[4]Haystack Observatory, Route 40, Westford, ma 01886, United States

It has been known that a strong poleward electric field is created in the evening sector at sub-auroral latitudes during mainphases of geomagnetic storms (Galperin et al., 1981). Recently, ground observation efforts from Millstone Hill Radar, GPS receiver stations have related these phenomena to high sunward flow velocities and enhanced electron densities in a narrow latitudinal band at sub-auroral latitudes, Sub-Auroral Polarization Streams (SAPS) and directly related them to the so-called plasmaspheric drainage plume (Foster et al.). Model tests with the Comprehensive Ring Current Model (CRCM) by M. -C. FOk have shown that the formation of the inospheric poleward electric fields in the SAPS regin are an effect of (1) enhanced Region 2 (R2) field-aligned currents (FAC), and (2) the existence of a Pedersen currents that flow poleward from the dusk R2 FACs to high latitudes through a low conductance gap. Goldstein et al. have shown the effect of the SAPS on the plasmasphere and found that it strips of the outer layers of the evening plasmapause pointing at the effects of the SAPS formation. It appears that SAPS are related to the formation of strong pressure gradients in the ring current and plasma sheet which is consistent with enhanced the R2 FACs. To illuminate the cause/driver for the SAPS, we will investigate the relation with the ring current by utilizing field-aligned current (FAC) observations from magnetometers on board Iridium, total electron content (TEC) maps from GPS receivers, DMSP passes and global proton pressure distributions derived from energetic neutral atom (ENA) data from the high energy neutral atom (HENA) imager on board image together with model runs of the CRCM.

SM52C-04 1440h

Plasmaspheric plumes: CRRES observations

John Howard[1] (iamjohnahoward@hotmail.com)

Mark B Moldwin[2] (310-825-5556; mmoldwin@igpp.ucla.edu)

Jeff Sanny[1] (jsanny@msn.com)

Hamid K Rassoul[3] (rassoul@pss.fit.edu)

Roger R Anderson[4] (roger-r-anderson@uiowa.edu)

[1]Loyola Marymount University, Dept of Physics, Los Angeles, CA 90045-8227, United States

[2]UCLA, IGPP Box 951567, Los Angeles, CA 90095-1567, United States

[3]Florida Institute of Technology, Department of Physics and Space Sciences, Melbourne, FL 32901, United States

[4]University of Iowa, Department of Physics and Astronomy, Iowa City, IA 52242, United States

CRRES plasma wave receiver density data were used to study the distribution and properties of dense plasmaspheric-like plasma observed outside the plasmapause. Our study indicates that outer plasmaspheric structure, often called plasmaspheric plumes, blobs, or detached plasma regions exist at all local times under all levels of geomagnetic activity. Of the 549 CRRES orbits that had at least one clearly defined plasmapause, 201 (or 36.6%) had plasmaspheric-like density structures at higher L shells than the plasmapause. Most of the occurrence of plasmaspheric-like plasma observed by CRRES was in the noon-to-dusk sector and was observed following moderate geomagnetic activity.

SM52C-05 1455h

A new banded hiss-like emission observed by CLUSTER near the plasmapause

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

Umran S Inan[2] (inan@stanford.edu)

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

Ondrej Santolik[3] (ondrej.santolik@mff.cuni.cz)

Pierrette Decreau[4] (pdecreau@cnrs-orleans.fr)

[1]RSSD of ESA, ESTEC, Noordwijk 2201AZ, Netherlands

[2]STAR laboratory, Stanford University, Stanford, CA 94305, United States

[3]Charles University, V Holesovickach 2, Praha 8, Prague CZ-18000, Czech Republic

[4]LPCE and Universite d'Orleans, CNRS, 3A avenue de la recherche scientifique, Orleans 45071, France

A newly discovered whistler mode ELF/VLF emission, based on CLUSTER measurements, will be presented. When observed, this 1-2 kHz banded hiss-like electromagnetic emission is systematically found near or at the plasmapause, below the electron gyrofrequency but above the lower hybrid resonance. An explanation why this emission has not been studied using previous satellites will be first suggested. The MLT, MLAT, L-shell and Kp dependences will be then presented and their consequences related to the source of these emissions will be discussed. These geophysical properties have been deduced through a survey of more than one year of data measured by three different wave instruments (WHISPER, WBD and STAFF), on each of the four CLUSTER spacecraft. Spatial extent using multipoint measurements, propagation characteristics of these waves and high time resolution insight will also be presented. Finally, some comparisons of this emission observed by CLUSTER together with IMAGE satellite data will be detailed.

