at geosynchronous orbit. We examine two magnetospheric storm intervals where plasma sheet loading begins prior to the storms and continues under all IMF B_Z orientations, reaching its maximum during the peaks of the storms. Subsequently, ENA emissions are weak indicating that the plasma sheet is depleted for several days following these storms. This study indicates that routine ENA observations of the plasma sheet content could become an important part of space weather monitoring.

SM21D-06 1135h

Modeling the Inner Plasma Sheet Protons and Magnetic Field Under Enhanced Convection

Chih-Ping Wang[1] (cat@atmos.ucla.edu)

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

Margaret W. Chen[2] (Margaret.W.Chen@aero.org)

Richard A. Wolf[3] (wolf@alfven.rice.edu)

Frank R. Toffoletto[3] (toffo@rice.edu)

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

[2]Space Science Applications Laboratory, The Aerospace Corporation, P.O.Box 92957 M2-260, Los Angeles, CA 90009, United States

[3]Dept of Physics and Astronomy,, Rice University, Houston, TX 77251, United States

In order to understand the evolution of the protons and magnetic field in the inner plasma sheet from quiet to disturbed conditions, we incorporate a modified version of the Magnetospheric Specification Model with a modified version of the Tsyganenko 96 magnetic field model to simulate the protons and magnetic field under an increasing convection electric field with two-dimensional force balance maintained along the midnight meridian. The local-time dependent proton differential fluxes assigned to the model boundary are a mixture of hot plasma from the mantle and cooler plasma from the low latitude boundary layer. We previously used this model to simulate the inner plasma sheet under weak convection corresponding to a cross polar-cap potential drop ($\Delta\Phi_{PC}$) equal to 26 kV and obtained two-dimensional quiet time equilibrium for proton and magnetic field that agrees well with observations. We start our simulation for enhanced convection with this quiet time equilibrium and time independent boundary particle sources and increase $\Delta\Phi_{PC}$ steadily from 26 kV to 146 kV in 5 hours. Simulations are also run separately to steady states by keeping $\Delta\Phi_{PC}$ constant after it is increased to 98 and 146 kV. The magnitudes of proton pressure, number density, and temperature and their increase from quiet to moderate activity ($\Delta\Phi_{PC}$ = 98 kV) are consistent with most observations. Our simulation at high activity ($\Delta\Phi_{PC}$ = 146 kV) underestimates the observed pressure and temperature. This disagreement indicates possible dependence of the boundary particle sources on activity and possible effects of solar wind dynamic pressure enhancements that have not yet been included in our simulation. The simulated equatorial pressures and temperatures show stronger enhancement on the dusk side than on the dawn side as convection is increased, while density profiles show an increase on the dawn side and a decrease on the dusk side. The simulated proton flow speed at the equatorial plane increases with enhancing convection while the overall flow direction does not change significantly, a result of enhancement in both the earthward electric drift and azimuthal diamagnetic drift. The equatorial magnetic field strength decreases more in the near-Earth plasma sheet than at larger radial distances as $\Delta\Phi_{PC}$ increases, resulting in an increasing flat radial profile with enhancing convection. The feedbacks from diamagnetic drift and magnetic fields to increasing convection are found to restrain the pressure increase. Based on the good agreement between our results and observations at moderate activity, our magnetic field indicates the plasma and magnetic field in the plasma sheet can be in a state far from possible force balance inconsistency during periods of moderately enhanced convection. A scale analysis of our results shows that the frozen-in condition E = -vxB is not valid in the inner plasma sheet for moderate activity.

SM21D-07 1150h

Auroral Poleward Boundary Intensifications: their two-dimensional structure and the associated dynamics in the Plasma Sheet

Eftyhia Zesta[1] (310-206-2710; ezesta@atmos.ucla.edu)

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

Eric Donovan[2]

Harald U. Frey[3]

Tsugunobu Nagai[4]

[1]UCLA - Dept of Atmospheric Sciences, 405 Hilgard Ave Box 951565, Los Angeles, CA 90095-1565, United States

[2]University of Calgary, Deparment of Physics and Astronomy, Calgary, Alb T2N 1N4, Canada

[3]University of California, Berkely, Space Science Lab, Berkeley, CA 94720-7450, United States

[4]Tokyo Inst Technology, Dept Earth Planetary Sciences Ookayama 2-12-1 Meguro, Tokyo 152-8551, Japan

Auroral poleward boundary intensifications (PBIs) have an auroral signature in ground meridional scanning photometer (MSP) data that appears as an increase in intensity at or near the magnetic separatrix. This increase is often seen to extend equatorward through the ionospheric mapping of the plasma sheet. PBIs are associated with plasma sheet flow bursts and are thus important to plasma sheet dynamics. We previously found that equatorward extending PBIs are either north-south (NS) aligned structures or east-west (EW) arcs that mostly propagate equatorward. We further investigate the plasma sheet dynamic structures associated with these two types of PBIs by combining data from the CANOPUS MSPs, auroral images from the IMAGE spacecraft, and magnetic field and plasma data from the Geotail spacecraft. We study a period on January 3, 2001, when a series of PBIs were seen in the MSP data for 2.5 hrs. From simultaneous IMAGE and Geotail data we find that: (a) PBIs correlate well with plasma sheet fast flows observed within the local time sector of the PBIs. There can be several PBIs over the longitudinal range of fast flows in the tail, (b) multiple PBIs can occur over the whole width of the plasma sheet or in a more restricted local sector (i.e. only premidnight). When PBIs are seen only in a local sector fast flows are seen only in that local sector as well. Where no PBIs are seen no fast flows are seen, (c) most of the observed PBIs were EW arcs that initiated near the poleward boundary and then propagated equatorward. They often tilted and became mostly NS structures as they propagated equatorward and duskward, (d) there is a local time dependence on the type of PBI structure. Most PBIs seem to be narrow structures and primarily aligned with a line that goes through the 02 MLT and 17 MLT sectors. This results in PBIs that are NS structures in the postmidnight sector and EW arcs in the dusk sector. In the premidnight sector (22-00 MLT) PBIs start as EW arcs that then tilt and become primarily NS structures. These results suggest that the same plasma sheet dynamics produce EW and NS PBI structures.

