orbits and the injected particle fluxes. We also discuss the dependence of the ion and electron injections on pulse parameters, such as speed, field magnitude and spatial extent. The results with the non-dipolar, time-dependent background field show marginal increase in injection strength for energies of 10 to 400 keVs and typical pulse parameters compared to the case of dipole background, however the differences become more significant for very active events or very high particle energies.

SM31A MCC: 2002-2004 Wednesday 0800h

Multipoint Observations of Reconnection Signatures

Presiding: **R Strangeway,** Institute of Geophysics and Planetary Physics, University of California, Los Angeles**; J D Scudder,** University of Iowa

SM31A-01 0800h

A CLUSTER INVESTIGATION OF THE OCCURRENCE AND CAUSES OF RECONNECTION IN THE VERY NEAR-EARTH TAIL (X > -19Re)

J. A. Slavin[1] (james.a.slavin@nasa.gov); E. Tanskanen[1] (eija.tanskanen@nasa.gov); S. Imber[2] (suzanne.imber@nasa.gov); A. Szabo[1] (adam.szabo@nasa.gov); C. J. Owen[3] (cjo@mssl.ucl.ac.uk); M. W. Dunlop[4] (m.dunlop@ic.ac.uk); E. Lucek[2] (e.lucek@ic.ac.uk); A. Balogh[2] (a.balogh@ic.ac.uk); K. -H. Fornacon[5] (k-h.fornacon@tu-bs.de)

[1]NASA GSFC, Laboratory for Extraterrestrial Physics, Greenbelt, MD 20771, United States

[2]Imperial College, Space and Atmospheric Physics, London SW7 2BZ, United Kingdom

[3]Mullard Space Science Laboratory, Holmbury St. Mary, Dorking Surrey, United Kingdom

[4]Rutherford-Appelton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, United Kingdom

[5]Technische Universität Braunschweig, Institut für Geophysik und Meteorologie, Braunschweig D-38106, Germany

The Cluster spacecraft cross the plasma sheet at distances of X -16 to -19 Re, significantly earthward of the mean X-line location of -25 Re determined by Geotail. Indeed, transport in the plasma sheet observed by Cluster is usually directed sunward during both quiescent and active intervals. Cluster's polar orbit is ideally suited for the detection of traveling compression regions (TCRs) in the tail lobes and, to a lesser extent, flux ropes in the plasma sheet. TCRs are caused by the rapid motion of flux ropes embedded in high-speed plasma sheet flows generated by multiple X-line reconnection. Hence, they can be used to remotely sense the movement of flux ropes and the plasma sheet flows in which they are embedded. Cluster fluxgate magnetometer measurements taken during the 2001 and 2002 tail seasons have been used to identify and analyze flux rope motion in the near-tail. Earthward moving flux ropes, detected either in situ or remotely as TCRs, are found to outnumber tailward moving flux ropes by a ratio of 3 to 1. Here we investigate the interplanetary and magnetospheric conditions associated with the production of tailward moving flux ropes at Cluster and, by implication, X-line formation in the very near-tail (i.e., X > -19 Re). The results will be discussed in terms of the processes leading to plasma sheet thinning and current sheet filamentation.

SM31A-02 0815h

Near-Earth Magnetotail Reconnection and Plasmoid Formation in Connection With a Substorm Onset on 27 August 2001

Stefan Eriksson[1] (1-303-492-8573; eriksson@lasp.colorado.edu); M. Øieroset[2] (oieroset@ssl.berkeley.edu); D. N. Baker[1] (daniel.baker@lasp.colorado.edu); R. L. McPherron[3] (rmcpherron@igpp.ucla.edu); S. Monk[1] (monk@lasp.colorado.edu); M. W. Dunlop[4] (M.W.Dunlop@rl.ac.uk); H. Rème[5] (henri.reme@cesr.fr); T. E. Sarris[1] (sarris@lasp.colorado.edu); C. Shen[6] (sc@center.cssar.ac.cn); A. Balogh[7] (a.balogh@ic.ac.uk)

[1]Laboratory for Atmospheric and Space Physics, University of Colorado, 1234 Innovation Drive, Boulder, CO 80303-7814, United States

[2]Space Sciences Laboratory, University of California, Centennial Dr at Grizzly Peak Blvd, Berkeley, CA 94720-7450, United States

[3]Institute of Geophysical and Planetary Physics, University of California, 405 Hilgard Avenue, Los Angeles, CA 90024-1567, United States

