SM42B-0609 1330h POSTER

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

Hiroki Tanaka[1] (+81-042-759-8170; htanaka@stp.isas.ac.jp)

Yoshifumi Saito[1] (saito@stp.isas.ac.jp)

Kazushi Asamura[1] (asamura@stp.isas.ac.jp)

Toshifumi Mukai[1] (mukai@stp.isas.ac.jp)

[1]The Institute of Space and Astronautical Science, 3-1-1 Yoshinodai, Sagamihara 229-8510, Japan

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 $\sim$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

Eric Donovan[1] (403-220-6337; eric@phys.ucalgary.ca); Mikko Syrjasuo[1] (mikko@phys.ucalgary.ca); Brian Jackel[1] (bjackel@phys.ucalgary.ca); Trond Trondsen[1] (trondsen@phys.ucalgary.ca); Mike Greffen[1] (greffen@phys.ucalgary.ca); Leroy Cogger[1] (cogger@phys.ucalgary.ca); Emma Spanswick[1] (emma@phys.ucalgary.ca); Stephen Mende[2] (mende@ssl.berkeley.edu); Stu Harris[2] (sharris@ssl.berkeley.edu); Martin Connors[3] (martinc@athabascau.ca); Harald Frey[2] (hfrey@ssl.berkeley.edu); Vassilis Angelopoulos[2] (vassilis@ssl.berkeley.edu)

[1]Department of Physics and Astronomy, University of Calgary, 2500 University Drive, Calgary, AB T2N 1N4, Canada

[2]Space Science Laboratory University of California, Berkeley, 7450 Centennial Drive, Berkeley, CA 94720-7450, United States

[3]Center for Science, Athabasca University, 1 University Drive, Athabasca, AB T9S 3A3, Canada

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

Martin Connors[1] (780-434-1786; martinc@athabascau.ca); Eric F Donovan[2] (eric@phys.ucalgary.ca); Mikko Syrjaesuo[2] (mikko@phys.ucalgary.ca); Mike Greffen[2] (greffen@phys.ucalgary.ca); Stephen B Mende[3] (mende@ssl.berkeley.edu); Christopher T Russell[4] (ctrussel@igpp.ucla.edu); Brian J Jackel[2] (bjackel@phys.ucalgary.ca); Trond Trondsen[2] (trondsen@phys.ucalgary.ca)

[1]Centre for Science, Athabasca University, 1 University Drive, Athabasca, AB T9S 3A3, Canada

[2]Physics and Astronomy, University of Calgary, 2500 University Drive N.W., Calgary, AB T2N 1N4, Canada

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

[4]Institute of Geophysics, University of California, 405 Hilgard Ave, Los Angeles, CA 90095-1567, United States

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

Kyoung W. Min[1] (82-42-869-2525; kwmin@space.kaist.ac.kr); J. Lee[1] (jjlee@space.kaist.ac.kr); Jerry Edelstein[2] (jerrye@ssl.berkeley.edu); George Parks[2] (parks@ssl.berkeley.edu); Michael McCarthy[3] (mccarthy@geophy.washington.edu); W. Han[4] (whan@kao.re.kr); K. Ryu[1] (ksryu@satrec.kaist.ac.kr); Eric Korpela[2] (korpela@ssl.berkeley.edu); U. Nam[4] (uwnam@kao.re.kr); D. Lee[1] (dhlee@satrec.kaist.ac.kr); Kaori Nishikida[2] (kaori@ssl.berkeley.edu); H. Jin[4] (jinho@kao.re.kr); J. Park[1] (jhpark@space.kaist.ac.kr); H. Kim[1] (woodcar@space.kaist.ac.kr); J. Hwang[1] (jahwang@space.kaist.ac.kr)

[1]Korea Advanced Institute of Science and Technology, KAIST, 373-1 Gusong-dong, Yusong-gu, Taejon 305-701, Korea, Republic of

[2]University of California, Berkeley, Space Sciences Laboratory, UCB, Berkeley, CA 94720-7450, United States

[3]University of Washington, Geophysics Program, UW, Seattle, WA 98195, United States

[4]Korea Astronomy Observatory, Space Sciences Group, KAO, Taejon 305-348, Korea, Republic of

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

Robert V Hilmer[1] (Robert.Hilmer@Hanscom.af.mil)

David L Cooke[1] (David.Cooke@Hanscom.af.mil)

[1]Air Force Research Laboratory/ Space Vehicles Directorate, AFRL/VSBXR, 29 Randolph Rd, Hanscom AFB, MA 01731, United States

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

Shawn L Young[1] (781-377-9666; Shawn.Young@Hanscom.AF.mil)

Richard E Denton[2] (603-646-2732; Richard.Denton@Dartmouth.EDU)

Brian J Anderson[3] (Brian.Anderson@JHUAPL.edu)

Mary K Hudson[2] (maryk@sunset.dartmouth.edu)

[1]Air Force Research Laboratory Space Vehicles Directorate, AFRL/VSBXR 29 Randolph Road, Hanscom AFB, MA 01731, United States

[2]Dartmouth College, Department of Physics and Astronomy, Hanover, NH 03755, United States

[3]Johns Hopkins University Applied Physics Laboratory, APL/JHU PO Box 670, Laurel, MD 20725-0670, United States

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 function of Dst, season, and UT (season and UT being proxies for the angle between the dipole axis and the solar wind) using Tsyganenko 01 magnetic field model. We show that the diffusion is strongly dependent on both the initial distribution and Dst, and examine the weaker dependence on the direction of the dipole axis relative to the solar wind. Using the results of these calculations we estimate thresholds in parameter space for which the particle populations will decay in 10 hours for electrons, protons, and O^{+8} ions. To demonstrate the sharpness of these thresholds we also estimate the threshold for decay in 1000 hours for protons.

