The mesopause region (ca. 80-110 km) is a cold and curious place in the Earth's atmosphere. Temperatures therein are colder in summer and warmer in winter because gravity waves that propagate into the region from the lower atmosphere dissipate, depositing their energy and momentum and driving a residual circulation from the summer to winter hemispheres with upwelling and downwelling over the respective poles. Large and ubiquitous solar atmospheric tidal variations characterize the large-scale dynamics near the mesopause. These global waves also originate in the lower atmosphere and grow exponentially as they propagate upward. Solar geomagnetic disturbances can penetrate downward into the mesopause region and affect the dynamics and chemistry. This presentation will overview the penetration of solar storm effects into the Earth's atmosphere with an emphasis on the mesopause region effects during the April 2002 storm period. These effects include modifications to the quiescent circulation, neutral composition changes, and temperature variations.

SM41A-06 0940h

The role of solar wind dynamic pressure in driving geoeffectiveness: Global MHD simulation results

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The ionospheric energy deposition analysis carried out using a global MHD simulation has yielded a high-correlation power law between the solar wind parameters (density, velocity and IMF) and the total ionospheric power consumption. In particular, the energy budget analysis has demonstrated that the solar wind dynamic pressure has a role in the ionospheric Joule heating. The working hypothesis has been that since the Region 1 field-aligned currents close to the Chapman-Ferraro currents driven by the dynamic pressure variations, the Joule heating produced by the closure of Region 1 currents would be controlled by the solar wind dynamic pressure. Furthermore, the global MHD simulation results show that the energy content inside various volumes within the simulation magnetosphere appears to be driven by the solar wind dynamic pressure. Therefore we argue that the solar wind dynamic pressure has a strong contribution to the global energetics of the magnetosphere and ionosphere as determined from a global MHD simulation (GUMICS-4). We demonstrate quantitatively both the role of solar wind dynamic pressure on the Region 1 currents as well as its effect on the ionospheric Joule heating by using GUMCS-4. We discuss the role of weak Region 2 currents in GUMICS-4 in the interrelation of the solar wind dynamic pressure and the ionospheric Joule heating.

SM41B MCC: Level 1 Thursday 0830h

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

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

SM41B-0560 0830h POSTER

Kinetic Simulation of Nonlinear Interactions Mediated by Alfven Waves

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An electromagnetic particle-in-cell (PIC) code is used to identify key nonlinear interactions mediated by large amplitude shear Alfven waves that propagate between distant boundaries along the geomagnetic field, as may be of interest to I-M coupling studies. At the upper boundary waves are excited at frequencies below the ion gyrofrequency and with a transverse spatial structure having a scale length comparable to the ion gyroradius or the electron skin-depth. The waves propagate along and across the geomagnetic field and reflect from a lower ionospheric boundary. It is found that strong wave-particle interactions with electrons leads to the distortion of the propagation characteristics of the signals. The reflecting Alfven waves generate a self-consistent current system that flows along the edges of field-aligned density striations that are formed by the large plasma pressure resulting from heating by the Alfvenic electric fields. This work is sponsored by NSF.

SM41B-0561 0830h POSTER

Dynamic Planar Double Layers: Filamentary Substructures, Electron Holes and Ion Heating

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High-resolution measurements from FAST in the auroral return current plasma have revealed a wealth of information on the myriads of small-scale structures imbedded in large-scale ones. The fine structures appear in electric fields both parallel and perpendicular to the ambient Earth's magnetic field associated with the so-called diverging electrostatic shocks. The upward-accelerated electron flux and, therefore, the downward parallel current also show filamentary behavior. Using 2.5-D particle-in-cell (PIC) simulations, we study here the formation of a double layer (DL) and its stability. We find that the ion beam accelerated by the DL generates waves, which trigger fragmentation of the DL into substructures (DLSSs) like U- and V-shaped electrostatic shocks. The DL and DLSSs are seen to continually emit electron holes of varied shapes and sizes into the high-potential plasma above them, while below them in the low-potential plasma ions are transversely heated. Our simulation suggests important coupling between various auroral processes, namely, formation of DL, acceleration of electrons and ions, ion instabilities below the DL, filamentation of the DL by the waves generating DLSS, and continual emission of electron holes from them. In addition to revealing the coupling processes, simulations also bring out some of the quantitative features of return current plasma.

