al. (2002) used SAMPEX 2-6MeV electron flux data to extend these studies from L=1.1 to L=10.0, and studied the non-stationarity of the radiation belt system by demonstrating significant solar cycle and seasonal variability in the global linear response functions. The studies using Vsw as a driver for radiation belt dynamics all noted a significant drop in electron response at a time lag of zero days, but could say little more about its cause with no temporal structure at less than a daily resolution. We have incorporated modern techniques in adaptive system identification to produce global response functions at sub-daily time scales that update with each new measurement. Combining these techniques with SAMPEX orbit-averaged electron data, one is able to track real-time variations in solar wind-driven radiation belt dynamics, in particular electron loss and acceleration mechanisms, with spatial (L-shell) and temporal resolutions more amenable to physical interpretation. From a more practical standpoint, an appropriate implementation of these techniques promises to allow for more accurate, robust, and operationally useful space weather forecasts than are currently available.

SP22A-10 1615h INVITED

Controlled Precipitation of Radiation Belt Particles

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The sources and losses of the energetic radiation belt particles, and in particular the relativistic electron population of the radiation belts is one of the most important concerns of 'Space Weather', with a rapidly growing number of civilian and military assets in space being increasingly vulnerable to enhanced radiation levels. Thus, potential mitigation of enhanced radiation levels is a topic of significant interest. In this paper, we quantify the possibilities of the control of trapped radiation levels using satellite-based ELF/VLF transmitters, by providing estimates (based on scaling from published theoretical calculations/measurements of particle loss rates) of the potential effects of a VLF transmitter(s) operating near the magnetic equatorial plane. For quantitative examples, we focus our attention on 1.5 MeV and 3 MeV electrons. Simple estimates indicate that the lifetimes of energetic electrons can be halved by using space-borne transmitter(s) which can radiate whistler-mode waves with total integrated (over spatial regions) power levels of many tens of kilowatts at the appropriate frequencies and magnetospheric locations. The estimates are based on simple power scaling from previous calculations of the effects on particle lifetime of continuously operating VLF transmitters using frequencies in the 17-23 kHz range. The power requirements may actually be substantially lowered via the use of lower ($<$10 kHz) frequencies, due to the highly efficient storage (via multiple reflections) of VLF wave energy in the magnetospheric cavity, which significantly enhances the total number of particles scattered by the injected waves. The effectiveness of such storage is exemplified by commonly observed Magnetospherically Reflected (MR) whistlers. The lifetimes of such whistlers, and thus also VLF signals injected in-situ, is limited only by Landau damping of the injected waves, which have recently been quantified using new data on the suprathermal electron fluxes from the HYDRA instrument on the POLAR satellite.

SP22B WCC: TH-Air NZ Tuesday 1315h

Space Weather Threats to Human Technology: The International Space Weather Program

Presiding: **D Baker,** University of Colorado, Boulder, Laboratory for Atmospheric and Space Physics**; J B Blake,** The Aerospace Corporation

SP22B-01 1315h INVITED

Preliminary Study of Solar-Interplanetary-Geomagnetic Chain Weather

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On the basis of a ongoing national major project, Adverse Weather Process in Solar-Terrestrial System and Its Effects to Human Activities (1999-2003), sponsored by National Natural Science Foundation of China, some progress in space weather research on Solar-Interplanetary-Geomagnetic(SIGMA) chain and other related national proposed projects are presented. 1.Research Progress 1.Numerical Simulation of Asymmetric corona with multi-streamer structures–A new procedure, called the magnetic field fitting-modification method, is proposed to generate planar asymmetric coronas with multi-streamer structures, as shown in SOHO/LASCO observations. It could be used for producing complex coronal magnetic structures and for providing the real initial-boundary conditions of CME propagating through the corona; 2.Numerical Research for the interaction between CME and Streamer–the CME triggered by the magnetic emergence at northern latitude 10o and 45o will keep deflecting to current sheet when it propagates away from the sun and this deflecting effect mostly happens within tens of solar radius before CME propagates finally along the heliospheric current sheet; 3.Source Surface structures of solar plasma and magnetic field outputs–Using the K-coronal white light brightness and the photo spheric magnetic field observations as inputs, the source surface structures of solar plasma and magnetic fields could be obtained by solving MHD equations and could be used for predicting weather tendency of interplanetary space near the earth orbit; 4.Study of prediction method for solar wind storm–A so-called "ISF" prediction method for geomagnetic disturbances caused by solar wind storm blowing to the earth is suggested. The method is based on a combined approach of interplanetary scintillation (I), three dimensional propagation characteristics of solar wind storm (S) and the fuzzy mathematics (F). Prediction test result of 24 larger geomagnetic disturbance events is encouraging. 2.Effects to Human Activities effects of June 2000 event to the radio-transmission in China; effects of April 2001 event to the radio-transmission in China; 3.Proposed national projects related to space weather study "Space Weather Research Program" will be conducted by National Natural Science Foundation of China/Department of Earth Sciences; To accelerate the step of "Meridian Project" internationalization, an International Space Weather Meridian Circle Program is being suggested by Chinese Meridian Project Working Group.

