2018 Sun-Climate Symposium – Poster Abstracts

Poster Session I: Wednesday, March 21, 4:30 – 6:30 pm
Poster Session II: Thursday, March 22, 4:50 – 6:30 pm

In alphabetical order (as of 12 March 2018):

The Solar-Stellar Spectrograph: A 25-year Retrospective

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The data compiled within this retrospective poster stem from the on-going and past 25 years of observations by the Solar-Stellar Spectrograph (SSS) project at Lowell Observatory, and some time series from the Mount Wilson Observatory (MWO) HK Project, granting us as much as 50 years for some activity records. We show a variety of time series from the SSS project and, for select targets, from the MWO HK Project for the Sun and solar analog stars. We see the usual three types of behaviors in solar analog stars: irregular activity, cyclic activity, and flat activity (FA), and examine their prevalence in the SSS data relative to results reported from MWO. We also compare the activity levels of FA stars with those of cycling star minima to identify any systematic differences. We also present the ensemble properties of the entire SSS sample to provide some snapshots of stellar activity as revealed by our quarter century of observations.

Update to the Whole Heliosphere Interval (WHI) Reference Spectrum

Stéphane Béland *[stephane.beland@lasp.colorado.edu], Marty Snow, Thomas Woods, Jerald Harder; Laboratory for Atmospheric and Space Physics (LASP), University of Colorado, Boulder, CO, USA*

As part of the 2008 Whole Heliosphere Interval (WHI) efforts, a new Solar Irradiance Reference Spectra (SIRS,) near solar minimum, was determined from 0.1 nm to 2400 nm using a combination of satellite and sounding rocket observations. The WHI campaign covered the solar Carrington Rotation 2068 (20 March to 16 April 2008) and included a Quiet Sun period (10 - 16 April 2008). We are presenting an update to the SIRS using the latest version of the various data products used initially as well as a different time range for the Quiet Sun to reflect the observed period of Solar minimum.

Impact of Solar Activity on Thermospheric Density during ESA's Gravity Mission GOCE

Francesco Berrilli *[francesco.berrilli@roma2.infn.it], Mija Lovric, Carlo Cauli, Alberto Bigazzi, and Marco Colace; University of Rome, Tor Vergata, Italy*

The impact of solar activity on thermospheric density during ESA's gravity mission GOCE (17 March, 2009 - 11 November, 2013, rising phase of solar cycle 24) has been investigated using different solar indices. Thermospheric densities at a mean altitude of 254 km, derived from the high-precision accelerometers on board the GOCE satellite, represent a unique low-altitude dataset. Solar activity indices such as the F10.7 flux, the Mg II core-to-wing ratio and the Ap geomagnetic index in the period of GOCE mission have been firstly examined in time and their correlations with GOCE thermospheric density have been studied. Then, solar indices have been analyzed through the Empirical Mode Decomposition (EMD), a technique best suited in analyzing non-stationary and non-periodic time signals. After extracting the individual components (IMFs) from the solar indices, thermospheric density have been reconstructed and compared with the GOCE dataset. The preliminary results presented in this work suggest how significant advantages may be gained using the Mg II index and EMD method in describing the solar-thermospheric connection.

(SIST) How does the Sun's Spectrum Vary: A Summary of NASA SIST Research Activities

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Our proposal objective is to establish the magnitude and temporal structure of the Sun's irradiance variability at ultraviolet, visible and infrared wavelengths over time scales from months to multiple decades with greater certainty, and to consolidate this new information into an improved proxy model of spectral irradiance variability with associated uncertainties. The primary products of our research efforts include a revised database of solar ultraviolet irradiance made by the Solar Mesosphere Explorer that operated from 1982 to 1989 and an improved version of the Naval Research Laboratory (NRL) solar spectral irradiance model (NRLSSI2) that is publically available as the National Centers for Environmental Information Solar Irradiance Climate Data Record (CDR).

