SH42A-0500 1330h POSTER

Assessment and Control of International Space Station Spacecraft Charging Risks

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Electrical interactions between the F2 region ionospheric plasma and the 160V photovoltaic (PV) electrical power system on the International Space Station (ISS) can produce floating potentials (FP) on ISS conducting structure of greater magnitude than are usually observed on spacecraft in low-Earth orbit. Flight through the geomagnetic field also causes magnetic induction charging of ISS conducting structure. Charging processes resulting from interaction of ISS with auroral electrons may also contribute to charging, albeit rarely. The magnitude and frequency of occurrence of possibly hazardous charging events depends on the ISS assembly stage (six more 160V PV arrays will be added to ISS), ISS flight configuration, ISS position (latitude and longitude), and the natural variability in the ionospheric flight environment. At present, ISS is equipped with two plasma contactors designed to control ISS FP to within 40 volts of the ambient F2 plasma. The negative-polarity grounding scheme utilized in the ISS 160V power system leads, naturally, to negative values of ISS FP. A negative ISS structural FP leads to application of electrostatic fields across the dielectrics that separate conducting structure from the ambient F2 plasma, thereby enabling dielectric breakdown and arcing. Degradation of some thermal control coatings and noise in electrical systems can result. Continued review and evaluation of the putative charging hazards, as required by the ISS Program Office, revealed that ISS charging could produce a risk of electric shock to the ISS crew during extra vehicular activity. ISS charging risks are being evaluated in ongoing ISS charging measurements and analysis campaigns. The results of ISS charging measurements are combined with a recently developed detailed model of the ISS charging process and an extensive analysis of historical ionospheric variability data, to assess ISS charging risks using Probabilistic Risk Assessment (PRA) methods. The PRA analysis (estimated frequency of occurrence and severity of the charging hazards) are then used to select the hazard control strategy that provides the best overall safety and mission success environment for ISS and the ISS crew. This paper presents: 1) a summary of ISS spacecraft charging analysis, measurements, observations made to date, 2) plans for future ISS spacecraft charging measurement campaigns, and 3) a detailed discussion of the PRA strategy used to assess ISS spacecraft charging risks and select charging hazard control strategies.

SH42A-0501 1330h POSTER

Specifying the ISS Plasma Environment

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Quantifying the spacecraft charging risks and corresponding hazards for the International Space Station (ISS) requires a plasma environment specification describing the natural variability of ionospheric temperature (Te) and density (Ne). Empirical ionospheric specification and forecast models such as the International Reference Ionosphere (IRI) model typically only provide estimates of long term (seasonal) mean Te and Ne values for the low Earth orbit environment. Knowledge of the Te and Ne variability as well as the likelihood of extreme deviations from the mean values are required to estimate both the magnitude and frequency of occurrence of potentially hazardous spacecraft charging environments for a given ISS construction stage and flight configuration. This paper describes a statistical analysis of historical ionospheric low Earth orbit plasma measurements used to estimate Ne, Te variability in the ISS flight environment. The statistical variability analysis of Ne and Te enables calculation of the expected frequency of occurrence of any particular values of Ne and Te, especially those that correspond to possibly hazardous spacecraft charging environments. The database used in the original analysis included measurements from the AE-C, AE-D, and DE-2 satellites and recent work on the database has added additional satellites to the database and ground based incoherent scatter radar observations as well. Deviations of the data values from the IRI estimated Ne, Te parameters for each data point provide a statistical basis for modeling the deviations of the plasma environment from the IRI model output.

SH42A-0502 1330h POSTER

Evolving the Living With a Star Data System Definition

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NASA's Living With a Star (LWS) Program is a space weather-focused and applications-driven research program. The LWS Program is soliciting input from the solar, space physics, space weather, and climate science communities to develop a system that enables access to science data associated with these disciplines, and advances the development of discipline and interdisciplinary findings. The LWS Program will implement a data system that builds upon the existing and planned data capture, processing, and storage components put in place by individual spacecraft missions and also inter-project data management systems, including active and deep archives, and multi-mission data repositories. It is technically feasible for the LWS Program to integrate data from a broad set of resources, assuming they are either publicly accessible or allow access by permission. The LWS Program data system will work in coordination with spacecraft mission data systems and science data repositories, integrating their holdings using a common metadata representation. This common representation relies on a robust metadata definition that provides journalistic and technical data descriptions, plus linkages to supporting data products and tools. The LWS Program intends to become an enabling resource to PIs, interdisciplinary scientists, researchers, and students facilitating both access to a broad collection of science data, as well as the necessary supporting components to understand and make productive use of these data. For the LWS Program to represent science data that are physically distributed across various ground system elements, information will be collected about these distributed data products through a series of LWS Program-created agents. These agents will be customized to interface or interact with each one of these data systems, collect information, and forward any new metadata records to a LWS Program-developed metadata library. A populated LWS metadata library will function as a single point-of-contact that serves the entire science community as a first stop for data availability, whether or not science data are physically stored in an LWS-operated repository. Further, this metadata library will provide the user access to information for understanding these data including descriptions of the associated spacecraft and instrument, data format, calibration and operations issues, links to ancillary and correlative data products, links to processing tools and models associated with these data, and any corresponding findings produced using these data. The LWS may also support an active archive for solar, space physics, space weather, and climate data when these data would otherwise be discarded or archived off-line. This archive could potentially serve also as a data storage backup facility for LWS missions. The plan for the LWS Program metadata library is developed based upon input received from the solar and geospace science communities; the library's architecture is based on existing systems developed for serving science metadata. The LWS Program continues to seek constructive input from the science community, examples of both successes and failures in dealing with science data systems, and insights regarding the obstacles between the current state-of-the-practice and this vision for the LWS Program metadata library.

SH42A-0503 1330h POSTER

Data Integration in the Virtual Solar Observatory

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The aim of the Virtual Solar Observatory (VSO) is the integration of diverse data archives relevant to the study of Solar Physics into a virtual collection providing common search and delivery services. The back-end query services are implemented as Web Services and accessible via the Simple Object Access Protocol (SOAP). SOAP defines a remote procedure call mechanism that employs HTTP as its transport and encodes the client-server interactions in XML documents. In addition to its core function in identifying relevant datasets locally, a SOAP server at each data provider acts as a wrapper that maps descriptions in an abstract data model to those in the provider's specific model, and vice versa. Heterogeneous data search services can thereby be integrated with a common interface. This allows scientists to access multiple archives with differing data organizations at once, enhancing their ability to discover and analyze correlative data from multiple sources. We have chosen two SOAP implementations for the VSO: SOAP::Lite and OpenSOAP. The former, written in Perl, is suitable for fast and flexible prototyping in data search applications. SOAP::Lite servers have been set up at each of the VSO archives, and can be readily installed at other servers. OpenSOAP, written in C with built-in support for service description and dispatch, may prove useful in transforming current computing utilities into Web Services. We report on initial experiments using OpenSOAP to provide additional services to the basic query functionality of VSO.

