proton plasma beta of $\sim$ 0.01 and a smooth rotation of the magnetic field polar angle from 43° to -62°. In addition, SWOOPS also observed bidirectional electron streaming throughout the CME, indicating that even at this distance it contained closed field lines. Assuming the CME lift-off speed was greater than or equal to the speed measured by Ulysses, this CME left the Sun on November 6, or later. We are undertaking a study to identify a unique SOHO/LASCO counterpart on the western limb of the Sun, which corresponds to the Ulysses position of 5° north of the ecliptic and 100° west of the Earth. In the days preceding the CME Ulysses observed disturbed solar wind conditions, including six shocks from November 6 to November 15 and a small CME on November 7, indicating a high degree of solar activity.

SH32A-05 1135h

Shock Events at Cassini Associated With the October-November 2003 Solar Flares

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The huge solar events of late October and early November 2003, which had such a large impact on the Earth, produced interplanetary shocks that were also observed at 8.7 AU by Cassini some 10-15 days later. At least two shock-associated particle events were observed by the MIMI particle instruments with shocks arriving on Nov. 10 and Nov. 16, 2003. Cassini was about 65 degrees west of the sun-earth line, making the Nov. 2, X8.3, W56 flare closest to the Cassini subsolar point. This presentation will emphasize the ion composition and energy spectra of these events, especially in the suprathermal 3-220 kev/e range measured by the MIMI/CHEMS spectrometer. The ion composition differs from that typically observed in events at 1 AU in that the heavier ions are dominated by accelerated interstellar pickup ions; namely, He+ and O+. We will use composition variations to assess the relative importance of solar and interstellar pickup seed particles. The Cassini spacecraft generally is oriented so that the solar wind cannot be detected directly. Therefore, away from the shocks, we will use the He+ cutoff energy to obtain an indirect measurement of the solar wind speed and thereby evaluate the degree of deceleration from 1 AU.

SH32A-06 1150h

The Propagation of the October/November 2003 Events to the Outer Heliosphere

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The October/November 2003 events were the most intense of this solar cycle. Since many CMEs were observed across the solar surface, these events may create a GMIR, a shell of material moving outward through the heliosphere. We use the Wind, ACE, and IMP 8 data from 1 AU as input to an MHD model of the solar wind which includes pickup ions. This model will be used to predict the progation times and evolution of the ICMEs as they move outward. Comparison of the model results to observations will be made when possible. In particular, we will predict the arrival time and structure of these events at the Voyager spacecraft and compare these predictions with observations. The large series of ICMEs in 1991 are thought to be responsible for an intense episode of heliospheric radio emission; we will predict when the current events should reach the heliosphere and thus when we would expect a future intensification of the radio emission.

SH33A CC: 518 A Wednesday 1330h

Violent Sun-Earth Connection Events of October-November 2003: Energetic Particles *(joint with SA, SM)*

Presiding: **R Lin,** University of California, Berkeley**; C M Cohen,** California Institute of Technology

SH33A-01 1330h INVITED

An Overview of SEPs During the October-November 2003 Storms

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The October-November 2003 solar energetic particle (SEP) events were some of the largest in solar cycle 23. Measurements of the heavy ion composition and spectra were made throughout the events from energies of 0.1 to 100 MeV/nucleon by the Solar Isotope Spectrometer and the Ultra Low Energy Isotope Spectrometer on ACE, yielding valuable information regarding the energy and time dependence of the composition. We will present these measurements and compare them to similar ones made in other large SEP events from this cycle, such as the Bastille Day event and the April 2002 storms period. In addition, we will examine characteristics of the locally accelerated energetic particles (e.g., the maximum energy and flux increase) at the time of the shock passage for these and other big events.

SH33A-02 1350h

Unusual Features of the October 28, 2003 Ground Level Enhancement

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The ground level enhancement (GLE) of October 28, 2003 was unusual in a number of respects. Instead of a single, anisotropic peak from the Sunward field direction followed by an isotropic decay in intensity, this event exhibited two highly anisotropic spikes from very different directions. The earliest onset was seen by Norilsk, Russia, which is surprising because this station at the time was viewing approximately anti-Sunward along the nominal Parker spiral direction. While that spike rapidly declined, another spike was observed by several neutron monitor stations, lasting about 60 minutes. This spike was also not from the Sunward field direction, but rather from a far South latitude. The decay of the event, on the other hand, was unusually slow. In fact, the particle intensity remained at elevated levels until the CME associated with the GLE arrived at Earth and swept the solar particles away. In addition, this event had an unusually hard energy spectrum compared to other GLE. We report on observations of the event made by the Spaceship Earth neutron monitor network, together with preliminary modeling of the event based on the Boltzmann equation. This work was supported by NSF grant ATM-0000315, the Thailand Research Fund, and the Rachadapisek Sompoj Fund of Chulalongkorn University.