[4]Space Sciences Division, Rutherford Appleton Laboratory, DIDCOT, Chilton, Oxfordshire OX11 0QX, United Kingdom

[5]Centre d'Etude Spatiale des Rayonnements, 9 Ave Colonel Roche, Toulouse 31029, France

[6]Laboratory for Space Weather, Center for Space Science and Applied Research, No.1, Nanertiao, Zhongguancun, Haidian District, Beijing 100080, China

[7]Physics Department, The Blackett Laboratory, Imperial College, Prince Consort Road, London SW7 2BZ, United Kingdom

We have examined the magnetic field and ion velocity data from the Cluster spacecraft on 27 August 2001 when the spacecraft were located in the postmidnight magnetotail at $x_{GSM} = -19R_E$ and $y_{GSM} = -2R_E$. Fast earthward flows were recorded at both Cluster sc1 and sc3 $\sim$32 min prior to a substorm onset at $\sim$0401 UT, when enhanced tailward flows were detected at both spacecraft. Cluster sc3 also detects earthward directed flows $\sim$30 min after the onset. These plasma flows are suggestive of slow-mode shocks in a Petschek-type reconnection layer. The negative B_y component of the observed magnetic field coincident with high-speed tailward flows at substorm onset strongly suggest the formation and ejection of a plasmoid. We apply a curvature analysis technique on the magnetic field data to investigate the topology of the plasmoid during its evolution. The indication that reconnection is active prior to the downtail release of the plasmoid at substorm onset may be interpreted as a semi-continuous erosion of magnetic fields in the near-Earth magnetotail region and may provide us with information on the dynamic evolution of the near-Earth neutral line (NENL) to the point of plasmoid release.

SM31A-03 0830h

Cluster Observations of a Near-Earth Neutral Line on August 27, 2001

Robert L McPherron[1] (310-825-1882; rmcpherron@igpp.ucla.edu); Daniel N Baker[2] (Dan.Baker@lasp.colorado.edu); Margaret G Kivelson[1] (mkivelson@igpp.ucla.edu); Khrishan Khurana[1] (kkhurana@igpp.ucla.edu); Andre Balogh[3] (a.balogh@ic.ac.uk); Henri Reme[4] (Henri.Reme@cesr.fr); Iannis Dandouras[4] (Iannis.Dandouras@cesr.fr); Howard Singer[5] (Howard.Singer@noaa.gov); Eric Donovan[6] (eric@phys.ucalgary.ca)

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

[2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309, United States

[3]Space and Atmospheric Physics Group, The Blackett Laboratory Imperial College Prince Consort Road, London SW7 2BW, United Kingdom

[4]CESR BP4346 , 9 avenue du Colonel Roche, Toulouse, Cedex 04 31028, France

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

[6]Department of Physics and Astronomy, University of Calgary, Calgary, ALB T2N 1N4, Canada

At 0400 UT on August 27, 2001 the Cluster spacecraft located near midnight at 19 Re began to observe a tailward flow with southward magnetic field. This flow persisted for several minutes and then both field and flow reversed to northward and Earthward. The event was associated with a rotation of the magnetic field from its usual orientation along the GSM X-axis to nearly antiparallel to the Y-axis. In a principal axis system the Bx' component changed from +12 nT to -12 nT and then back. As the spacecraft passed downward through Bx' = 0 significant current antiparallel to the magnetic field was encountered. At this time the line containing the field and current pointed roughly 45 from gsm Bx towards dawn. The plasma flow was generally tailward orthogonal to the line containing the field and current. While the spacecraft were in the region of negative Bx' the plasma flow was tailward along X. When the spacecraft returned through Bx' = 0 the current and field were again antiparallel at 45 and the flow was still tailward orthogonal to the current and field. Next the flow rotated 180 becoming Earthward with a duskward component. These observations suggest that an x-line formed Earthward of Cluster releasing a structure that was convected tailward past the spacecraft. This x-line remained Earthward of Cluster for four minutes steadily forcing plasma tailward with imbedded southward magnetic field. The x-line then moved tailward past Cluster rotating the field to northward and the flow to Earthward. These observations become particularly important when placed in the context of substorm activity on this day. A major substorm expansion followed the onset of the x-line signatures by about six minutes.

