SM42A-0597 1330h POSTER

One-Dimensional Upward Continuation of the Ground Magnetic Field Using Spherical Elementary Current Systems

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The method of spherical elementary current systems (SECS) has been successfully applied to derive ionospheric equivalent currents from ground magnetometer data. Its one-dimensional variant (1D SECS) is now introduced especially for situations with data available only from a chain of magnetometers. We compare equivalent currents obtained by the 2D and 1D SECS methods and by 1D Fourier method using synthetic 1D current models. Then we study real situations with data from a 2D (IMAGE) and 1D (MM210) magnetometer network. We show that the 1D SECS reveals the integrated eastward and westward current densities very reasonably compared to the 2D SECS, also during clearly non-1D situations. It also follows that the 1D SECS can be applied in a routine manner to replace the commonly used local electrojet proxies (local AL and AU indices) by a direct quantitative estimate of the ionospheric currents.

SM42B MCC: Level 1 Thursday 1330h

Dynamic and Global Aurora II Posters *(joint with SA, AE)*

Presiding: **P L Rothwell,** Air Force Research Laboratory/Space Vehicles Directorate**; R E Ergun,** University of Colorado

SM42B-0598 1330h POSTER

Conjugate and Same-Scene Auroral Imagery

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Conjugate studies of high-latitude geomagnetic activity are central to understanding the global magnetospheric response to external perturbations, i.e. the solar wind, and the role of the ionosphere in modulating and coupling with the magnetosphere. Interhemispheric asymmetries as manifested in auroral emissions have been observed for over 40 years. Unfortunately, the nature of the problem has limited the type and extent of studies that can be performed to either conjugate ground based observations or comparison of space based images with all-sky cameras. Recently Frank and Sigwarth (2002) published results using unique simultaneous images from Polar of the northern and southern aurora, but these are necessarily limited to the nighttime and at oblique angles. However, images made with the cameras from the Polar and IMAGE missions contain simultaneous conjugate images as well as same-scene images of the large-scale aurora under many and varying conditions. This rich data set provides an opportunity to study interhemispheric auroral asymmetries and investigate their occurrence as a function of solar wind conditions and ionospheric parameters such as conductivity. In order to use images of different scenes from each of these cameras, knowledge of their relative response to a common scene is required. To that end, this paper will present preliminary results of comparing images with emphasis on data from the Polar UVI LBH filters and the IMAGE FUV WIC.

SM42B-0599 1330h POSTER

Local Time Displacement of Substorm Expansion in Conjugate Hemispheres

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Because the Earth's magnetic field is largely dipolar and symmetric, many auroral features are conjugate between the northern and southern hemispheres. However, previous work has shown that the aurora can be nonconjugate. Most previous optical conjugacy studies have been limited to ground based observations or ground based and space based imager comparisons. In both cases at least one observation point is restricted to viewing only small scale features. Conjugate observations of the large scale behavior of the aurora have been confined to rare, serendipitous space based imager conjunctions and single spacecraft viewing of both hemispheres which is tempered by large oblique viewing angles. As the Polar spacecraft's apogee has descended in the the southern hemisphere, the Polar Ultraviolet Imager (UVI) has spent an increasing amount of time viewing the southern aurora. Simultaneously, the Wideband Imaging Camera (WIC) onboard the IMAGE spacecraft has been observing the northern aurora. By using image data from both spacecraft, we are able to systematically analyze the degree of auroral conjugacy on synoptic scales and over a wide variety of geomagnetic conditions. In this work, we focus on the conjugacy of the region of intense auroral emission during substorm onset and expansion. We find a persistent displacement in local time of the region of active aurora during substorm expansion; features in the northern hemisphere are shifted westward (duskward) relative to the conjugate point of the southern hemisphere aurora by up to a few thousand kilometers. Often there is a shift in the opposite direction observed before and at substorm onset. The same sense of displacement has been reported in earlier work. The sense or magnitude of the displacement showns no obvious correlation with the interplanetary magnetic field orientation or strength as suggested in previous studies. Therefore, we suggest that the displacement in local time of the region of intense auroral emission is a result of the asymmetric distortion of the magnetic field by the large scale field-aligned currents associated with substorms.

