Modern ground-based auroral imaging instruments produce vast amounts of data. Increased temporal and spatial resolution allow for more detailed studies, but typically only a fraction of the data is utilised due to the extreme manual labour required for analysing all images. Full analysis of all images is only possible through the use of machine vision, in which classification of image contents is performed automatically. Our recent research has resulted in a content-based image retrieval system, which can be used to locate similar auroral images in the CANOPUS all-sky image set consisting of over 200000 images. The retrieval is initiated by a user supplied image, after which supervised learning techniques are utilised to refine the search for similar images. Based on the automatically classified auroral data, we discuss the occurrence of arcs and patchy aurora within the context of auroral precipitation boundaries, and the local time distribution of other space physical phenomena which are likely related to the formation of these auroral shapes (eg., Pc5 pulsations).

SH51A-0434 0830h POSTER

The Beginnings of a Space Physics Virtual Observatory

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We present a Visual System for Browsing, Analysis, and Retrieval of Data (ViSBARD) that provides the core for what we will extend to a Space Physics Virtual Observatory (SPVO). This presentation is largely intended to obtain feedback from the community on what features are most important. The project will provide open-source software to encourage contributions from everyone. As currently configured (this should be much further advanced by the time of the meeting) the software is capable of reading data (ASCII/CDF) for many existing missions. ViSBARD can be extended to interpret any number of ASCII and CDF formats through XML definitions, and we intend to add other formats. The program features extensive 3-D viewing capabilities coupled with 2-D displays for browsing and/or analyzing the data as viewed on the orbits of the spacecraft. ViSBARD can display the SSC database that gives orbits of most currently operating SEC-related satellites as well as the COHOWeb database that contains most of the hourly averages of interplanetary spacecraft. A combine tool allows the user to assemble, e.g., plasma, magnetic field, and orbit data from separate files for a single satellite into a one data set at any desired resolution. ASCII output makes it possible to save subsets or combined datasets for later or other use. Currently, data files must be downloaded separately, so building a true virtual observatory will require linking this system to databases at many locations on the Web. We will start with the NSSDC and add others when this is working well. Future plans include linking to solar images (ultimately via the Virtual Solar Observatory) and magnetospheric and ionospheric images, as well as including model output in the visualization.

URL: http://lep694.gsfc.nasa.gov/visbard

SH51A-0435 0830h POSTER

SDO: A Systems Challenge

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The Solar Dynamics Observatory, scheduled to launch in August 2007, presents several significant challenges to the Systems Engineering team. The spacecraft will be built, tested and integrated in-house at the NASA Goddard Space Flight Center, with four instruments to be developed by three Principal Investigator teams. Though few new technologies are required in developing a robust, reliable and versatile spacecraft, the combination of numerous requirements (scientific and otherwise) require a significant effort to ensure complete mission success. The presentation will include a discussion of the SDO subsystems and the status of the SDO Systems Engineering team efforts.

SH51B MCC: 124 Friday 0830h

Particle Populations Upstream of the Earth's Bow Shock: Observations, Theory, and Simulations I *(joint with SM)*

Presiding: **A Posner,** University of Kiel**; J Dwyer,** Florida Institute of Technology

SH51B-01 0830h INVITED

Coupled Ion Acceleration and Wave Excitation at Earth's Bow Shock

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A brief observational and theoretical history of coupled ion acceleration and wave excitation at Earth's bow shock is presented including the "reflected" (R), "intermediate" (I), and "diffuse" (D) ion populations, the ultra-low-frequency (ULF) waves upstream of Earth's bow shock, and the spatial structure of the wave and ion "foreshock". Emphasis is placed on the spatial transition of the bow shock from "quasi-perpendicular" to "quasi-parallel". In addition, the origin of the ions, the acceleration of electrons, the downstream "thermalization" of ions at weak quasi-perpendicular portions of the shock, and the foreshocks observed at other planets are reviewed. The current understanding of these phenomena is assessed. Finally, a few issues which remain unresolved or controversial since the era of the ISEE 1, 2, and 3 spacecraft are discussed including the origin of the exponential ion energy spectra, the ion "injection" mechanisms at the shock, and the relative contribution of magnetospheric ions to the diffuse ion population.