SM41B-0562 0830h POSTER

Determination of the Short- and Long-Range Parallel Potential in the Downward Auroral-Current Region From FAST Satellite Data and Theory

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Over the years, satellite observations have suggested the following characteristics of the downward auroral-current region: diverging electrostatic shocks and a downward pointing parallel E-field; upflowing low energy (less than a few kilovolts) field-aligned electrons; intense transverse ion heating; small-scale density cavities; intense ELF and VLF electric-field turbulence; and sometimes rapidly moving bipolar solitary structures. We give a multimoment fluid theory for the auroral return-current region that is based on the Vlasov-Maxwell equations for the particle dynamics and a Fokker-Planck model for the wave-particle interactions. Using FAST particle and wave data as a boundary condition, these equations may be integrated from the satellite altitude down to the shock- and transition-region altitude and up to several earth radii in order to determine both the short- and long-range, self-consistent parallel potential. For a particular winter satellite pass near local midnight, this model finds that typical voltage distributions are: a 240 volt increase from the bottom of the shock region to the top of the transition region (2800 km); a 30 volt increase from the top of the transition region to the satellite altitude (4130 km); and a 330 volt increase from the satellite altitude to 3 earth radii for a total potential increase from the topside ionosphere to 3 earth radii of about 600 volts.

SM41B-0563 0830h POSTER

Particle simulation of electromagnetic field signature associated with electrostatic solitary waves

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We present particle simulations of electrostatic solitary waves (ESW) observed by the GEOTAIL spacecraft and recent spacecraft in the Earth's magnetosphere. Recent particle simulations have demonstrated that ESW correspond to Bernstein-Greene-Kruskal electron holes formed through nonlinear evolution of electron beam instabilities. Since an electron hole is a coherent electrostatic potential structure, electron beam instabilities were conventionally studied by electrostatic particle simulations. However, the POLAR spacecraft and FAST spacecraft observed electromagnetic field signatures associated with ESW. To study interaction between coherent electrostatic potentials and electromagnetic waves, we extend the previous electrostatic particle model to an electromagnetic particle model. In the present two-dimensional simulations of an electron beam instability, electromagnetic field components are enhanced around two-dimensional electron holes. We found that the enhancement of electromagnetic fields is due to a current formed by electrons undergoing the $E \times B_0$ drift, where the electric field is a perpendicular electrostatic field at the edge of a two-dimensional electron hole. An electromagnetic beam mode is excited by the current due to the drifting electrons moving with the electron hole. The amplitude ratio of the electric field to the magnetic field is estimated based on the present simulation result, and it is in agreement with those of the POLAR and FAST observations.

SM41B-0564 0830h POSTER

Kinetic Simulations of Shear Alfvén waves: Electron Dynamics in uniform and nonuniform magnetic fields

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Standing and travelling shear Alfvén waves contribute to electron acceleration and parallel electric field formation on auroral field lines in Earth's magnetosphere. We model the shear Alfvén waves in one dimension and use a self-consistent kinetic simulation code to study the parallel electron dynamics in the presence of shear Alfvén waves in the inertial regime. We study both travelling shear Alfvén wave pulses as well as standing shear Alfvén waves which represent field line resonances. We compare results from simulation runs with uniform and non-uniform magnetic fields in order to demonstrate the effect of including the magnetic mirror force term. We also show results from simulation runs with non-uniform density profiles, to investigate the effect of varying the Alfvén speed and electron inertial length along the field line.