SM42C-0615 1330h POSTER

Radial diffusion simulation of relativistic electron transport by ULF waves in the September 1998 storm

Yue Fei[1] (7133482408; yfei@rice.edu)

Anthony Arthur Chan[1] (713-348-2531; aac@rice.edu)

Scot R Elkington[2] (303-735-0810; scot.elkington@lasp.colorado.edu)

Michael Wiltberger[3] (303-497-1532; wiltbemj@ucar.edu)

[1]Rice University, 6100 Main St, MS-108, Houston, TX 77005

[2]LASP, University of Colorado, 1234 Innovation Drive, Boulder, CO 80303

[3]UCAR/HAO, P.O. Box 3000, Boulder, CO 80307

The MHD-particle simulation of radiation belt electron fluxes during the September 1998 storm gives results which are in reasonable agreement with major features of spacecraft flux measurements at synchronous orbit. The evolution of the MeV electron radial flux profile appears to be diffusive, and diffusion caused by ULF waves has been invoked as the probable mechanism. In this work we solve a diffusion equation with ULF-wave diffusion coefficients and a time-dependent outer-boundary condition to better quantify the radial diffusion coefficient. We use a radial diffusion coefficient DLL which includes contributions from symmetric resonances and asymmetric resonances. DLL depends on the ULF power spectrum which is obtained from Fourier analysis of the MHD fields. The radial diffusion calculation uses the Roederer L value calculated in MHD magnetic field as the radial coordinate. The location of the simulation outer-boundary is defined as the last closed drift shell. The fluxes from the MHD-test particle simulation are converted to phase space density for comparison with the radial diffusion calculations. The radial diffusion simulation can reproduce the main features of the MHD-particle results quite well. The analytic ULF-wave-driven radial diffusion coefficients must be increased by factors of 2 to 3 to give the best fit to the MHD-particle result, and the asymmetric resonances dominate in the outer region of the simulation, whereas the symmetric resonances dominate in the inner region. Using both symmetric and asymmetric terms gives a better result than using one or the other, and better than using a simple power law diffusion coefficient.

SM42C-0616 1330h POSTER

Derivation of a new 3x3 Relativistic Quasilinear Radiation Belt Diffusion Tensor

Anthony A Chan[1] (713-348-2531; aac@rice.edu)

Alain J Brizard[2] (802-654-2886; aac@rice.edu)

[1]Rice University, 6100 Main Street, Houston, TX 77005-1892, United States

[2]Saint Michael's College, Box 254, One Winooski Park, Colchester, VT 05439, United States

Under appropriate conditions the phase-space transport of radiation belt particles can be described by an equation of the Fokker-Planck form. In canonical adiabatic-invariant action-angle coordinates this equation has the standard drag-diffusion form with a 3x3 diffusion tensor. Much work has been done to obtain expressions for the diffusion tensor elements, particularly the diagonal elements, but often assuming that only one or two of the adiabatic invariants is broken. In this work, starting from the Vlasov equation and Hamiltonian guiding center theory, we have derived from first principles a relativistic Fokker-Planck equation which contains a 3x3 diffusion tensor [Brizard and Chan, submitted to Physics of Plasmas, 2003]. The 3x3 diffusion tensor describes quasilinear transport due to general electromagnetic perturbations which can break all three adiabatic invariants and it is therefore potentially very useful for evaluating the relative contributions of VLF waves versus ULF waves to radiation belt transport, including effects of off-diagonal tensor elements.

SM42C-0617 1330h POSTER

Radiation Belt Modeling: Implementation Issues When Solving Three-dimensional Diffusion Equations

Gregory P. Ginet[1] (781-377-3974; gregory.ginet@hanscom.af.mil)

Shawn L. Young[1] (781-377-9666; shawn.young@hanscom.af.mil)

Jay M. Albert[2] (781-377-3992; jay.albert@hanscom.af.mil)

[1]Space Vehicles Directorate, Air Force Research Laboratory, AFRL/VSBX 29 Randolph Rd, Hanscom AFB, MA 01731, United States

[2]Institute for Scientific Research, Boston College, 140 Commonwealth Ave, Boston, MA 02467, United States