SM52C-06 1510h

In-Situ and Ground-Based Intercalibration Measurements of Plasma Density at L=2.5

Mark A Clilverd[1] (m.clilverd@bas.ac.uk)

Fred W Menk[2]

[1]Mark A Clilverd, British Antarctic Survey, Cambridge CB3 0ET, United Kingdom

[2]Fred W Menk, School of Mathematical and Physical Sciences and Cooperative Research Centre for Satellite Systems, University of Newcastle, Callaghan 2308, Australia

Two independent ground-based experiments and two satellite-borne experiments are used to intercalibrate the instruments, and interpret the changes in plasmaspheric composition at the same point in space during a range of geomagnetic activity in 2001 and 2002. Mass density at L=2.5 was determined from an array of magnetometers on the Antarctic Peninsula, while the electron number density along the same flux tube was determined from analysis of the group delay of man-made VLF transmissions from north-east America. The IMAGE satellite RPI experiment provided in-situ measurements of the electron number density in passing the equatorial region of the same field line, while the IMAGE EUV experiment was able to resolve the He+ abundance by looking back toward the same place a few hours later. With a moderately-disturbed plasmasphere, at Antarctic Peninsula longitudes, electron and ion concentrations show good agreement on specific study days. He+ column abundance values of 6×10^{10} cm^{-2} are found to be equivalent to plasmaspheric electron density levels of 3000 cm^{-3} at L=2.5. For these conditions the He+ mass abundance was about 12-16% compared with H+. The work has been extended to severely-disturbed plasmasphere conditions, also studied at Antarctic Peninsula longitudes, and we present results which are compared with less disturbed times in terms of He+ column abundance, electron number density profiles, and heavy ion mass abundance. Insight is gained in the interpretation of the effects of severe geomagnetic storms on long-term data sets derived from ground-based VLF whistler-mode experiments.

SM52C-07 1525h

Stormtime Redistribution of the Low-Latitude Ionosphere and the Formation of the Plasmaspheric Bulge

John C Foster[1] (7819815621; jcf@haystack.mit.edu)

Anthea J Coster[1] (ajc@haystack.mit.edu)

William C Rideout[1] (wrideout@haystack.mit.edu)

Frederick J Rich[2] (Frederick.Rich@afrl.af.mil)

Thomas Immel[3] (immel@ssl.berkeley.edu)

[1]MIT Haystack Observatory, Atmospheric Sciences Group, Westford, MA 01886, United States

[2]Air Force Research Laboratory, Hanscom AFB, Bedford, MA 01731, United States

[3]Space Sciences Laboratory, University of California, Berkeley, CA 94720, United States

Ground-based observations of total electron content (TEC) from a global array of GPS receivers are used to map the evolution of the low-latitude ionosphere-plasmasphere system during the onset of strong disturbances.Such images depict a large-scale redistribution of plasma from equatorial latitudes near the dusk terminator to form a region of greatly-enhanced TEC immediately inside the plasmapause between L=2 to 3. The erosion of the plasmasphere and the formation of plumes of storm enhanced density (SED) at mid and high latitudes takes place where the sub auroral polarization stream (SAPS) electric fields overlap this enhanced plasmaspheric bulge region. We combine the GPS maps with overflights of the DMSP satellites and FUV imagery of the equatorial anomaly region from the IMAGE satellite to investigate the causes and development of this inner-magnetospheric stormtime phenomenon. These processes result in a large-scale depletion of the topside ionosphere-plasmasphere over the region of the South Atlantic magnetic anomaly (SAA) and extreme space weather perturbations over the North American continent.

SM52D MCC: 2006 Friday 1340h

Is a New Lexicon Required for High-Latitude Field-Aligned Current Systems? II *(joint with SA, AE)*

Presiding: **D Weimer,** Mission Research Corporation**; V Papitashvili,** Space Physics Research Laboratory, University of Michigan

SM52D-01 1340h INVITED

Birkeland (Field-Aligned) Currents - Then and Now

Lawrence J. Zanetti (443-778-6897; Lawrence.Zanetti@jhuapl.edu)

The Johns Hopkins Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723-6099, United States

(Take) Iijima and (Tom) Potemra pioneered the development of statistical, satellite-measured low altitude models of field-aligned currents that were proposed by Birkeland in 1908. The renowned Region 1 and Region 2 current systems that ring both northern and southern polar regions are still valid today and are still the standard against which geospace models and simulations are measured. Lesser known field-aligned current patterns were inferred from equatorial magnetic field measurements by this same group; the general location and sense of these equatorial patterns are consistent with the Birkeland currents globally connecting both the low and high altitudes. Variations and additions to the low altitude configuration as influenced by the IMF and it's merging with the magnetosphere (e.g. Region 0, IMF By, NBZ) will also be discussed. This presentation is a tribute to the above researchers and a status of their long-cited results.