SM31B MCC: Level 2 Wednesday 0830h

Sun-to-Earth Elements and Linkages That Drive Geoeffectiveness I Posters

(joint with SA, SH, NG)

Presiding: **J U Kozyra,** University of Michigan**; L Goncharenko,** MIT Haystack Observatory

SM31B-1105 0830h POSTER

Mass and Speed of the April 21, 2002 CME at 1.64 Solar Radii

John C Raymond (617-495-7416; jraymond@cfa.harvard.edu)

John Raymond, Center for Astrophysics 60 Gardden St., Cambridge, MA 02138

A partial halo CME was associated with an X-class flare on April 21, 2002. It accelerated to 2500 km/s and produced an SEP event. UVCS/SOHO observed the event at 1.64 solar radii, near the peak acceleration. The UV spectra establish the conditions in the pre-CME streamer where much of the mass of the CME originates. Doppler shifts show that a large part of the streamer motion is transverse rather than radial, with an Earth-directed velocity component of 850 km/s. The transverse acceleration is even larger than the radial acceleration. From the density and acceleration we derive a lower limit to the magnetic field at 1.64 solar radii. High temperature emission indicates a probable current sheet, which in some CME models is vital to the CME acceleration. Thus we obtain estimates of the mass, acceleration and magnetic field of the CME in the region of the corona where these quantities are established.

SM31B-1106 0830h POSTER

Source Regions and Storm Effectiveness of Earth-Directed Halo CMEs Between 14 and 24 April 2002

Xue Pu Zhao[1] (650-7250474; xpzhao@solar.stanford.edu)

Yang Liu[1] (650-7245605; yliu@sun.stanford.edu)

[1]Stanford University, 455 Via Palou, Stanford, CA 94305-4085, United States

All three halo CMEs occurred between 14 and 24 April 2002 are found to be associated with flares, interplanetary trasient shocks and geomagnetic storms, and thus are Earth-directed. To understand why the April 15 and 17 Earth-directed halo CMEs cause geomagnetic storms much stronger than the April 21 Earth-directed halo CME, we first determine the central position and the line-of-sight propagation velocity of the three halo CMEs using the cone model (Zhao et al., 2002), and then identify source regions of the halo CMEs and examine the magnetic configuration of those source regions. It is found that the April 15 and 17 halo CMEs originated in a bipolar closed field regions with the bipolar boundary layer being favourable for the occurence of the southward IMF event, and the April 21 halo CME originated in an unipolar region with the

unipolar boundary layer being not favourable for the occurrence of the southward IMF event, though the later has a very high propagation velocity. The storm effectiveness of the three Earth-directed halo CMEs are discussed.

SM31B-1107 0830h POSTER

Two peaks of Forbush decreases and SSCs in one solar cycle: What causes them?

H. S. Ahluwalia[1] (505-277-2941; hsa@stelab.nagoya-u.ac.jp)

Y. Kamide[2] (81-533-89-5183)

[1]H.S. Ahluwalia, Physics and Astronomy Department University of New Mexico, 800 Yale Blvd NE, Albuquerque, NM 87131-1156, United States

[2]Y. Kamide, Solar Terrestrial Environment Laboratory, Nagoya University Honohara 3-13, Toyokawa 442-8507, Japan

We have studied the annual frequency distribution of the Forbush decreases (FDs) for three solar cycles (20, 21, 22). Most of them are associated with the fast ICMEs and the SSCs. The frequency varies in step with the solar cycle but the distribution has a notable gap embedded in it, near the maximum of cycle. We show that the gap coincides with the epoch of the solar polar field reversal. There is an indication of an even/odd cycle effect in the frequency distribution of FDs and the associated SSCs. Comparing the FD and SSC frequency distributions with the similar distribution of solar wind electric field, we find that the two peaks in FD and SSC distributions are separated by the Gnevyshev gap. We also show that a large value of the solar wind electric field by itself does not cause a FD to occur unless accompanied by a fast ICME.