SP22B-02 1345h

The Structure of Magnetopause Layers at Low Latitudes

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The magnetopause is a principal boundary dividing the magnetospheric and solar wind plasma. It is usually considered as a sharp boundary but the magnetopause region is highly structured. An inner layer at low latitudes which consists of tailward flowing plasma having properties intermediate between those of magnetosheath and magnetosphere is called the low-latitude boundary layer (LLBL). There is evidence that the LLBL is at times on open field lines. Its formation on open field lines during times of the southward interplanetary magnetic field (IMF) is well understood in terms of dayside reconnection. However, there is another evidence that LLBL can exist on closed field lines under some circumstances. An outer magnetopause layer is even more confusing. The gasdynamic model of the magnetosheath flow predicts that the density decreases toward the magnetopause. MHD models add a further density depletion just in front of the magnetopause. However, some magnetosheath models attribute the plasma depletion layer (PDL) to the magnetic field pile-up and predict it during northward IMF, but other models connect this depletion with an intensive magnetic merging at the magnetopause which is typical for the southward IMF orientation. The region under question was crossed by the INTERBALL-1/MAGION-4 satellite pair in different local times and with different separations between both satellites. A careful analysis of several passes reveals that a very complicated temporal changes of plasma parameters measured by the spacecraft can be easily interpreted as a scanning of a smooth profile due to surface waves.

SP22B-03 1400h

Sources of the Cusp and LLBL Plasma During Intervals of the Horizontal IMF

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We have used simultaneous measurements of several spacecraft operating in different regions of interplanetary space and two closely spaced satellites crossing the cusp-magnetosheath boundary with motivation to show the connection between the short and large-scale phenomena. Our case study reveals the importance of interplanetary magnetic field (IMF) horizontal components on a global magnetospheric configuration as well as on small-scale processes at the cusp-magnetosheath interface. In the northern hemisphere, observations suggest a presence of two spots of cusp-like precipitation supplied by reconnection occurring simultaneously in both hemispheres. A source of this bifurcation is the positive IMF By component further enhanced by the field draping in the magnetosheath. This magnetic field component shifts the entry point far away from the local noon but in the opposite sense in either hemisphere. An analysis of the pitch-angle distribution of high-energy ions reveals the quasiparallel bow shock being a source of these particles in the cusp as well as in the adjacent magnetosheath. The behaviour of these particles suggests that antiparallel merging can occur even when the magnetosheath flow is supersonic and this merging then contributes to the tail twisting.

SP22B-04 1415h

Responses of the polar ionosphere to extreme solar conditions

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The Antarctic Zhongshan Station (69.4°S, 76.4°E, L=13.9) is situated under the ionospheric projection of the magnetospheric cusp region, a unique location for ground-based measurements in studying important problems related to geospace environment. After a brief introduction to a composite measurement system at Zhongshan Station, multiple observations are presented in this paper to show responses of the polar ionosphere to extreme solar conditions.

Ionospheric records were examined for the day of May 11,1999 when the solar wind almost disappeared. By comparing the data on May 11 with the one on a control day of May 14, it is found that the ionosphere was much steady and well stratified, the dayside F2 trace was less spread, the value of foF2 was much higher and the magnetic noon anomaly was less obvious. The geomagnetic observations showed that the dayside Pc3 waves were nearly absent on May 11, indicating that the magnetosphere was much quieter than usual.