SM22A MCC: Hall D Tuesday 1330h

Coupling of the Subauroral Ionosphere, Plasmasphere, and Magnetosphere II Posters *(joint with SA)*

Presiding: **P C Anderson,** The Aerospace Corporation**; M W Liemohn,** University of Michigan

SM22A-0557 1330h POSTER

Simulations of Stormtime Diffuse Aurora Using AMIE Electric Field and Flux-Dependent Electron Scattering Model

David L. McKenzie[1] (David.L.McKenzie@aero.org); Margaret W. Chen[1] (mchen@aero.org); Michael Schulz[2] (mike.schulz@lmco.com); Phillip C. Anderson[1] (Phillip.C.Anderson@aero.org); Gang Lu[3] (ganglu@hao.ucar.edu); Martin P. Wuest[4] (mwuest@swri.edu)

[1]The Aerospace Corporation, POB 92957, M2-260, Los Angeles, CA 90009-2957, United States

[2]Lockheed Martin Technology Center, O/L9-42, B/255, 3251 Hanover Street, Palo Alto, CA 94304

[3]High Altitude Observatory/NCAR, POB 3000, 3450 Mitchell Lane, Boulder, CO 80307-3000, United States

[4]Southwest Research Institute, 6220 Culebra Rd, San Antonio, TX 78228, United States

We obtain distributions of precipitating electrons by tracing drift shells of plasmasheet electrons in the limit of strong pitch angle diffusion in Dungeys model magnetosphere, which consists of a dipolar magnetic field plus a uniform southward field. Under strong pitch-angle diffusion particles drift so as to conserve an adiabatic invariant L equal to the enclosed phase-space volume (i.e., the cube of the particle momentum p times the occupied flux-tube volume per unit magnetic flux). Here we model the magnetospheric convection electric field by mapping an analytical expansion of the AMIE (Assimilative Model of Ionospheric Electrodynamics) ionospheric potential (a function of latitude and magnetic local time) along magnetic field lines from ionospheric latitudes $\geq 50^{\circ} (L \geq 2.5)$ in Dungeys magnetic field model. We trace the bounce-averaged drift motions of representative plasmasheet electrons with values of L corresponding to kinetic energies of $0.25 - 64$ keV on a field line of equatorial radius $r = 6R_E$, which maps to 65° latitude in the ionosphere. Using the simulation results, we map stormtime phase space distributions along particle drift shells, taking into account loss due to precipitation. We consider 3 models of electron scattering: (1) the limit of strong scattering everywhere, (2) an MLT-dependent scattering that is less than everywhere strong in the plasma sheet, and (3) an electron flux-dependent scattering. Our flux-dependent scattering model is based on the Kennel-Petschek concept that wave growth occurs where there is sufficient electron flux to cause it. From the phase space distributions thus obtained, we calculate the precipitating electron energy flux into the ionosphere. For this study we focus on the main phase of the October 19, 1998, storm. Magnitudes of the integrated electron energy flux obtained from our simulations are consistent with statistical averages of precipitating electron flux obtained from NOAA data. For selected times of interest we compare the simulated electron flux with Polar UVI images. We also weight our simulated electron flux by the Bremsstrahlung X-ray production curve to obtain simulated X-ray fluxes for comparison with PIXIE images. Our simulations with the electron flux-dependent scattering model indeed reproduce some of the features that are observed in UVI and X-ray images.

SM22A-0558 1330h POSTER

Penetration Electric Field Observations and Modeling in the Pre-Noon Mid-Latitude Ionosphere

Shauna M Nolin[1] (937-255-3636; smnolin@yahoo.com); Devin J Della-Rose[1] (937-255-3636 x4514; devin.della-rose@afit.edu); Jan J Sojka[2]; Robert W Schunk[2]; Michael David[2]; F Tom Berkey[2]

[1]Air Force Institute of Technology, 2950 P. Street, Bldg 640, Wright-Patterson AFB, OH 45433-7765, United States

[2]Center for Atmospheric and Space Sciences, Utah State University, Logan, UT 84322-4405, United States

We have studied the mid-latitude ionospheric response to a large geomagnetic storm that occurred on 11 April 2001. The storm main phase began at about 1600 UT, and by 1630 UT, two western U.S. ionosondes (Bear Lake, UT, and Boulder, CO; a separation of 700 km) began recording similar, periodic ($\sim$ 1 hr) oscillations in h_mF2. Both stations were in the pre-noon sector at the start of the event. The fluctuations lasted the rest of the UT day, and the vertical displacements were up to 100 km (virtual height). Significant IMF B_z oscillations are evident in the WIND data during this same period, but the IMF and h_mF2 time series exhibit a phase difference that varies in time as the event progresses. We attribute the rapid vertical *F*-layer motions to $\mathbf{E}\times\mathbf{B}$ drifts associated with zonal penetration electric fields. To test this hypothesis, we derived the zonal fields from the Boulder ionosonde data, and used these fields to drive the Utah State Time-Dependent Ionospheric Model (TDIM). The modeled h_mF2 values matched well with the Boulder observations. However, the modeled f_oF2 oscillations are somewhat out-of-phase with, and have smaller amplitudes than, the Boulder data; the cause of this is still under study. We have also examined DMSP data for this storm, which revealed strong pre-noon vertical ion drifts and Birkeland currents in an F15 pass at the start of the event, as well as the signature of dusk meridional penetration fields in the F13 SSJ/4 data throughout the storm. Finally, we consider whether our zonal penetration field time series could be caused by the ionospheric closure of the storm-time asymmetric ring current.

SM22A-0559 1330h POSTER

Alfvénic Field Line Resonances in the Nightside Subauroral Zone

Anatoly V. Streltsov[1] (streltsov@dartmouth.edu)

Evgeny V. Mishin[2] (evgenii.mishin@hanscom.af.mil)

John C. Foster[3] (jcf@haystack.mit.edu)

[1]Thayer School of Engineering, Dartmouth College, Hanover, NH 03755

[2]Boston College, Institute for Scientific Research 402 St. Clements Hall 140 Commonwealth Ave., Chesnut Hill, MA 02467

[3]MIT/Haystack Observatory, Rt 40, Westford, MA 01886

Results from a numerical study of localized, intense electromagnetic structures recently revealed from DMSP observations in the nightside sub-auroral zone are presented. It is shown that some of these structures can be interpreted as Alfvén waves produced in a result of electromagnetic interaction between the equatorial magnetosphere and the nightside sub-auroral ionosphere. The main part of this interaction is the active ionospheric response (feedback) on a large-scale electric field generated in the equatorial magnetosphere and penetrating down to the ionospheric E-layer when the ionospheric Pedersen conductivity is low. In particular, computations show that when the Pedersen conductivity is less then 1 mho small-scale irregularities in the E-layer plasma density can generate Alfvén waves with substantial amplitude. Initially, perpendicular electric and magnetic fields in those waves are in phase and corresponding Poynting vector is directed along the ambient magnetic field from the ionosphere. As time proceeds, the standing pattern of the resonant Alfvén waves has been developing between the ionospheres and $\pi/2$ phase shift between wave $E_\perp$ and $B_\perp$ appears. In this time the Poynting vector can change several times direction along the ambient magnetic field within one structure. Both behaviors of Poynting vector were observed within intense electromagnetic structures registered by DMSP satellites in the sub-auroral zone. In this study the non-linear aspects of the ionosphere-magnetosphere coupling leading to the formation of small-scale intense electromagnetic structures are investigated depending on the parameters of the ionosphere and magnetospheric plasma along the entire subauroral flux tube. Computations show good quantitative agreement between numerical results and selected satellite and Millstone Hill radar observations.