SM31B-1108 0830h POSTER

Using solar wind low-energy energetic ion enhancements to forecast large geomagnetic storms

Zdenka Smith[1] (303 497 3473; Zdenka.smith@noaa.gov)

William Murtagh[1] (303 497 7492; William.Murtagh@noaa.gov)

Thomas R. Detman[1] (303 497 5394; Thomas.Detman@noaa.gov)

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

A forecasting method is developed based on the relationship between energetic ion enhancements and geomagnetic storms. This relationship was investigated in previous paper, Smith et al 2003 (hereafter referred to as Paper 1). An excellent correlation was found between large geomagnetic storms (storms with Kp equal to or greater than 7) and large energetic ion enhancements (those with high maximum flux values). An energetic Ion enhancement is hereafter referred to as an EIE. However there were many more large EIEs than large storms. Therefore other characteristics were sought in Paper 1 to help discriminate the EIEs likely to be followed by large storms. A forecasting method is developed here using the characteristics found useful in Paper 1. These are the nature of the IP driver (whether transient or co-rotating high speed stream) and whether the EIE was part of enhanced activity. An additional parameter, the magnitude of the total magnetic field is introduced here. The forecasting technique is developed using EIE events between February 1998 through December 2000 found primarily in ACE data. The prediction results obtained by this technique are presented for various maximum flux thresholds, together with the performance statistics. For a flux threshold that was exceeded by 60 of the 115 events found in this time interval, this technique would have predicted 24 of the 30 large storms that occurred in this time period. By including the other criteria, 83% of those events would have been correctly identified. The warning times obtained are also presented.

SM31B-1109 0830h POSTER

Forecasting Magnetospheric Dynamics Using Solar Wind Measurements: Role of Global and Multi-Scale Processes

Aleksandr Y Ukhorskiy[1] (2402280201; aleksandr.ukhorskiy@jhuapl.edu)

Mikhail I Sitnov[2] (sitnov@umd.edu)

Surjalal A Sharma[2] (ssh@astro.umd.edu)

Dennis Papadopoulos[2]

[1]JHU APL, Applied Physics Laboratory 11100 Johns Hopkins Road MS MP3-E116, Laurel, MD 20723, United States

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

Earth's magnetosphere is a nonlinear spatially extended system which is driven far from the equilibrium by the turbulent solar wind. On the global scales the magnetospheric dynamics appear to be well organized and coherent and therefore allow deterministic considerations. However, on the smaller scales it exhibits scale-invariant behavior which is retained over a wide range of spatial and temporal scales. These multi-scale features do not reveal low effective dimension and therefore can not be predicted dynamically. At the same time, the input-output statistical analysis shows that the scale-free properties of magnetospheric dynamics are strongly affected by the solar wind and therefore can be described in terms of conditional probability. This allows constructing a unified data-derived model of solar wind - magnetosphere coupling which combines the elements of nonlinear dynamical approach with Bayesian consideration of statistical physics. It yields deterministic predictions of the global component of the dynamics and probabilistic predictions of its multi-scale features.

SM31B-1110 0830h POSTER

Signatures of Magnetic Storms Induced by Magnetic Clouds

Xiaoyan Zhou[1] ((818)354-9169; xiaoyan.zhou@jpl.nasa.gov); Bruce T Tsurutani[1] (bruce.tsurutani@jpl.nasa.gov); John M Ruohoniemi[2] (Mike.Ruohoniemi@jhuapl.edu); Geoff Reeves[3] (reeves@lanl.gov); Gordon Rostoker[4] (rostoker@space.ualberta.ca); Wei Sun[5] (sun@elvis.gi.alaska.edu); Yohsuke Kamide[6] (kamide@stnet1.stelab.nagoya-u.ac.jp); Tony Y Lui[2] (Tony.Lui@jhuapl.edu); George K Parks[7] (parks@ssl.berkeley.edu); Walter D Gonzalez[8] (gonzalez@dge.inpe.br)

[1]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, United States

[2]Applied Physics Laboratory, Johns Hopkins Rd, Laurel, MD 20723, United States

[3]Los Alamos National Laboratory, NIS-2, Mail Stop D-436, Los Alamos, NM 87545, United States

[4]University of Alberta, 412 Avadh Bhatia Physics Laboratory University of Alberta, Edmonton T6G 2J1, Canada

[5]Univ Alaska Fairbanks, POB 757320, Fairbanks, AK 99775, United States

[6]Nagoya University, Nagoya University Honohara 3-13, Toyokawa, Aichi-ken 442, Japan

[7]Univ California, Berkeley, Centennial & Grizzly Peak Blvd, Berkeley, CA 94720, United States

[8]The National Institute for Space Research, INPE-CEA/DGE CAIXA POSTAL 515, S.J.DOS CAMPOS 12201, Brazil

