

SH21B MCC: 124 Tuesday 0830h

Total Solar Irradiance Variability: Do Observations or Models Imply a Secular Change? (*joint with A, SA, GC*)

Presiding: H S Hudson, University of California, Berkeley; J M Pap, University of Maryland, Baltimore County

SH21B-01 0830h INVITED

Modeling the Variations in TSI Using Precision Ground-Based Photometric Images

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Precision photometric full-disk images of the sun have been obtained at the San Fernando Observatory (SFO) beginning in mid-1985. Images in several wavelengths are obtained daily but for modeling the Total Solar Irradiance (TSI) from spacecraft, the red (672 nm) and the K-line (393 nm) images have been the most useful. Two telescopes are in regular operation, Cartesian Full Disk Telescope (CFDT) number 1 and 2. They produce images that have 512 x 512 pixels and 1024 x 1024 pixels, respectively. Multiple linear regressions of sunspot deficits and facular excesses compared with Nimbus-7 and ACRIM-I values of TSI give values of R^2 of from 0.80 to 0.85, depending on data intervals and the particular spacecraft. More recent fits to the composite TSI of Fröhlich and Lean for cycle 22 give values of R^2 of 0.91. These fits are affected by noise in both ground-based and space-based data. This value of R^2 suggests, especially considering the effects of noise, that less than 10% of the TSI variance is unexplained by the effects of sunspots and faculae/network. We are in the process of determining whether or not the coefficients from fits to cycle 22 TSI will also provide good fits to cycle 23 TSI. This research has been partially supported by grants from NSF (ATM-9912132) and NASA (NAG5-7191 and NAG5-7778).

SH21B-02 0850h

Has the Sun's Total Output at Minimum and Maximum Changed Over the Last 24 Years ?

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During the last twenty-four years, Total Solar Irradiance (TSI) has been measured by the Nimbus 7/ERB, SMM/ACRIMI, ERBS/ERBE, UARS/ACRIMII, SOHO/VIRGO, and ACRIMSAT/ACRIMIII instruments. These measurements allow construction of a composite TSI record covering more than two solar cycles. This is the first record capable of revealing secular change in the Sun's total radiative output in the epoch from 1978 to 2002. Other space and ground-based observations such as the CaII K index, MgII core/wing index, 10.7 cm radio flux, and indices for sunspot deficit and facular excess allow verification and modeling of the composite TSI record. We review the TSI and irradiance measurements with emphasis on our ability to detect trends in the radiative output at both solar minimum and maximum over the last 24 years. Progress (or lack thereof) in reconstructing the TSI record from spectral irradiance and solar activity indices will be discussed. The accuracy of the current TSI records does not allow detection of secular change in amplitude of the 11-yr Schwabe cycle or the base level at time of solar minimum

SH21B-03 0905h

Long-Term Solar Irradiance Variations From Solar Cycle 21 to 23

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In this paper we show the recent results on total solar and UV irradiance variations and their relation to solar magnetic activity over solar cycles 21 to 23. Comparison of the multi-decade long irradiance and magnetic field measurements indicates that the shape and magnitude of irradiance variations are different from that of magnetic indices. Specifically, while magnetic indices show that solar cycle 23 is weaker than the two previous cycles, the long-term variation of total solar irradiance over solar cycles 21 to 23 is rather symmetrical, showing that its maximum and minimum levels were about the same within their measuring uncertainties. In this paper we address the questions: (1) is there a strict linear relationship between solar variability and irradiance variations; (2) what is the role of polar magnetic fields in irradiance changes; (3) is there a significant non-magnetic component in the observed irradiance variations? The results presented in this paper underscore the need to further develop new analysis techniques to determine whether there is a secular variation in solar irradiance over years to decades - a necessary step to study and predict the climate impact of solar variability.

SH21B-04 0920h INVITED

Variations of total solar irradiance during solar cycles 21-23: measurements and models

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A series of satellite total solar irradiance (TSI) observations can be combined in a precise composite TSI database of solar magnetic cycle length by establishing a precise relationship between two key non-overlapping components: the SMM/ACRIM1 and UARS/ACRIM2 results. Two independent sets of TSI observations, the Nimbus7/ERB and ERBS, overlap both ACRIM experiments and can be used to establish the ACRIM relationship. Composite TSI time series using the Nimbus7/ERB results to relate ACRIM1&2 demonstrate a secular upward trend of 0.04 percent-per-decade between consecutive solar activity minima. A composite TSI model using ERBS comparisons to relate ACRIM1&2 yields different results in two significant respects: a negligible trend between solar minima and lower TSI at solar maxima. These differences are resolved by our findings that the lower minima-trend is an artifact of uncorrected ERBS degradation and the lower TSI at solar maxima results from use of a solar-proxy model known to underestimate TSI at solar maxima.