SM22A-0560 1330h POSTER

Wave Structures Within Sub-Auroral Polarization Streams during the November 6, 2001 magnetic storm

Evgeny V Mishin[1] (781 377-1309; evgenii.mishin@hanscom.af.mil)

William J Burke[2] (william.burke@hanscom.af.mil)

Cheryl Y Huang[1] (cheryl.huang@hanscom.af.mil)

Frederick J Rich[2] (frederick.rich@hanscom.af.mil)

Anatoly V Streltsov[3] (streltsov@dartmouth.edu)

[1]Boston College Institute for Scientific Research, 402 St. Clements Hall, Chestnut Hill,, MA 02467, United States

[2]Air Force Research Laboratory, AFRL/VSBP, 29 Randolph Road, Hanscom AFB, MA 01731, United States

[3]Thayer School of Engineering, Dartmouth College, Hanover, NH 03755, United States

Intense wave structures observed by the DMSP F15 satellite at mid-latitudes during the magnetic storm on November 6, 2001 are reported. These structures are found inside the so-called Sub-Auroral Polarization Streams, i.e., a strongly-enhanced, localized westward convection flow inside the density trough. Electric (magnetic) field variations in the wave structures amount to 70 mV/m (20 nT). Relative plasma density variations reach up to 20%. Precipitations of energetic (30 keV) protons accompany particularly strong structures.

A detailed exposition of measurements acquired during one of the SAPS crossing illustrates the quasi-dc circuit and embedded small-scale plasma and fields irregularities. Our analysis demonstrates that the irregularities often have nearly monochromatic frequency spectra. Both quasi-electrostatic and electromagnetic wave structures can coexist in close physics proximity. At times the Poynting flux carried by the electromagnetic waves was directed away from the ionosphere. Possible wave-generation mechanisms and their roles in ring current-plasmasphere-ionosphere interaction are discussed. We suggest that some of these structures are due to Alfvén waves produced in a positive feedback interaction between the nightside sub-auroral ionosphere and the equatorial magnetosphere in agreement with the numerical modeling results.

SM22A-0561 1330h POSTER

Investigation of Electron Density Profile in the Lowest Ionosphere by SRP-4 rocket experiment

Keigo Ishisaka[1] (81-766-56-7500; ishisaka@pu-toyama.ac.jp); Toshimi Okada[1] (okada@pu-toyama.ac.jp); Joseph G Hawkins[2] (ffjgh@uaf.edu); Satoshi Murakami[1] (murakami@rdw.pu-toyama.ac.jp); Taketoshi Miyake[1] (miyake@pu-toyama.ac.jp); Isamu Nagano[3] (nagano@totoro.ec.t.kanazawa-u.ac.jp); Hiroshi Matsumoto[4] (matsumot@kurasc.kyoto-u.ac.jp)

[1]Toyama Prefectural University, 5180 Kurokawa, Kosugi, Toyama 939-0398, Japan

[2]University of Alaska Fairbanks, PO Box 755919, Fairbanks, AK 99775-5919, United States

[3]Kanazawa University, 2-40-20 Kodatsuno, Kanazawa, Ishikawa 920-8667, Japan

[4]RASC, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan

The radio wave propagation characteristic in the lower ionosphere is important because of its effect on commercial radio communication, navigation, and broadcast services. The electron density is of primary interest in this region because the high ion-neutral collision frequencies result in radio wave absorption. Previous studies have examined the electron density profile and structure of the ionosphere using the rocket and satellite measurements. The standard International Reference Ionosphere (IRI) model gives the estimated electron density profile based on the measurements, but no sufficient measurements have been accumulated below 65 km to estimate the model ionosphere to lower altitudes.

In order to investigate the ionization structure in the altitude below 90 km by means of MF-band signals propagation, the Alaska rocket SRP-4 experiments has been carried out. The rocket was launched at 12:08 LT on March 18, 2002 at Poker Flat Research Range. The apex of rocket trajectory was about 89 km. We observed three different signals, CHENA (257 kHz), KFAR (660 kHz) and KCBF (820 kHz), transmitted from navigation and broadcast stations near Fairbanks, Alaska. Three signals were successfully observed from an altitude 0 km - 89 km during the ascent flight. The intensity of 257 kHz signal decreases steeply at an altitude higher than 65 km and reflects perfectly at about 75 km. The altitudes of perfect reflection of 660 kHz and 820 kHz signals are about 79 km and about 81 km, respectively. The approximate electron density profile can be determined from the comparison between these experimental results and propagation characteristics calculated by the full wave method. We will get the most probable electron density profile in the lowest ionosphere below 65 km.

SM22A-0562 1330h POSTER

Composition of Auroral Polar Cap Boundary Ion Conics

Yeh-Kai Tung[1] (510-643-3500; yktung@ssl.berkeley.edu); Charles W Carlson[1] (cwc@ssl.berkeley.edu); James P McFadden[1] (mcfadden@ssl.berkeley.edu); Geroge K Parks[1] (parks@ssl.berkeley.edu); Eric J Lund[2] (eric.lund@unh.edu); Stefan Eriksson[3] (eriksson@fast.colorado.edu); Robert E Ergun[3] (ree@lasp.colorado.edu)

[1]Space Sciences Lab, University of California, Berkeley, CA 94720, United States

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

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

Ion conics have frequently been observed by FAST on the auroral polar cap boundary, which we have defined as where the ion energy flux sharply drops off. These polar cap boundary (PCB) ion conics are particularly prevalent in the nightside sector near midnight. Of medium energies (100 eV to 1 keV), these ion conics are characterized by intense number fluxes and often constitute the majority of the outflow from the nightside auroral oval. An earlier study has reported that the PCB ion outflow consisted predominantly of H+ and He+, while a separate study presented data that showed PCB ion conics that consisted primarily of oxygen ions. Possible explanations for the composition change include solar cycle variation or seasonal variation. We will explore through a systematic consideration of FAST orbits from 1997 through 2000 the change in composition of PCB ion conics. Since neither the solar cycle nor the seasons alone seem to explain the variation in ion composition of the PCB ion conics, we will consider alternative possibilities such as convection, IMF dependence, or auroral activity level and history.

SM22A-0563 1330h POSTER

The Global Development of Energetic Electron Precipitation During the Storm Sudden Commencement on September 24, 1998

Bjarte Ursin[1] (47 55 58 27 46; bjarte.ursin@fi.uib.no); Johan Stadsnes[1] (47 55 58 27 48; johan.stadsnes@fi.uib.no); George K Parks[2] (parks@ssl.berkeley.edu); Nikolai Ostgaard[2] (nikost@ssl.berkeley.edu); Reiner H Friedel[3] (friedel@lanl.gov); Richard D Belian[3] (rbelian@lanl.gov); Rune Stadsnes[1] (rune.stadsnes@fi.uib.no)

[1]Department of Physics, University of Bergen, Allegaten 55, Bergen N-5007, Norway

[2]Space Sciences Laboratory, University of California, Centennial Dr./Grizzly Pk.Blvd., Berkeley, CA 94720, United States

[3]Los Alamos National Laboratory, Mail Stop D436, Los Alamos, NM 87545, United States

Observations by the PIXIE and UVI cameras on the POLAR satellite give information about the global distribution of energetic electron precipitation. We have studied the development of the electron precipitation observed in connection with the sudden commencement of the geomagnetic storm occurring on September 24-25, 1998. The SSC, which occurred in the late recovery phase of a complex substorm period, caused transient ($\sim$4 min) precipitation of energetic electrons (>5 keV) in the morning - pre noon magnetic local time sector. The precipitation shows azimuthal spectral differences. We suggest that this precipitation is caused by wave particle interaction. Simultaneously, the LANL geosynchronous spacecraft see a rapid increase in the electron fluxes in the morning sector associated with the SSC. In the precipitation of less energetic electrons, a prolonged enhancement is occurring in the afternoon MLT sector. This precipitation may be associated with field aligned currents set up in the afternoon sector in connection with the SSC.