We have studied 11 magnetic storms (in 1997) that were induced by the smoothly varying Bz component of the interplanetary magnetic field typical of interplanetary magnetic clouds. It was found that there was a lack of substorm expansion phases for long periods of time (up to 7 hr) in 5 out of 11 storm main phases. In this paper, a relatively weak magnetic storm event (with minimum SYM-H at -47 nT) that occurred on July 15, 1997 is studied using ground-based magnetograms, polar cap potentials from SuperDARN, and LANL geosynchronous energetic particle data as well as the Polar UV imaging (for aurorae) and Wind (for the solar wind) data. It is shown that during the storm main phase, there was a lack of substorm expansion phase activity (from imaging and the ground-based data) and a lack of energetic particle injections at the geostationary orbit. The corresponding ring current intensification was weak. The most prominent auroral forms were north-south aligned auroral patches and torches. Dawn and dusk aurorae were more intense than the aurorae near midnight, where auroral gaps were seen. In addition, this paper shows that there was significant directly driven activity during the storm main phase when the IMF was continually southward. We argue that during this event the ring current intensification was more strongly associated with enhanced magnetospheric convection than with substorm-generated impulsive unloading of energy from the tail. Three scenarios are suggested to explain the relatively low-intensity of the magnetic storm induced by a magnetic cloud. They are: 1) weak nightside auroral zone ionospheric ion outflows (due to lack of substorms), 2) choked penetration of the tail plasma flow (due to lack of substorms), 3) retarded magnetospheric convection (due to reduced solar wind-magnetosphere reconnection). The observed saturation of the polar cap potential drop is consistent with this last mechanism.

SM31B-1111 0830h POSTER

Electromagnetic Ion Cyclotron Waves in the Subsolar Region Under Normal Dynamic Pressure: Wind Observations and Theory

Gnavi Graciela[1] (ggnavi@arnet.com.ar); Charles J. Farrugia[2] (charlie.farrugia@unh.edu); Fausto T Gratton[1] (fgratton@arnet.com.ar); Hiroshi Matsui[2] (hiroshi.matsui@unh.edu); Roy B. Torbert[2] (roy.torbert@unh.edu); Ronald P Lepping[3] (RPL@leprpl1.gsfc.nasa.gov); Marit Oieroset[4] (oieroset@ssl.berkeley.edu); Robert P Lin[4] (boblin@ssl.berkeley.edu)

[1]Institute of Plasma Physics, University of Buenos Aires, Buenos Aires 1114, Argentina

[2]Space Science Center, University of New Hamsphere, Durham, NH 03824

[3]NASA Goddard Space Flight Center, Greenbelt, Greenbelt, MD 20771, United States

[4]Space Science Lab, University of California, Berkeley CA 94720, United States

We analyze observations on electromagnetic ion cyclotron waves (EICWs) in the plasma depletion layer (PDL) made by Wind on 3 inbound passes of the magnetosheath near the stagnation streamline, and model the observations using recent theory (*Gnavi et al.*, 2000). While one pass was under substantially high solar wind dynamic pressure P_{dyn} ($\sim$ 6.4 nPa), two passes were under typical P_{dyn} at 1 AU ($\sim$ 2.2 nPa) which allows us to extend the study of EICWs into this lower pressure regime. Two passes were under steady, and one under time varying, conditions. We subdivide the PDL into inner, middle and outer regions and compute in each the power spectral density (PSD) of the magnetic fluctuations transverse to the background field, using high resolution ($\sim$ 11 samples/s) data from the Magnetic Field Investigation (MFI). The theory solves the kinetic dispersion relation in a plasma composed of electrons, protons, and α particles, each species modeled by biMaxwellian distribution functions. Parameters for calculating growth rates are taken from the observations, where available, and from average values quoted in the literature otherwise. Qualitative, and on occasion even quantitative, agreement between theory and data is very good. The observations show (i) at the inner PDL position the spectral PSD weakens as P_{dyn} decreases, and (ii) the frequency range of emission shifts downward with diminishing P_{dyn}. Comparing observations with the classification of spectral types in the PDL under compressed conditions proposed by *Anderson et al.* [1994], we find a preponderance of so-called low and continuous spectra and only marginally bifurcated spectra with activity peaks below and above the alpha-resonance frequency. In general, near the magnetopause our temperature anisotropies A_p are at the lower end of values characterizing bifurcated spectra in AMPTE/CCE. Using bipolytropic laws for the anisotropic magnetosheath, we argue that the effect of a reduction of P_{dyn} is to lower A_p, thereby weakening the driver of EICWs leading to marginally bifurcated spectra and weaker EICW activity in the PDL under typical conditions. This work is partially supported by NASA grants NAG5-13116, NAG5-11803, and and the Argentinean UBACYT grant X059.