URL: http://vso.stanford.edu/papers/agu03.html

SH42B MCC: Level 1 Thursday 1330h

Coronal Magnetic Fields: Models to Measurements IV Posters

Presiding: **C E DeForest,** Southwest Research Institute**; P Riley,** Science Applications International Corp.

SH42B-0504 1330h POSTER

CONDITIONS LEADING TO ERUPTIONS OF CMEs ASSOCIATED WITH ERUPTIVE FILAMENTS

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We report on a few recent and interesting observations of coronal mass ejections associated with eruptive filaments recorded in multiwavelengths using various data sets obtained from ground- and space-based observatories. These include chromospheric observations in H-alpha and the inner coronal data recorded from Mauna Loa Solar observatory (MLSO). The CME recorded in white light observations from the LASCO/SoHO is included in the analysis. In this paper, we attempt to investigate the pre-eruptive scenario of these events leading up to the eventual eruption. The role of the restructuring of the magnetic field and changes in the magnetic field due to the emergence and cancellation of magnetic flux in the source region of the CME will be discussed.

SH42B-0505 1330h POSTER

A Coronal Multi Channel Polarimeter For Magnetic Field Measurements

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The Coronal Multi-channel Polarimeter (CoMP) is a filter-based polarimeter designed to provide quantitative measurements of magnetic fields in the solar corona. It will measure the Stokes parameters at the 1074.7 and 1079.8 FeXIII coronal emission lines (1.67 x 106 degrees K), and the 1083.0 nm HeI chromospheric line. The CoMP is based on a four stage birefringent filter and is designed such that the corona is imaged in two wavelengths simultaneously. The strength of the line-of-sight component of the coronal magnetic field is inferred from the measured amplitude of the Stokes V profile and an estimate of the plane-of-sky direction is made from the Stokes U/Q ratio. Further, inference of line-of-sight velocities can be made from Stokes I (red and blue wing) amplitudes. Finally, it may be possible to obtain a coronal density diagnostic capability from the ratio of the 1074.7/1079.8 amplitudes. This poster will present the latest test results as well as any preliminary data that have been obtained.

URL: http://comp.hao.ucar.edu

SH42B-0506 1330h POSTER

Some Considerations about Inferring Coronal Magnetic Fields and Other Coronal Properties from Coronal Emission Line Polarization

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Ground based studies of Coronal Emission Lines (CEL) linear polarization had been carried out for the 530.3 nm FeXIV line at Pic du Midi and for the 1074.7 nm Fe XIII line at Sac Peak in the 1977-1980 period. The large scale organization of the polarization has clearly revealed the existence of a large scale structure of the coronal magnetic field. More recently, the first successful eclipse CEL polarimetric measurements were made in the 1074.7 nm line during the total solar eclipse of 21 June 2001, confirming earlier results of the predominance of a radial direction of the coronal magnetic field. A first measurement of the circular polarization in the 1074.7 nm line has also recently been performed. Circular polarization gives access to the strength of the LOS magnetic field while the linear polarization maps the transverse magnetic field direction. We will use ground based and eclipse 1074.7 nm line polarimetric data to provide examples of the properties (e.g., magnetic field, abundances, inhomogeneities) such observations can help to infer in this 3-D and optically thin medium.

SH42B-0507 1330h POSTER

Coronal Magnetic Fields in a Sunspot Plume at the Limb

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We obtained coordinated EUV and radio observations of NOAA Active Region 10139 on 2002 October 14 when the region was on the west limb of the Sun. Observations were obtained with the Very Large Array (VLA) and three instruments aboard the Solar and Heliospheric Observatory (SOHO) satellite, including the Coronal Diagnostic Spectrometer (CDS), the Extreme-ultraviolet Imaging Telescope (EIT), and the Michelson Doppler Imager (MDI). A sunspot plume is clearly seen in EUV emission lines formed at temperatures between about 0.2 and 0.5 MK. Polarized 8 GHz radio emission from the plume suggests 4th harmonic gyroemission (from 760 Gauss fields) above the limb, and 3rd harmonic gyroemission (from 960 Gauss fields) on the disk.

SH42B-0508 1330h POSTER

Coronal Radio Magnetography of Solar Active Region 8365

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Using the microwave radio observations with Siberian Solar Radio Telescope (SSRT) and Nobeyama Radio Heliograph (NoRH) we derived 2D coronal magnetograms of solar active region NOAA 8365. The circular polarization (CP) of radio source is modified, when the radiation passes through the overlying magnetic field transverse to the line-of-sight. This change in CP was used to study the properties of coronal fields. We employed the known theory of wave-mode coupling in quasi-transverse (QT) region to evaluate the distribution of the field strength at the level of transformation of 5.2 cm radiation (SSRT, field strength $\sim$ 10-30 G) and 1.76 cm (NoRH, $\sim$ 50-110 G). The magnetic field strength was derived under the assumption N L_α = 10^{18} cm^{-2}, where N is electron density and L_α is the scale of coronal field divergence along line-of-sight. The height of QT-region (H_{QTR}) was estimated using force free field extrapolations, $H_{QRT} = 6.3 \times 10^9$ cm (2.3×10^9 cm) for 20 G (85 G). We then compared the coronal radio magnetograms and the force free field extrapolation of photospheric magnetic field, and we found close similarity between them on large spatial scale.

SH42B-0509 1330h POSTER

Temperature, Density, and Magnetic Field Reconstructions of Active Region Coronae

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We present simulated coronal emission pictures of some case-study solar active regions, including NOAA-designated regions 8210 and 8038. The simulated emissions are calculated from a 3-d temperature, density, and magnetic field model of the corona based on first principles. The method involves a static energy balance along individual coronal loops, with the heating term taken from a given coronal heating theory. The predicted emissions can be compared with observed X-ray and UV satellite images. By comparing the predictions of various heating theories with observations, we can determine constraints on the probable mechanisms of coronal heating. The model is also useful for a variety of other applications, such as testing of coronal magnetic field extrapolation techniques, calculations of wave propagation and shock phenomena, and testing assumptions about the spatial distribution of heating along loops. This work was supported by a DoD/AFOSR MURI grant, "Understanding Magnetic Eruptions and their Interplanetary Consequences."

SH42B-0510 1330h POSTER

Modeling the Large-Scale Corona Surrounding an Active Region

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Recent advances in our 3D MHD computational model have extended our capability to study the detailed structure of an active region, particularly how it is embedded in the magnetic field of surrounding large-scale coronal streamers. Our spherical MHD code now gives us the capability of concentrating the mesh points in an active region, where the magnetic field is strong, while at the same time modeling the weaker field of the large-scale corona of the whole Sun. It is thus possible to study the interaction of the active-region magnetic field with that of the Sun's overlying large-scale dipolar magnetic field. We will show the active-region/streamer structure for particular simulations of the solar minimum corona. These kind of simulations will be the starting point for the study of fast CMEs that originate in active regions. Research supported by NASA and the Center for Integrated Space Weather Modeling (an NSF Science and Technology Center).