URL: http://www.bartol.udel.edu/~neutronm/

SH33A-03 1405h INVITED

Heliospheric energetic particle observations during the October-November 2003 superstorm events

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We present a multi-spacecraft analysis of the energetic particle observations during the October-November 2003 "superstorms" period. We use energetic particle measurements from the following instruments: (1) the Low-Energy Magnetospheric Measurement System (LEMMS) on board the Cassini spacecraft, (2) the Heliosphere Instrument for Spectra, Composition and Anisotropy at Low-Energies (HI-SCALE) and the Cosmic Ray and Solar Particle Investigation (COSPIN) telescopes on board Ulysses, (3) the Electron, Proton and Alpha Monitor (EPAM) on board ACE and (4) the Energetic Particle Sensor (EPS) on board the GOES spacecraft. We combine energetic particle data with solar wind and magnetic field observations from the magnetometers and plasma instruments on board the respective spacecraft. The Cassini spacecraft was en route to Saturn, close to the ecliptic plane, at 8.7 AU from the Sun and less than 70 degrees west in longitude with respect to the Sun-Earth line. The Ulysses spacecraft was at 5.2 AU from the Sun, very close to the ecliptic plane, and 54 degrees to the west with respect to the Sun-Cassini line. Prior to the occurrence of these series of events, the structure of the inner heliosphere was well-organized by recurrent corotating high-speed streams. The intense solar events of October-November 2003 disturbed this stable structure, filling the inner heliosphere with energetic particles and sending a sequence of fast CMEs past the three spacecraft. In this paper we characterize the particle intensity enhancements seen at the three spacecraft and associate them with the solar wind disturbances traveling between the Sun and the spacecraft.

SH33A-04 1425h

Solar Energetic Particles Near the Orbit of Jupiter From the Oct/Nov. 2003 Solar Events: Observations From the Ulysses COSPIN Instruments

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During the period of intense solar activity in October/November 2003, Ulysses was a little more than 5.2 AU from the Sun, and between about 4 and 6 degrees North of the heliographic equator. During the same period its heliographic longitude with respect to Earth decreased by about 1 degree per day starting from 128 degrees west of Earth on Oct. 22 (day 295), when the large active region No. 486 rotated onto the face of the Sun. Exceptionally strong solar activity began with an X17 flare having an X-ray maximum at 1110 on Oct. 28 (Day 301), and continued at least through Nov. 4 (Day 308), when an X28 flare occurred near the Sun's west limb. Protons with energy >40 MeV from the Oct. 28 event had clearly begun to arrive at Ulysses by 2300 UT, showing a rapid increase in intensity and strong outward flow along the interplanetary magnetic field. At energies of 2-4 MeV, proton intensities, already somewhat elevated, showed a clear and abrupt increase, also with strong particle flow outward along the field, several hours earlier at about 1700 UT, while 5-10 MeV electrons showed a very minor increase in intensity starting about 2300 UT, but did not show a large increase (again with outward flow) until 0600 UT on Oct. 29. For the protons, outward flow along a very quiet magnetic field persisted during a smooth decay (at high energies) and during a period with little intensity change (at low energies) until Nov. 7 (day 311). Other large X-class flares observed on Oct. 29, Nov. 2, and the X28 on Nov. 4, all of which produced significant particle flux increases at 1 AU, produced no clear increases in the particle fluxes at Ulysses. A second onset with a much softer energy spectrum began on Nov. 8 and continued through a period of disturbed magnetic structure until Nov. 14 (day 318) when a rapid decrease in intensity of the high-energy particles began. The decrease was associated with a progressive increase in solar wind speed towards the maximum of 1000 km/s observed on Nov. 15. We will present a comprehensive report of the particle intensities, spectra, and anisotropies from the COSPIN energetic particle telescopes, and will attempt to relate them to the evolving interplanetary disturbances initiated by the solar events. The instruments provide measurements over a proton energy range from 0.3 MeV up to GeV energies, and for electrons from a few MeV up to >100 MeV

SH33A-05 1440h

Cosmic Ray Observations During the October-November 2003 Storms With Spaceship Earth and the Muon Detector Network

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A series of very large relativistic solar proton events occurred in October-November 2003. During this period, many instruments observed events associated with this solar activity, such as large geomagnetic storms, cosmic ray ground level enhancements (GLE) and Forbush decreases. The global network of high energy cosmic ray observatories on Earth is able to measure precisely temporal variations of cosmic ray streaming (the anisotropy of intensity) from those events. We use data of the 11-station "Spaceship Earth" network of high-latitude neutron monitors and the ground-based muon detector network to analyze three types of anisotropies: Loss cone, bidirectional streaming, and $\mathbf{B}\times\nabla$n. Loss cone anisotropy is a cosmic ray intensity deficit in the small pitch angle region. This anisotropy may exist ~10% of an interplanetary scattering mean free path ahead of the shock front, which implies that it may be observed as a precursor of the CME shock impacting Earth. Bidirectional streaming is a type of second order anisotropy and indicates the presence of ejecta around Earth. The $\mathbf{B}\times\nabla$n anisotropy is produced from density (n) gradients associated with the cosmic ray depleted region in and near the CME. This anisotropy allows us to deduce the near-Earth trajectory of the ejecta. We will report temporal variations of anisotropies and discuss precursor anisotropies, bidirectional streaming, and the orientation of ejecta for each storm event during this solar high activity period. This work is supported in part by U.S. NSF grants ATM-0207196 and ATM-0000315 and in part by the joint research program of the Solar-Terrestrial Environment Laboratory, Nagoya University.