SM31B-1112 0830h POSTER

Plasma Depletion Layer Dependence on Solar Wind Conditions and the Earth Dipole Tilt

Yongli Wang[1] (ylwang@igpp.ucla.edu)

Joachim Raeder[2] (603-862-3412; J.Raeder@unh.edu)

Christopher T. Russell[3] (310-825-3188; ctrussell@igpp.ucla.edu)

[1]Los Alamos National Laboratory, NIS-1, Mail Stop D466, Los Alamos, NM 87545

[2]University of New Hampshire, Space Science Center 245G Morse Hall 39 College Road, Durham, NH 03824

[3]IGPP/UCLA, 405 Hilgard Avenue, Los Angeles, CA 90095-1567

As a layer between the magnetosphere and the solar wind, the plasma depletion layer (PDL) is continuously affected by the ever changing solar wind conditions, as well as the resulting oscillations of the magnetopause to these variations. Some former studies have shown strong dependence of the PDL on solar wind conditions. Experimentally such a dependence study is very difficult because of the scarcity of observations. An alternate approach is to use models to investigate and document the dependence of the PDL on solar wind conditions. Such an approach would be similar to the one taken several decades ago by Spreiter et al. [1966] for the basic properties of the magnetosheath.

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We have previously shown [Wang et al., 2003] that the UCLA/NOAA global model is very well capable of reproducing the structure of the magnetosheath for two case studies. This result now gives us the confidence to attempt a study similar to Spreiter's description of the magnetosheath. With the introduction of MHD and a self-consistent model significantly more free parameters enter the problem compared to a study based on a gasdynamic model. At a minimum, the IMF strength and orientation need to be considered besides the gasdynamic parameters (mostly the solar wind Mach number). In this study, we first introduce the parameters for the model runs for this PDL dependence study. Then we will discuss some more detailed issues about the definition of the PDL boundary. After that, we will show the dependence of the PDL and the slow mode front on the solar wind Mach number, the IMF clock and tilt angles, and the Earth dipole tilt. Finally, we will summarize the results from this study.

SM31B-1113 0830h POSTER

How does the solar wind power the magnetosphere during geoeffective high speed streams?

Ramona L Kessel[1] (301-286-6595; Ramona.L.Kessel@nasa.gov)

Xi Shao[1] (301-286-1847; shao@mail630.gsfc.nasa.gov)

Yaireska Collado-Vega[1] (yaireska@mail630.gsfc.nasa.gov)

[1]NASA Goddard Space Flight Center , code 632 , Greenbelt, MD 20771, United States

We compare and contrast two mechanisms explaining the source of enhanced Pc5 energy in the magnetosphere during the high speed stream beginning 30 March 2002. In the first mechanism fast solar wind streams lead to an enhanced Kelvin-Helmholtz (K-H) instability on the magnetopause flanks causing enhanced Pc5 power inside the magnetosphere. In the second mechanism compressional fluctuations intinsic to the solar wind drive Pc5 power in the magnetosphere, either directly at the same frequencies or indirectly where the input frequencies are broadband and cause random boundary motion that excites magnetospheric cavity eigenfrequencies. We use observations from ACE and Wind to show the power intrinsic to the solar wind. Geotail and Cluster, at the magnetopause, together with MHD simulations highlight the K-H instability. GOES data and ground-based data from the SAMNET, IMAGE, or SAMNET arrays are used to show the magnetospheric response. We compare the wave frequencies in all regions focusing particularly on the existence of cavity eigenfrequencies. Results from these analyses will be presented.

SM31B-1114 0830h POSTER

Particle entry through sash in the magnetopause with a dawndard IMF as simulated by a 3-D EM particle code

Dong-Sheng Cai[1] (81-298-53-5541; cai@is.tsukuba.ac.jp)

Xiaoyang Yan[1] (81-298-53-4956; yxy@aoi3.is.tsukuba.ac.jp)

Bertrand Lembege[2] (33 1 39 25 47 70; Bertrand.Lembege@cetp.ipsl.fr)

Ken-Ichi Nishikawa[3] (256-961-7614; Ken-Ichi.Nishikawa@nsstc.nasa.gov)

[1]The University of Tsukuba, Institute of Information Sciences and Electronics,, Tsukuba, Ibaraki 305-8573, Japan