SH42B-0511 1330h POSTER

TRACE and SOHO/MDI Observations of 3 Rotating Sunspots in AR9002 and AR9004, Along With Modeled Coronal Magnetic Fields

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The TRACE data set provides a view of the solar atmosphere from the photosphere in white light, through the transition region in ultraviolet wavelengths, and into the corona in extreme ultraviolet wavelengths (EUV). From May 16-23, 2000 TRACE and MDI/SOHO observed at least 3 rotating sunspots in AR9002 and AR9004 at several wavelengths. Over this time period several small flares, along with a CME on May 23, occurred in these regions. In addition we have potential-field renderings of the coronal magnetic fields for the TRACE pointings, extrapolated based on the Virtual Starlab forecaster data, which in turn has been generated from the MDI/SOHO observations. An analysis of the rotating sunspots, together with images and movies, will be provided for these active regions, accompanied by images of the extrapolated coronal magnetic fields for comparison with images of the TRACE 1-1.5 MK EUV loops. This work was supported by NASA, in part under the TRACE contract NAS5-38099 and in part under the MDI/SOHO contract NAG5-13261.

SH42B-0512 1330h POSTER

The role of flux emergence as a driver of coronal mass ejections

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Recently it has been suggested that coronal mass ejections (CMEs) are closely related to the interaction between different magnetic domains formed in the corona. For example, a so-called breakout model of

CMEs shows that a core domain field which is enhanced by shearing motions in the photosphere interacts with the overlying field, and this weakens the confining effect of the overlying field and eventually enables the core domain field to erupt outwards. In this study, we take the subphotospheric dynamics into this model and see how flux emergence affects the breakout process. Our work is based on 3-dimensional resistive MHD simulations in which we initially set a potential bipolar field above the photosphere and place a magnetic flux tube below the photosphere. The flux tube then emerges into the photosphere and starts to interact with the bipolar field. As the flux tube expands into the corona, a current layer develops around the interface between emerging magnetic field and preexisting coronal field. We focus on its structure and evolution because that current layer plays a crucial role in a breakout of emerging magnetic field. To see this, we apply a locally enhanced resistivity around the current layer and study the magnetic reconnection between emerging field and preexisting field.

SH42B-0513 1330h POSTER

Current Sheets in Stressed Coronal Magnetic Fields

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The extrapolation of magnetic fields into the solar corona generally assumes that the fields are fully relaxed - all possible reconnection has occurred. This assumption is in conflict with the low magnetic diffusivity in the corona. I will present initial results on extrapolation based on stressed magnetic fields - those for which no reconnection has occurred. As an opposite extreme to traditional methods, stressed fields offer a different view of coronal fields. The locations of current sheets between flux systems are directly determined. Observational evidence of coronal reconnection can test the completeness of the extrapolation, as the field lines spanning flux systems must be in contact prior to reconnection. This work is supported by NASA SEC GI grant NAG5-13020.

SH42B-0514 1330h POSTER

Pre-eruption Magnetic Field Configurations with High Magnetic Energy Storage

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Previously it was believed that the energy of a force-free field cannot exceed the energy of the corresponding open field. This proposition was established as the Aly-Sturrock Theorem. According to this theorem, the energy budget for coronal mass ejections (CMEs) and eruptive flares is very tight. Magnetograms and soft X-ray observations before solar eruptive events often indicate that the pre-eruption magnetic fields consist of multiple flux systems. We construct numerical solutions of force-free magnetic fields in multiple flux systems and investigate their eruption energetics. Our study of multiple flux systems shows that there can be many classes of force-free fields having more energy than the open fields. The energy of an interwinding two-flux system is found to exceed the open field energy for a winding angle near 360 degrees. Comparison of the numerically constructed solutions with observations of active eruption regions also reveals that the eruption indeed takes place for a winding angle slightly larger than 360 degrees. The dynamic evolution from high energy equilibria will be discussed based on 3D MHD simulations.

SH42B-0515 1330h POSTER

Linear Force Free Field Models of Observed Coronal Loops

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Although active region magnetic fields have an overall expansion with height, soft X-ray and EUV loops are observed to have nearly constant cross sections. To investigate this apparent discrepancy, we have compared coronal loops observed by TRACE in the 171 A band with corresponding magnetic flux tubes obtained from linear force-free extrapolations (Demoulin et al. 1997) of nearly concurrent MDI magnetograms. The flux tubes were determined using a procedure that varies the force-free parameter alpha and searches for the field line that most closely coincides with the observed loop axis. Once the axis field line is identified, we construct flux tubes from the model field using a variety of assumed footpoint shapes and orientations. Our detailed comparison confirms the mystery of constant loop cross sections. Although the expansion of the extrapolated flux tube as seen projected onto the plane-of-the-sky varies depending on the footpoint shape and orientation, it is always considerably greater than the expansion of the corresponding TRACE loop. Furthermore, the extrapolated flux tubes are often highly asymmetric (with one leg much wider than the other), in stark contast to the TRACE loops. These results imply that the magnetic structure and possibly also the heating of coronal loops are more complex than we currently understand. Extrapolations of observed photospheric fields are very useful, but direct measurement of the coronal field may be necessary to make fundamental progress on this important problem. This work was funded by NASA and the Office of Naval Research.

SH42B-0516 1330h POSTER

Observational consequences of a magnetic flux rope topology

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We consider the implications of a magnetic flux rope topology for the interpretation of observations of sigmoidal active regions. A region of tangential magnetic discontinuities can be identified using techniques that determine a bald patch (BP) and corresponding separatrices or a quasi-separatrix layer (QSL) – for a flux rope this region can be S-shaped, or sigmoidal. If such a region is physically driven, current sheets can form yielding conditions appropriate for reconnective heating. Using a numerical simulation of an emerging flux rope driven by the kink instability, Fan and Gibson (ApJL, 2003) showed that current sheets indeed formed a sigmoidal surface. In this poster we will demonstrate that the current sheets formed on the BP and BP separatrices. Moreover, we will use the results of the numerical simulation as proxies for observations: specifically the simulated field at the photosphere as proxy for the magnetic boundary condition, the sigmoidal current sheets as proxy for the X-ray active region emission, and the location of dipped magnetic field lines as proxy for a filament. We will then consider to what extent such observations might be used to understand and constrain the basic properties of the coronal field.