The Diffusion in I, L, and B Energetic Radiation Tracker (DILBERT) is being developed by AFRL to model radiation belt dynamics on both radial and pitch-angle diffusive time-scales with a realistic magnetic field model in three dimensions, where one of the dimensions is parameterized by the L shell. Large spatial variations in the pitch-angle ($D_{\alpha\alpha}$), energy (D_{EE}) and cross-term ($D_{\alpha E}$) quasi-linear diffusion coefficients make the calculations challenging. Two basic aspects of the calculation will be considered here, the variable sub-space in which the diffusion is computed, i.e pitch angle–energy, $\{\alpha_{eq}, E\}$, or adiabatic invariant, $\{\mu, J\}$, and constraints on the grid size. In the $\{\alpha_{eq}, E\}$ space the coefficients compare to each other as $|D_{\alpha\alpha}| \gg |D_{\alpha E}| \gg |D_{EE}|$, while in $\{\mu, J\}$ space, the coefficients $D_{\mu\mu}, D_{\mu J}$ and D_{JJ}, have the relation, $|D_{\mu\mu}| \sim |D_{\mu J}| \sim |D_{JJ}|$. Pitch angle–energy space is attractive in two dimensions because the dominance of $D_{\alpha\alpha}$ makes the calculation almost one dimensional. Complications are introduced, however, by including the third dimension and it is argued that adiabatic invariant space is the better choice. Large spatial gradients in the coefficients in either variable space cause "convective" behavior in the numerical formulation of the equations. Based on estimated timescales for the "convective" and "diffusive" components of the equation constraints are derived on the grid resolution and it is shown that the required grid spacing varies by orders of magnitude.

SM42C-0618 1330h POSTER

Quasilinear Diffusion Coefficients for Chorus Waves in a Low Density Plasma

Jay M Albert (781 377 3992; jay.albert@hanscom.af.mil)

Air Force Research Lab, 29 Randolph Rd, Hanscom AFB, MA 01731-3010, United States

Chorus waves have been established as an important ingredient in the dynamics of outer zone electrons, especially in the aftermath of geomagnetic storms. Low plasma density conditions (plasma frequency comparable to cyclotron frequency) are especially favorable for significant changes in particle energy. The quasilinear formulation of cyclotron-resonant interactions gives diffusion coefficients in pitch angle and energy for this process. A newly developed form of the dispersion relation for such chorus waves yields upper and lower bounds on the index of refraction, which are very useful in evaluating the diffusion coefficients in this setting, in the same spirit as previous versions for hiss and EMIC waves. The method will be described, the diffusion coefficients evaluated, and the physical consequences will be presented.

SM42C-0619 1330h POSTER

Numerical Experiment of the Resonant Scattering Process of Relativistic Electrons in the Outer Radiation Belt

Yuto Katoh[1] (81-22-217-6518; yuto@stpp1.geophys.tohoku.ac.jp)

Takayuki Ono[1]

Masahide Iizima[1]

[1]Department of Geophysics, Graduate School of Science, Tohoku Univ., Aramaki-aoba, Aoba, Sendai 980-8578, Japan

By using a newly developed hybrid simulation scheme of electrons, pitch angle and energy diffusion processes of relativistic electrons through the wave particle interaction with electromagnetic waves are studied. To overcome the difficulty owing to the significant difference of Larmor radii between thermal electrons and relativistic electrons, we developed a new hybrid simulation scheme, where cold component of electrons are treated as a fluid and hot component of electrons are treated as particles including relativistic effects. This simulation scheme allows us to investigate the scattering process of relativistic electrons through the resonant interaction with electromagnetic waves. In the outer radiation belt, the acceleration process of relativistic electrons has been studied in details for the case of the resonant interaction with enhanced whistler mode waves (Horne and Thorne 1998; Summers et al., 1998). Although studies based on the quasi-linear approach have been achieved to explain energizing of relativistic electrons (Summers and Ma 2000; Miyoshi et al., 2003), there have been still remained problems to be evaluated. One is the nonlinear effect of plasma waves and energetic particles and the other is the accuracy of diffusion coefficients which actually control the energy range and time scale of the energization. The purpose of present study is to evaluate the diffusion coefficients derived through the previous works and the nonlinear effects possibly appeared in the energizing process of electrons by resonant interactions of energetic electrons. The comparison of the diffusion rates between the result of present numerical experiment and the quasi-linear estimation by solving the diffusion equation is performed under the same parameters of whistler mode waves and the initial distribution of high energetic electrons. The comparison is performed for the plasma parameter fp/fc is equal to 1.0. As a result, it is revealed that the quasi-linear theory tends to overestimate the energy diffusion and underestimate the rate of the pitch angle scattering taken place in the resonant interaction. This result suggests that the estimation of diffusion coefficients becomes not accurate under the low density plasma condition, owing to the assumption of wave dispersion relation in the previous studies. In addition, another possibility is pointed out that the difference is caused by a discrepancy of assumption between the simulation model and the quasi-linear theory. In the simulation model, an open system is used by treating whistler mode waves as propagating into the simulation system from external source, which seems realistic condition in the storm-time inner magnetosphere. On the other hand, in the quasi-linear theory, the diffusion in the velocity space is assumed to be under the condition that energy exchange between particles and the field is a quasi-equilibrium state in the closed system. Based on the results of present study, it is shown that the reexamination is necessary for the resonant interaction process including the treatment of appropriate plasma settings with consideration of an open plasma system as it is in the outer radiation belt during geomagnetic storms.