SM41B-0565 0830h POSTER

Generation of Alfven waves by upper hybrid waves

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There is a great interest in ionospheric heating and modification as evidenced by the HAARP facility in Alaska and a large effort in Norway, and long time effort at Arecibo. In a series of laboratory experiments at the upgraded **LA**rge **P**lasma **D**evice (LAPD) at UCLA we are simulating these interactions. We launch high power microwave pulses into a strongly magnetized plasma (n $\leq 10^{12}$cm^{-3}, $B_0 = 1 - 2.5$ kG, He,Ne, Dia= 50 cm, Length 17m). The microwaves (f $\simeq$ 9 GHz) are beamed either along the magnetic field into

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an axial density gradient or across the magnetic field into a radial density gradient. The microwave power is 250 kW for 1 μs pulses. The plasma is diagnosed with high frequency rf probes, magnetic pickup loops and fast optical cameras. Preliminary results have shown evidence of a strong interaction, which we have tentatively identified as a large amplitude shear Alfven wave. When the microwaves are incident at right angles to the magnetic field Alfven waves are created at the upper hybrid resonance location which is determined by the magnetic field and local density. Preliminary data indicate that the Alfven waves are radiated by the current systems generated by fast electrons in the resonant region. We will present results of experiments focussing on the magnetic interaction measured with miniature pickup loops and on fast electron generation. Movies of the experimental data on the Alfven wave generation will be presented.

SM41B-0566 0830h POSTER

Reflection of Alfven Waves from Boundaries with Various Conductivities

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The reflection of Alfvén waves from conducting boundaries or boundary layers plays a crucial role in many laboratory and natural plasmas because the reflected wave can reduce or enhance the electric field pattern of the incident wave. In the Large Plasma Device at UCLA we are investigating the reflection of shear Alfvén waves from surfaces of various conductivities, from insulating to conducting. A single frequency wave is launched from an antenna and reflects from a large reflecting surface inserted into the plasma column. By using various materials, the axially integrated conductivity of the reflecting disk can be adjusted relative to the Alfvén conductivity, $1/(\mu_0 v_A)$. The data are compared with the expected theoretical behavior of the reflected wave amplitude and phase as a function of the reflecting surface conductivity.

SM41B-0567 0830h POSTER

Widespread Electrostatic ion Cyclotron/ion Acoustic Turbulence Above Auroral Acceleration Region; CLUSTER Observations

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We present CLUSTER observations based on a study of broadband ELF emissions above the auroral oval at altitudes around $\sim 4.5\ R_E$. The study focuses on the parallel electric field with the aim to identify the different emissions involved. We have found different emissions sorted by the ratio $\delta E_{\parallel}/\delta E_{\perp}$. No associated magnetic field component has been detected indicating electrostatic emissions. The numerical package WHAMP, solving the dispersion relation, shows that all emissions exist on the so-called ion acoustic dispersion surface, but with different wave vectors. For the event presented here, we have also identified dispersive Alfvén waves at lower frequencies with a period well correlated with the most intensive emissions in the broadband region, which indicate that dispersive Alfvén waves can trigger the electrostatic emissions at frequencies above the proton gyrofrequency.

SM41B-0568 0830h POSTER

Beaming Angular Sizes of Individual AKR Bursts determined from Cluster WBD Observations

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We have used the Wideband Data (WBD) instrument on four Cluster spacecraft to determine the beam angular size and sky distribution of more than 700,000 individual AKR bursts. We analyzed 15 observing epochs between July 2002 and May 2003 during which the Cluster constellation subtended at least 10 degrees angular separation as viewed from the AKR source region. After correcting for distance scaling, we compared flux densities at each of the four Cluster spacecraft in matching 300 ms by 1 KHz data windows. For each pair of spacecraft, we plotted the fractional number of bursts received at only one spacecraft compared with the total number. We fit a beaming model consisting of a randomly oriented uniformly filled beam. For most epochs the data are consistent with angular widths $39^\circ \pm 7^\circ$ (0.94 sr) , $42^\circ \pm 7^\circ$ (0.98 sr), and $24^\circ \pm 4^\circ$ (0.73 sr) at emission frequencies of 125, 250, and 500 KHz respectively. These values are considerably smaller than previously reported values, which were determined by averaging over many individual AKR bursts. More complex beaming geometries are also possible, e.g., a hollow cone of emission. In the latter case, the derived beam sizes correspond to the cone thickness. These observations are the first direct measurement of the angular size of the radiation pattern of individual AKR bursts.