SH42B-0517 1330h POSTER

Formation of Electric Current-Sheets and Magnetic Flux Ropes During Magnetic Flux Emergence

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We present a numerical study of the formation of electric current sheets and magnetic flux ropes during emergence of flux into the solar corona. Using analytical initial states in which a new flux has emerged into a corona containing a preexisting flux system of the opposite polarity, we study the dynamical interaction between the two flux systems using the ZEUS MHD Codes. We find that the initially smooth interface between the opposite flux systems quickly steepens into a current sheet which immediately leads to magnetic reconnections and changes in magnetic topology. Magnetic flux ropes formed out of the reconnected fields. The ratio of the emerging flux to the preexisting flux is a discriminating physical factor. If this ratio is below some critical value, the flux rope produced will stay in some quiescent state in the atmosphere. If this ratio is sufficiently high, the flux rope produced will rise through the atmosphere and escape from the computational domain. These numerical results corroborate our recent theoretical studies which will be briefly summarized (Zhang and Low 2002, 2003, 2004).

SH42B-0518 1330h POSTER

Experimental Investigation of the Stability of a Single and Multiple Magnetic Flux Ropes

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Both the stability of a single magnetic flux rope and the interaction between multiple magnetic flux ropes are fundamental issues in the dynamics of the solar corona. Examples are in coronal mass ejections, in which highly twisted flux ropes are believed to play a crucial role, and in solar flares and large-scale eruptions in which transport of twist through magnetic reconnection is observed between distinct coronal flux systems. To study the interaction of magnetic flux ropes in a controlled laboratory environment, we use the Reconnection Scaling eXperiment (RSX) device at Los Alamos National Laboratory, which was originally designed to study three-dimensional magnetic reconnection during the coalescence of parallel current channels. Commercial plasma guns are used to inject magnetic helicity into hydrogen plasma column ($r = 2$ cm radius, $L = 0.2 - 3$ m length). Multiple flux ropes carrying currents up to 1 kA are created along the axial direction of a 4 m linear vacuum vessel. A set of 12 identical external coils surrounding the vessel provides an axial magnetic field parallel to the current channels. The azimuthal ($B_\theta = 0 - 100$ Gauss) and axial ($B_z = 0 - 1000$ Gauss) magnetic field components as well as the plasma density ($10^{12} - 10^{14}$ cm^{-3}) can be varied independently. In particular, the twist of magnetic field lines, defined by $\Phi = LB_\theta/rB_z$, can be scaled in the range $1 < \Phi < 10$ independently of the plasma collisionality. In the present work, the stability of single flux rope and the interaction of two flux ropes are studied in the RSX operational space. Magnetic data and visible light emission from a fast CCD camera are presented showing twisting and braiding of magnetic flux ropes.

SH42B-0519 1330h POSTER

Evolution of CME Magnetic Field from the Sun to 1 AU

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Theoretical modeling of the dynamics of coronal mass ejections (CMEs) has progressed to the point where calculated CME acceleration and speed can be quantitatively compared with observed data (e.g., TRACE, MK3, and C1–C2 data). However, the coronal magnetic fields underlying CMEs and their evolution have not been accurately observed. Nevertheless, the magnetic fields of CMEs are indirectly known by *in situ* measurements of their presumed interplanetary counterparts. Anticipating improved future measurements and the increasing importance of the CME phenomenon in terms of Sun-Earth connection, we investigate the magnetic fields of CMEs and their evolution to 1 AU. For this purpose, we use a flux-rope model of CMEs that has been extensively tested against observed CMEs with good agreement: (1) we will construct an ensemble of equilibrium flux ropes imbedded in a range of overlying coronal magnetic field; (2) we then allow the flux ropes to erupt and propagate to 1 AU through the corona and the interplanetary medium. We calculate the initial magnetic field of a CME based on its geometrical size (e.g., using the length of a magnetic neutral line obtained from magnetogram data as a proxy for the footpoint separation distance). For various scenarios with or without injection of poloidal

magnetic flux into the initial flux rope, we quantitatively determine the range of coronal magnetic field that yields realistic CME dynamics within 30 $R_{\odot}$ and that results in magnetic fields at 1 AU that are consistent with those of observed magnetic clouds. We discuss predicted magnetic field signatures in the photosphere, the corona, and at 1 AU for a number of distinct scenarios. Work supported by ONR and NASA

SH42B-0520 1330h POSTER

The Magnetic Structure of CR1922

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The May 12, 1997 halo CME occurred during CR 1922, when the state of the sun was quiet. The CME is associated with decaying active region AR 8038. It was the only active center on the disk and was the sight for flaring activity for several day surrounding the CME. This event has gained great interest lately due to the wide range of observations made before, during and after the event. It has been selected by several groups as an example of a real event that they will try to simulate. We examine the magnetic structure of the solar corona during this Carrington rotation using a synoptic map driven MHD model of the solar corona.

SH42B-0521 1330h POSTER

On Flux Rope in the 1997 May 12 Event

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The solar source of this event was reported to be an C1.3/1N flare with a duration of more than 8 hours, occurring at 04:42 UT on 12 May 1997 in the active region AR8038 at N21W08, which was the only active region in solar disk. The magnetic configuration of this active region is very simple – a dominant leader sunspot with positive polarity surrounded by weak negative magnetic field patches. Associated with this flare were eruption of a filament and a complete halo CME with a speed of $250 km\dot{s}^{-1}$ (Plunkett, *et al.*, 1999). *SOHO* also observed double dimmings and EIT wave (Thompson, *et al.*, 1999). This flare appears to be a classic two-ribbon flare: With eruption of the filament, two bright ribbons showed up and moved apart, seen in Hα observation; sigmoidal bright patterns shown in *YOHKOH/SXT* and *SOHO/EIT* images became post-flare arcades; and magnetic shear computed from observed vector magnetic field significantly decreased. These observations provide an opportunity for us to investigate the possible flux rope in this event, as illuminated in the two-ribbon flare model. We took three approaches to estimate the properties of the flux rope in this event. We found that the twist from these methods is strikingly different. We will discuss possible errors in our computation. This research was supported by NASA under contract NAS5-30386, MURIs of UC Berkeley and Michigan University, and the CISM of Boston University. SOHO is a joint project between the ESA and NASA.

SH42B-0522 1330h POSTER

A scenario for three "homologous" CMEs from AR 8038 in May 1997

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The halo CME event of May 12, 1997 has been exceptionally well-documented, in part because of the Sun-to-Earth coverage afforded by the combination of comprehensive SOHO imaging, ground-based observations, and WIND spacecraft in-situ measurements, but also because it exhibited what some regard as a classic set of event signatures with exceptional clarity: C-class flare, Halo CME, coronal double dimming, EIT wave, type II radio burst, energetic particles, magnetic cloud, and moderate geomagnetic storm. One problem with interpreting halo CMEs is the head-on view. While the STEREO twin-spacecraft mission is aimed at resolving the question of what a halo event looks like from the side, and visualizations based on numerical simulations suggest a number of possible interpretations, nature has provided an opportunity in the form of nearly homologous events initiated at the same active region AR 8038. One is at the east limb on May 5, another near the west limb on May 16. Being shortly after the solar minimum, the Sun is very quiet and the coronal magnetic field is simple. During the entire disk passage of AR8038, it is the only active region present. We take advantage of this period to make a first comparison of the three similar events at different view angles. We also model the geometry of the CME in 3D, and discuss improved physical parameters such as the speed.