SM42C-0620 1330h POSTER

Artificial Depletion of the Relativistic Electrons in the Radiation Belt

Paul Song[1] (Paul_Song@uml.edu); Bodo Reinisch[1] (Bodo_Reinisch@uml.edu); Gary Sales[1] (Gary_Sales@uml.edu); Vadym Paznukhov[1] (Vadym_Paznukhov@student.uml.edu); Xueqin Huang[1] (Xueqin_Huang@uml.edu); Gregory Ginet[2] (Gregory.Ginet@hanscom.af.mil); Jay Albert[3] (jay.albert@hanscom.af.mil)

[1]University of Massachusetts Lowell Center for Atmospheric Research and Dept. of Environmental, Earth and Atmospheric Sciences, 600 Suffolk St, Lowell, MA 01854, United States

[2]Air Force Research Laboratory, 29 Randolph Rd, Hanscom AFB, MA 01731, United States

[3]Boston College Inst. for Scientific Research, 140 Commonwealth Ave, Chestnut Hill, MA 02467, United States

The lifetime of relativistic electrons in the inner radiation belt is very long, posing persistent harm to space systems, especially to low-earth orbit satellites. We propose to use a space-borne transmitter that radiates VLF waves to reduce the lifetime of these electrons via pitch angle diffusion. The transmitter can be located in a low-altitude high-inclination orbit flying through the feet of the flux tubes in which the electrons are trapped. The wave-particle interaction occurs near and lowers the mirror points of the particles until they fall into the loss-cone. An order of magnitude estimate indicates that to substantially reduce the lifetime of these electrons, i.e. shorten it by factor of 10 from natural processes, a transmitter of a few kilowatts is needed. We will demonstrate the feasibility of such a system

SM

SM42C-0621 1330h POSTER

Characteristics of Non-ducted Whistler-Induced Electron Precipitation

William B Peter[1] ((650)468-8403; wpeter@stanford.edu)

Umran S Inan[1] ((650)723-4994; inan@nova.stanford.edu)

[1]Space, Telecommunications, and Radioscience Laboratory, Stanford University, 350 Serra Mall, Stanford, CA 94305, United States

We examine two different four-hour sequences of subionospheric Very Low Frequency (VLF) signal perturbations and provide a characterization of electron precipitation induced by non-ducted obliquely propagating whistlers. These lightning-induced electron precipitation (LEP) events are typically associated with cloud-to-ground lightning, with the event magnitudes positively correlated with the magnitude of the peak current of the discharge. A distributed set of VLF observing sites, known as the Holographic Array for Ionospheric and Lightning Research (HAIL), captures the full latitudinal extent of the events, providing evidence that 90% of the precipitation occurs within a range of $\sim 6-8^{\circ}$ in latitude ($666-888$km). We further demonstrate that the onset delay ($\sim 0.5-3$s) and the duration of precipitation (~ 1–4s) steadily increase with increasing $L-$value, while the signal recovery time ($\sim 30-40$s) is independent of L. The dependence of the spatial and temporal parameters of the precipitation on the location of the causative lightning discharges is also examined. When the causative discharge is at higher latitudes, the LEP event is of longer duration and exhibits precipitation in a smaller area displaced less from the causative discharge. The onset delays and event durations increase more rapidly with increasing $L-$value for events associated with causative discharges at higher latitudes. The general spatial and temporal signatures are consistent with those expected for LEP events induced by nonducted whistlers.

URL: http://www-star.stanford.edu/~hail/

SM42C-0622 1330h POSTER

Precipitation Signatures and Lifetime Estimates of Energetic Radiation Belt Electrons Scattered by Magnetospherically Reflecting Whister Waves

Jacob Bortnik[1] (650-723-8487; jbortnik@stanford.edu)

Umran S Inan[1] (650-723-4994; inan@nova.stanford.edu)

Timothy F Bell[1] (650-723-3587; bell@nova.stanford.edu)

[1]Stanford University, 350 Serra Mall, Palo Alto, CA 94305, United States

In this paper we use a numerical model to estimate the energetic radiation-belt electron lifetimes driven by lightning-generated magnetospherically reflecting (MR) whistler waves. The model consists of several distinct stages: (i) we use an extensive ray tracing and interpolation technique to compute the frequency-time (f-t) signature of an MR whistler wave at 1 degree latitude intervals along a given L-shell in the magnetosphere, (ii) the above information is used as an approximation to the MR whistler wave structure along the particular L-shell, and the equations of motion for a series of test particles are integrated to obtain pitch angle changes. A broad range of resonant electron velocities is considered including harmonic resonances ranging from m=-5 to +5 including the Landau resonance. (iii) The pitch-angle change data obtained in (ii) is convolved with a realistic model for the electron distribution (AE8 with "sinusoidal" loss-cone distribution) to yield precipitated electron flux. (iv) Step (iii) is repeated for a range of L-shells in the range 1.3 to 5.5 to give a global view of the precipitation signature. This global view is then extrapolated in longitude and transformed to geographic coordinates to give an indication of the ionospheric patch sizes affected by the precipitating electrons, as well as the temporal fluence of the affected region. The global view is also used to estimate the lifetimes of energetic electrons driven by MR whistlers, by using crude estimates of lightning occurrence frequency and extent of the affected magnetospheric regions.