SM22A-0564 1330h POSTER

Study of High Latitude-Low Latitude Coupling using MTIEGCM

Geeta Jadhav[1] (303-497-8324; geeta@hao.ucar.edu)

Arthur Richmond[1] (303-497-1570; richmond@hao.ucar.edu)

Astrid Maute[1] (303-497-1539; maute@hao.ucar.edu)

Christophe Peymirat[2] (+33 (0)5-61-55-66-77; Christophe.Peymirat@cesr.fr)

[1]High Altitude Observatory, National Center for Atmospheric Research,, Boulder, CO 80307, United States

[2]Centre dEtude Spatiale des Rayonnements, 9 Avenue du Colonel Roche,, Toulouse 31028, France

Direct penetration of electric fields from high to low latitudes is controlled by number of parameters, such as disturbances at high latitudes, background and disturbance winds etc. The present investigation attempts to study the sensitivity of the electric field penetration to the polar cap potential and the wind system, using simulations by Magnetosphere-Thermosphere-Ionosphere-Electrodynamic general circulation model (MTIEGCM). The magnetic field perturbations on the ground stations estimated by MTIEGCM are compared with the actual observations.

SM22A-0565 1330h POSTER

Ionospheric convection patterns observed during periods of steady magnetospheric convection

John M. Hughes[1] (907-474-6316; hughesj@gi.alaska.edu)

William A. Bristow[1] (907-474-6316; Bill.Bristow@gi.alaska.edu)

[1]Geophysical Institute, University of Alaska Fairbanks 903 Koyukuk Dr., Fairbanks, AK 99709, United States

We present a study of ionospheric convection patterns observed by the Super Dual Auroral Radar Network (SuperDARN) during two recent steady magnetospheric convection (SMC) events. Our analyses foucus on the region near the Harang discontinuity (HD) and show, in contrast to prevous SMC studies, that the HD is not an uncommon feature during SMC events. Although often observed during these events, the HD appears less extended than during a typical substorm growth phase and often forms at relatively high geomagnetic latitudes.

SM22A-0566 1330h POSTER

Multi-point measurements of plasma drifts and densities near the plasmapause

Rejean Grard[1] (Rejean.Grard@esa.int)

Harri Laakso[1] (Harri.Laakso@esa.int)

Arnaud Masson[1] (Arnaud.Masson@esa.int)

[1]ESA/ESTEC, Code SCI-SB Postbus 299, Noordwijk 2200 AG, Netherlands

The coupling between the ionosphere, the plasmasphere and the outer magneto- sphere is not yet well understood. Erosion and recovery of the plasmasphere are important issues that are inherently related to the global dynamics and structure of the ionosphere and magnetosphere. At the plasmapause, the density decreases a few orders of magnitude over a relatively short distance and the plasma drift is switched from corotation into convection. Sometimes these changes occur very suddenly, sometimes slowly, and under some conditions, the transitions are quite oscillatory. This appears very clearly in the measurements from the Polar satellite that has encountered the plasmapause regions over 10,000 times. Now, the multi-point Cluster observations allows us to investigate the meso-scale (100-1000 km) structures in more detail so that spatial and temporal features can be separated from the data. We utilize measurements from the electric field experiment that measures both the plasma drift and total plasma density along the satellites' trajectories across the plasmapause. We present different kind of events, such as plasmapause density structures with various spatial and temporal scales, significant radial plasma drifts on both sides of the plasmapause, plasmpause modulation by wave activity (2-minute surface waves) causing plenty of plasmapause crossings (while the satellites are skimming the boundary), radial oscillation of the plasmapause ("breathing") etc.

SM22A-0567 1330h POSTER

Coupled Michigan MHD - Rice Convection Model Results

Darren De Zeeuw[1] (734-763-6224; darrens@umich.edu)

Stanislav Sazykin[2]

Dick Wolf[2]

Tamas Gombosi[1]

Ken Powell[1]

[1]Center for Space Environment Modeling, University of Michigan, 2455 Hayward St., Ann Arbor, MI 48109-2143

[2]Rice University, Herman Brown Hall Physics and Astronomy MS108, Houston, TX 77251

A new high performance Rice Convection Model (RCM) has been coupled to the adaptive-grid Michigan MHD model (BATSRUS). This fully coupled code allows us to self-consistently simulate the physics in the inner and middle magnetosphere. A study will be presented of the basic characteristics of the inner and middle magnetosphere in the context of a single coupled-code run for idealized storm inputs. The analysis will include region-2 currents, shielding of the inner magnetosphere, partial ring currents, pressure distribution, magnetic field inflation, and distribution of pVgamma.

SM22A-0568 1330h POSTER

The role of the ring current in the dynamics of the electric field of the inner magnetosphere

pontus C Brandt[1] (240-228-3837; pontus.brandt@jhuapl.edu); Shin Ohtani[1] (shin.ohtani@jhuapl.edu); Don G Mitchell[1] (don.mitchell@jhuapl.edu); Edmond C Roelof[1] (edmond.roelof@jhuapl.edu); Robert Demajistre[1] (robert.demajistre@jhuapl.edu); Jerry Goldstein[2] (jerru@rice.edu); Mei-Ching Fok[3] (Mei-Ching.Fok@gsfc.nasa.gov)

[1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, United States

[2]Rice University , Dept Physics Astronomy 6100 Main St MS-108, Houston, TX 77005, United States

[3]Goddard Space Flight Center, MC 692, Greenbelt, MD 20771

Analysis of the global proton distributions derived from the IMAGE/HENA energetic neutral atom (ENA) images, implies strong electric fields in the inner magnetosphere. The proton distribution typically shows that the storm main phase ring current is partial and very little is symmetric. The morphology of the partial ring current changes very little in the 10-200 keV range, which implies that the dominating transport mechanism has to be via $\mathbf{E}\times\mathbf{B}$ drift. These conclusions agree with kinetic ring current models that self consistently calculates the magnetospheric electric field by taking into account the closure of the ring current through the ionosphere. The conclusions are also consistent with observations by the CRRES satellite [Wygant et al., *J. Geophys. Res.*, p. 29527, 1998] and radar observations by the Millstone Hill Radar [Foster et al., JGR in press]. While there is a clear general agreement between the build-up of the partial ring current and the electric fields of the inner magnetosphere, it is still not yet understood what role the ring current plays in the dynamics of the electric field of the inner magnetosphere. The shielding of the solar wind electric field from the inner magnetosphere is established by the closue of the region 2 current system which can be disrupted by substorms, magnetospheric compression etc.. A good indicator of the dynamics of the electric fields is the motion of the plasmapause. Global images of the plasmasphere from the IMAGE/EUV camera have revealed erosion (an apparent "shrinking") of the plasmasphere about 30 min after the solar wind electric field enhances across the magnetosphere (during a southard turning of the IMF B_z) [Goldstein et al., *Geophys. Res. Letters* in press]. We will present and discuss different datasets to shed light on the role of the ring current in the dynamics of the electric fields of the inner magnetosphere.