URL: http://sprg.ssl.berkeley.edu/~yanli/cism/may97.html

SH42B-0523 1330h POSTER

Stream Structure and Coronal Sources of the Solar Wind During the May 12th, 1997 CME

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We report on our efforts to model the ambient solar wind out to 1AU around the time of the May 12th 1997 Halo CME and to identify its coronal source regions. We use three different coupled coronal/solar wind models to accomplish this: the simple physics and empirical based Wang-Sheeley-Arge (WSA) model, the advanced 3-D Magnetohydrodynamic (MHD) ENLIL solar wind model coupled to results generated by the SAIC 3-D steady state MHD coronal model, and the magnetostatic coronal component of the WSA model coupled to the ENLIL model. In addition, the sheath region of the ICME event is simulated using the ENLIL 3D MHD code by launching an over pressured hydrodynamic cloud with speed, extent, duration, and position determined by the Zhao Cone model [Zhao et al., JGR, 2001]. The simulation results generated by the different model combinations are then compared with the WIND satellite observations near Earth as well as with each other. We find that all three coupled models describe the ambient solar wind stream structure around the time of the May 12th, 1997 CME generally well, except for the ejecta itself, as evidenced by the overall good agreement between the solar wind observations at L1 and model simulation results, which are themselves in surprisingly good agreement with each other. The ENLIL model successfully replicates the ambient solar wind plus the shock and sheath region of the ICME when a simple over pressured hydrodynamic cloud is applied. Our results suggest that the source of the high-stream that followed the CME originated from a coronal hole extension located south of the Sun's equator.

SH42B-0524 1330h POSTER

Solar Corona Obtained with MHD Simulation Using Various Boundary Treatments Based on Characteristic Projection Method

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We will present the results of the experimental time-dependent MHD simulation of the solar corona, with various boundary treatments based on the concept of characteristics projection method. This method allows us to make the choices of the boundary treatment rather arbitrarily, and it is possible that the results may depend on them. We examined this point using TVD-MUSCL MHD code and found that, among the choice we made, a two-stage boundary treatment, where (i) the plasma density and temperature are fixed if $0 \leq V_r \leq V_c$ and (ii) the radial flow speed is reset to be V_c and instead the temperature is changeable if $V_r \geq V_c$, with the criteria flow speed $V_c = 5.0 km/s$, provides the steady solar wind best matching the reality, for example, the uniform plasma and magnetic field at the high heliographic latitude regions. This study is a part of our effort to construct the three-dimensional MHD simulation model of solar corona using SOHO/MDI data.

SH42B-0525 1330h POSTER

Prediction of Solar Wind Speed and B_r using CSSS Model

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The Current–Sheet Source Surface (CSSS) model developed by Zhao and Hoeksema (1995) has been shown to reproduce the radial variation of non–radial mid–latitude helmet streamers between 2.5 and 30 R_sun. The CSSS model has the advatage of a cusp surface at the cusp point of coronal streamers, which divides the corona into three regions, one bounded by the photosphere and the cusp surface, second, between the cusp surface and the source surface located at 15 R_sun, and the third one, beyond the source surface. In the model, the magnetic field between the cusp surface and the source surface are all open but not necessarily radial. Also, the source surface, placed at 15 R_sun, is closer to the Alfven critical point than the one in traditional Potential Field Source Surface model. Moreover, the CSSS model takes horizontal currents in the corona into consideration. The interplanetary magnetic field (IMF) observed by Ulysses does not show a latitudinal variation which again was successfully obtained by CSSS model.We present the preliminary results of the prediction of solar wind speed and the interplanetary magnetic field B_r using the CSSS model.

SH42B-0526 1330h POSTER

Recent Comparative Analyses of the CSSS UCSD Tomographic Solar Wind Model with in situ Spacecraft Observations

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Our tomographic techniques developed over the last few years are based on kinematic models of the solar wind. This allows us to determine the large-scale three-dimensional extents of solar wind structures using interplanetary scintillation (IPS) observations and Thomson scattering brightness data in order to forecast their arrival at Earth in real time. We are specifically interested in a technique that can be combined with observations presently available from IPS velocity data and with observations which are now becoming available from the Solar Mass Ejection Imager. We use solar surface magnetogram data, and a source surface provided by the Stanford Current-Sheet Source Surface model, to provide input to the UCSD tomography program. The UCSD tomography program extrapolates the magnetic field out to and beyond Earth. The latest results are compared with in situ data.

SH42B-0527 1330h POSTER

Coronal Magnetic Eigenmodes With m = 2

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This work offers a further application of eigenfunction methods developed by Schulz [JGR, 106, 15859-15867, 2001] for precise implementation of the Wang-Sheeley model [Wang et al., ApJ, 327, 427-450, 1988] for the coronal and heliospheric magnetic field, whereby latitude-dependent differential rotation leads (in the presence of magnetic footpoint diffusion) to rigidly rotating magnetic structures in the corona and heliosphere. The m = 1 case treated earlier [Schulz, 2001] dealt with the "tilted-dipole" configuration that generates a "two-sector" pattern in the IMF. The m = 2 case treated here deals with a "quadrupolar" perturbation of the heliospheric current sheet, which leads to the "four-sector" pattern typical of years near solar minimum.

SH42B-0528 1330h POSTER

Solar wind magnetic fluctuations and its Probability Density Function

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We examine an intermittent behavior observed in solar wind magnetic field and fat-tailed Probability Density Functions (PDFs) that are generated by shocks and discontinuities. In particular, the Kappa distribution function widely used for description of planetary magnetospheres, is shown to be particularly promising for modeling observed PDFs. We show that the reason for this lies in the asymmetric distribution of fluctuations in variance, i.e. that the variance is Gamma distributed on the logarithmic scale. This oposses to a Gaussian (symmetric) distribution of variances, which yields the Castaing distribution in a turbulent fluid flow. We examine how the Kappa PDFs are generated and discuss the roles of shocks and magnetic holes in that process.

SH42B-0529 1330h POSTER

Time Evolution of Coronal Holes and Their Impact on the Solar Wind

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Coronal holes, which can be defined as open magnetic field regions on the Sun, are the source of high-speed streams and possibly slow wind and thus play an important role in nature and structure of the solar wind/heliosphere. Over the last decade, significant progress has been made in our ability to predict ambient solar wind conditions days in advance using a number of different models that vary widely in their sophistication (e.g., MHD and Potential Magnetic Field Source Surface Models) but all of which are driven by observations of the photospheric magnetic field in the form of synoptic maps. These ambient solar models based on extrapolation from photospheric magnetic fields are limited and cannot duplicate the complexity of the solar wind during periods of transient wind. However, a very recent comprehensive study by Arge et al. has shown that significant discrepancies often occur between model predictions and observations after transient wind has completed its passage past Earth and the observed solar wind has returned to ambient/background conditions (i.e., when the model is expected to resume performing well). Such discrepancies can persist for 2 to 3 days after the passage of the transient. To understand the origin of these differences, we will use coronal observations at time of CMEs to study variations in the pattern of coronal holes at the Sun. Our goal is to investigate if changes in coronal holes (probably not visible in photospheric field synoptic maps) can be responsible for the changes seen at 1AU.