The polar ionosphere was also investigated for catastrophic solar events, such as the November, 1997 event, the April/May, 1998 event, the October, 1999 event and the Bastille Day (14 July, 2000) event. One of the main geo-effects of the solar events was the resulted major magnetic storm. During the storm onset the ionosphere F2 layer abruptly increased in altitude, the geomagnetic H-component started negative deviation and the spectral amplitude of the ULF wave intensified. During all courses of the storm the polar ionosphere was highly disturbed, as shown by frequently large deviations of the geomagnetic H-component, large riometer absorption events and strong ULF waves. The absorption increased enough to cause the digisonde to be blackout in most of time. However, the data still showed a substantial decrease of the F2 electron density and oscillation of the F2 layer peak height. Associated with the huge solar proton event produced by the X5/3B flare on 14 July, 2000, a polar cap absorption (PCA) was observed. Superposing on it, there was a large absorption event with a peak of 26dB, started at about 0300UT and ended at about 1110UT on 15 July. This absorption was probably produced by an intense cloud of energetic electrons during auroral substorms.

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SP22B-05 1450h

Seasonal Effects of the Storm Time Variations of the Latitudinal Distribution of Ionospheric Total Electron Content in Equatorial and Southern Hemisphere Mid and High Latitude Regions.

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The low cost of the Global Positioning System (GPS) receivers, their portability, and easy deployment have prompted their popular usage by researchers during numerous dedicated campaigns. For the past two decades, directly or indirectly, GPS has become an important tool for space weather determination. In this paper we present the study of the ionospheric effects of halo coronal mass ejections (CMEs), initiated from the Sun at different times of the year, which caused the magnetic storms on September 22-23, 1999, April 6-8 and July 14-16, 2000. The latitudinal ionospheric effects of these major magnetic storms are studied using the ionospheric Total Electron Content (TEC). During these major storm days the latitude profile of the ionospheric TEC in both Southern and Northern equatorial anomaly regions and the southern hemisphere mid and high latitude regions are examined by using the data from the GPS receiver network in the Australian region. It is found that the ionospheric TEC manifests a marked seasonal fluctuation regardless of the Dst and Kp index differences. The storm time TEC effect of the prompt penetration of magnetospheric origin east-west electric fields are also considered. Comparisons are also undertaken of GPS TEC with the International Reference Ionospheric model (IRI2000) and ionosonde data.

SP22B-06 1505h

Space Weather Impacts on HF Systems

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While HF is the oldest and probably best known system that is vulnerable to space weather influences, there can be no doubt that satellite systems are the way of the future. Can the satellite community learn anything about space weather strategies from the decades of experience gained by the HF community in dealing with the vagaries of the ionosphere? This talk will explore this idea, offering contrasts while drawing examples of HF services and developments of HF systems.

SP22B-07 1520h

Modeling the Spatial and Temporal Evolution of the Ring Current During Major Geomagnetic Storms

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The forecast of the terrestrial ring current as an indicator of geomagnetic storm strength is of central interest to space weather. In this study, we model ring current formation and decay during two of the largest geomagnetic storms of the current solar cycle: July 15, 2000, and March 31, 2001. The solar origin of both storms were coronal mass ejecta, whose geoeffectiveness was due to a southward IMF B_z of long duration. When the interplanetary shocks driven by these ejecta passed Earth, they induced powerful magnetic storms with minimum $Dst = -300$ nT and $Dst = -358$ nT, respectively. We use our kinetic model of ring current-atmosphere interactions and input data from the CIS instrument on CLUSTER, HYDRA and MICS instruments on POLAR, and MPA and SOPA instruments on LANL spacecraft as initial and boundary conditions. Our model calculates the temporal evolution of ring current distribution functions considering losses due to charge exchange, Coulomb collisions, and scattering by EMIC waves along adiabatic drift paths. We investigate the relative role of a) the convection electric field, b) variations in the plasma sheet fluxes, and c) polar cap potential saturation in the formation of strong ring currents. We present global images of H^+, O^+, and He^+ ion energy density, and study the transition from an asymmetric to a symmetric ring current population as the storms evolve. Global patterns of ion precipitation are obtained for various energy ranges and compared with observations from the CLUSTER/CIS and POLAR/IPS instruments during different storm phases.