SM22A-0569 1330h POSTER

The Magnetospheric and Ionospheric Configuration During the 1859 Carrington Event Super-Storm

Aaron J Ridley[1] ((734) 764-5727; ridley@umich.edu)

Tamas I Gombosi[1] (tamas@umich.edu)

Darren L De Zeeuw[1] (darrens@umich.edu)

[1]Center for Space Environment Modeling, Space Research Building University of Michigan, Ann Arbor, MI 48109-2143, United States

Using the University of Michigan MHD code, we have simulated the magnetospheric and ionospheric configuration during the 1859 Carrington event. This event is thought to have a solar wind speed of 2500 km/s and an IMF B_z of -250 nT. We show results for a number of different solar wind densities (from super-Alfvenic to a sub-Alfvenic flow). The magnetopause is significantly inside of geosynchronous orbit, while the bow shock is close to it, depending upon the Alfvenic mach number. Three dimension maps of the magnetospheric configuration are shown. The ionospheric potential, Joule heating, and auroral precipitation patterns are shown. The dependence of these quantites on the solar wind density is examined.

SM22A-0570 1330h POSTER

Modeling the Inner Magnetosphere and its Effects on the Global Current System

Mostafa El-Alaoui[1] (310-206-4175; mostafa@igpp.ucla.edu)

Maha Ashour-Abdalla[1]

Robert L. Richard[1]

Ferdinand V. Coroniti[2]

[1]Institute of Geophysics and Planetary Physics, University of California at Los Angeles, 405 Hilgard Avenue, Los Angeles, CA 90095-1567, United States

[2]Department of Physics and Astronomy, University of California, Los Angeles, 405 Hilgard Avenue, Los Angeles, CA 90095, United States

The interaction of the solar wind with the Earths geomagnetic field leads to a complex current system within the magnetosphere. Understanding this current system requires a global treatment of the solar wind-magnetosphere-ionosphere system. Global magnetohydrodynamic (MHD) simulations provide a reasonable description of the large-scale structure of the Earths magnetosphere as it responds to changes in the interplanetary magnetic field (IMF) direction. Modeling the inner magnetosphere however, is limited by the lack of a proper representation of ring current formation. This is particularly important for modeling magnetic storms. In this talk, we will discuss the consequences of including some of the physical effects of the ring current to the MHD solutions. The approach will be to modify the pressure distribution in the inner magnetosphere. Comparison of results with and without these modifications will be made. The changes to the inner magnetosphere can have an impact on the entire magnetospheric configuration.

SM22A-0571 1330h POSTER

Self-Consistent Modeling of Storm-Time Subauroral Electric Fields

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

Robert W. Spiro[1] (spiro@rice.edu)

Richard A. Wolf[1] (rawolf@rice.edu)

Pontus C:son Brandt[2] (pontus.brandt@jhuapl.edu)

Donald G. Mitchell[2] (don.mitchell@jhuapl.edu)

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

[2]John Hopkins Univ., Applied Physics Laboratory, 11100 John Hopkings Rd., Laurel, MD 20723-6099, United States

Highly dynamic inner magnetospheric electric fields are associated with pressure gradients near the inner edge of the plasma sheet and with the closure of field-aligned region-2 (Birkeland) currents through the auroral and subauroral ionosphere. During geomagnetic storms, the inner edge of the ion plasma sheet, which carries the bulk of the plasma-sheet pressure, is brought closer to the Earth in the dusk-midnight local time sector than the electron population whose precipitation into the ionosphere provides most of the enhanced conductance in the auroral ionosphere. The result is a SubAuroral Polarization Stream (SAPS), a band of fast westward convection located equatorward of the diffuse aurora. This picture of the SAPS phenomenon has been consistently predicted by the Rice Convection Model (RCM), a numerical model of the coupled ionosphere-magnetosphere system. In this paper, we present results of self-consistent RCM simulations of inner magnetospheric electric fields, for several geomagnetic storms, to show that: (1) The dynamics of a SAPS is controlled by the strength of the overall plasma sheet convection. (2) While field-aligned currents associated with pressure gradients in the asymmetric ring current play an integral role in the dynamics of the inner magnetosphere during storms, self-consistent calculations show that the ring current itself responds quickly to changes in the overall strength of magnetospheric convection. (3) The RCM-based picture is consistent with images obtained from the HENA instrument on board the IMAGE spacecraft. In particular, both the RCM and the HENA images indicate formation of the asymmetric ring current in the main phase; however, the ring current pressure quickly becomes nearly symmetric (in local time) if the convection strength suddenly decreases.

SM22A-0572 1330h POSTER

Ring Current Modeling Using AMIE Potentials

V K Jordanova[1] (vania.jordanova@unh.edu)

A Boonsiriseth[2] (amyb@atmos.ucla.edu)

R M Thorne[2] (rmt@atmos.ucla.edu)

Y Dotan[2] (yaniv.dotan@aero.org)

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

[2]Department of Atmospheric Sciences, UCLA, Los Angeles, CA 90095, United States

We simulate the dynamical evolution of the ring current during several geomagnetic storms and compare the results inferred from Volland-Stern type and AMIE convection electric field models. A penetration electric field is added to the AMIE model [*Boonsiriseth et al.*, 2001] to improve the agreement with measurements from the electric field instrument on Polar spacecraft. The ionospheric electric potentials are mapped to the equatorial plane using the Tsyganenko 1996 magnetic field model and the resulting equatorial potential models are coupled with our ring current model. While both Volland-Stern and AMIE models predict the largest electric potentials during the main phase of the storm, detailed comparison indicates that AMIE model predicts stronger and localized electric field penetrating to lower L shells near dusk. Ring current energy density calculations indicate a very asymmetric distribution during the main and early recovery phases. Ring current injection is larger, penetrating to lower L shells, and the Dst index better reproduced in AMIE than in Volland-Stern model. EMIC waves are predominantly excited near Dst minimum and have larger wave gain and cause stronger ion precipitation when AMIE model is used. The ion precipitation patterns predicted by our model exhibit features consistent with storm-time POLAR/IPS observations. However, in the dusk to midnight sector there seems to be a need to include the effect of current sheet scattering at $L{>}5$ during highly active conditions.

Boonsiriseth et al., *J. Geophys. Res., 106*, 12903, 2001.