SM52D-02 1400h INVITED

Is a New Lexicon for Field-Aligned Current Systems Needed?

George Siscoe (siscoe@bu.edu)

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

In general it is bad to rename something that has a name in general use whose meaning is unambiguous enough to enable efficient communication. For instance, region 1 currents mean high-latitude currents that flow into the dawnside ionosphere and out the duskside; region 2 currents mean currents that flow oppositely at lower latitudes. Oppositely flowing currents at higher latitude are called NBZ currents. These highly serviceable names should be retained as long as the meaning intended does not go beyond the one defined or differs from it. The problem, however, is that these names as defined fail to cover the range of meanings needed to communicate results of recent research. The full range of current morphologies revealed by data and physics-based modeling includes the standard morphologies as part of more integrated patterns that have no labels at present. Moreover, how do we refer to the global current system whose ionospheric part we label region 1, etc.? The goal of this talk is to expose the problem of nomenclature that field-aligned currents present, point to analogous problems in other fields, and offer options to address them.

SM52D-03 1420h

Evolution of current systems in the magnetosphere-ionosphere during the transition from northward to southward IMF

Kumiko K Hashimoto[1] (hashimoto@crl.go.jp)

Takashi Kikuchi (kikuchi@crl.go.jp)

[1]Communications Research Laboratory, 4-2-1, Nukui-kita, Koganei, Tokyo 184-8795, Japan

In order to examine how the current systems evolve in the magnetosphere and ionosphere, we have compared plasma flows in the dayside polar cap and the global DP2 current during the transition from northward to southward of the interplanetary magnetic field

(IMF) with two events:November 17, 1996 and March 26, 1998. DP2 magnetic field perturbations instantaneously begin from the polar cap to the dip-equator on the dayside indicating development of the global ionospheric currents that connect to the Region-1 Field-aligned currents (FACs). During the events, the SuperDARN measurements in the polar region showed dramatic changes in the ionospheric plasma flow from the multi-cell convection pattern associated with the northward IMF to the large scale two-cell pattern associated with the southward IMF. The dusk cell in the two-cell convection emerged and developed around a center of 15 MLT at 78 degrees magnetic latitude, as the reverse cells in the multi-cell pattern disappeared. We found that the reverse convection cells remained in the polar cap for the first six minutes while the DP2 current were developing. The observational results suggest that it takes about six minutes for the potential electric field of the Region-1 FACs to surpass that of the NBZ FACs in the polar cap when the IMF turns southward.

SM52D-04 1435h

Electrodynamics of Storm Time Auroral Disturbances

Jesper W Gjerloev[1] (301 286 9563; gjerloev@pop600.gsfc.nasa.gov); Robert A Hoffman[1] (301 286 7386; Robert.A.Hoffman.1@gsfc.nasa.gov); Matthew Friel[1] (mfriel@gds.org); Louis A Frank[2] (frank@IowaSP.Physics.UIowa.EDU); John B Sigwarth[2] (john-sigwarth@uiowa.edu); Raymond A Greenwald[3] (ray_greenwald@jhuapl.edu)

[1]NASA-GSFC, CODE 696, Greenbelt, MD 20771, United States

[2]University of Iowa, Department of Physics and Astronomy, Iowa City, IA 52242-1479, United States

[3]Johns Hopkins Applied Physics Laboratory, Johns Hopkins Road, Laurel, MD 20723-6099, United States

The electrodynamics of magnetic storm-time auroral disturbances is contrasted with the electrodynamics of isolated, classical bulge-type auroral substorms. Global auroral images are used to organize in-situ electrodynamic data from satellites and ground magnetic data from a large array of stations. The distribution of onset locations, the conductance distribution, convection electric field, and the electrojet topology are all analyzed during the development of the main phase magnetic storm. It is found that the onset locations of auroral disturbances are generally later in local time during magnetic storms than for substorms. The convection electrojet throughout the post-midnight region into dawn dominates over the more classical premidnight wedge electrojet of substorms and continues over the long period of main phase development. Specific examples and statistical results will be presented, with dominant attention on the electrojet configuration and it relationship to the evolution of the Dst.