On solar rotation time scales, spanning days to several months, we will show the irradiance variations are relatively, but not completely, well specified. At longer time scales, spanning years to decades, the irradiance variations are less well specified and larger disagreement between irradiance observations and independent models will be shown. Using the SORCE total solar irradiance (TSI) and Lyman alpha measurements, which exhibit unprecedented long-term repeatability, we tested parameterizations from different records of proxies of solar variability (sunspots and faculae) in modeling the TSI and Lyman alpha observations. We made progress in identifying the causes of differences on solar cycle timescales between the NRL2 models and SORCE observations and will show new advances in statistical modeling of irradiance variability.

We will also discuss the current status of our efforts in reanalyzing the SME data. The SME data, spanning nearly one solar cycle in length, has the potential to be an ultraviolet irradiance time series of greater stability because of its limited solar exposure and in-flight degradation monitoring. We will discuss our research efforts that have led to an improved understanding of SME uncertainties.

The Future of Full-Disk Photometry at the San Fernando Observatory (SFO)

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The National Science Foundation (NSF) continues to value ground-based, multi-wavelength, full-disk photometry as both a scientific research and an educational tool. NSF has funded a new CCD telescope, representing the next generation of solar photometry at the San Fernando Observatory and due to come on-line mid-2018. Initially running side-by-side with the existing linear diode array telescopes that have operated for the past 30+ years, the new 2048x2048 telescope will eventually replace these telescopes as they age out. SFO looks forward to many more years of full-disk photometry that will continue to contribute to solar irradiance and climate studies.

SFO Solar Indices, Irradiance Variations, and a New TSI Composite – An update

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One of the goals of the solar irradiance community is to produce the most accurate record of Total Solar Irradiance (TSI) possible, created from data supplied by several space-based monitors since 1978. SFO's contribution to this work is a set of solar indices derived from active region elements (light and dark magnetic features). These indices, derived from 30+ years of full-disk, multi-wavelength, photometric images, are used with irradiance data to help determine the causes of irradiance variation, which irradiance values alone cannot tell us. The irradiance community now has a new methodology for creating a TSI composite based on work by Dudok de Wit *et al*. (2017). Recognizing that this composite is not yet the final version, what can be learned from correlations of this new composite and SFO feature-based indices?

Comparing Radiative Transfer Codes for Synthesis of Solar and Stellar Irradiance

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Different radiative transfer codes employed to reproduce stellar spectra rely on different atomic and molecular databases, as well as on different numerical techniques and approximations. As a result, spectra obtained with different codes may differ significantly, especially in the UV. In this contribution we investigate the effects of employing different codes for irradiance reconstructions focusing in particular on three aspects. First, we present a comparison of NLTE synthesis obtained with FAL atmosphere models representing quiet and magnetic regions using two widely used radiative transfer codes, RH and COSI. Second, we compare spectra synthetized with 3D MHD simulations of the solar atmosphere obtained using binned opacities computed with the ATLAS 9 and with the RH codes, as well high –spectral resolution synthesis obtained with RH. Finally, we investigate the effects of the use of different opacities for the solution of the MHD equations and for the spectral synthesis.

The SoSWEET-SOUP (Solar, Space Weather Extreme EvenTs and Stratospheric Ozone Ultimate Profiles) Dual Constellation Mission

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SoSWEET-SOUP is an innovative small satellites constellation which aims to measure on complementary platforms the solar influence on climate, namely on one part solar activity and spectral variability and on the other, the different components of the Earth radiation budget, energy input and energy reemitted at the top of the Earth atmosphere, with a particular focus on the UV part of the spectrum and on the ozone layer, which are most sensitive to solar variability. The far UV (FUV) is the only wavelength band with energy absorbed in the high atmosphere (stratosphere), in the ozone (Herzberg continuum, 200–220 nm) and oxygen bands, and its high variability is most probably at the origin of a climate influence. A simultaneous observation of the incoming FUV and of the ozone (O_3) production, would bring an invaluable information on this process of solar-climate forcing. Space instruments have already measured the different components of the Earth radiative budget but this is, to our knowledge, the first time that all instruments will be operated simultaneously on coordinated platforms. This characteristic guarantees by itself obtaining significant original scientific results.

SoSWEET-SOUP is an evolution of the SUITS/SWUSV and SUMO proposed missions, acknowledging the scientific advantages of associating a constellation of 10 to 12 small satellites of some 20 to 30 kg (large 6 to 12 "U" nanosatellites) on equatorial orbits (+/- 20° in latitude) to a larger polar satellite of 100 to 120 kg on a OneWeb like platform for an almost continuous solar covering (a polar orbit is also essential to the understanding of the relation between solar UV variability and stratospheric ozone on arctic and antarctic regions).