URL: http://sprg.ssl.berkeley.edu/∼matt/AGU2003/

SM42B-0600 1330h POSTER

Conjugate auroral observations under various interplanetary conditions

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Recently, it has been possible to observe the entire auroral oval in both the northern and southern hemispheres simultaneously with the IMAGE FUV imagers and Polar VIS Earth camera, respectively. These rare opportunities allow us to study conjugate and nonconjugate effects between the two hemispheres under various interplanetary conditions. This enables us to better understand the transfer of mass and energy from the solar wind to the magnetosphere/ionosphere system. The events we study here are from late 2002 with periods of simultaneous observation lasting between about 35 and 60 minutes. Most events are associated with a steady IMF B_X component, where the IMF B_Y and B_Z components vary.

SM42B-0601 1330h POSTER

Comparison of Rice Field Model to Simultaneous Conjugate Auroral Images

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We examine simultaneous conjugate satellite images of the north and south hemispheres from a two-hour time period on August 17, 2001. IMF conditions during this time show a strong B_y component and a negative B_z component, with geomagnetic indices indicating that this time period took place in the middle of a magnetic storm, as well as during the growth phase and onset of a substorm. As a result of these conditions, the satellite images show a large polar cap size shifted toward dawn in the north and dusk in the south. We use the Rice Field Model to map field lines from one hemisphere to the other in order to determine the polar cap size and the positions of conjugate features in the auroral zone. This comparison between model output and data allows us to optimize the adjustable parameters of the model, resulting in greater accuracy for the field model. The angle of rotation of the magnetotail was increased in order to match the polar cap shape and position to the satellite images. The final output of the model successfully described to first order the polar cap size, shape, and position and the direction of shift of various features from one hemisphere to the other. The model fell short, however, in its attempt to model the more dynamic substorm effects. In general, simultaneous images of the aurora allow for a better understanding of how magnetic field lines and polar cap boundaries map from one hemisphere to the other, as well as aid in determining which auroral features are real and are most likely to be seen in model outputs.

SM42B-0602 1330h POSTER

Local time propagation of electron and proton auroras in substorms

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Latitudinal expansion of substorm auroras is explained by the poleward motion of the dipolarization region during the expansive phase. However the cause of the expansion of the aurora in local time is not fully understood and we used IMAGE FUV observations of 154 substorms to investigate it. Images of the Wideband Imaging Camera and the SI-12 proton auroral imager were re-projected to a rectangular magnetic latitude local time coordinate grid during 154 substorms. A representative function of the intensity distribution as a function of magnetic latitude, composed of two Gaussian peaks, was fitted to the projected images and the fitting parameters were obtained for all magnetic local times (MLT-s). This fitting permitted the effective removal of dayglow and other non auroral artifacts and yielded simple parameters to examine the properties of the aurora. The integrated intensity of the fitted double Gaussian functions were used to represent the intensity of the aurora at a particular MLT. Using this, intensity MLT-keograms were produced to examine the MLT development of the proton and electron aurora. These keograms show that the nightside aurora expands after substorm onset, but in addition to the expansion, the luminosity exhibits a bulk motion in the (MLT) direction towards dawn or dusk. No regular trends were derived in the direction or speed of the luminosity of the aurora in either the proton or the electron case. The MLT motion of the post substorm aurora therefore does not represent the drift motion of the injected particles in the magnetosphere but rather it represents a gradual drift of the particle injection source region. In previous case studies, comparison of energetic neutral atom (ENA) data with FUV showed that there is good agreement between lower energy trapped and precipitating fluxes. From our study therefore we propose that the substorm expansion in local time is a motion of the source of the particle injection during the process of the substorm.

SM42B-0603 1330h POSTER

The development of parallel electric fields during substorm growth phases as a result of differential particle mirroring

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Recent work has shown that the development of an auroral arc during a substorm growth phase is a gradual process where the arc forms within a region of diffuse precipitation and appears to intensify throughout the growth phase. The gradual intensification and stationarity of the arc suggests that the acceleration potential does not result from double-layers or Alfven waves, but perhaps from charge separation. Charge separation resulting from differential mirroring has been studied for decades. During a substorm growth-phase, ions are scattered as a result of increased magnetic field curvature; electron scattering does occur, but may or may not coincide with the evolution of the growth phase. In any case, the scattering mechanisms for ions and electrons are clearly different from each other and so a parallel electric field would result unless each pitch-angle bin is filled with equal numbers of positive and negative particles by chance. The improbability of this situation implies that differential mirroring may play a key role in the development of growth-phase auroral arcs. In this study, specific cases of growth–phase arcs are examined using ground and satellite data and compared with theoretical predictions of parallel fields resulting from differential