SM22A-0573 1330h POSTER

Self-Consistent Magnetosphere-Ionosphere Coupling

George V. Khazanov[1] (256-961-7666; george.khazanov@msfc.nasa.gov)

T. S. Newman[2]

M. W. Liemohn[3]

M.-C. Fok[4]

R. W. Spiro[5]

[1]NASA, Marshall Space Flight Center, 320 Sparkman Drive, Huntsville, AL 35805, United States

[2]University of Alabama in Huntsville, Computer Science Department, Huntsville, AL 35806, United States

[3]University of Michigan, Space Physics Research Laboratory, Ann Arbor, MI 48109, United States

[4]NASA Goddard Space Flight Center, Code 692, Greenbelt, MD 20771, United States

[5]Rice University, Physics Department, Houston, TX 77005, United States

A self-consistent ring current (RC) model has been developed that couples electron and ion magnetospheric dynamics with the calculation of the electric field. Two new features were taken into account in order to close the self-consistent magnetosphere-ionosphere coupling loop. First, in addition to the RC ions, we have solved an electron kinetic equation in our model. Second, using the relation of Galand and Richmond [2001], we have calculated the height integrated ionospheric conductances as a function of the precipitated high energy magnetospheric electrons and ions that are produced by our model. To validate the results of our model we simulate the magnetic storm of May 2, 1986, a storm that has been comprehensively studied by Fok et al. [2001], and have compared our results with different theoretical approaches. The self-consistent inclusion of the hot electrons and their effect on the conductance results in deeper penetration of the magnetospheric electric field. In addition, a slight westward rotation of the potential pattern (compared to previous self-consistent results) is evident in the inner magnetosphere. These effects change the hot plasma distribution, especially by allowing increased access of plasma sheet ions and electrons to low L shells.

SM22A-0574 1330h POSTER

Observation of Enhanced Magnetospheric Convection Using Medium Energy (1.0-3.0 keV) Energetic Neutral Atoms.

Jörg-Micha Jahn[1] ((210)522-2491; jjahn@swri.edu); Mei-Ching H Fok[2]; Michael G. Henderson[3]; Craig J. Pollock[1]; Geoffrey Reeves[3]; Ruth Skoug[3]; Michelle F. Thomsen[3]

[1]Southwest Research Institute, Space Science Department 6220 Culebra Road, San Antonio, TX 78238-5166, United States

[2]NASA Goddard SFC, MC 992, Greenbelt, MD 20771, United States

[3]Los Alamos National Laboratory, MS D466, Los Alamos, NM 87545, United States

Observations of electric field induced magnetospheric convection to a large extent have relied on measurements in the low-altitude ionosphere, at the footpoints of magnetospheric field lines. Relating those ionospheric measurements back to the magnetosphere is of course subject to all the know problems with mapping along magnetic field lines. Another candidate to measuring magnetospheric convection at least during times of enhanced convection electric fields are medium energy (1.0 - 3.0 keV) ions traced by their energetic neutral atom (ENA) signature observed by the MENA instrument onboard IMAGE. In this energy range, and under the absence of any enhanced electric fields, those ions drift very slowly through the inner magnetosphere, requiring tens of hours to pass from geosynchronous orbit on the nightside to geosynchronous orbit on the dayside. During a single IMAGE orbit (13 hours orbital period) these particles will appear stationary when observed by the MENA instrument. However, in cases of enhanced convection, these ion populations and their associated ENA emissions will visibly move on timescales of an hour, providing a measure of the convection electric field. We present observations of such events, measuring the drift of medium energy ENA populations through the inner magnetosphere and estimating the electric fields responsible for those drifts. This technique allows us to observe the global transport of actual magnetospheric material, rather than inferring that motion from the mapping of low-altitude measurements. We compare our measurements to simulation results of the presented time periods. At this point the ENA measurements remain somewhat crude due to remaining uncertainties in the exact source location of the observed ENA's. Eventually, however, we will compare these measurements to measurements taken in the ionosphere below.

SM22A-0575 1330h POSTER

Evolution of the Inner Magnetosphere from Quiet to Storm Times: MENA Observations

Earl E. Scime[1] (escime@wvu.edu)

Anna Zaniewski[1] (annamz@hotmail.com)

Eric Edlund[2] (ee9@mail.csuchico.edu)

Craig Pollock[3] (cpollock@swri.edu)

Joerg-Micha Jahn[3] (jjahn@swri.edu)

[1]Department of Physics, West Virginia University, Box 6315, Morgantown, WV 26506

[2]California State University - Chico, 835 W. 4th Ave. 1, Chico, CA 95926

[3]Southwest Research Institute, 6220 Culebra Road, San Antonio, TX 78238-5166

In this study, we will present energetic neutral atom (ENA) images from the Medium Energy Neutral Atom (MENA) imager on the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) observatory as a function of DST. The MENA instrument detects ENAs with 1-60 keV per nucleon. To obtain sufficient counts during quiet times, i.e., small values of DST, we have developed a code that combines into a single composite image, MENA images from different times in a single IMAGE orbit and MENA images from different orientations of the IMAGE orbital plane relative to the Earth-Sun direction. We find that with these techniques, composite images of the quiet time magnetosphere can be constructed from approximately 1000 individual MENA images. To improve MENA image sharpness, we have also developed an algorithm that removes the effects of neutral scattering in the MENA instrument. Using these sharpened composite images, the evolution of the inner ring current and plasmasheet structure as a function of DST magnitude will be presented. As shown in previous work [Scime et al. GRL 2002], it is possible to construct images of the plasma ion temperature from the images obtained at different ENA energies. Therefore, the evolution of the ion temperature in the inner magnetosphere as a function of DST will also be presented.

SM22A-0576 1330h POSTER

Storm Time Equatorial Belt - an Image of Ring Current Behavior

Finn Soraas[1] (+47-55582714; finn.soraas@fi.uib.no)

Kjellmar Oksavik[1] (+47-55589406; kjellmar.oksavik@fi.uib.no)

Kjell Aarsnes[1] (+47-55582715; kjell.aarsnes@fi.uib.no)

David S. Evans[2] (devans@sec.noaa.gov)

Mary Sue Greer[2] (sgreer@sec.noaa.gov)

[1]University of Bergen, Department of Physics, Allegaten 55, Bergen N-5007, Norway

[2]NOAA Space Environment Center, 325 Broadway, Boulder, CO 80305, United States

During geomagnetic storms a well defined belt of trapped protons and ENAs (energetic neutral atoms) is observed around geomagnetic equator at low L-values. Their source is RC (ring current) protons existing at larger L-values. Through charge exchange with the geocorona RC protons become ENAs and if subjected to a new charge exchange become trapped protons. From low latitude particle observations at four different local times we follow; the RC injection region, the drift of RC-particles through the evening/afternoon into the morning sector, the RC-asymmetry and convection loss to the dayside during the storm initial and main phase, and its development into a symmetric RC in the recovery phase of the storm. The low L-value ion/ENA belt is thus a monitor of the RC.