URL: http://phobos.physics.uiowa.edu/rlm/research/akr-angular.html

SM41B-0569 0830h POSTER

Perpendicular Heating of H^+ and O^+ Ions Due to an Oblique Double Layer at the Transition Region of the Auroral Cavity

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The acceleration mechanism of the precipitating electrons associated with the visible aurora is investigated in this paper. These precipitating electrons form in the upward current region of the auroral cavity, a region separating the magnetosphere and the ionosphere. There are several possible mechanisms that may contribute to electron acceleration. One possible cause of electron acceleration is quasi-static, parallel electric fields, which have been observed in the auroral cavity. Recent research has shown that the auroral cavity may have two boundaries associated with it: one between the ionosphere and the auroral cavity and the other between the magnetosphere and the auroral cavity. We present work that explores the boundary between the ionosphere and the auroral cavity known as the lower transition region. Observations suggest that this lower boundary may be an oblique double layer, which is the cause of the quasi-static parallel electric field. Using test particle simulations we explore the effects on distributions of weakly magnetized O^+ ions and moderately magnetized H^+ ions. The observed width of the oblique double layer is much greater than the H^+ gyroradius but on the same order as O^+gyro-radius. Therefore, we expect the O^+ distribution to be heated more than the H^+distribution in the direction perpendicular to the magnetic field. This may partially explain the distributions of ion beams observed at higher altitudes.

SM41B-0570 0830h POSTER

High-Resolution, Low-Frequency Electric Field Measurements on an Auroral Sounding Rocket Experiment

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The NASA SIERRA rocket mission was a multiple-payload experiment which flew into a 100 nT auroral substorm at altitudes up to 735 km over the Poker Flat Research Range in Alaska on January 14, 2002. The SIERRA experiment was composed of electric field instruments, magnetometers, and particle detectors. Here we examine high resolution and high sensitivity electric field results from one of the three payloads. The particle instrumentation indicates an equatorward region of inverted-V electron precipitation followed by a poleward region of mostly field-aligned suprathermal electron bursts. In the inverted-V region, the electric field record reflects the precipitation in that it varies inversely with the intensity of the electron precipitation. In the poleward precipitation region, the average electric field is much larger, 50 mV/m compared to 20 mV/m, with time varying components that exceeded 100 mV/m and periods of 0.5-5 s. We interpret the electric field fluctuations, also observed in the magnetometer data, as Alfvenic, and we compare the Poynting vector of the fields with the electron precipitation fine structure.

URL: http://sierra.ece.cornell.edu/

SM41B-0571 0830h POSTER

Generation of electron holes and electron heating in the auroral upward current (inverted V) region : A simulation study

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The presence of electron holes in and their effects on the auroral plasma is well established fact. FAST measurements have shown that both in the upward and downward current regions such holes are accompanied by various kinds of particle beams, and it is believed that they form as a result of the nonlinear evolution of instabilities caused by these beams. We study various types of beam instabilities in application to the upward current region (downward auroral electron beam, upward ions, two-temperature electron plasma), using a one-dimensional full-particle simulation code. It is shown that several instabilities can contribute to the formation of holes and to their dynamics, but the most important one is the two-stream instability which can occure even under auroral conditions. We investigate the dynamics of the electron beam and the plasma under hole formation, plasma heating, and the evolution of the distribution functions in view of the application to the processes in the auroral upward current region.