SH42B-0530 1330h POSTER

Magnetic Element Tracking and the Small-Scale Solar Dynamo

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We have developed flux concentration tracking software to track and identify flux concentration behavior and origin events in photospheric magnetogram sequences. The tracking software is switchable to test and compare the behavior of two existing tracking codes, those of Hagenaar et al. (1999) and Parnell (2002). We present initial results from the use of the software on a deep-field sequence of MDI magnetograms. In particular, the two tracking methods yield significantly different distributions of flux concentration sizes. Furthermore, based on the ratio of coherent and incoherent origin of magnetic flux concentrations in a sequence of deep-field MDI magnetograms, we conclude that ephemeral regions are not typically formed by emergence but rather by random coalescence of groups of smaller, unresolved flux concentrations. Hence, the size distribution of the solar network magnetic field is not determined by the scale of the small-scale dynamo but rather by the clustering statistics of magnetic field elements in the surface flow field.

SH42B-0531 1330h POSTER

Polar Coronal and Magnetic Activity in Solar Cycle 23

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The results of investigation of the polar coronal activity using EUV data from SOHO/EIT and its relations to the magnetic activity studied from SOHO/MDI for 1996-2002 are presented. The observations of formation and evolution of polar coronal structures during the current activity cycle reveal close correlations between eruptive magnetic flux, coronal topology and changes of the global magnetic field, which have interesting implications for understanding the mechanism of the solar cycle.

SH42B-0532 1330h POSTER

The New 1.7 m Off-Axis Solar Telescope (NST) Project: a Path to Better Solar Science

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Big Bear Solar Observatory (BBSO) of New Jersey Institute of Technology is upgrading its 65 cm aperture vacuum telescope with a modern, off-axis 1.6 m clear aperture instrument - New Solar Telescope (NST). The NST offers a significant incremental improvement in ground-based infrared and visible light high angular resolution capabilities. It will fully utilize the optical and dynamical range advantages of its unobstructed (off-axis) pupil. The NST enhances our continuing program to understand photospheric magneto-convection and chromospheric dynamics. This new telescope will be the largest aperture solar telescope, and the largest aperture off-axis telescope located in one of the best observing sites. It will enable new, cutting edge science.

SH42B-0533 1330h POSTER

Remote sensing of the active regions on both the front and the far side of the Sun by Nozomi Lyman alpha observation

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The ultraviolet imaging spectrometer (UVS) on board the Nozomi spacecraft on a transfer orbit to Mars has measured the interplanetary Lyman alpha emission at 121.6 nm on the routine basis over a period of three years since January 1999. There is a flow of interplanetary hydrogen and helium atoms in the heliosphere. This neutral hydrogen and helium flow is called the "interstellar wind". Interplanetary hydrogen atoms induce resonant scattering of solar Lyman alpha emission. One of the most effective factors causing the temporal variations of this interplanetary Lyman alpha emission is enhanced Lyman alpha radiation from the active regions on the Sun. Accordingly, the intensity of the interplanetary Lyman alpha emission changed synchronously with the solar rotation period. Bertaux et al. [2000] showed that excess of illumination from the active regions on the Sun is clearly identified in the interplanetary Lyman alpha map constructed by the SOHO/SWAN data, including excess resulting from active regions on the far side of the Sun. Since CME events from these active regions cause geomagnetic storms on the Earth, earlier detection of the active regions on the far side of the Sun is significantly important for space weather forecast. Particularly, the precise estimation of both the location of the active regions and the scale of activity would be key parameters for space weather forecast. In this study, we have precisely estimated the location of the active regions on both the front and the far side of the Sun by comparing the observed temporal variations of interplanetary Lyman alpha emission with those of the model calculations. The model calculation consists of two parts. The first part is calculation of interplanetary hydrogen density distribution based on Wu and Judge [1979]. The second part is the calculation of the Lyman α emission intensity due to resonant scattering of solar photons with IPH atoms. We have reproduced observed temporal variations of the interplanetary Lyman alpha emission, and changes in the Lyman alpha flux distribution on the Sun. It is found that the temporal variations of the interplanetary Lyman alpha emission due to the generation, disappearance, growth and decline of the active regions. The methods of the estimation and the transient effect will be discussed.

SH42B-0534 1330h POSTER

Time-Distance Helioseismology: How The Inversion Results Depend On The Approximation Used

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During the last decade, time-distance helioseismology has provided important new insight into the solar sub-photospheric structure and dynamics of sunspots, active regions, supergranular cells, and large-scale flows. These results were based either on the ray-path or on the Fresnel-zone approximations. We present inversion results of travel-time perturbations of wavepackets propagating inside the Sun, using both ray-path and Fresnel-zone kernels for real and artificial data. The ray approximation was the first approximation in time-distance helioseismology for deriving the travel-times. However new types of kernels are being developed to take into account the finite-wavelength effects of the wavepackets (such as Fresnel-zone kernels), and thus improve the resolution and accuracy of the inversions. Since many results have been obtained with the ray-path approximation, it is important to compare them with the new Fresnel-zone inversions to quantify their accuracy.

SH42B-0535 1330h POSTER

MHD Waves in Magnetic Flux Concentrations

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Results from 2D MHD simulations of waves in a stratified isothermal atmosphere will be presented and analyzed. The waves are generated by a localized piston source situated on the lower, photospheric, boundary of the computational domain. A combination of fast and slow magneto-atmospheric waves propagates with little mutual interaction until they encounter the surface where the sound speed and the Alfven speed are

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comparable in magnitude. The waves couple strongly in this region and emerge with different amplitudes and phases. Owing to this mode mixing and the large variation in the Alfven speed in the magneto-atmosphere, the fluctuations observed at a given location are often a superposition of both fast and slow waves which have traversed different paths and have undergone different transformations during their journies.

SH42B-0536 1330h POSTER

Turbulent Magnetic Field Generation in Rotating Stars

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Observationally, it has been found that magnetic activity is a strong function of rotation rate. The connection between rotation and dynamo-generated fields is not well understood, however. The typical interface dynamo theory applied to the Sun to describe its activity cycle assumes the existence of a velocity shear layer. Such a model is inappropriate for fully convective stars that are nevertheless active, such as late-type M and L stars and pre-main sequence T Tauri stars; in these stars a turbulent dynamo is generally believed to be the mechanism of magnetic field generation. We investigate the connection between observed activity behavior and magnetic field generation in fully convective stars through a series of simulations of the turbulent dynamo. The simulations were performed in a Cartesian domain using ANMHD, a 3D MHD anelastic code. We compare the resulting magnetic topologies for a series of Rossby numbers and comment on the implications for the sizes of coronal loops and activity levels.