SM42C-0623 1330h POSTER

Investigation on the Cause of the Dawnside Local Maximum in Energetic Electron Precipitation Following Substorms

Arne Aasnes[1,2] (+1 505 667 8894; aasnes@lanl.gov)

Reiner H. W. Friedel[2] (+1 505 665 1936; friedel@lanl.gov)

Johan Stadsnes[1] (Johan.Stadsnes@fi.uib.no)

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

Thomas Cayton[2] (tcayton@lanl.gov)

[1]University of Bergen, Fysisk institutt Allegt. 55, Bergen 5007, Norway

[2]Los Alamos National Lab, Mail Stop D436, Los Alamos, NM 87544, United States

A local maximum in the energetic electron precipitation on the dawnside following substorm onsets is a common feature in the PIXIE X-ray images. The cause of this maximum is thought to be whistler waves scattering electrons into the loss cone. The MPA instrument on the LANL satellites measures the full 3-dimensional particle distribution, and from the symmetry axis of the distribution the magnetic field direction can be determined. With the magnetic field direction at the satellite we can obtain pitch angle distributions from both the MPA and SOPA instruments to investigate if they are likely to support whistler wave growth. Events will be shown where we have both a dawnside maximum in the PIXIE images and LANL satellites in the corresponding local time.

SM42C-0624 1330h POSTER

Coupling of Thunderstorm Generated Relativistic Electron Beams with the Inner Magnetosphere

Michael W Chevalier[1] (650-723-3789; chamonix@stanford.edu)

Umran S Inan[1] (650-723-4994; inan@nova.stanford.edu)

Timothy F Bell[1] (650-723-7721; bell@nova.stanford.edu)

[1]Stanford University, 356 Packard EE Building, Stanford, CA 94305, United States

Gamma ray observations from the BATSE experiment on the Compton Gamma Ray Observatory indicate that some gamma ray bursts originate in the Earth's atmosphere near large scale thunderstorm systems. It is believed that these gamma ray bursts consist of bremsstrahling from relativistic electrons accelerated to MeV energies by the intense quasi-static electric fields which temporarily exist above thunderclouds after intense positive cloud to ground discharges. If so , most of these relativistic electrons would escape the atmosphere and enter the Earth's radiation belts without much loss of energy. In the radiation belts the relativistic electron beam will interact with the cold background plasma through the two-stream instability, and some of the relativistic electrons may become trapped in the radiation belts. In the present paper we carry out a theoretical analysis of how relativistic electron beams, which form in the earth's atmosphere, can couple to the magnetosphere. The primary motivation for this study is to assess the contribution of this phenomenon to the relativistic electron population in the inner radiation belts. The interaction of the beam and the cold magnetoplasma results in changes in the beam's velocity distribution. We use 1D and 2D electromagnetic, particle-in-cell (PIC) simulators to calculate the evolution of the beam's velocity and pitch angle distributions. We first study the 1D electrostatic interactions for a full traverse of the beam through the magnetosphere for a given L shell and initial beam density. We then assess the importance of other electromagnetic beam/plasma interactions with our 2D model. On the basis of these interaction models, we estimate the fraction of the original relativistic electron beam which can be trapped in the radiation belts. Our analysis is carried out for a range of initial beam densities and L shell values.

SM42C-0625 1330h POSTER

Systematic analysis of whistler-mode emissions below the lower hybrid frequency based on the data of the Cluster project.

F. Nemec[1] (frantisek.nemec@matfyz.cz)

O. Santolik[1] (ondrej.santolik@mff.cuni.cz)

K. Gereova[1] (katka.gereova@matfyz.cz)

E. Macusova[1] (eva.macusova@matfyz.cz)

N. Cornilleau-Wehrlin[2] (nicole.cornilleau@cetp.ipsl.fr)

[1]Charles University, Faculty of Mathematics and Physics, V Holesovickach 2, Prague CZ-18000, Czech Republic

[2]CETP, 10/12 Av. de l'Europe, Velizy F-78140, France

We report results of a systematic analysis of equatorial noise below the local lower hybrid frequency. Our analysis is based on the entire data set collected by the STAFF-SA instruments on board the Cluster spacecraft during the first two years of operation (2001 - 2002). We compare intensities of equatorial noise with other whistler-mode emissions, for example with chorus or hiss. The results indicate that these emissions can play a significant role in the dynamics of the inner magnetosphere. Using the multipoint measurement we show considerable spatio-temporal variations of the wave intensity.