SM52D-05 1450h INVITED

What Features of Field Aligned Currents Might Global Scale Fits Miss?

Brian J Anderson[1] (240-228-6347; brian.anderson@jhuapl.edu)

Freddy Christiansen[2]

[1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723-6099, United States

[2]Solar-Terrestrial Physics Division, Danish Meteorological Institute, Lyngbyvej 100, Copenhagen DK-2100, Denmark

Much of the nomenclature for field aligned current systems is based on analyses of satellite magnetometer data consisting of visual inspection of time series traces. Recent statistical analyses take advantage of digital data processing and nearly continuous solar wind data coverage. These advances allow more mathematically sophisticated techniques using multiple parameter regression with upstream parameters and various global fitting techniques. For several reasons the new methods do not necessarily provide a better basis for understanding the current systems. First, because of dynamics in both solar wind/IMF and the magnetosphere itself statistical analysis over many passes, will suffer from temporal and spatial smoothing even when binned by solar wind/IMF conditions. Second, the solar wind/IMF measurements do not provide a perfect system state monitor due to variability in the solar wind and the associated time history effects on the magnetosphere, uncertainties in the convection time from L1 and dynamics in conditions actually imposed on the magnetosphere resulting from phenomena at the bow shock. Third, global fitting procedures have inherent limitations in spatial resolution determined by the spatial density of the input data which in turn is related to the resolution with which the governing' parameters are binned. By using data from the Iridium constellation we obtain a global snapshot' representation of the FAC system during stable IMF conditions to minimize problems with the first two effects. By comparing these results with Oersted we identify the features that are most likely to be missed in similar global-scale fit analyses. We find that currents near or at the polar cap boundary, often near the cusp, are the most likely to suffer from poor fidelity in large scale fitting analyses. These currents have densities typically ten times larger than the nominal large scale currents and comparable net current. These results illustrate the need to make sure that any new nomenclature reflects both the results of large-scale fitting analyses and the finer spatial resolution afforded by the time series data used historically to characterize the current systems.

SM52D-06 1510h

New Terminology for the High-Latitude Field-Aligned Current Systems

Vladimir Papitashvili[1] (703-292-7417; papita@umich.edu)

Daniel Weimer[2] (603-886-8860; dweimer@mrcnh.com)

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

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

Since pioneering works of Iijima and Potemra in mid-1970s, the lexical meaning of terms Region 1 and Region 2 have formulated a definitive lexicon for describing the field-aligned currents systems linking the outer and inner magnetosphere with both the northern and southern polar ionospheres. However, the Region 0 system remains problematic in its clear detection or definition; at the same time, the NBZ FAC system has been easily accepted for describing of reverse (to R1) currents at the near-pole dayside developed during the northward IMF. The separate IMF B_Y-related FAC configurations were either observed by satellites or reconstructed from ground-based data for the dayside cusp region; multi-sheet current systems were proposed for the nightside polar area. Although it seems that these lexical elements were sufficient in describing various components of the global 3-D FAC systems, a number of recent studies utilized high-precision satellite magnetic field measurements for deriving detailed FAC polar maps as a function of the IMF strength and direction. The basic R1/R2 and NBZ patterns are seen, but the maps show structures that are more complex and evolving as the IMF vector rotates. In addition, a potentially new FAC system is detected from statistical maps for IMF ~ 0, having the same current directions as NBZ. This system might be considered as a part of the R0 system; from the other hand, what might be considered as a R1 current footprint often wraps around, through noon or midnight, connecting with either R2 or R0 currents (when IMF By is either negative or positive, respectively) without any obvious boundary line. Interestingly, the new statistical maps show features resembling the "upward current spiral" and "downward current spiral" introduced by *Siscoe and Maynard* [JGRA, *96*, 21,071, 1991] from combining two theoretical models of R1 and R2 currents. These spirals "rotate" over the polar cap showing R0, R1, and R2 segments at the corresponding MLT hours. We will discuss new terms that might be needed for the existing lexicon - to extend its old terminology in describing the modern understanding of morphology and evolution of the high-latitude field-aligned current systems.