SH51B-02 0850h INVITED

Heavy Ion Composition of Upstream Events: New Challenges for Old Models

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Enhancements in the intensities of energetic ions above a few keV nucleon^{-1} have been routinely observed upstream of the Earth′s bow shock since the 1960′s. Such upstream events were typically attributed either to the leakage of ionospheric ions accelerated inside the Earth′ magnetosphere into the upstream region or to the acceleration of solar wind ions via a first-order Fermi process occurring at the bow shock. Although studied extensively until the early 1990′s, the origin of upstream ions remained controversial primarily due to the lack of composition measurements in the suprathermal energy range i.e., from the thermal solar wind energy through the tens of keV nucleon^{-1}. However, the launch of the Wind spacecraft in 1994 with mass spectrometers such as the SupraThermal through Energetic Particle (STEP) instrument has offered new opportunities to investigate the origin of upstream ions. In this talk, we will focus on results of a comprehensive survey of the heavy ion composition and energy spectra above ~30 keV nucleon^{-1} measured by the STEP instrument during more than a thousand upstream events. Our results show that energetic ions during such events originate primarily from the solar wind, and occasionally from ^{3}He-rich impulsive solar flares and corotating interaction regions. Recently, measurements from the SupraThermal Ion Composition Spectrometer (STICS) have shown that ionospheric species such as O^+ and N^+ can also be present simultaneously during some of these events, indicating that the ionosphere can also be an important source of ions in upstream events. We will also present a detailed analysis of some events when both ionospheric and solar wind ions are present simultaneosuly and compare our new results with predictions of the above two models, namely, magnetospheric leakage and Fermi acceleration at the bow shock.

SH51B-03 0910h

Ion Events Observed by Wind far Upstream From the Bow Shock and by Geotail / Imp-8 Near the Bow Shock and Within the Plasma Sheet

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Mason et al. (1996) reported characteristics of short duration energetic (>~30 keV/neucleon) heavy ion enhancements observed by the WIND spacecraft at large distances upstream from the bow shock during two periods of high speed streams (Jan. 20, 1995 Feb. 19, 1995) and Desai et al (2000) extended their study and presented results from a statistical analysis of upstream events rich in CNO species as observed by the WIND spacecraft between 1994 day 325 to 1999 day 92. Desai et al. suggested that some ion characteristics (as for instance, the fact that the majority of the events were observed in the dawn-noon sector, the solar-wind-like ion composition and the heavy ion dominance of the total energy ion spectrum above ~0.5 MeV) appear to pose severe problems for the leakage model, while other characteristics appear to pose serious challenges for the Fermi acceleration model. In this paper we compare the statistical results of Desai et al. with the results from previous statistical and case studies and we show that the Wind observations are in general consistent with the leakage model. Furthermore, we examine simultaneous multispacecraft observations during time periods of some typical events presented by the authors (Mason et al., 1996; Desai et al., 2000) and we compare them with predictions from the leakage and bow shock acceleration models. In particular: (a) we present observations by WIND far upstream from the bow shock and by Geotail and IMP-8 within the magnetosphere and we infer that particle acceleration within the plasma sheet and subsequent leakage to the upstream region are responsible for the generation of these upstream ion events, and (b) we compare the upstream WIND observations with observations obtained by Geotail and IMP-8 near the bow shock, and we infer that the near bow shock observations do not fit with major predictions of Fermi acceleration models.

SH51B-04 0925h INVITED

Evidence for a Cusp Source of Upstream Energetic Particles

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The present debate about the source of upstream particles has traditionally centered on the role of the bow shock versus leakage from the magnetosphere as the source for providing the energetic (> 20 keV) component of these upstream particles. With the advent of the Polar and Cluster satellite programs with their modern mass and charge state compositional capabilities, a third possibility has been established. The Polar satellite has discovered that the shocked solar wind plasma enters the weak field region of the polar cusps and produces diamagnetic cavities of tremendous size within the traditional magnetosphere. Within these cavities the local magnetic field is greatly depressed and turbulent and usually carries the remnant signature of the upstream interplanetary magnetic field (IMF) in the two transverse components, By and Bz. Measurements, which demonstrate that ions of recent solar wind origin that have been energized to energies associated with the Earth's ring current, are observed inside these cavities will be presented and discussed. On occasions there are also ions of ionospheric origin that appear to be energized at the same time showing the same spectral and time variations as those ions originating in the solar wind. The Cluster suite of satellites has observed a layer of energetic particles to be continually present at the high latitude magnetopause but these particles are seen upstream more infrequently. Logically the condition for the energetic particles to be seen upstream from this cusp-associated source is the same IMF orientation as that ascribed to the quasi-parallel bow shock. Results of an ongoing study of

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the correlation of ions upstream of the magnetopause with magnetic field orientation and energetic particle streaming direction will be presented.