URL: http://terezka.ufa.cas.cz/santolik/papers/agu2003

SM42C-0626 1330h POSTER

Generation mechanism of chorus emissions in the dayside magnetosphere

Mitsuru Hikishima[1] (81-76-234-4858; hikisima@reg.is.t.kanazawa-u.ac.jp)

Satoshi Yagitani[1] (81-76-234-4858; yagitani@reg.is.t.kanazawa-u.ac.jp)

Isamu Nagano[1] (81-76-234-4857; nagano@reg.is.t.kanazawa-u.ac.jp)

Yoshiharu Omura[2] (81-774-38-3811; omura@kurasc.kyoto-u.ac.jp)

Hiroshi Matsumoto[2] (81-774-38-3805; matsumot@kurasc.kyoto-u.ac.jp)

[1]Graduate School of Natural Science and Technology, Kanazawa University, 2-40-20 Kodatsuno, Kanazawa 920-8667, Japan

[2]Radio Science Center for Space and Atmosphere, Kyoto University, Gokanosho, Uji 611-0011, Japan

The chorus emissions have been observed by the GEOTAIL spacecraft around the equatorial plane in the dayside outer magnetosphere. We analyze the wave - particle interaction involved in the generation and propagation of the chorus emissions. The chorus emissions are generally considered as generated via the cyclotron resonance between electrons and whistler mode waves. Detailed examination of the measured velocity distributions of the resonant electrons has shown that their pitch angle anisotropy is too small to generate simultaneously observed chorus emissions via linear cyclotron resonance. This seems to be caused by the pitch angle scattering of cyclotron resonant electrons due to the generated chorus emissions. The whistler mode wave first grows linearly and incoherently within a certain frequency band. The unstable pitch angle anisotropy of the resonant electrons is pitch - angle scattered by the linear cyclotron interaction and rapidly reduced to the small "critical anisotropy." With such a reduced anisotropy the linear cyclotron interaction can no longer be sustained. The pitch angle scattering occurs within much less than 1 second, which is quite short enough compared with the time resolution of GEOTAIL particle measurements (several tens of seconds). This would suggest that we could observe only the "already well-reduced and marginally stable anisotropy" with GEOTAIL. In this study, by means of theoretical analysis and particle simulation, we investigate the cyclotron resonance and pitch angle diffusion of the resonant electrons, to analyze the generation mechanism of the chorus emissions.

SM42C-0627 1330h POSTER

The Role of the DNT Resonance in the Classification of Magnetospheric and Ionospheric Resonances

Vladimir A. Osherovich[1] (301 286-3649; vladimir@urap.gsfc.nasa.gov)

Joseph Fainberg[2] (301 286-6940; joseph.fainberg@nasa.gov)

Robert F. Benson[2] (301 939-4037; u2rfb@lepvax.gsfc.nasa.gov)

[1]NASA Goddard Space Flight Center, Code 690.2, Greenbelt, MD 20771, United States

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

A prominent sounder-stimulated plasma resonance with a frequency between the upper-hybrid frequency f_{uh} (f_T in ionospheric notation) and the electron plasma frequency f_{pe} (f_N in ionospheric notation) was first identified and designated as the DNT resonance in ionospheric topside sounder ionograms [Benson, Radio Sci., 17, 167, 1982]. The letter D indicates that it has a diffuse appearance on the topside ionograms. Recently this resonance has also been observed to be stimulated in the magnetosphere by the Radio Plasma Imager (RPI) on the IMAGE satellite [Benson et al., JGR, 108(A5),1207, doi:10.1029/2002JA009589, 2003]. No theory has been offered to explain the formation of the DNT resonance. We will present the theoretical foundation for the following formula for the frequency of DNT which is a function of only f_{pe} and the electron gyrofrequency f_{ce}: $F_{DNT} = \sqrt{(F_p^2 + 1 + \sqrt{F_p^4 + 1})/2}$ where $F_{DNT} = f_{DNT}/f_{ce}$ and $F_p = f_{pe}/f_{ce}$. We will show that this formula reproduces the Alouette 2, ISIS-1 and IMAGE/RPI observations. The results indicate that the use of this formula will provide a valuable additional independent confirming element to the spectral identification of sounder-stimulated plasma resonances in certain F_p ranges. This confidence in spectral classification, in turn, leads to confidence in determining the electron density N_e to within a few per cent even in space plasmas with $N_e < 10\ cm^{-3}$ where determinations to this accuracy are difficult to achieve.

SM42C-0628 1330h POSTER

Critical Temperature for the Onset of Spacecraft Charging, An Update

Shu T. Lai (Shu.Lai@hanscom.af.mil)

Space Vehicles Directorate, Air Force Research Laboratory 29 Randolph Road, Hanscom AFB., MA 01731, United States

The onset of spacecraft charging at geosynchronous altitudes occurs at a critical value of the space plasma electron temperature for a given spacecraft surface. We review the theoretical formulation and computational results and compare the results with the Los Alamos National Laboratory spacecraft charging observations. It is amazing that the observational data show that the onset of charging occurs at a critical temperature in almost every charging event, no matter which satellite, which year and which month. It is equally amazing that the theoretical critical temperature values remain the same no matter in Maxwellian plasma or in kappa plasma, in eclipse or even in sunlight. We also offer a full theoretical formulation of critical temperature in cut-off Maxweliian distributions and a good reason why spacecraft charging seldom occurs in the dusk sector.