SoSWEET-SOUP definition's options are still under assessment but will include, on the polar satellite, SUAVE (*Solar Ultraviolet Advanced Variability Experiment*), an optimized heavy-duty thermally stable SiC telescope for FUV (Lyman-Alpha) and MUV (200–220 nm Herzberg continuum) imaging (sources of variability, extreme events detection), and SOLSIM (*SOLar Spectral Irradiance Monitor*), a newly designed double-monochromator instrument covering the 170-340 nm ultraviolet spectral range and with a mass of only 8 kg. Other instruments include a small coronagraph, UV and ozone radiometers, Earth radiative budget assembly, Electron-Proton detectors and a vector magnetometer. The constellation of small satellites includes on its side precise ozone profiles measurements (miniGOMOS experiment with dual Sun and stars occultations) and detailed energy radiative budget monitors. Science objectives, mission profiles and model payload will be presented and opportunities of missions and potential collaborations discussed.

(SIST) Creation of the V2 Composite Solar Spectral Irradiance Data Set

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The first long-term composite solar spectral irradiance (SSI) data set was released in 2008 by DeLand and Cebula [2008]. They used data from six separate satellite instruments to create daily spectra covering 170-400 nm for the period November 1978 – July 2005. We are now creating a Version 2 (V2) SSI product that extends the coverage of this data set through 2017 as part of the NASA Solar Irradiance Science Team (SIST) program. Artifacts in the V1 data set identified by users, such as outlier samples and steps at spectral or temporal transitions between individual instrument data sets, are being corrected. A long-term calibration has been developed for NOAA-16 SBUV/2 data by using UARS SUSIM reference measurements as a transfer standard. This method provides new SSI data for the period 2005-2007. We use irradiance data from the Aura OMI instrument to cover the period 2007-2017. These data extend our SSI wavelength coverage into the visible region (265-500 nm), and provide unprecedented long-term accuracy (~0.1%) for SSI measurements. The status of our V2 composite SSI data set will be presented.

A Long-Term Dissipation of the EUV He II (30.4 nm) Segmentation in the Full-Disk Solar Images

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Power spectra of segmentation-cell length (a dominant length scale of EUV emission in the transition region) from full-disk He II images observed during days of quiet-Sun conditions by the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO) were analyzed. Our previous analyses of the spatial spectral ratios (spectral densities over some time interval) reported in Didkovsky and Gurman, Solar Phys., 289, 153, (2014) and in Didkovsky et al., Solar Phys., 292, 32, (2017) were based on the results from the images taken by the Extreme ultraviolet Imaging Telescope (EIT) onboard the Solar and Heliospheric Observatory (SOHO) and from the AIA images. The results presented in this investigation show a continuation of the increase of these ratios for a number of quiet-Sun days during the AIA operation (2010 -- 2017). We represent the changes of these spatial spectral ratios during a 22-year (1996 to 2017) period as a network transformation that is interpreted as a dissipation of mid-size EUV network structures to smaller-size structures in the transition region. In contrast to expected cycling of the segmentation-cell dimension structures and associated spatial power in the spectra with the Solar Cycle, the spectra demonstrate a significant and steady change of the EUV small-dimension network from the 22/23 Solar Cycle minimum (1996) through the 23/24 minimum (2008) to the post-minimum quiet-Sun dates for up to 8 November 2017. Each of the latest changes calculated for a number of short-term intervals has been converted to a monthly mean change. The monthly mean ratio values demonstrate variable-sign and magnitudes, thus confirming the solar nature of the dissipation. The dissipation does not follow the long-term activity profile from the soft X-ray and He II (30.4 nm) irradiance measured by the Extreme ultraviolet Spectrophotometer (ESP), a channel of the Extreme ultraviolet Variability Experiment (EVE) onboard the SDO.