SP22B-08 1535h INVITED

Radiation Belt Study as an Important Issue for the Space Weather

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Importance of relativistic electrons to the Space Weather has recently been recognized, because large increase of the relativistic electrons in the outer radiation belt can disrupt the satellite operation. It has been an important outstanding problem over 40 years how the source populations are being supplied in the outer radiation belt and how they are energized. By using recent NOAA/Akebono electron observations, the followings are revealed, (1) Source electrons with intermediate energy were supplied during the main phase of the magnetic storms. Internal acceleration by intense whistler mode waves was taking place in the heart of outer radiation belt during the recovery phase of the magnetic storms. Expansion of the outer radiation belt both inward and outward was evident, due to the enhanced radial diffusion. (2) In case of super storms, a new radiation belt was formed in the so-called slot region (at L values between 2 and 3) due to a large impulse of the electric field. The internal acceleration was observed in the new belt electrons. As time progressed the new belt diffused into the inner belt, and a life time of a new belt strongly depends on L-value. An effort to predict the relativistic electron flux at geostationaly orbit was made by using artificial neural network technique. Integration of AL index during the storm recovery phase was found to be a good input parameter to predict relativistic electron flux level at GEO. This result seems to be consistent with above mentioned observations

SP22B-09 1600h INVITED

ULF Waves and Space Weather Diagnostics

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One of the most ubiquitous indicators of the state of the magnetosphere are ultra-low frequency (ULF) waves. These may be continuously and inexpensively monitored from the ground using networks of magnetometers. The most easily understood and measured ULF wave signatures are field line resonances (FLR) resulting from Alfven wave propagation along closed geomagnetic field lines. These vary in frequency from 100 mHz at very low latitudes down to 2 mHz at high latitudes. Applications will be shown illustrating how FLR may be used to determine the open-closed field line boundary and map the plasma density in the magnetosphere and plasmasphere. Most methods employed assume a geomagnetic field model and, in some situations, a plasma density model. Possible methods to remove or reduce these limitations will be discussed.

SP31A WCC: TH-Auditrm Wednesday 0830h

Solar System Plasma Waves and Radio Emissions I Posters

Presiding: **I Cairns,** University of Sydney

SP31A-01 0830h POSTER

The Calibration of the Cassini RPWS Antenna System

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In October 15, 1997, the Cassini/Huygens spacecraft with scientific instruments was launched to explore the Saturnian system. One major objective of this deep space mission is the investigation of the Saturnian radio emissions, focussing on the wave-particle interaction, the generation mechanism, as well as on the determination of the source locations via the so-called direction finding technique. For this purpose, three electric monopoles, an essential part of the Radio and Plasma Wave Science Experiment (RPWS), are designed to measure the voltages induced by the electric field of the incident wave.

We investigate the reception properties of the RPWS antennas, which are crucial for the precise direction finding technique. Rheometric measurements and numerical simulations are briefly described to focus on the inflight calibration. Radio waves emitted from Jupiter during several roll maneuvers of the Cassini spacecraft in its inbound- and outbound phase provided the possibility to derive the effective length, the co-latitude and the azimuth angles of each (monopole) antenna. The Stokes parameters of the incident radio waves showed significant influence on the calibration procedure.

SP31A-02 0830h POSTER

Theoretical Predictions of Interplanetary type II Radio Emission from the Corona to 1 AU

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Type II solar radio bursts have been observed for more than 50 years. However, only in 1998 were the first in situ observations obtained of an interplanetary type II source. These observations showed electron beams, Langmuir waves, and radio emission produced upstream of a rippled CME-driven interplanetary shock. We present here a semiquantitative model of interplanetary type II radio bursts which involves: electron reflection and acceleration at collisionless shock fronts; beam formation upstream of a shock via time-of-flight effects; Langmuir wave growth driven by the electron beams; and the conversion of Langmuir waves into freely propagating radiation. The resulting model is used to predict: (i) emission region characteristics such as the beam properties and volume emissivities of radiation as functions of location; (ii) trends in the radiation flux seen by a distant observer for varying solar wind and shock parameters; and (iii) dynamic spectra for a shock propagating from the solar corona to 1AU. The predictions of the model agree well with the observed radiation flux for the only type II burst to date with in situ observations of the source. The predicted dynamic spectra agree qualitatively with the typical burstyness observed for interplanetary type IIs.

SP31A-03 0830h POSTER

Jovian Anomalous Continuum as Observed by Cassini

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The Cassini gravity-assisted flyby of Jupiter has provided nearly continuous Radio and Plasma Wave System (RPWS) data from the early part of 2000 to the present (the distance between the Cassini spacecraft and Jupiter has ranged from 137 to over 5000