SM42B-0604 1330h POSTER

Shock-Induced Proton Aurora: Five Case Studies

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The shock-induced proton aurora, observed in Doppler-shifted Lyman alpha with the IMAGE FUV Spectrographic Imager, is characterized by the same general features and behavior that have been reported in recent studies of the aurora that is produced primarily by precipitating electrons. Typical features include (1) a sudden, short-lived dayside brightening, covering over several hours of local time and often extending over a wide latitude range, coincident with the storm sudden commencement/sudden impulse; (2) subsequent instantaneous brightening of the entire oval or a rapid propagation of enhanced luminosity from the dayside to the nightside; (3) a thickening and poleward expansion of the oval; and (4) shrinking of the polar cap. Comparison of the proton emission pattern with the distribution of OI emissions observed at 135.6 nm with the FUV/SI13 channel allows differences between the proton and electron components of the shock-induced aurora to be distinguished. In one of the cases presented, the dayside cusp and a localized emission feature at the polar cap boundary are observed to move in local time in concert with one another in response to a strong variation in IMF By.

SM42B-0605 1330h POSTER

Association of north-south Poleward Boundary Intensifications (PBI) orientation with plasma sheet flow direction and the IMF

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Auroral poleward boundary intensifications (PBIs) are typically seen both in ground meridional scanning photometers (MSP) and in ground and spacecraft auroral images. They appear as a localized 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 for the remote monitoring of plasma sheet dynamics. From the study of simultaneous IMAGE FUV auroral images and Geotail plasma sheet data we recently found that: (a) PBIs correlate well with plasma sheet fast flows observed within the local time sector of the PBIs, and there can be several PBIs over the longitudinal range of fast flows in the tail, and (b) 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 going from 02 MLT to 17 MLT. This results in PBIs that are north-south (NS) structures in the postmidnight sector and east-west (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. We further found for one event that the PBI fast flows have a large Vy component resulting from tail convection during positive IMF By, which offers a possible explanation for the alignment direction of PBIs. We now use a variety of spacecraft and ground data (Polar VIS, IMAGE FUV, and ground all-sky images of the aurora, in-situ data from Geotail, and solar wind data) to investigate the generality of the above conclusions. We identify NS PBIs and investigate whether (a) there is a clear distinction in the orientation of the NS PBIs along the 02-17 MLT, the 22-07 MLT lines, or strictly along the NS meridian, (b) the orientation of the NS PBIs is correlated with the direction of the plasma sheet convection and thus with the IMF By direction, and (c) the local time dependence of the PBI orientation in our previous study is generally observed during all NS PBI periods.

SM42B-0606 1330h POSTER

The theta aurora and ionospheric flow convection: Polar ultraviolet imager and SuperDARN radar observations

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We report results from a case study of the theta aurora that occurred during a magnetic cloud event on November 8, 2000. The interplanetary magnetic field (IMF) was strongly northward for more than 12 hours, while the y-component of IMF changed signs several times. Auroral images from the Ultraviolet Imager on board the Polar satellite show clear instances of theta auroras during the prolonged northward IMF period. This event provides a good opportunity for testing current models of theta aurora generation and evolution. We examine in situ particle data from the DMSP satellites to find magnetospheric source regions responsible for the theta auroras. We also examine ionospheric plasma flow convection data from the SuperDARN radar network to study relationships between the ionospheric plasma flow pattern and the location of the theta auroras. Our results clearly indicate that the theta aurora bar, at least on nightside, was located in a region of anti-sunward convecting flow. This is not consistent with the current view that theta auroras reside in regions of closed field lines and hence in regions of sunward convecting flow. Implication of the new findings will be discussed.