SM41B-0572 0830h POSTER

Energy Budget of Alfven Wave Interactions with the Auroral Acceleration Region

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Recent Polar satellite observations of intense Alfven ULF bursts over auroral arcs prompted researchers to suggest that ULF wave activity does provide energy to the auroral arc intensification. However, to provide physical grounds for this suggestion, it is important to know possible bounds on the rate of the ULF wave energy transfer into electron acceleration. To estimate the power dissipated in the ionosphere and that transferred into electron acceleration, we consider the interaction of magnetospheric Alfven waves with the auroral ionosphere, comprising the auroral acceleration region (AAR). The AAR is characterized by a mirror resistance to the field-aligned upward current that can provide the potential drop and the acceleration of electrons. Analytical treatment of the interaction of Alfven waves with the combined magnetosphere-AAR-topside ionosphere-E-layer system has been made within the "thin" AAR approximation, which is valid for small-scale disturbances. The input of Alfven waves into the energy balance of the AAR depends critically on their transverse scale. Only waves with scales comparable to

the Alfven transit scale, that is $k_\perp \lambda_A \simeq 1$, will provide energy into electron acceleration. This process is expected to be more effective above a conductive ionosphere. These theoretical predictions could be verified with the multi-satellite measurements in the Cluster-2 mission.

SM41B-0573 0830h POSTER

Polar distributions of small-scale magnetic disturbances derived from the Akebono magnetometer data

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In the cusp and its vicinity, burst-like disturbances of magnetic and electric fields are often observed on Freja, FAST, and Akebono spacecraft. Recent studies suggest that these small-scale disturbances are signatures of the dispersive Alfvén waves (DAW) and the ionospheric Alfvén resonator (IAR) excited in the topside ionosphere. These disturbances would play a key role in the energy coupling between the magnetosphere and the ionosphere. The purpose of this study is to obtain the polar distributions of these small-scale disturbances and their contributions to field-aligned currents from the Akebono magnetometer data. We analyzed the magnetometer data of 2596 passes in 1991 during the periods when the Akebono satellite was located above an altitude of 5000 km with the FFT method. The obtained polar maps show that the region of intense magnetic disturbances in the frequency range 0.0156-0.125 Hz covers the local time sector from the dayside cusp to the dawnside. In contrast, no intense disturbances are found on the nightside and duskside region. It is also found that in the altitude region from 5000 to 8000 km intense magnetic disturbances are observed over a wide latitude range from the auroral oval to the polar cap, while in the altitude region above 8000 km, these disturbances are concentrated in the dayside cusp region and its vicinity. We will discuss the origins of such day-night and dawn-dusk asymmetry and altitude dependency.

SM41B-0574 0830h POSTER

Effects of the seasonal asymmetry in magnetospheric thermal density distribution and ionospheric conductance on the rate of energy deposition into auroral ionosphere

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A 2D numerical model of the coupled magnetosphere-ionosphere system has been used to analyze the effects of seasonal variations in thermal plasma density distribution along magnetic flux tube and ionospheric solar-induced Pedersen conductance on the development of ionospheric feedback instability and associated energetic electron precipitation. The numerical model includes a model of the horizontally inhomogeneous auroral ionosphere with conductivity dynamics coupled to a two-fluid MHD model describing dispersive shear Alfvén dynamics in the magnetosphere. Effects of plasma anomalous resistivity and Alfvén wave dispersion in the magnetospheric MHD model lead to the formation of parallel electric fields above the ionosphere as the feedback instability evolves. The energy deposition rate of energetic electrons is estimated from Fridman-Lemaire theoretical model based on adiabatic motion of loss-cone electrons originating in the equatorial magnetosphere. Due to the seasonal asymmetry in thermal electron density distribution along magnetic field lines and ionospheric Pedersen conductance the rate of kinetic electron energy deposition is significantly greater in the dark winter hemisphere where the thermal plasma density at the auroral acceleration region and solar-induced ionospheric conductance are substantially lower. It is also demonstrated that the asymmetry in thermal density distribution leads to seasonal variations in the altitude of acceleration region, while the asymmetry in ionospheric conductance results in hemispherical asymmetry of field-aligned Poynting flux. The higher energy deposition into the dark ionosphere may increase the occurrence of discrete aurora as been demonstrated by satellite measurements of energetic electron precipitation and UV auroral imaging.