SC 24 vs SC 23: A Decreased EUV Irradiance Measured by SOHO/SEM and TIMED/SEE

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Solar extreme ultraviolet (EUV) irradiances from spectral bands centered at a strong emission line of 30.4 nm measured by SOHO/CELIAS/SEM and TIMED/SEE are compared and analyzed. The irradiances from the two instruments are in good agreement (~ 5% for Solar Cycle 22/23 minimum and about 12% for December 2017) and show significantly lower Solar Cycle (SC) 24 as compared to the SC 23. The decrease of the SEM EUV irradiance continues toward the SC 24/25 minimum. SEM irradiance measured for up to February 2018 is lower than the Solar Cycles 22/23 (1996) and 23/24 (2008-09) minima.

Long-term Variability of the Spectral Irradiance Cannot be Reconstructed from its Short-term Response

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One of the important open questions in solar irradiance studies is whether long-term variability (i.e. on timescales of years and beyond) can be reconstructed by means of models that describe short-term variability (i.e. days) using solar proxies as inputs. Preminger and Walton (2005, GRL, 32, 14109) showed that the relationship between spectral solar irradiance and proxies of magnetic-flux emergence, such as the daily sunspot area, can be described in the framework of linear system theory by means of the impulse response. We significantly refine that empirical model by removing spurious solar-rotational effects and by including an additional term that captures long-term variations. Our results show that long-term variability cannot be reconstructed from the short-term response of the spectral irradiance, which cautions the extension of solar proxy models to these timescales. In addition, we find that the solar response is nonlinear in such a way that cannot be corrected simply by applying a rescaling to sunspot area.

Identifying and Extracting Undocumented Trends from Solar Irradiance Records

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The unusually large solar cycle variations reported by the SORCE/SIM and SORCE/SOLSTICE instruments challenge our ability to identify and correct undocumented trends in solar irradiance records. This problem of detecting undocumented trends frequently arises as well in the homogenization of climate data, e.g. ozone records.

In the absence of an external reference, most trend detection schemes proceed by comparing the observations with some reconstruction that is based on proxy data. This approach has two problems: different assumptions on the reconstruction may lead to substantially different answers, and the errors associated with the proxy reconstruction may be hard to distinguish from the true trend. This situation calls for a strategy that is traceable and fully transparent, allowing the user to know exactly how significant the trend is for a given proxy.

Here we present a new scheme that fulfills these two conditions. The method proceeds by comparing the spectral irradiance at two dates when the solar proxy reaches the same level. This idea of comparing two observations of the spectral irradiance has been applied before. We considerably improve it by providing a method that 1) allows us to extract the trend at any time without the need to explicitly build a model that relates the irradiance to the proxy, 2) provides realistic confidence intervals, allowing us to test how significant the trend actually is, and 3) whose transparency avoids the risk of confusion between the trend and a proxy model error.

We illustrate this new method with two examples: a comparison of different reconstructions of the MgII index for solar UV irradiance, and an assessment of the trends extracted from SORCE/SIM and SORCE/SOLSTICE observations since 2003 by considering different solar proxies. The Matlab code is available upon request.

High-Spectral Resolution SORCE SOLSTICE Degradation Model and Improved Irradiance Data Products

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The SOlar Stellar Irradiance Comparison Experiment (SOLSTICE) aboard the SORCE spacecraft performs solar irradiance measurements in the FUV and MUV spectral ranges. In order to properly calibrate the data, it is important to understand the evolution of the degradation of the instrument throughout the life of the mission. To first order, the degradation of the instrument is defined as a simple exponential decay model that is wavelength dependent. However, changes in spacecraft operation changed the way in which we measure the degradation of the instrument. Degradation measurements earlier in the mission were only collected at eight different wavelengths in the MUV. Later, higher spectral resolution measurements were collected. We present an algorithm that takes advantage of these new measurements. The new degradation spectrum, in combination with the lower spectral resolution degradation spectrum collected earlier in the mission, is then used to retroactively calibrate the entire mission MUV dataset. The resultant data products benefiting from this update will also be presented.

A Concept for the Measurement of the Earth Radiation Imbalance

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The concept study will be presented for an adapted version of the Davos Digital Absolute RAdiometer (DARA) to observe the reflected short-wave and emitted long-wave radiation from a nadir-pointing EO satellite, such as the proposed EAGER mission. Together with a sun-pointing DARA the Earths radiation imbalance will be determined.