URL: <http://www.acrim.com>

SH21B-05 0940h

Ionospheric Sensitivity to Different Representations of EUV Spectra

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It is well established that solar EUV radiation is responsible for the formation of the ionosphere, and in lieu of continuous direct observations, there exist a number of different models of this spectra. Empirical models have been developed from parameterized fits of past rocket and satellite measurements, while the newly developed NRLEUV model computes the spectra by accounting for the fractional coverage of solar magnetic features (active regions, network, coronal holes) and their temperature-dependent emissions. For a given level of solar activity, as determined by proxies (e.g. $F_{10.7}$, Mg index), these models often produce considerably different spectra, but it remains to be seen how strongly these differences propagate through to ionospheric quantities such as the peak electron density ($N_m F_2$). In this work, we compare electron density profiles computed with the Time-Dependent Ionospheric Model (TDIM), using five different EUV representations as input. We see up to a factor of two spread in the modeled $N_m F_2$ during solar maximum decreasing to roughly 1.5 during solar minimum. Considerable differences are also seen in the peak density and profile shape of the E-layer. These results indicate that attempts to operationally specify and forecast the ionosphere will be limited until knowledge of the EUV spectral irradiance is better constrained, by regular observations and/or improved models.

SH21C MCC: 124 Tuesday 1010h

Anticipating the Solar Dynamics Observatory (*joint with SA*)

Presiding: B J Thompson, NASA Goddard Space Flight Center; J T Hoeksema, NASA Headquarters

SH21C-01 1010h

The SDO Mission

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The Solar Dynamics Observatory, scheduled to launch in August 2007, will view the Sun continuously from an inclined geosynchronous orbit. The spacecraft will be a robust, three-axis stabilized spacecraft with low jitter and will deliver 150 Mbps of continuous high rate data. 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. The primary challenges include maintaining an ambitious schedule, designing a communications and ground system which can handle an unprecedented volume of space science data, and a baseline of five years reliability. The presentation will focus on the progress of the GSFC SDO Project team in developing the Solar Dynamics Observatory.

SH21C-02 1025h INVITED

Overview of the SDO Extreme ultraviolet Variability Experiment (EVE)

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The NASA Solar Dynamics Observatory (SDO), with its launch in 2007, is the first mission for the NASA Living With a Star (LWS) program. The SDO mission will provide measurements and modeling of the solar radiation and dynamics that can disturb Earth's environment. The Extreme ultraviolet Variability Experiment (EVE) is one of the three instrument suites on SDO. The EVE measures the solar extreme ultraviolet (EUV) irradiance with unprecedented spectral resolution, temporal cadence, accuracy, and precision. Furthermore, the EVE program will incorporate physics-based modeling to advance the understanding of the solar EUV irradiance variations based on the activity of solar magnetic features. The EVE instrument consists of three subsystems. The Multiple EUV Grating Spectrograph (MEGS) measures the 4-120 nm spectral irradiance with 0.1 nm spectral resolution. The Optics Free Spectrometer (OFS), being ionization cells, provides daily, in-flight calibrations for the MEGS channels. The EUV Spectrophotometer (ESF) completes the spectral coverage at 0.1-5 nm and 119-125 nm and provides additional MEGS calibrations. Collectively, the EVE instrument measures the solar EUV irradiance from 0.1 to 125 nm with 7% accuracy and 4% long-term precision.

URL: <http://lasp.colorado.edu/eve/>

SH21C-03 1045h

Coronal Canals

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As the first mission of LWS, one of SDO's most important goals will be to determine how the plasma and magnetic structures observed on the Sun connect to those observed in the heliosphere. In this paper, we show that the topology of the coronal open field, (and consequently the geometry of the heliospheric current sheet), is likely to be much more complex than previously believed. Using the source-surface model, we calculate the response of a polar coronal hole to the slow emergence of a high-latitude bipolar active region. We show that at a critical point in the active region growth, the coronal hole boundary must jump discontinuously to form a narrow channel of open field that encircles the trailing polarity spot. Contrary to a common misconception, the open field region does not form a new coronal hole that is disconnected from the polar one, but remains as one continuously connected region. The boundary of the open field region, however, acquires enormous structure, with canals that extend down to low latitudes. We argue that these open-field canals are the explanation for the wide-spread belief that open field emanates from closed field regions. We also discuss how magnetic reconnection would, in fact, lead to the type of structure produced by the source-surface model, and how SDO would observe the canals on the Sun.