SH51B-05 0945h

Bow Shock is not the Main Source of Upstream Energetic (> 40 keV) Ions

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The origins of upstream energetic (40 keV - 1.5 MeV) ions have been investigated. Simultaneous multiple spacecraft observations show that the energetic ion flux upstream of the magnetopause is always lower than that in the high-altitude dayside cusp. During an upstream ion event when the INTERBALL-1 spacecraft was upstream near the bow shock, GEOTAIL was in the post dusk magnetosheath, and POLAR was near the cusp on open magnetospheric field lines, the measurements reveal that (1) the ion energy spectra, measured by these three spacecraft had a similar spectral shape, (2) no comparable energetic ion phase space density (PSD) was observed at the forward libration point, (3) ion PSDs measured near the cusp were about one order of magnitude higher than that measured near the quasi-parallel bow shock, (4) the time profiles of ion PSDs measured by POLAR and INTERBALL-1 seem to track fairly closely, (5) the ion PSD peaks were detected first by POLAR then by INTERBALL-1, and (6) the energetic ion PSD measured near the bow shock was independent of whether the bow shock was quasi-parallel or quasi-perpendicular. These observational facts demonstrate that the bow shock is not the main source of the energetic (> 40 keV) ions in this upstream event. These upstream energetic ions most likely come from the high-altitude dayside cusp along open field lines.

SH51B-06 1000h INVITED

Interplanetary Magnetic Field Connection to the L1 Lagrangian Orbit During Upstream Energetic Ion Events

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Energetic ions moving upstream from the Earths bow shock frequently appear at the sunward Lagrangian (L1) point. The most common orientation of the interplanetary magnetic field (IMF) during these upstream events is near-radial from the sun (the nominal direction for connection to the magnetosphere). However, strong unidirectional beams of ions streaming away from Earth, consistent with good magnetic connection to the bow shock, are observed even when the IMF is transverse to the radial direction. We present observations of upstream events from as many as four upstream spacecraft. Included in this presentation are energetic ion and magnetic field measurements from: (1) ACE/EPAM, ACE/MAG; (2) WIND/3DP, WIND/MFI; (3) IMP8/EPE, IMP8/MAG; (4) GEOTAIL/EPIC, and GEOTAIL/MAG. In addition, the ACE/SWEPAM instrument identifies IMF connection between the L1 point and the Earths bow shock by the presence of low-energy (272-372 eV) bi-directional electron flux. Instruments on the IMP8 and GEOTAIL spacecraft simultaneously measure the energetic ion intensity and IMF configuration close to the Earths bow shock during times of particle enhancements observed at L1. Analysis of ACE, WIND, IMP8, and GEOTAIL observations show that >40% of upstream events are observed during times of non-radial IMF orientation. Observations from ACE/EPAM of over 500 upstream energetic ion events confirm this result. We find similar distributions of radial and non-radial IMF orientations both close to the bow shock and at L1. This implies that the IMF configurations during upstream events are large-scale spatial structures with radii of curvature on the order of the Earth-L1 distance, i.e. 0.01 AU. These spatial structures are being convected through the L1 point into the Earths foreshock.

SH51B-07 1035h INVITED

Diffusive ions in the foreshock region: review of GEOTAIL observations

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GEOTAIL has been exposed to the upstream solar wind more than 50 % of time on its orbit, and providing a good database for the study of upstream ion populations. It has been shown,

(1) that the spatial extent of the diffuse ions is more than 50-60 Re extending to the upstream region of Xgse -60 Re,

(2) that the energy spectrum of the diffuse ions is the hardest in the nose region of the bow shock, and softened toward the downwind direction,

(3) that the diffuse ions appeared almost instantaneously after the IMF rotation made GEOTAIL connected to the quasi-parallel part of the bow shock while GEOTAIL was separated from the magnetosphere more than 20-30 Re in the cross-field direction,

(4) and that the bow shock has a 'Cosmic-Ray-Modified' shock nature: well ahead of the main shock ramp the upstream solar wind flow is decelerated by a few tens of km/s in the foreshock region where the diffuse ions have non-negligible pressures, which are proved to be balanced with the changes of the solar wind ram pressure.