SM42D MCC: 2008 Thursday 1340h

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

Presiding: **R L Kessel,** NASA Goddard Space Flight Center**; M Henderson,** Los Alamos National Laboratory

SM42D-01 1340h

A Taxonomy of the Magnetosphere's Reaction to Solar-Wind Driving

Joseph E Borovsky[1] ((505)667-8368; jborovsky@lanl.gov)

Ruth M Skoug[1] (rskoug@lanl.gov)

Charles W Smith[2] (Charles.Smith@unh.edu)

[1]Los Alamos National Laboratory, Mail Stop D466, Los Alamos, NM 87545, United States

[2]University of New Hampshire, 297 Morse Hall, Durham, NH 03824, United States

By statistically examining the properties of the solar wind during various types of magnetospheric phenomena, we have produced a suggested taxonomy of the magnetospheric phenomena resulting from various properties of the solar-wind driver. These phenomena include periodic substorms, steady-magnetospheric-convection (SMC) events, storms with global sawtooth oscillations, storms without sawtooth oscillations, quiet periods with viscous convection, quiet periods without viscous convection. Periodic substorms tend to be found in times of modest southward vBz and normal to high amplitudes of upstream MHD turbulence. SMC events tend to be found in times of modest southward vBz and low-amplitude upstream turbulence. Global sawtooth oscillations tend to be found in times of big B, modest n, and low-amplitude upstream MHD turbulence. The geomagnetic indices are well correlated with the amplitude of upstream solar-wind turbulence. Under northward vBz this correlation is very clear, suggesting that (in analogy with fluid dynamics experiments) a viscous driven convection in the magnetosphere is being controlled by the amplitude of the solar-wind turbulence. A single diagram is presented summarizing the hypothesized taxonomy in vBz (reconnection) turbulence (viscosity) space. If the solar-wind-driver parameters are maintained for a sufficient amount of time, the predicted magnetospheric phenomena should occur.

SM42D-02 1355h

Plasmaspheric Dynamics: Solar-Wind/IMF and Sub-Auroral Coupling

Jerry Goldstein[1] (jerru@alum.dartmouth.org)

Bill Sandel[2] (sandel@arizona.edu)

Janet Kozyra[3] (jukozyra@umich.edu)

Anthony Mannucci[4] (Tony.Mannucci@jpl.nasa.gov)

[1]Southwest Research Institute, Space Science (Div 15), SwRI 6220 Culebra Road, San Antonio, TX 78238, United States

[2]University of Arizona, Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721, United States

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

[4]Jet Propulsion Laboratory, Jet Propulsion Lab California Institute of Technology, Pasadena, CA 91109, United States

The images produced by the IMAGE extreme ultraviolet (EUV) imager have provided the first global view of plasmaspheric dynamics, including the process of erosion and the formation and evolution of drainage plumes. The traditional picture holds that the zero-order behavior of the plasmasphere is described by superposition of corotation and solar-wind-driven sunward convection. We test this long-standing hypothesis by comparing EUV images and the output of a plasmapause evolution model driven by a time-varying Volland-Stern electric potential field. Volland-Stern simulations of two June 2001 erosion events reproduce the EUV plasmapause position on the dawnside, but place it too far from Earth near dusk, implying strong duskside flows not in the model. Low-altitude DMSP data show that duskside flows are often enhanced by the sub-auroral polarization stream (SAPS) phenomenon which couples the ring current, ionosphere and plasmasphere together. Our simple adhoc SAPS model corrects the duskside plasmapause position in the model. Thus, both convection and SAPS play a significant role in the global dynamics of the plasmasphere during geomagnetic disturbances. Analysis of DMSP data and model results indicate that SAPS flows may be responsible for a duskside "undulation" of the plasmapause observed on 17 April 2002. There is also evidence that SAPS plays a significant role in the creation of "tongue"-like regions of enhanced ionospheric/plasmaspheric total electron content (TEC) observed by the GPS network to extend poleward from low latitudes.

SM42D-03 1410h

Global Observations of O/N_2 in Earth's Thermosphere During the April 2002 Sun-Earth Storms

John B Sigwarth[1] (319-335-1867; john-sigwarth@uiowa.edu)

Geoffrey Crowley[2] (210-522-3475; gcrowly@swri.edu)

Louis A Frank[1] (319-335-1695; louis-frank@uiowa.edu)

[1]The University of Iowa, Dept. of Physics and Astronomy, Iowa City, IA 52242, United States

[2]Southwest Research Institute, 6220 Culebra RD, San Antonio, TX 78238, United States