[2]CETP/UVSQ/IPSL, 10-12 Avenue de l'Europe, Velizy FR-78140, France

[3]National Space Science and Technology Center, 320 Sparkman Drive, SD 50, Huntsville, AL 35805, United States

We report a new progress in the long-term effort to represent the global interaction of the solar wind with the Earth's magnetosphere using a three-dimensional electromagnetic particle code with the improved resolutions using the HPF Tristan code. After a quasi-steady state is established with an unmagnetized solar wind we gradually switch on a northward interplanetary magnetic field (IMF), which causes a magnetic reconnection at the nightside cusps and the magnetosphere to be depolarized. In the case that the northward IMF is switched gradually to dawnward, there is no signature of reconnection in the near-Earth magnetotail as in the case with the southward turning. On the contrary analysis of magnetic fields in the magnetopause confirms a signature of magnetic reconnection at both the dawnside and duskside. And the plasma sheet in the near-Earth magnetotail clearly thins as in the case of southward turning. Arrival of dawnward IMF to the magnetopause creates a reconnection groove which cause particle entry into the deep region of the magnetosphere via field lines that go near the magnetopause. This deep connection is more fully recognized tailward of Earth. The flank weak-field fan joins onto the plasma sheet and the current sheet to form a geometrical feature called the cross-tail S that structurally integrates the magnetopause and the tail interior. This structure contributes to direct plasma entry between the magnetosheath to the inner magnetosphere and plasma sheet, in which the entry process heats the magnetosheath plasma to plasma sheet temperatures. These phenomena have been found by Cluster observations. Further investigation with Cluster observations will provide new insights for unsolved problems such as hot flow anomalies (HFAs), substorms, and storm-substorm relationship. 3-D movies with sash structure will be presented at the meeting.

URL: http://gammaray.nsstc.nasa.gov/~nishikawa

SM31B-1115 0830h POSTER

Measurements of the Geomagnetic Cutoff Rigidity-Dependence for Solar Energetic Particle Events

Allan W Labrador[1] (626-395-2964; labrador@srl.caltech.edu); R. Leske[1]; S. Kanekal[2]; B. Klecker[3]; M. Looper[4]; R. Mewaldt[1]

[1]California Institute of Technology, MC 220-47, Pasadena, CA 91125, United States

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

[3]Max Planck Institut, feur Extraterrestrische Physik, Garching Bei Munchen, CA D-85741, Germany

[4]The Aerospace Corp., P.O. Box 92957, M/S M2/260, Los Angeles, CA 90009, United States

During large solar energetic particle (SEP) events, charged particles can ionize the atmosphere and alter atmospheric chemistry. Geomagnetic cutoff latitudes bound the polar regions of the atmosphere exposed to solar particles. The size of the exposed polar regions may change significantly during SEP events, correlating well with geomagnetic activity. During SEP events, the geomagnetic cutoff latitude can vary by more than 10 degrees. Using data from the MAST instrument on SAMPEX, we have measured geomagnetic cutoffs for 17 large SEP events, including the 4/21/02 event. We will combine these measurements with data from other SAMPEX instruments to investigate how the size of the polar regions depends on particle rigidity, how this dependence may change with time during an event, and how the measurements compare with models.

SM31B-1116 0830h POSTER

Variable Contributions of Solar Energetic Protons, Helium, Heavy-Ions and Electrons to the Ionization of the Upper Atmosphere

R. A. Mewaldt[1] (626-395-6612; RMewaldt@SRL.caltech.edu); C. M. S. Cohen[1] (Cohen@SRL.caltech.edu); A. W. Labrador[1] (Labrador@SRL.caltech..edu); R. A. Leske[1] (RAL@SRL.caltech.edu); G. M. Mason[2]; M. L. Looper[3]; J. E. Mazur[3]; E. C. Roelof[4]

[1]Caltech, MS 220-47, Pasadena, Ca 91125, United States

[2]University of Maryland, Space Sciences Dept., College Park, MD 20742, United States

[3]Aerospace Corporation, M2/259, El Segundo, CA 90009, United States

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

During large Solar Energetic Particle (SEP) events such as that on April 21, 2002, particles precipitating into the upper atmosphere can have significant effects on atmospheric chemistry. Using data from ACE and SAMPEX the composition and energy spectra of SEPs from H to Fe with energies from $\sim$0.1 to $\sim$100 MeV/nuc and electrons from $\sim$0.04 to 14 MeV were measured during the April 2002 "Storms" period. Of these species, protons made the largest contribution to the ionization of the upper atmosphere at all energies, as is commonly assumed. However, electrons of similar penetrating power contributed $\sim$10% to $\sim$40% of protons, depending on energy, and He and heavier ions contributed $\sim$10% and $\sim$1-2% of protons, respectively. We have surveyed the relative contributions of these species in a number of other large events from 1997 to 2002 and find that the relative contributions of He and heavier ions are sometimes several times greater than in the 4/21/02 event, while electron contributions (relative to protons) can be up to $\sim$10 times greater. These results suggest that models of SEP energy deposition and associated chemical effects in the atmosphere may need to include other SEP species besides protons.