I will address the question of the origin of the diffuse ions based on the above observations. It is noted that (4), being the follow-up of the classical observations by IMP and ISEE, provides the clearest evidence that the diffuse ions are actively interacting with the incoming solar wind.

SH51B-08 1050h

Scale Size and Orientation of Structures at the Earths Quasi-Parallel Bow Shock

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Spacecraft observations of the quasi-parallel bow shock, where the magnetic field is approximately aligned with the shock normal, are characterised by an extended and disturbed transition. An integral part of the shock are perturbations to the upstream plasma characterised by large enhancements in the magnetic field magnitude and plasma density, and a reduction and deflection in flow velocity, called pulsations or SLAMS (short, large amplitude magnetic structures). We present four point Cluster measurements of SLAMS and compare their characteristics with those of the ultra-low frequency (ULF) waves found further upstream. The magnetic field signatures of SLAMS at spacecraft separated by about 100 km are well correlated, in contrast to the differences observed, especially in the magnetic field magnitude, at 600 km tetrahedron scales. We describe the appearance of the SLAMS, where the magnetic field magnitude increase is often preceded by a region of small scale variations which are uncorrelated between spacecraft, even at 100 km separation. Resolving differences between spacecraft pairs as a function of separation parallel and perpendicular to the plasma flow, we do not find evidence for time evolution in the short convection time of the SLAMS over the tetrahedron. Most SLAMS have the same form at all four spacecraft, but when differences occur they tend to be greater for larger flow-perpendicular separations. This is consistent with magnetic field changes at the edges of the structures occurring on scales comparable with the tetrahedron size. We compare SLAMS orientation and motion with those found for ULF waves. We find that the SLAMS and ULF waves have sunward directed velocities, as expected. The ULF wave properties remain relatively constant over several hours, but the apparent orientation of the ULF waves varies systematically within a single wave period. Comparison between ULF waves and SLAMS suggests that the latter have the same orientation as one part of each ULF wave cycle, consistent with the SLAMS preferentially developing from field variations during one phase of the ULF wave.

SH51B-09 1105h

Source of Diffuse Upstream Ions: Injection from the Thermal Solar Wind Distribution, Acceleration of a Suprathermal Population, or from the Magnetosphere?

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We discuss the origin of the diffuse ions upstream of the Earth's bow shock. It is argued that the parallel bow shock cannot exist without upstream waves, which are excited by backstreaming ions. These ions are further accelerated by their interaction with the shock. From the analysis of individual orbits obtained in one-dimensional (1-D) hybrid simulations it is argued that part of the solar wind thermal ions are reflected by the shock potential. These ions gain energy by resonant interaction in an upsteam wave. Subsequently nonresonant interaction in the upstream and downstream wave field accelerates them further. We have investigated questions such as: (1) does a hot solar wind inject more diffuse ions, (2) what is the time scale for the apperance of diffuse ions during directional changes of the interplanetary magnetic field, and (3) why do diffuse protons and alpha particles exhibit the same spectra in terms of energy per charge. Since 1-D simulations are often critisized on the basis that particles are strictly tied to field lines we will also compare the 1-D simulations with three-dimensional quasi-parallel shock simulations.

SH51B-10 1120h

Upstream Events and Magnetospheric Disturbances

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Upstream events are energetic particles that escape from or through the earth's bow shock into interplanetary space, with energies extending up to 1 MeV. Despite having been observed for several decades, there is still no consensus on whether these events originate from the magnetosphere or the bow shock. Recent observations by the Wind spacecraft have shown that geomagnetic disturbances caused by CIRs are especially efficient at producing upstream events, but CMEs often do not produce them in any significant numbers. In this talk, preliminary results will be presented from an investigation of upstream events observed during solar maximum conditions, using data from the Wind and ACE spacecraft. In addition, the occurrence of upstream events during geomagnetic disturbances will be compared with the state of the magnetosphere in order to identify what aspects of geomagnetic activity, if any, are associated with the production of upstream events, and which indicators best characterize them.

SH51B-11 1135h

Magnetospheric Ions Upstream of the Bow Shock

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Six years of observations in the upstream region of the Earth's bow shock have revealed the circumstances under which suprathermal magnetospheric origin ions escape sunward. The long-term trends, spectral and

charge state composition of these events will be discussed. Two classes of magnetospheric outflow have been identified, both occuring mainly under southward IMF conditions. First, in high speed solar wind streams, series of short bursts of magnetospheric ions can typically be observed on the time scale of Alfvénic fluctuations. Second, magnetic clouds of ICMEs are linked to highly structured flux tubes of magnetospheric ions. Analysis of one of these events has revealed non-gyrotropic ion outflow from the magnetosphere along a reconnected field line during the main reovery phase of the Earth's ring current.