URL: http://solarmuri.ssl.berkeley.edu/∼fisher/public/images/turbdyn/

SH42B-0537 1330h POSTER

Solar Subsurface Synoptic Flow Maps by Time-Distance Helioseismology

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The synoptic flow maps have been made up to 12 Mm beneath the solar surface by use of time-distance helioseismology measurements and inversions. The study selects one Carrington rotation each year from 1996 to 2002, covering from solar minimum to maximum. The synoptic flow map has a high spatial resolution of 0.24 heliographic degree per pixel, and supergranular flows are able to be shown. Zonal and meridional flows, as well as the vorticity distribution are derived from such maps. It is found that after the subtraction of the solar minimum data, the residual meridional flows converge toward the activity belts, and migrate toward the equator together with the sunspot zones. Results are to be compared with those obtained from previous studies such as frequency splitting and ring-diagram analysis.

SH42B-0538 1330h POSTER

Thermal Properties of Prominence Motions as Observed in the UV

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The mechanisms by which solar prominences are filled with plasma are still undetermined. In this study we perform a quantitative analysis of the thermal properties of moving features in prominences in order to put constraints on models of prominence formation and dynamics. In order to make such measurements of moving features seen in prominences in the UV we use the SOHO spectrometers SUMER and CDS to take a time series of exposures at a single pointing position, providing a measurement of spectral line properties as a function of time and position along the slit. The resulting observations in spectral lines in a range of "transition region" temperatures allow us to analyze the evolution of thermal properties of quickly moving prominence features as a function of time.

SH42B-0539 1330h POSTER

Looptop Density Enhancement By Nonlinear Magnetohydrodynamic Waves

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We discuss the possibility that disturbances generated in flares can produce the emission measure enhancement at the top of coronal loops observed by the Transition Region and Coronal Explorer (*TRACE*). The mechanism involved is the ponderomotive force of standing waves in the loops. We study the effect of large amplitude waves in loops using first a simple one-dimensional model for which analytical expressions are available, and second by solving the time dependent nonlinear magnetohydrodynamic (MHD) equations in a more realistic three-dimensional configuration. Waves are launched by an initial transverse velocity profile in the loop with footpoints fixed in the photosphere. We find that large initial disturbances can provide an imbalance along the loop, which results in an upflow from the legs of the loop. The accumulation of mass at the top of the loop produces a strong density enhancement. In a later stage, the pressure gradient becomes dominant and inhibits the concentration of mass at the loop apex.

SH42B-0540 1330h POSTER

Intensity Oscillations in the upper transition region above active region plage

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Although there are now many observations showing the presence of oscillations in the corona, almost no observational studies have focused on the bright upper transition region (TR) emission (so-called moss) above active region plage. Here we report on a wavelet analysis of observations (made with TRACE, the Transition Region and Coronal Explorer) of strong ($\sim 5-15\%$) intensity oscillations in the upper TR footpoints of hot coronal loops. They show a range of periods from 200 to 600 seconds, typically persisting for 4 to 7 cycles. These oscillations are not associated with sunspots, as they usually occur at the periphery of plage regions. A majority of the upper TR oscillations are directly associated with upper chromospheric oscillations observed in Hα, i.e., periodic flows in spicular structures. The presence of such strong oscillations at low heights (of order 3,000 km) provides an ideal opportunity to study the propagation of oscillations from photosphere and chromosphere into the TR and corona, and improve our understanding of the magnetic connectivity in the chromosphere and TR. In addition, we use new high resolution observations of the photosphere and chromosphere, taken with the Swedish Solar Telescope, to shed light on the source of chromospheric mass flows such as spicules.

SH42B-0541 1330h POSTER

Solar Activity Explored With Wavelet Methods

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In order to improve the forecasting of the impact of solar activity on the terrestrial environment on time scales longer than days, improved understanding and forecasts of the solar activity are needed. Time series of solar activity indicators, such as sunspot number, group sunspot number, F10.7, E10.7, solar magnetic mean field, Mount Wilson plage and sunspot index have been studied with new advanced wavelet methods. Ampligrams and time scale spectra are shown. The processes behind the variability are discussed. New modes of solar magnetic variability are found. The amplitude of solar magnetic activity, as indicated by the sunspot number, has not only increased since 1850 but the modes have also varied since 1850 up till present. A dramatic change is taking place around 1940. Finally, the future evolution of the solar activity is discussed.

URL: http://www.lund.irf.se

SH42B-0542 1330h POSTER

Preliminary Results of Solar Latitudinal Differential Rotational Pattern Deduced From Traces of Supergranulations Observed by Taiwan Oscillation Network

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Solar latitudinal differential rotation, which can generate toroidal magnetic field from a poloidal magnetic field, plays an important role on solar dynamo and formation of solar cycle. Solar differential rotation law obtained from sunspots motion is only applicable to the middle and lower latitude and has a poor latitudinal resolution during solar minimum. Supergranulations, or chromosphere networks, are excellent targets for studying solar differential rotation in all latitudes and during different phases of solar cycle. Differential rotation of supergranulations has been studied using MDI Dopplergrams. The one-minute broadband K-line images obtained from Taiwan Oscillation Network (TON) provide another kind of data set to study differential rotation of supergranulations up to very high latitude. Differential rotation rate of supergranulations during raising phase of solar cycle 23 are studied. Our preliminary results indicate that for latitude less than 60 degrees, rotation rate of super-granulations decreases with increasing latitude, which can be approximated by a quadratic function of $\sin^2$(latitude). For latitude greater than 60 degrees, one or two reversed differential rotational patterns are found. Our preliminary results are similar to the differential rotational pattern observed below the photosphere as obtained by helioseismology analysis of MDI data. The cause of the observed solar differential rotational pattern will be discussed.

SH42B-0543 1330h POSTER

Multiscale Feature Identification in the Solar Atmosphere

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Multiscale methods offer a powerful approach to solar image processing and analysis. In this paper, wavelet-based methods are applied to a sequence of TRACE 195 passband images and LASCO C2/C3 white-light images to unambiguously identify faint features associated with the 2002 April 21 X-class flare and CME. Morphological properties, such as feature width, height, velocity and acceleration are then extracted, and compared to recent results from traditional image processing techniques.

SH42B-0544 1330h POSTER

Moving Magnet Features around Sunspots

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Moving magnetic features (MMF's) associated with small-scale emerging fluxes near the sunspot penumbra are believed to play an important role in mass and energy flow near sunspots. Since their discovery 30 year ago, only a few theoretical interpretations have been proposed on the real identity of MMF's: they may be associated with field lines detached from a decaying spot, or with closed magnetic loops. MMF's have remained a difficult subject for observations, requiring high spatial resolution movies for at least several hours. Coronal emission does not show immediate response to the birth and disappearance of individual MMF's; and the role of MMF's in the dynamics of upper layers of the atmosphere remains unclear. We present the results of recent, multi-wavelength observations designed to study the dynamics of MMF's from the time of their emergence to the moment when they merge into network or moat. Vector magnetograms made with the Dunn Telescope at Sunspot, NM, are co-aligned with MDI magnetograms, and TRACE 1600 Å and Fe IX/X 171 Å images, showing field orientation at the site of emergence, and the response of the chromosphere and corona to dynamic changes in the MMF's. These data allow meaningful statistics on MMF's and their relation to sunspot evolution.