This work was supported in part by NASA and ONR.

SH21C-04 1100h

Bright Knots in EUV Post-flare Loops : TRACE Observations and 1D Hydrodynamic Modeling

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EUV post-flare loops often possess bright knots along them. Some examples of such post-flare loops seen by TRACE will be shown, along with a brief outline of their properties. We will then present the results of a series of 1D hydrodynamic simulations of flaring loops, which employ different heating functions for the impulsive and decay phase of the simulated flares. It will be demonstrated that the creation of these knots depends crucially on the spatio-temporal distribution of the heating during the decay phase. This provides strong constraints on both post-flaring conditions and AR loop heating. We will finally briefly outline how SDO instrumentation could improve our knowledge of this topic.

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SH21C-05 1115h INVITED

MAGRITTE / SPECTRE : the Solar Atmospheric Imaging Assembly (AIA) aboard the Solar Dynamics Observatory

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The Solar Atmospheric Imaging Assembly (AIA) aboard the Solar Dynamics Observatory will characterize the dynamical evolution of the solar plasma from the chromosphere to the corona, and will follow the connection of plasma dynamics with magnetic activity throughout the solar atmosphere. The AIA consists of 7 high resolution imaging telescopes in the following spectral bandpasses: 1215 Ly- α , 304 He II, 629 OV, 465 Ne VII, 195 Fe XII (includes Fe XXIV), 284 Fe XV, and 335 Fe XVI. The telescopes are grouped by instrumental approach: the Magritte Filtergraphs (R. Magritte, famous 20th Century Belgian Surrealistic Artist), five multilayer EUV channels with bandpasses ranging from 195 to 1216 \AA , and the SPECTRE Spectroheliograph with one soft-EUV channel at OV 629 \AA . They will be simultaneously operated with a 10-second imaging cadence. These two instruments, the electronic boxes and two redundant Guide Telescopes (GT) constitute the AIA suite. They will be mounted and coaligned on a dedicated common optical bench. The GTs will provide pointing jitter information to the whole SHARPP assembly.

This poster presents the selected technologies, the different challenges, the trade-offs to be made in phase A, and the model philosophy. From a scientific viewpoint, the unique combination high temporal and spatial resolutions with the simultaneous multi-channel capability will allow Magritte/SPECTRE to explore new domains in the dynamics of the solar atmosphere, in particular the fast small-scale phenomena. We show how the spectral channels of the different instruments were derived to fulfill the AIA scientific objectives, and

we outline how this imager array will address key science issues, like the transition region and coronal waves or flare precursors, in coordination with other SDO experiments. We finally describe the real-time solar monitoring products that will be made available for space-weather forecasting applications.

SH21C-06 1135h

Acoustic Tomography of the Sun's Interior with SDO: Possibilities and Limitations

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Helioseismic and Magnetic Imager on board SDO will significantly expand the possibilities for imaging plasma flows and structures in the solar interior. It will provide for the first time high-resolution data for continuous monitoring of emerging flux and developing active regions in the upper convection zone. It will also allow us to look for localized structures and flows in the tachocline region and deeper interior, and also investigate the near-polar regions. The expected results may give important clues of how the solar dynamo works and active regions develop. HMI will observe the entire spectrum of the solar acoustic and surface gravity waves, and provide the most comprehensive data for global and local helioseismology. The high-frequency part of the oscillation spectrum will be used for studying seismic properties of the solar atmosphere in the quiet Sun and active regions. The method of acoustic tomography or time-distance helioseismology is one of the primary tools of the HMI investigation. It is based on measurements and inversions of travel-time delays of solar waves, caused by plasma flows and variations of temperature and magnetic field. The data analysis requires deep understanding of the physics of wave propagation in the Sun and substantial computer resources. One of the important goals is to provide the flow and sound-speed maps of the upper convection zone in near-real time for space weather applications. We present the current status of the field, and discuss plans and challenges for the HMI data analyses and interpretation.

SH21C-07 1150h

Drinking From the Data Firehose: The SDO Ground System

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The Solar Dynamics Observatory will generate an unprecedented space science data stream of 150 Mbps. The primary challenge of the SDO Ground System is to provide continuous, near-real-time science delivery of the large volumes of science data. Other challenges include high data completeness requirements and utilization of a new Ka band antenna network for the data capture. The presentation will report on the progress of the SDO Ground Systems team in designing a cost-effective, reliable ground system for SDO.

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