SH51B-12 1150h

Rapid Movements of the Earth's Bow Shock

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28 years of Earth bow shock crossings observed by the IMP 8 spacecraft between 1973 and 2000 have been compiled into a reference database. Each individual shock crossing is tabulated separately, rather than averaged together, allowing the systematic study of the location and motions of the bow shock over more than two solar cycles. The nearly circular IMP 8 orbit kept the observations near the same flank locations on both the dawn and dusk sides allowing meaningful comparisons over the years. The results of our systematic study will be presented showing the variability of the bow shock location as a function of the upstream solar wind parameters and their standard deviations. Moreover, dawn-dusk asymmetries largely due to the average orientation of the interplanetary magnetic field will be demonstrated. Also, wave analysis shows that for the cases when the bow shock was encountered many tens of times, a simple damped traveling wave does not fit the observations suggesting that the bow shock is continuously driven. These results suggest that the bow shock is very rarely in its steady state position, hence discrepancies with steady state model predictions are expected and the development of dynamic models becomes necessary. The upstream particle populations are also expected to be strongly influenced by the moving and accelerating bow shock.

SH52A MCC: Hall D Friday 1330h

Solar and Coronal Physics Posters

Presiding: **S E Gibson,** National Center for Atmospheric Research, High Altitude Observatory

SH52A-0436 1330h POSTER

Active regions as sources of the heliospheric field

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The magnetic field in the heliosphere originates from a variety of sources on the surface of the Sun, including mature, decaying, and decayed active regions, as well as sunspots. The emergence of new active regions together with the dispersal of flux from older active regions causes the coronal magnetic field topology to continually evolve, allowing previously closed-field regions to open into the heliosphere and previously open-field regions to close. Such evolution of the coronal field, together with the rotation of the Sun, drive space weather through the continually changing conditions of the solar wind and the magnetic field embedded within it. We combine observations and numerical simulations by assimilating SOHO/MDI magnetograms into a surface flux transport model, in order to investigate the origins of the heliospheric field on the solar surface through the rising phase of the current activity cycle. We find that around cycle maximum, the interplanetary magnetic field (IMF) is typically rooted in a dozen disjoint regions on the solar surface. Whereas active regions are sometimes ignored as a source for the IMF, the fraction of the IMF that connects directly to magnetic plage is found to reach up to 30-50% at cycle maximum, with even direct connections between sunspots and the heliosphere. We further compare this data assimilation model with a pure simulation model, in which the properties of the emergent active regions were chosen at random from parent distribution functions measured for the sun. The two models show remarkable agreement in the temporal behavior of the sector structure of the IMF, in the magnitude and time-behavior of the heliospheric field, and even in such global properties as the tilt angle of the Sun's large scale dipole. We thus conclude that no additional flux-emergence patterns or field-dispersal properties are required of the solar dynamo beyond those that are included in the model in order to understand the large-scale solar and heliospheric fields.

SH52A-0437 1330h POSTER

A naturally driven reconnection mechanism for the solar corona

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Reconnection in the solar corona is believed to be important for a series of processes from flares and CMEs to coronal heating. However, theoretical understanding of the reconnection process still remains elusive. The reconnection rate predicted by the Sweet-Parker model is determined by resistivity and is very many orders of magnitude too small to explain the observations.

A possible mechanism that can provide fast reconnection rate is driven reconnection, When external flows drive field lines together, the rate of reconnection is determined by the driving mechanism and is indipendent of resistivity. In related works applied to the Earth's magnetopause [1], it as been shown that a Kelvin Helmholtz instability (KHI) can cause local compressive motions that push field lines together and drive reconnection.

We propose here that the same mechanism could conceivably be at work in the solar corona. We propose that photospheric motions cause torsional Alfven waves that propagate in the chromosphere and are amplified in the transition regions, emerging as sizabe velocity shears in the solar corona. Simulaiton works have proposed that such shear can be amplified to a good fraction (e.g. 0.3) of the Alfven speed [2]. The velocity shear injected in the corona can cause magnetic loops previously stressed by photospheric motions [3] to reconnect.