SM42B-0607 1330h POSTER

Velocities of Morning Sector Patchy Auroral Forms

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Using 6 years (1993-1998) of CANOPUS Gillam All-Sky Imager (ASI) 558 nm data we identified 80 occurrences of morning sector patchy aurora. For these events, we calculated the velocity field for each ASI image frame using a machine vision optical flow technique. An optical flow computation determines the velocity field of an image based on changes in the brightness pattern between two consecutive frames separated by a small time interval, and is subject to the constraints that (1) the brightness of a given object point remains relatively constant over time and (2) only small motion changes occur between two consecutive images. Only patchy auroral data that reasonably fit these two constraints, and for which the optical flow field represented the motion reasonably well (37 occurrences which produced $>$ 1700 vector fields corresponding to $> 4.4 \times 10^5$ velocities) were considered. From the 16×16 vector fields obtained in the optical flow computations, the average vector of the inner 4×4 vector field (inner 64×64 pixels of the ASI image) was computed for each image. Average velocity occurrence statistics show that auroral patches flow eastward with speeds on the order of $\sim$ 55 m/s. We present the results focussing on a comparison of these motions with convection on a statistical basis, and where possible on an event basis. Our working hypothesis is that these auroral features are due to co-existing hot and cold plasma populations in the trough region. The hot electrons are precipitated by wave particle interactions in the vicinity of the cold drifting "blobs" of plasma, possibly of plasmaspheric origin. Establishing whether or not these patches move with the convection velocity would be valuable, both in terms of identifying the source mechanism for this type of precipitation as well as providing an additional means of remote sensing convection.

SM42B-0608 1330h POSTER

Mesoscale Structures Within the Auroral Bulge

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We present ground-based optical, riometer, and magnetometer, Polar UVI and GOES magnetic field observations from a substorm that occurred on November 24, 1997. This event involved a clear optical onset followed by poleward motion of the auroras which demark the expanding auroral bulge. During the first minutes of the expansive phase, there were three distinct mesoscale (10-1000km) structures embedded in the bulge: at first a series of equatorward moving auroral arcs, followed by a well-defined spiral structure, and finally north-south directed auroras. The spirals occurred several minutes after the onset, and indicate either a field-aligned current or a more global ballooning-type instability. The north-south directed auroral forms occurred roughly 10 minutes after the onset and ostensibly indicate rapid bursty bulk flow type flows in the central plasma sheet. As well, the riometer data suggest high energy electron precipitation in the vicinity of the the poleward moving edge of the auroral bulge, starting at the onset and continuing through until the north-south structure. In this paper, we examine this evolving auroral morphology within the context of substorm theories.

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SM42B-0609 1330h POSTER

Multiple Electron Energy-time Dispersions Observed in the High-latitude Part of the Dayside Cusp Region

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Multiple electron energy-time dispersions (MEEDs) were observed at altitude of several hundred km in the high-latitude part of the dayside cusp region by a sounding rocket, which was launched on December 2000 from Ny-Ålesund. The MEEDs were characterized by field-aligned precipitation with falling energies from 200 eV down to 20 eV at a repetition rate of ∼2 Hz. Their time-of-flight analysis resulted in the source altitude of several thousand km. With test particle simulations, these characteristics of the MEEDs can be quantitatively interpreted in terms of the resonance acceleration of electrons with field-aligned electric fields generated by large amplitude inertial Alfvén waves. The Alfvén waves might originate at the dayside magnetopause, associated with magnetic reconnection.

SM42B-0610 1330h POSTER

The THEMIS All-Sky Imager Array

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THEMIS (Time History of Events and Macroscale Interactions During Substorms) is a NASA MIDEX mission scheduled for launch in 2006. THEMIS will consist of five satellites on equatorial orbits with apogees at 10, 20, and 30 Re, relatively phased on those orbists so every four days the five satellites are in conjunction over central Canada. The primary scientific objective of the THEMIS mission is to elucidate the physical sequence of events leading up to substorm expansive phase onset. THEMIS has a significant ground-based observational component which includes a continent wide array of white light auroral All-Sky Imagers (ASIs), sixteen of which will be deployed in Canada. The ASIs will operate at a cadence of one image every five seconds, and will be useds to identify the location and timing of auroral substorm onset. Data from the ASIs will be available in real time and retrospectively from a web-based data archive. The first of these imagers was deployed in Athabasca in the summer of 2003 (see http://www.phys.ucalgary.ca/NORSTAR/themis/themis_main.html) We will deploy five more imagers in Canada in each of the next three years.

URL: http://www.phys.ucalgary.ca/NORSTAR/themis/themis_main.html

SM42B-0611 1330h POSTER

An Evening Sector Ps 6 - Omega Band Event

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Ps 6 magnetic disturbances and associated optical forms known as omega bands are usually associated with the morning sector. The positive Y and transitional Z perturbations of the Ps 6 signal indicate localized regions of equatorward equivalent current in the auroral ionosphere, associated with the bright and vortical forms of the omega bands. The currents and optical forms drift sunward (eastward) at speeds typical of bulk convection. Evidence for similar phenomenology in the evening sector has been presented by Solovyev et al. (JGR 104, 28019, 1999). We confirm and enhance these results by presenting early results from the new Athabasca University Geophysical Observatory from July 27, 2003. These are magnetic perturbations from the UCLA magnetometer, and high time resolution optical imaging of associated omega bands from the all sky imager, which together make a prototype ground based networked observatory for the NASA THEMIS MIDEX mission. The signatures drift sunward (westward) and the magnetic perturbations feature negative Y and transitional Z indicating passage of poleward equivalent currents overhead. These results suggest that Kelvin-Helmholtz instablilities, the likely cause of the morning sector features, can also excite waves in the evening sector under appropriate circumstances.