URL: http://www.bartol.udel.edu/~neutronm/

SH34A CC: 517 A Wednesday 1530h

Parker Lecture *(joint with SA, SM)*

Presiding: **D N Baker,** Laboratory for Atmospheric and Space Physics

SH34A-01 1540h INVITED

The Sun and Heliosphere as Revealed by Suprathermal Electrons

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Solar wind electron distributions near 1 AU are generally well described as a superposition of two distinct components: a cool core or thermal component and a relatively hot suprathermal component. The breakpoint between these two populations commonly occurs at about 60 eV at 1 AU. The suprathermal component carries the solar wind electron heat flux, is almost always nearly collisionless, behaves largely as a test particle population streaming freely through the solar wind along the heliospheric magnetic field, and is commonly highly anisotropic in the solar wind rest frame. In this lecture I demonstrate some of the remarkable spatial and temporal intensity and pitch angle variability of the suprathermal electron component at energies below about 1.4 keV, relate that variability to different solar and heliospheric processes, and illustrate aspects of the large-scale magnetic topology of the heliosphere revealed by suprathermal electron observations.

SH41A CC: 220 C-E Thursday 0830h

Solar Wind I Posters

Presiding: **P Riley,** Science Applications International Corporation**; B J Vasquez,** University of New Hampshire

SH41A-01 0830h POSTER

Recent Developments in the Virtual Heliospheric Observatory (VHO)

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The Virtual Heliospheric Observatory (VHO) is the currently developed distributed data system for the NASA Sun-Earth Connection heliospheric data sets. The purpose of this middleware, remote data distribution system is to bring the same data products available to the PI sites to the general scientific users as quickly as it is generated via a uniform interface and with proper description of the data content. The latest versions of the data dictionary used for the VHO metadata generation along with prototype interfaces currently tested will be presented.

URL: http://vho.nasa.gov

SH41A-02 0830h POSTER

MHD Simulations on an Unstructured Tetrahedral Grid with MH4D

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MH4D (Magnetohydrodynamics on a TETRAhedral Domain) is a numerical algorithm to solve the resistive and viscous MHD equations on an unstructured grid of tetrahedra. MH4D is device independent and runs on desktop computers as well as massively-parallel systems. Thanks to the use of an unstructured grid, the computational domain can be of arbitrary shape and the resolution can be increased in the regions of physical interest. Consequently, a wide range of spatial scales can be studied at the same time, for example active regions can be embedded in the large scale corona. A variational formulation of the differential operators ensures accuracy and the preservation of the analytical properties of the operators ($\nabla\cdot\mathbf{B}=0$), and self-adjointness of the resistive and viscous operators. The combined semi-implicit treatment of the waves and implicit formulation of the diffusive operators can accommodate the wide range of time scales present in the solar corona. The capability of mesh refinement and coarsening is also included. We will present some new results obtained with the full MHD algorith on the IBM SP3.

SH41A-03 0830h POSTER

Differences in Plasma Conditions Among 85 Large Coronal Holes

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We have measured ultraviolet spectroscopic parameters as a function of heliocentric distance for more than 85 coronal holes, in order to characterize the physical properties of coronal holes at different phases of the solar cycle. The Ultraviolet Coronagraph Spectrometer (UVCS) aboard SOHO was used to observed O VI (103.2 and 103.7 nm) and H I Lyman alpha (121.6 nm) emission lines to determine kinetic temperatures, average densities, and outflow speeds in coronal holes. UVCS observations provide unique information on the heating and acceleration processes in the corona. Our previous analyses of UVCS observations have shown that solar minimum (polar) and solar maximum (equatorial) coronal holes produce different acceleration profiles and have different oxygen kinetic temperatures. We also examine the differences in the characteristics of representative coronal holes producing a variety of high-speed conditions (550-800 km/s) at 1 AU. These analyses provide limits on the coronal plasma properties and put constraints on the physical processes that are responsible for the heating of the extended corona and the acceleration of the solar wind. This work is supported by NASA under Grant NAG5-12865 to the Smithsonian Astrophysical Observatory, by the Italian Space Agency and by PRODEX (Swiss contribution).

SH41A-04 0830h POSTER

Relative Timing of Coronal Mass Ejections, Flares and Type II Radio Bursts

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