New Characterization of the PMO6V Radiometer of VIRGO/SoHO

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The results of a detailed thermal model of the aperture and the corresponding heating has provided new insight into the behaviour of the PMO6V radiometer. The model results are compared to the air-to-vacuum measurements of the SOVIM radiometers (2001-2003) for the SOLAR experiment on the International Space Station, and also to some newer measurements of VIRGO-2 (from the spare VIRGO experiment) at PMOD (1994, 2003-2008) and those at the TRF facility at LASP (July 2009). These results are used for a new characterization of the PMO6V type radiometer in air and vacuum. For the application of the radiometers in air the question is whether the heat transport is by conduction or convection. The small temperature differences within a radiometer and the absence of an orientation dependence of the sensitivity during solar measurements on a solar tracker suggest that convection may be not important. This is confirmed by comparison of the results of the thermal model with the results from characterization experiments. They also allow us to determine the performance in vacuum (in space). Together with my earlier characterization of DIARAD – the absolute value of the VIRGO TSI record can be determined. Moreover, the model together with the behaviour of the oxide (Cr_2O_3) on the stainless steel aperture under strong UV radiation in space explains the early increase and provides also a method to treat aperture heating in the covered operation of the PMO6V radiometers.

Climate and Radiative Properties of a Tidally-locked Planet around Proxima Centauri

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Red dwarf stars are the most common type of stars in our Galaxy and the most long-lived ones. For this reason the search for habitable exoplanets is generally focused around such stars though the exposure to high XUV fluxes can be responsible for a planetary atmospheric loss rate of heavy elements, e.g., oxygen and nitrogen.

We present a study about the climate of a tidally locked Earth-like planet, with preindustrial atmosphere, circular orbit and null axial tilt in the Proxima Centauri System, based on the intermediate complexity atmospheric general circulation model PlaSim and the 1-D radiative transfer model uvspec. The thermal emission of the planet-host star system is calculated in the mid-infrared region of the spectrum in order to evaluate the color-magnitude variability in function of the system inclination with respect to a distant observer.

How can the Sun explain the Correlations between CaII and Hα Emissions of Stars?

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The CaII and Hα emissions are known to be correlated for the Sun, but several studies have shown that is not always true for other stars. Some stars indeed show anti-correlated relationships between their CaII and Hα emissions. The only current hypothesis to explain this anti-correlation is the presence of filaments at the surface of these stars: filaments absorb more emission in Hα than in CaII, which could cause a reversal of the correlation. The goal of this study is to investigate this hypothesis and try to validate it with a model.

First, we investigate the characteristics of the anti-correlated stars to define the stellar parameters that can affect the correlation between the CaII and Hα emissions. We select a sample of 391 FGK stars and study their CaII and Hα time series provided by HARPS instrument. We show that anti-correlated stars are less active than the correlated stars and that the correlation does not depend on the temperature of the stars, as previously supposed.

In the future, we plan to try to reproduce the observed anti-correlations by using the solar case and modifying the photospheric magnetic field configuration and its diffusion. These simulations will give us series of magnetograms, to be transformed into CaII and Hα time series, from which the correlation will be inferred.

Introduction to China FY-3 Satellite Plans and SSIM (Solar Spectral Irradiance Monitor)

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The FengYun 3 (FY-3) series is the second generation of Chinese sun-synchronous meteorological satellites. Four of them, FY-3A/B/C/D, have been successfully launched in 2008, 2010, 2013, and 2017 separately. This paper introduces the FY-3 series follow-up satellite plans until 2025. The FY-3 series will provide three-dimensional, quantitative, multi-spectrum global remote sensing data under all weather conditions, which will greatly help global change research, climate diagnostics and prediction, and natural disasters monitoring. Observations from all of the instruments aboard FY-3 satellites are broadcast on X bands. Ground receiving stations operated by National Satellite Meteorological Center (NSMC) receive the data from FY-3 satellites and then send the data to the Center of Data Processing and Service (CDPS) at NSMC in Beijing routinely. The remote sensing data are processed by using various algorithms and different kinds of products are generated routinely with the high-speed computers and networks of NSMC. The data and products are available to users worldwide.