SM22A-0577 1330h POSTER

New ionic structures observed in the equatorial Ring Current during CLUSTER perigee passes

Claire Vallat[1] (0033 5 61 55 66 79; vallat@cesr.fr); Iannis Dandouras[1] (dandouras@cesr.fr); George Parks[2] (parks@ssl.berkeley.edu); Mark Wilber[2] (wilber@ssl.berkeley.edu); Malcolm Dunlop[3] (m.dunlop@ic.ac.uk); Lynn Kistler[5] (lynn.kistler@unh.edu); Henri Reme[1] (reme@cesr.fr); Andre Balogh[4] (a.balogh@ic.ac.uk)

[1]CESR, 9 avenue du colonel Roche,BP n4346, Toulouse 31028, France

[2]Space Science Laboratory, University of California, Berkeley CA 94530, United States

[3]Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QXUK, Didcot OX11, United Kingdom

[4]Blackett Laboratory, Imperial College,Exhibition Road, London SW7 2AZ, United Kingdom

[5]University of New Hampshire, Space Science Center, Science and Engineering Research Center, Durham NH 03824, United States

Clusters highly eccentric polar orbit at 4 Re perigee permits sampling of the ring current, the radiation belts and the plasmasphere. The CIS (Cluster Ion Spectrometry) experiment onboard Cluster is capable of obtaining full three-dimensional ion distributions (from about 5eV/q to 40 keV/q) with one spacecraft spin time resolution (4 sec) and with mass-per-charge composition determination. The ion distribution functions obtained in situ by CIS during numerous perigee passes reveal new and very interesting structures on the ion spectrograms: the presence of narrow and stable energy bands. These bands are observed for all the major ion species. The pitch-angle distributions, which are highly structured and energy dependent, confirm the presence of distinct populations. Furthermore, the four point measurements of the magnetic field, obtained by the FGM experiment, allow to calculate the ring current density profile along the spacecraft orbit, using the curlometer technique. This is the first time that in situ multi-measurements of the ring current are made (ions and magnetic field), and this permits to study its latitudinal profile. Our statistical analysis, including various magnetospheric conditions and Cluster trajectories (with a wide range in local time and positioning with respect to the plasmapause), shows the dependence of these ion energy bands on the magnetospheric activity. The combination of high time and energy resolution, good mass per charge discrimination, and favorable orbits has enabled Cluster to discern inner magnetospheric populations that have not been well-studied and characterized in previous observations.

SM22A-0578 1330h POSTER

Ionospheric Outflow and Ring Current Composition During 2001 Geomagnetic Storms

K C Retterer[1]; M E Hill[1] (301 405-6209; mehill@umd.edu); D C Hamilton[1]; L M Kistler[2]; C G Mouikis[2]; M R Collier[3]; T E Moore[3]; D G Mitchell[4]

[1]University of Maryland, Department of Physics, College Park, MD 20742, United States

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

[3]NASA Goddard Spaceflight Center, Greenbelt Road, Greenbelt, MD 20771, United States

[4]Johns Hopkins University, Applied Physics Laboratory, Laurel, MD 20723, United States

We will examine compositional changes in the near-Earth neutral H and O emissions detected with the Low & High Energy Neutral Atom imagers (LENA & HENA) aboard the Imager for Magnetosphere-to-Aurora Global Exploration (IMAGE) satellite during magnetic storm periods in 2001. In comparison with in situ ion composition measurements from the CLUSTER Ion Spectrometry (CIS) experiment on three of the CLUSTER spacecraft, remote neutral atom measurements from IMAGE will be used to probe the global behavior of upflowing and ring current ions, whose interaction with the neutral H geocorona produces energetic neutral atoms. By analyzing temporal and spatial variations in the composition of neutral atoms measured with LENA that are associated with upflowing ions, ring current ions deduced from HENA data, and direct ion observations from CIS, and by making comparisons between individual storm periods, we will investigate the possible transport of upflowing ionospheric ions to the ring current region.

SM22A-0579 1330h POSTER

Guiding-Center Simulations of Stormtime Ring Current Electrons

Shuxiang Liu[1] (1–310-794-9273; hanzo@atmos.ucla.edu); Margaret W Chen[2] (mchen@aero.org); Larry R Lyons[1] (larry@atmos.ucla.edu); Haje Korth[3] (haje.korth@jhuapl.edu); Jay M Albert[4] (albert@plh.af.mil); James L Roeder[2] (james.roeder@aero.org); Phillip C Anderson[2] (phillip.c.anderson@aero.org)

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

[2]Space Science Applications Laboratory, M2-260, The Aerospace Corporation, P.O.Box 92957, Los Angeles, CA 90009, United States

[3]Johns Hopkins Univ, Applied Physics Lab MS 4-134, 11100 Johns Hopkins Rd, Laurel, MD 20723, United States

[4]Air Force Research Lab/VSB, 29 Randolph Rd, Hanscom AFB, MA 01731-3010, United States

We examine the stormtime injection of electrons to the stormtime ring current by simulating the drift and loss of electrons from the plasma sheet to the inner magnetosphere. We use a similar method and magnetic and electric field model that *Chen et al.* [*JGR, 99*, 5745-5759, 1994] used previously to account for the stormtime injection of ring current ions to determine the extent to which that model can also account for observed stormtime electron injections. The model traces the guiding-center motion of representative particles, having selected first adiabatic invariants μ. The magnetic field model is a dipole field plus constant southward IMF, and we impose corotation and a 25-kV quiescent Stern-Volland cross polar cap potential. We simulate two real storms (August 27, 1990, and October 10, 1990) by applying additional storm-associated enhancements in the convection electric field that are less well shielded than the Stern-Volland field. The enhancements in the cross-polar cap potential are obtained by linearly interpolating DMSP measurements of the cross polar cap potential minus an assumed 25-kV quiescent potential. We perform simulations for representative equatorially-mirroring electrons for $\mu = 1$ MeV/G to 200 MeV/G. Using the simulation results, we map stormtime phase space distributions by invoking Liouvilles Theorem modified by losses. We consider electron loss due to precipitation via a model in which there is strong diffusion far in the plasma sheet ($L > \sim 8$) and weak diffusion within the plasmasphere. The loss rates in the region $L \sim 8$ to the plasmapause boundary are based on diffusion rates calculated by *Lyons* [*JGR, 79*, 575-580, 1974]. We apply a boundary spectrum at geosynchronous orbit that is based on averaging 12 years of geosynchronous LANL/MPA electron data and is parameterized by Kp and binned in 0.5 hr MLT increments. The initial quiescent electron distribution for trapped electrons is taken from the steady-state balance between radial diffusion and weak-pitch-angle-scattering losses. From the simulation results, we find significant stormtime enhancements of ring current electrons at equatorial radial distance r = 2.6 to 6.6 R_E for energies from tens of keV up to 180 keV. We compare features of our stormtime electron flux distribution with CRRES/LEPA and CRRES/MEA data. We find good agreement between simulated and observed electron flux profiles at low energies ($\lesssim$ 20 keV). Measurements are not available from $\sim$20 keV to 150 keV. However, our model does not reproduce stormtime enhancements of electron flux at high energies ($\gtrsim$ 150 keV) at $L \sim 3$ to 4, suggesting that a local energization may be responsible for these enhancements.