SM41B-0575 0830h POSTER

Automated Classification of Auroral Images

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Modern ground-based auroral All-Sky Imager (ASI) networks capture millions of images annually. While case studies still play an important role in auroral research, there are important reasons for developing automated analysis tools for use on large numbers of images, which is required for objective statistical studies. Future programmes such as NASA's THEMIS (Time History of Events and Macroscale Interactions during Substorms), which will produce about 84 million auroral images annually, can not fully utilise the data without automated tools. We have developed computer vision techniques for automatic classification of auroral images in terms of the type of aurora they contain. In this paper, we discuss our approach in formulating a numerical representation of the contents of each image, and the results of the application of these techniques to roughly 500,000 images from CANOPUS and MIRACLE. We also discuss possibilities for incorporating these techniques in multi-instrument statistical studies in which extensive ASI data sets will be combined with other obsevations, like solar wind or ground-based magnetometer data.

SM41B-0576 0830h POSTER

The global patterns of Joule heating in the high-latitude ionosphere

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Joule heating in the high-latitude ionosphere and upper atmosphere, which depends on geomagnetic activities and the solar activities, is an important factor for several critical problem areas in the space weather, among them satellite drag, changing satellite position and lifetime. The statistical global patterns of the hemispheric Joule heating are being studied over a complete solar cycle, based on Weimer electric field model and height-integrated conductance model. These statistical patterns are used to study the dependence of the hemispheric Joule heating on the levels of geomagnetic activity and the phase of solar cycle. This investigation also provides the opportunity to identify periods of variations in the upper atmospheric temperature and neutral density. The preliminary results of this study are presented.

SM41B-0577 0830h POSTER

Correlation between DMSP Particle Data and Polar Image Intensities

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Precipitating particle data from the DMSP F12 and F13 satellites has been merged with image intensities from the Ultraviolet Imager (UVI) and Earth Camera (EC) on the Polar satellite. Particle data were averaged within an image accumulation time and matched with the image intensity along the corresponding segment of the DMSP trajectory in magnetic local time coordinates. The particle data and image intensity data of many hundreds of such matches were then correlated with a simple linear fit. The image intensities have the best correlation with precipitating electron energy, and the intensities correlate less well with other particle data such as the precipitating proton data, at least when considering the overall polar region. Similar correlations can be performed to detail energy input into a specific region of interest, such as the dawn or dusk side of the oval, or the equatorward or poleward side. The good correlation between the precipitating particles and the image intensities suggests that imagers can be directly calibrated to measure energy input without the additional complication of modeling the intensities based on hypothetical particle fluxes. In this way, a map of global energy input into the aurora may be derived based wholly on measurements

SM41C MCC: Level 1 Thursday 0830h

Radiation Belts and the Inner Magnetosphere I Posters

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

SM41C-0578 0830h POSTER

Exploring the Inner Magnetosphere with the Magnetospheric Multiscale Phase I Orbit

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We discuss the use of the unique space-time separated measurements that will obtained by the Magnetospheric Multiscale (MMS) Solar Terrestrial Probe mission for better understanding the dynamics of the terrestrial inner magnetosphere. The first phase of MMS will involve a low inclination orbit approximately 1.2 X 12 earth radii geocentric. The MMS primary science goals center on measurements made at the outer part of this orbit. However measurements will also be possible during the inner part of the orbit which would allow studies of microscale processes of importance to inner magnetospheric dynamics. We will discuss the applicability of these observations to the objectives of the Living With A Space Geospace program

SM41C-0579 0830h POSTER

The feasibility of measuring electric and magnetic field parameters at geostationary orbit using LANL satellites

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In this paper we investigate the feasibility of deriving large-scale electric and magnetic fields at geostationary orbit by comparing particle flux time series between pairs of LANL geostationary satellites. In the Earth's magnetosphere particle motions can be described by parameterized drift equations. By measuring the particle drift velocities at different energies and pitch-angles, we can in some situations fit for these parameters and thus have a description of the large-scale fields. The drift velocities are derived by measuring the time-offset between time series measured at different satellites. There are several complications: First