URL: http://maggy.engin.umich.edu/mist/limie.html

SM52D-07 1525h

Mapping the Field-Aligned Currents During a Superstorm

William J. Burke[1] (781-377-3980; william.burke2@hanscom.af.mil)

Cheryl Y. Huang[2] (781-377-1312; cheryl.huang@hanscom.af.mil)

[1]Air Force Research Laboratory, Space Vehicles Directorate, Hanscom AFB, MA 01731, United States

[2]ISR, Boston College, 140 Commonwealth Avenue, Chestnut Hill, MA 02467, United States

During the superstorm of April 2000 four DMSP satellites crossed 1A/m sheets of field-aligned current (FAC) that were widely distributed in local time and centered at magnetic latitudes less than 60°. FAC positions relative to particle precipitation boundaries (B2e, B2i), described by Newell et al., [1996], mandate generation sources in the central plasma sheet. The phenomenon repeated four times near the storm's maximum epoch, on each occasion after the AE index indicated a pseudo breakup event. As the evening-sector system decayed, an upward FAC sheet formed near the equatorward boundary of auroral electron precipitation. This requires a westward ion pressure gradient in the inner plasma sheet near 21:00 MLT, consistent with radially differential gradient-curvature drifts subsequent to substorm-like plasma injections into a ring-current inflated inner magnetosphere. Net Poynting fluxes, estimated from measured magnetic and electric field perturbations, indicate that these FACs carry several percent of the total ring-current energy into the mid latitude ionosphere where it dissipates as Joule heat.

SM52E MCC: 2002-2004 Friday 1600h

The Role of the Plasmasphere in Ionospheric and Magnetospheric Dynamics III *(joint with SA, AE)*

Presiding: **M Moldwin,** University of California, Los Angeles**; J Foster,** Millstone Hill Observatory

SM52E-01 1600h

Stormtime Refilling of the Slot Between the Inner and Outer Radiation Belts

Richard M Thorne[1] (310 825 5974; rmt@atmos.ucla.edu)

Richard B Horne[2] (44 1223 221542; r.horne@bas.ac.uk)

[1]Department of Atmospheric Sciences, UCLA 7127 MS, Box 951565, Los Angeles, CA 90095, United States

[2]British Antactic Survey, Madingly Road, Cambridge CB3OET, United Kingdom

During geomagnetically quiet periods a pronounced slot develops between the inner and outer energetic electron radiation belts, due to wave induced scattering by whistler-mode waves inside the plasmapause. This slot can be rapidly filled during strong magnetic storms, when the plasmapause is compressed towards the location of the inner zone. The stormtime refilling of the slot at energies above several hundred keV cannot be explained by convective injection from the plasmasheet since the Alfven layer for high-energy electrons lies much further out than the plasmapause, which demarcates the convection boundary for thermal plasma. Instead we demonstrate that the refilling is due to local acceleration during resonant interactions with intense whistler-mode chorus, which is generated in the region exterior to the plasmapause during storms. The characteristic time-scale for acceleration ranges between a few hours at 100 keV to a day at 1 MeV. Refilling of the slot is consequently most effective at lower energy and is limited by the outward expansion of the plasmapause during the storm recovery.

SM52E-02 1615h

Long-period Magnetic Pulsations Associated with Detached Proton Auroral Arcs

Thomas J Immel[1] (immel@ssl.berkeley.edu)

Harald U Frey[1] (hfrey@ssl.berkeley.edu)

Stephen B Mende[1] (mende@ssl.berkeley.edu)

John W Bonnell[1] (bonnell@ssl.berkeley.edu)

Michelle F Thomsen[2] (mthomsen@lanl.gov)

[1]Space Sciences Laboratory University of California Berkeley, Centennial Dr @ Grizzly Peak, Berkeley, CA 94720, United States

[2]Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545, United States

One remarkable discovery of the NASA-IMAGE mission is the occurrence of detached proton auroral arcs. These are fairly long lived (>30 minutes) relative to other subauroral phenomena, are found separated by hundreds of kilometers from the main dusk-sector auroral oval, and generally occur several hours into a period of heightened geomagnetic activity. Interaction of 10-50 keV ring-current protons with a cold plasmaspheric population drawn outward and sunward by enhanced magnetospheric convection is generally believed to be the source of the precipitation. The cold-hot plasma interaction is prone to the growth of the ion-cyclotron instability, which subsequently scatters hot ions into the loss cone, which are then seen as precipitation of energetic protons in detached arcs by the SI-12 proton auroral imaging instrument on IMAGE. It has now been noted that most, if not all, of the detached