SM31C MCC: Level 2 Wednesday 0830h

Solar Wind-Magnetosphere Coupling: Comparative Magnetospheres II Posters *(joint with P, SH)*

Presiding: **J L Green,** NASA Goddard Space Flight Center**; F J Crary,** Southwest Research Institute

SM31C-1117 0830h POSTER

The Effects of the IMF Bx Component on the Earth's Magnetosphere

Tatsuki Ogino[1] (81-533-89-5207; ogino@stelab.nagoya-u.ac.jp)

Raymond J Walker[2] (rwalker@igpp.ucla.edu)

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, 3-13 Honohara, Toyokawa, Aic 442-8507, Japan

[2]Institute of Geophysics and Planetary Physics, University of California, Hilgard Ave., Los Angeles, CA 90095-1567, United States

We have used a 3-dimensional global magnetohydrodynamic (MHD) simulation of the interaction between the solar wind and the magnetosphere to study the effects of the IMF Bx component on magnetospheric structure and dynamics. In the upstream solar wind, we assumed that the IMF field lines are in the plane of the Parker spiral which is inclined by 45 degrees to the y-z plane. We found that including an IMF Bx component in the simulation creates transient phenomenon with dawn-dusk and north-south asymmetry in the earth's magnetosphere and that the asymmetric structure is maintained even when the magnetosphere reaches a quasi-steady state. The asymmetries persist when Bx is small. The asymmetric structure in the magnetosheath and magnetosphere is enhanced when the IMF is large and the Alfven Mach number becomes small (<2). Since the IMF grows at the expense of the flow across the bow shock the flow is easily influenced by the IMF asymmetry in the magnetosheath. The existence of the IMF Bx component as well as the IMF By and Bz components precludes any symmetry in the magnetospheric structure. Thus an asymmetric configuration appears in the magnetosphere and this tendency is enhanced for strong IMF. For non-zero IMF Bx magnetopause magnetic reconnection occurs differently on the dawn and dusk sides. IMF lines on the dusk side are straighter than those on the dawn side. This increases the magnetic pressure and pushes the plasma sheet toward dawn. On the other hand, the IMF lines on the dawn side are bent sharply. This decreases the magnetic pressure. This dawn-dusk asymmetry in dayside reconnection and the related magnetospheric convection are the main reasons the plasma sheet is inclined, and the magnetotail is rotated about the sun-earth line. This also causes asymmetric plasma flows.

SM31C-1118 0830h POSTER

Modelling Mercury's Magnetosphere

James W Scuffham[1] (02075947678; james.scuffham@imperial.ac.uk)

Andre Balogh[1] (a.balogh@imperial.ac.uk)

[1]Imperial College London, South Kensington, London SW72BW, United Kingdom

There have been many attempts to model the magnetosphere of Mercury based on simply scaling models of the Earth's magnetosphere. This approach has had many successes, but it remains physically unsatisfactory, as it ignores the different boundary conditions that apply at the two planets. The higher Solar Wind dynamic pressure and smaller dipole moment at Mercury make its magnetosphere very small and highly dynamic; Solar Wind driven convection is the dominant plasma transport process. The higher interplanetary magnetic field means that reconnection may be able to proceed more efficiently, making the magnetosphere adopt a very open configuration. In the absence of trapped particles, no ring current forms at Mercury. In addition, field aligned currents may be insignificant due to the lack of a significant ionosphere. We have analysed existing magnetospheric modelling techniques, particularly those of Tsyganenko, and have applied them directly to Mercury with these different boundary conditions. The lack of data has made the parameterisation of the model very difficult. However, the advantage of the model is that it will be possible to use new data as it becomes available from Messenger and BepiColombo. In the meantime, we have explored the possibility of using the results of MHD simulations to constrain the various parameters of the model.