SM42B-0612 1330h POSTER

KAISTSAT-4

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KAISTSAT-4, the fourth satellite developed by Korea Advanced Institute of Science and Technology, is to be launched into a sun-synchronous orbit at 685 km altitude on September 26, 2003. While the primary objective of the mission is to provide spectral sky survey data of hot Galactic plasmas with Far Ultra-violet Imaging Spectrograph (FIMS, also known as SPEAR), the same instrument observes auroras and airglow with high spatial resolution and detailed spectral information. The FIMS bandwidth, 900 ?1175 A and 1335 ?1750 A, includes important atomic oxygen lines and Lyman-Birge-Hopfield (LBH) emissions that provide information on the precipitated electron energy associated with auroras. This information is compared with simultaneous in-situ measurements of keV electrons on the same spacecraft. It should be noted that previous similar studies require a serendipitous opportunity of two independent spacecraft observing the same region at the same time. A 10 Hz FIMS sampling rate yields images of sub-kilometer spatial resolution which can be used to study the small scale dynamics of auroras. Also, the effects of precipitating electrons on the ionosphere are monitored by two sets of cylindrical Langmuir probes, which are oriented perpendicular to each other. The initial result of KAISTSAT-4 is presented in this paper.

SM42C MCC: Level 1 Thursday 1330h

Radiation Belts and the Inner Magnetosphere II Posters

Presiding: **R H Friedel,** Los Alamos National Laboratory**; S R Elkington,** Laboratory for Atmospheric and Space Physics, University of Colorado

SM42C-0613 1330h POSTER

Spacecraft Charging Specification Using Model Environments

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The specification and prediction of spacecraft charging at geosynchronous orbit represents an important goal of space weather research. While significant correlations exist between geomagnetic indices and the occurrence of satellite frame charging, for example with sunlit frame charging of the DSCS III satellite [Krause et al., IEEE Trans. Nucl. Sci., 47(6), 2000], the relationships are inadequate for useful predictions of charging at specific locations. Charged particles drift across the geosynchronous orbital path, and not along it, so spacecraft within less than an hour in local time experience completely different charging conditions. To account for these differences, a simple geosynchronous spacecraft surface charging application is driven using particle environments from the Magnetospheric Specification Model (MSM). Preliminary analysis using the NASCAP spacecraft-plasma interaction code indicated that spacecraft geometry and materials are responsible for the partial suppression of photoelectrons leading to frequent daylight charging of the DSCS III B-7 spacecraft. Analysis of the minimal spacecraft approximation we employ, i.e., a sunlit kapton sphere, also indicates that this so-called bootstrap charging phenomena is active. Surface charging is therefore identified by the net electron current to the kapton spacecraft determined by integrating electron, proton, and oxygen fluxes from the MSM along with secondary and backscatter yields specified as a function of energy. Spacecraft frame charging measurements from the Charge Control System on board the DSCS III satellite are compared with results obtained from the MSM-driven charging model. MSM/charging algorithm simulation output will be characterized at all local times in an effort to evaluate the model's potential effectiveness as a practical spacecraft charging specification tool.

SM42C-0614 1330h POSTER

Magnetic field line curvature induced pitch angle diffusion in the radiation belts

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We derive a diffusion equation to model the pitch angle dynamics of a trapped charged particle population strongly influenced by magnetic field line curvature. The equation is based on a recently published, empirical model for pitch angle scattering of single particles. In order to examine the predictions of this equation in the inner magnetosphere we define a diffusion time. Often the purely exponential decay time of the lowest eigenfunction is used to characterize the decay of a population. However, because our equation is singular for 90° equatorial pitch angles there is no physically meaningful lowest order eigenfunction. We define the diffusion time as the time it takes for a distribution to decay to half its initial density. Because this depends on the initial distribution we examine the decay of three distributions that vary in the degree to which they are peaked about the 90° equatorial pitch angle. We calculate diffusion times for these distributions as a