SH42B-0545 1330h POSTER

First Results from SOLIS

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SOLIS (Synoptic Optical Long-term Investigations of the Sun) is a project to replace antiquated synoptic observing equipment at the National Solar Observatory. SOLIS includes a suite of three instruments on an equatorial mount originally installed at a site in Tucson and will be moved to Kitt Peak before the end of 2003. The major SOLIS instrument is a vector spectromagnetograph that maps magnetic fields across the full solar disk using a slit spectrograph and one arc sec pixels. Daily observations include several line-of-sight component magnetograms in the photosphere and chromosphere and, for the first time, full-disk vector magnetograms. At a medium scan speed (∼10 minutes for the full disk) noise is less than 1 Mx/cm^2. This low noise, combined with negligible instrumental polarization and well resolved spectral line profiles, yields moderate resolution magnetograms of unprecedented quality. Sample observations show magnetic flux nearly everywhere in the photosphere from the disk center to the solar limb. The flux is organized in large scale patterns that heretofore had been visible only in strong flux elements or after substantial spatial smearing. Good results have been obtained from the other SOLIS instruments: a full-disk filter imager at several narrow wavelengths and a grating spectrograph that provides high-accuracy line spectra of integrated sunlight. SOLIS data are freely available via the Internet and users may submit observing time requests for special observations. The National Solar Observatory is operated by AURA, Inc. under a cooperative agreement with the National Science Foundation. Additional support for the development of SOLIS from NASA and ONR is gratefully acknowledged.

SH42B-0546 1330h POSTER

The Origin of Sunspots - A New Hypothesis

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Recent observations of sunspots, the high temperature of the corona and CMEs strongly suggest that they are all caused by highly energetic solid bodies falling into the Sun. This hypothesis is consistent with the rapid (3000 mph) downward flow of gases in sunspot interiors observed by SOHO, their lower temperatures, and the presence of large quantities of water in their spectra. The high velocity of the incoming body entrains the surface gases, carrying them rapidly downward. The vaporization of the bodies cools the local gases and the water released from the bodies produces the observed spectra. Solar flares and CMEs comprise the material splashed from the impact perimeter. The paired sunspots and the multiple secondary spots are the result of the partial breaking up of the incoming body in the solar atmosphere before it reaches the surface. The persistence of the sunspots is due to a quasi-stable toroidal circulation induced in the surface layer, similar to a smoke-ring or an inverse Hadley cell. An impact was recently captured in a sequence of ultraviolet images by the TRACE spacecraft. In the clip, the initial dark scene is suddenly illuminated by the splash or flare due to the primary impactor, which is not seen because it is dark. The resulting illumination makes it possible to observe the associated secondary bodies, which leave dark trails of gases as they vaporize and cool their surroundings. These were described as 'tadpoles' because they each leave undulating dark tails in contrast to the bright background. Their downward motion has created great difficulty for the current hypothesis, that sunspots are generated from within the sun, implying that all material should be moving outward. The estimated velocity of the 'tadpoles,' 400 miles/sec implies that they fell from the vicinity of Jupiter's orbit. Interestingly, the average sunspot cycle is close to the period of Jupiter, not the period of a body falling from Jupiter in a Sun grazing orbit. I suggest that the modulation of sunspot activity, illustrated by the well-known butterfly diagram, is due to millions of bodies which have been ejected from Jupiter's Great Red Spot (-20 latitude) in recent millennia. The differences in their orbits and the consequent modulation of the resulting impacts on the Sun are likely due to variations in the ecliptic and eccentricity, both of which follow Jupiter's period. The difference between Jupiter's period (11.8 earth years) and the average sunspot cycle (11.3) years, and the systematic variation of sunspot latitude during a cycle, may be due to relativistic effects on their sun grazing orbits (advance of perihelion) combined with the barycentric motion of the Sun caused primarily by Jupiter. The influx of numerous high velocity solid bodies is also consistent with the localized, non-thermal heating of the corona to millions of degrees. Yohkoh images show only the hottest part of the corona and SOHO's ultraviolet spectra of these regions have provided clear evidence for their non-thermal nature. These show the continually changing locations of heat deposition due to incoming bodies. The implication of the 'Maunder Minimum' and recent studies of the sunspot cylce on climate is that powerful bursts of energetic charged particles from the Sun are a significant factor in maintaining the temperature of the Earth at its current level. This accentuates the importance of understanding their origin, particularly when their future decline remains a possibility.

SH42C MCC: Level 1 Thursday 1330h

Radio Remote Sensing of the Corona and Heliosphere I Posters

Presiding: **N Gopalswamy,** NASA Goddard Space Flight Center

SH42C-0547 1330h POSTER

Radiations at Twice the Plasma Frequency Detected Upstream of the Earth's Shock by the CLUSTER/WHISPER Sounder

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Radiations at twice the plasma frequency, Fpe, have been commonly observed in the foreshock regions upstream of the Earth's bow shock and far beyond. These electromagnetic radiations are thought to be produced in the electron foreshock and most probably close to the interplanetary magnetic field line tangent to the shock surface. They are often seen simultaneously with suprathermal electrons that are energized at the shock and are backstreaming from it. The objective of the current presentation is to show and discuss a 2Fpe radiation event recorded on the CLUSTER spacecraft by the WHISPER experiment. In particular, the observed strong modulations of the 2Fpe signal intensity have been used to determine the apparent location of the radiation source. Surprisingly the source extension seems to be limited in this case. This could be due to the current solar wind behaviour. The interplanetary magnetic field direction and the solar wind density were indeed varying abruptly.

SH42C-0548 1330h POSTER

IPS investigation of CMEs in the solar wind

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Interplanetary scintillation (IPS) measurements of natural radio sources act as a useful tool for clarifying global properties of solar wind plasma, particularly of the transient streams associated with coronal mass ejections, since they allow us to probe the solar wind at multiple points within a relatively short time. Taking this advantage, we have investigated the 3D structure and radial evolution of CMEs in the interplanetary medium from IPS measurements made with the 327 MHz four-station system of the Solar-Terrestrial Environment Laboratory (STEL), Nagoya University. In the present study, the model fitting analysis has been preformed to derive 3D properties of CMEs from IPS data. As a result, the majority of analyzed CME events is found to have a loop-shaped global structure with an anisotropic angular extent. The remainder of the CME events is found to be well explained by a bubble-shaped model with a nearly uniform angular extent. The elongated structure of CMEs tends to be oriented nearly

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