SM22A-0580 1330h POSTER

Solar Wind Driving of the Stormtime Ring Current

Niescja E Turner[1] (915-747-7547; neturner@utep.edu); Ramon E Lopez[1] (relopez@utep.edu); Delores Knipp[2] (delores.knipp@usafa.af.mil); Ramon F Figueroa[1] (ramonf@utep.edu); Robert Bruntz[1] (bruntzr@utep.edu); Roberto Arceo[1] (rarceo@utep.edu)

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

[2]US Air Force Academy, Department of Physics, Colorado Springs, CO 80840

We present results describing the solar wind driving of the ring current. Results have shown that much of the behavior of the ring current is related to conditions in the solar wind, and in particular, shows reasonable agreement with the epsilon parameter. Recent results suggest that during times of more intense driving by the solar wind, the kinetic energy flux from the solar wind may have a stonger effect than previously believed. Other work shows a relationship between the type of solar wind driver and the energy deposited in the auroral ionosphere. In this study we examine several storms of various intensities to determine the response of the stormtime ring current to different driving conditions and different coupling mechanisms from the solar wind.

SM22A-0581 1330h POSTER

Observations of Storm-Time Ion Injection and Loss Processes in the Ring Current

Yaniv Dotan[1] (310-336-6057; yaniv.dotan@aero.org)

Richard M Thorne[2] (rmt@atmos.ucla.edu)

Vania K Jordanova[3] (vania.jordanova@unh.edu)

James L Roeder[4] (James.roeder@aero.org)

Joseph F Fennell[5] (joseph.fennell@aero.org)

[1]Yaniv Dotan, The Aerospace Corporation Mail Stop M2-255 PO BOX 92957, Los Angeles, CA 90009-2957, United States

[2]Richard M. Thorne, UCLA, Dept of Atmospheric Sciences 7127 MS, BOX 951565 405 Hilgard ave, Los Angeles, CA 90095-1565, United States

[3]Vania K. Jordaova, Space Science Center, University of New Hampshire, Durham, NH 03824, United States

[4]James L Roeder, The Aerospace Corporation Mail Stop M2-260 PO BOX 92957, Los Angeles, Ca 90009-2957, United States

[5]Joseph F. Fennell , The Aerospace Corporation Mail Stop M2-260 PO BOX 92957, Los Angeles, CA 90009, United States

Measurement of 20 keV ions pitch-angle distributions in the ring current during the magnetic storms of January 10,1997 and, May 15, 1997 show evidence of injection, pitch angle scattering and, precipitation. The observations were made with the IPS detectors of CEPPAD on the Polar spacecraft while intercepting the radiation belts at L-shells between 3 and 7 Earth radii, and at magnetic latitudes which span +/- 55 degrees. The magnetic local times (MLT) coverage of the Jan 10, 1997 measurements were confined to dawn and dusk. For the May15 storm the coverage was near noon and midnight. The progression of both storms was observed from onset through the main phase and early and late recovery phases. The main phase and early recovery of both storms exhibited elevated flux levels - indicating particle injection into the ring current over all L-shells. Very isotropic pitch-angle distributions were observed on the night side and at dusk local times, and over L-shells greater than 4, throughout main phase and early recovery - indicating strong pitch angle diffusion. In many cases these flat distributions extended over the loss cone regions - signifying enhanced precipitation. The observed enhanced precipitation, associated with strong diffusion into the loss cones at dusk and /or night local magnetic times, cannot be explained by recent modeling efforts that incorporate wave particle interaction scattering losses. Instead this precipitation has the signature of current sheet scattering of ions associated with distortions of the near geomagnetic tail, that cause a violation of the Measurement of 20 keV ions pitch-angle distributions in the ring current during the magnetic storms of January 10,1997 and, May 15, 1997 show evidence of injection, pitch angle scattering and, precipitation. The observations were made with the IPS detectors of CEPPAD on the Polar spacecraft while intercepting the radiation belts at L-shells between 3 and 7 Earth radii, and at magnetic latitudes which span +/- 55 degrees. The magnetic local times (MLT) coverage of the Jan 10, 1997 measurements were confined to dawn and dusk. For the May15 storm the coverage was near noon and midnight. The progression of both storms was observed from onset through the main phase and early and late recovery phases. The main phase and early recovery of both storms exhibited elevated flux levels - indicating particle injection into the ring current over all L-shells. Very isotropic pitch-angle distributions were observed on the night side and at dusk local times, and over L-shells greater than 4, throughout main phase and early recovery - indicating strong pitch angle diffusion. In many cases these flat distributions extended over the loss cone regions - signifying enhanced precipitation. The observed enhanced precipitation, associated with strong diffusion into the loss cones at dusk and /or night local magnetic times, cannot be explained by recent modeling efforts that incorporate wave particle interaction scattering losses. Instead this precipitation has the signature of current sheet scattering of ions associated with distortions of the near geomagnetic tail, that cause a violation guiding center approximation

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SM22B MCC: 131 Tuesday 1330h

Dipole Tilt Effects on Sun-Earth Connections II *(joint with SA, SH)*

Presiding: **R L McPherron,** University of California, Los Angeles**; E W Cliver,** Air Force Research Laboratory

SM22B-01 1330h INVITED

Internal or External? What MHD Simulation Can Say about the Cause of Semiannual Variation in Geomagnetic Activity

George Siscoe[1] (617 353 7423; siscoe@bu.edu)

Keith Siebert[2] (ksiebert@mrcnh.com)

Nancy Crooker[1] (crooker@bu.edu)

Gary Erickson[1] (Gary.Erickson@hanscom.af.mil)

Nelson Maynard[2] (nmaynard@mrcnh.com)

[1]Center for Space Physics, Boston University 725 Commonwealth Ave., Boston, MA 02215, United States

[2]Mission Research Corporation, 589 West Hollis Street Suite 201, Nashua, NH 03062, United States

To what degree does the semiannual variation of geomagnetic activity result from external causes (e.g., heliographic latitude of the earth or tilt between heliographic and geographic equators) versus internal causes (e.g., north-south asymmetry of ionospheric conductances during solstices)? MHD simulation is well suited to explore the degree of an internal cause since one can vary conductances at will in the two hemisphere separately to see the effect these variations have on indicators of geomagnetic activity such as convection potential. This talk will give the MHD-simulation answer to the question, "Does the convection potential, as measured in the ionosphere, increase or decrease during solstice compared to equinox for the same solar wind conditions (in the GSM coordinate system)?" Moreover, it will compare storm-time activity against moderate activity to show how interhemispheric comparisons of ionospheric electrodynamic parameters can test theories of transpolar potential saturation.

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SM22B-02 1350h INVITED

The Seasonal and Diurnal Variation of Dst Dynamics

Paul OBrien[1] (3103362190; paul.obrien@aero.org)