We have conducted a series of simulation to prove this scenario and to observe the properties of the reconeciton process. We have shown that indeed reconnection can be achieved trough local compression driven by the KHI and that the reconnection rate in that case is not sensitive to resistivity.

[1] Brackbill, J.U., Knoll, D.A., Phys. Rev. Lett., 86, 2329 (2001) [2] Kudoh, T., Shibata K., Ap. J., 514, 493 (1999) [3] Mikic, Z., Barnes, D.C., Schnack, D.D., Ap. J., 328, 830 (1988)

SH52A-0438 1330h POSTER

Chromospheric Waves Observed in HeI (1083 nm)- a Closer Look

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Although "Moreton" waves have historically been observed in H-alpha data, more recently waves have also been observed in chromospheric He I (1083 nm) images. In a previous study, we found that chromospheric waves observed in He I data (from the Mauna Loa Solar Observatory) in two events are co-spatial with the corresponding coronal waves observed by EIT (Fe XII 19.5 nm). In an effort to better understand the nature of chromospheric waves, we focus on these two wave events observed in He I in which two interesting phenomena occur: the waves are visible in the He I velocity data, and multiple waves are observed for each event. We suggest the velocity signal is a result of slow-mode wave compression followed by a slow-mode wave rarefaction in the chromosphere. We also suggest the observed multiple waves indicate more than one driving mechanism may be involved .

SH52A-0439 1330h POSTER

Correlations on Arcsecond Scales Between Chromospheric and Transition Region Structures in Active Regions

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The discovery of active region moss, i.e, dynamic and bright upper transition region emission at chromospheric heights above active region (AR) plage, provides a powerful diagnostic to probe the structure, dynamics, energetics and coupling of the magnetized solar chromosphere and transition region (TR). Here we present an observational study of the interaction of the chromosphere with the TR moss, by studying correlations (or lack thereof) between emission at varying temperatures: from the low chromosphere (Ca II K-line), to the middle and upper chromosphere (wings of Hα), to the low transition region (C IV 1550 Å at 0.1 MK), and the upper transition region (Fe IX/X 171 Å at 1 MK and Fe XII 195 Å at 1.5 MK). We use several datasets at high cadence (24 to 42 seconds) obtained with the Swedish Vacuum Solar Telescope (SVST, La Palma) and the Transition Region and Coronal Explorer (TRACE).

This correlation analysis from low chromosphere to upper TR in AR plage quantifies and considerably expands on previous studies. Our results elucidate various issues, such as: 1. how the heating mechanisms of the chromosphere and lower and upper transition region are related (if at all), 2. how important heating of spicular jets is for the energy balance of the lower TR, 3. the occurrence of significant periodic activity at all levels of the transition region and its coherence over a wide range of temperatures, 4. which time scales dominate the dynamic behavior of the AR transition region, and, 5. whether the spatial and temporal variability of moss can be used as a diagnostic for coronal heating.

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Solar Cycle Variations of the F Corona Brightness Resulting from the Interaction of Dust Grains with CMEs

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The density of interplanetary dust increases sunward to reach its maximum in the F corona, where its scattered white-light intensity dominates that of the electron K corona above about 4 Rs. We consider the effects of interactions between the dust and the particles and fields of coronal mass ejections (CMEs). The dominant forces, with and without CMEs, acting on the dust close to the Sun are calculated for dust grain radii ranging from 0.01 to 100 microns. Dust grain orbits are then computed to compare the drift rates from assumed grain injections at 5 Rs to lower orbits for periods of minimum and maximum solar activity, where a simple CME model is adopted to distinguish the two periods. The CMEs result in significantly shorter drift times of the large ($>$ 3 microns) dust grains, hence faster depletion rates and lower dust grain densities, at solar maxima. This would explain a relatively strong ($>$ 30%) solar cycle variation of the near infrared brightness close to the dust plane of symmetry. While trapping the smallest of the grains, the CMEs also help scatter in latitude the grains of intermediate size (0.1 to 3 microns). The consequences for the optical brightness should be a time variation correlated to the solar cycle, not to exceed 10% at high latitude with a better isotropy reached at solar maxima. Limits on the dust size spectra are set from the basic features of the optical and infrared brightness distributions and variations.

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3-DIMENSIONAL EVOLUTION OF A MAGNETIC FLUX TUBE EMERGING INTO THE SOLAR ATMOSPHERE

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