During the period of April 14-24, 2002, a series of solar disturbances began several chains of events that influenced geospace. Earth's thermosphere is one endpoint for these chains. The Polar spacecraft was in a unique position to observe the end effects on the thermosphere. During April 2002, the 8 R_E apogee altitude of the Polar orbit was near the equator at approximately 1015 local time. The ultraviolet sensitive Earth Camera of the Visible Imaging System on the Polar spacecraft acquired global images of Earth's dayglow through a broadband filter at FUV wavelengths. For this filter, percentage variations in dayglow intensity relative to quiet times across the dayside hemisphere are related to variations in the O/N_2 column density ratio of the thermosphere. An initial small decrease in the O/N_2 ratio was observed on April 17, 2002. The O/N_2 ratio reached a maximum depletion of 45% during the magnetospheric storm on April 19, 2002 at 1907 UT. Full recovery of the O/N_2 ratio followed in less than 36 hours. The O/N_2 depletions were located in the polar regions and extended to mid-latitudes in both the northern and southern hemispheres. These depletion regions were highly structured and differed significantly between the hemispheres. The variability of the solar EUV photon flux can be observed in the hemisphere-integrated dayglow intensities and must be taken into account in order to obtain accurate retrieval of the O/N_2 ratios. Discussion will concentrate on the north-south asymmetry of the depletion regions and the variations of the observed O/N_2 ratio in the thermosphere as compared with the model results from the TIMEGCM.

SM42D-04 1425h

Interplanetary-Ionospheric Coupling: The 6 November 2001 Magnetic Storm Event

B. T. Tsurutani[1] ((818) 354 7559; Bruce.Tsurutani@jpl.nasa.gov); A. J. Mannucci[1] (Anthony.Mannucci@jpl.nasa.gov); B. Iijima[1] (Byron.Iijima@jpl.nasa.gov); M. A. Abdu[2] (abdu@dae.inpe.br); J. Sobral[2] (sobral@dae.inpe.br); W. Gonzalez[2] (gonzalez@dge.inpe.br); T. Tsuda[3] (tsuda@kurasc.kyoto-u.ac.jp); B. Fejer[4] (bfejer@cc.usu.edu); T. Fuller-Rowell[5] (Tim.Fuller-Rowell@noaa.gov); J. Kozyra[6] (jukozyra@srvr5.engin.umich.edu); J. Foster[7] (jcf@haystack.mit.edu)

[1]JPL, 4800 Oak Grove Drive, Pasadena 91109, United States

[2]INPE, CP515, Sao Jose dos Campos, SP 12200-000, Brazil

[3]RSCSA, Kyoto University, Uji 611, Japan

[4]Utah State University, USU, Logan, UT 84322, United States

[5]University of Colorado, UC, Boulder, CO 80905, United States

[6]University of Michigan, UM, Ann Arbor 48109, United States

[7]Haystack Obs., Millstone Hill, Westford, MA 01886, United States

The effects of the intense southward interplanetary magnetic fields of the 6 November 2001 event is studied using ground-based GPS receiver data, satellite (vertical) GPS receiver data, satellite altimeter data and Brazilian near-equatorial ionosonde data. Strong dawn-to-dusk directed interplanetary electric fields are generated by shock compression of an upstream slow magnetic cloud southward Bz magnetic fields. The electric field reached an unusually high approx. 55 mV/m intensity. Immediately after shock impingement, there were strong dayside and nightside ionospheric effects. The CHAMP GPS data plus ground based GPS data indicate that the dayside ionosphere was lifted to altitudes above the satellite (approx. 430 km). The vertical ionospheric TEC increased by 50-100 %. Nightside ionosonde data indicate strong decreases in TEC. During the intense interplanetary electric field event, an unusual plasma feature is noted. Enhanced midlatitutde densities occur with a sharp drop-off of densities at higher latitudes. The latitude of the drop-off decreased with storm development, similar to plasmaspheric erosion during magnetospheric convection electric field events. Finally large decreases in the dayside TEC are noted approx. 6 hrs after shock passage. This decrease is approx. 40 % below quiet daytime values. These interesting ionospheric features will be discussed in terms of prompt penetration of interplanetary electric fields, shielding fields, and neutral winds and composition.

SM42D-05 1440h

Non-uniform precipitation of solar energetic particles across the Earth's polar caps

Joseph E Mazur[1] (310-336-2389); J Bernard Blake[1]; Mark D Looper[1]; Glenn M Mason[2]; Richard A Mewaldt[3]; Berndt Klecker[4]; Shri Kanekal[5]

[1]The Aerospace Corporation, 2350 E. El Segundo Blvd., El Segundo, CA 90245-4691, United States

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

[3]California Institute of Technology, Space Radiation Lab 220-47 Downs, Pasadena, CA 91125, United States

[4]Max Planck Institute for Extraterrestrial Physics, Garching, Munchen D-85741, Germany

[5]Department of Physics, Catholic University of America, College Park, MD 20742, United States

The Earth's magnetic field has a complex influence on the precipitation of solar energetic particles into the atmosphere at high latitudes. Besides the time-dependent cutoff latitude, one often observes large (> factor of 4) changes in the intensity of solar particles particles as a low-altitude satellite traverses the polar caps. These features were first observed in low-Earth orbit and modeled in the 1970's (e.g. Scholer 1972). Factors such as delayed particle access from deep in the magnetotail, favored access to one pole or the other due to the polarity of the interplanetary magnetic field; and quasi-trapping just above the cutoff latitude were thought to play a role. We revisit these phenomena using the high-sensitivity instruments on the SAMPEX satellite at 600km altitude. We will test the previous

SM