(SIST) Construction of a SORCE-based SSI Record for Chemistry Climate Models

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The objective of this proposal is to produce a solar spectral irradiance (SSI) record suitable for whole atmosphere chemistry-climate model (CCM) transient studies over the well-observed solar cycle 23 and 24 time period. This record will be based predominantly on observed irradiance of the SORCE mission as measured by the SIM and SOLSTICE instruments that accounts for ~97% of the total radiated output of the Sun. A viable SSI record for studies of this kind requires very broad wavelength coverage (110-10000 nm), daily spectral coverage, compliance of the integrated SSI record with the TSI, and well-defined and documented uncertainty estimates both absolute scale of the spectrum and the long-term stability of the record. While the majority of the record will be derived from SORCE observations, extensions back to the Solar Cycle 23 maximum time period (early 2002) must be generated. For this study, we will employ the Fontenla et al. (2011) Solar Radiation Physical Model (SRPM) since it gives the best estimates of a broad variety of solar structures that include bright facular and network features as well as contributions from sunspot umbra and penumbra. Image analysis of the Precision Solar Photometric Telescope (PSPT) data from both Rome Observatory (OAR) and the Mauna Loa Observatory (MLSO) also provides a very useful independent data product that provides valuable proxies that are consistent with bright facular components such as the Mg II index and the short-term sunspot darkening represented in the photometric sunspot index. The PSPT image analysis provides information about solar irradiance evolution not attainable through two-component decompositions, i.e. the evolution of network and active networks components that evolve on time scales longer than rotational period of the Sun.

Earth Energy Imbalance Explorer (EAGER)

Cristoph Jacobi [1]**, *Margit Haberreiter (presenter)*** [2]*, and the EAGER Team*

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In the climate community there is growing need to determine the global Energy budget, in particular Earth´s energy imbalance (EEI). This requires observations of the global energy budget at the top of the atmosphere (TOA) and the Solar Spectral Irradiance (SSI) at an accuracy and long-term stability not available from current observations. To address these issues, we propose the EArth enerGy imbalance ExploreR (EAGER) mission, which will – for the first time – determine the EEI through measuring both incoming Total Solar Irradiance (TSI) as well as the outgoing thermal and reflected solar radiation at the TOA with the same instrument type. To further ensure the highest possible accuracy and stability for the EEI observations, in-flight calibration of the solar observations will be enabled through applying the DARA TSI sensors in combination with transfer filters as a reference for the SSI observations, complemented by an ionisation chamber for the calibration in the EUV wavelength range. Similarly, for the Earth observations, fast bolometric sensors will be calibrated by an Earth-pointing DARA instrument. Ultimately, using the DARA TSI instrument as imbalance monitor and at the same time as calibration facility in space will allow us to determine the EEI with the required precision.

New Solar EUV Irradiance Measurements from GOES-16

Andrew Jones *[Andrew.Jones@lasp.colorado.edu], Laboratory for Atmospheric and Space Physics (LASP), University of Colorado, Boulder, CO, USA*

The space weather suite of instruments on the new series of GOES-R satellites includes a EUV spectrometer. These spectrometers make line-irradiance measurements, that form the input to an operational proxy-model that produces an EUV spectrum. Rather than talking about the model, I will concentration on the irradiance measurements that the GOES-16 / Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS) instrument is taking.

An Empirical Model of the Variation of the Solar Lyman-α Spectral Irradiance

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We propose a simple model that computes the spectral profile of the solar irradiance in the hydrogen Lyman alpha line, H Ly-α (121.567nm), from 1947 to present. Such a model is relevant for the study of many astronomical environments, from planetary atmospheres to interplanetary medium. This empirical model is based on the SOHO/SUMER observations of the Ly-α irradiance over Solar Cycle 23 and the Ly-α disk-integrated irradiance composite. The model reproduces the temporal variability of the spectral profile and matches the independent SORCE/SOLSTICE spectral observations from 2003 to 2007 with an accuracy better than 10%.

Revision of the Sun's Spectral Irradiance as Measured by SORCE SIM

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The Spectral Irradiance Monitor (SIM) instrument on board the Solar Radiation and Climate Experiment (SORCE) performs daily measurements of the solar spectral irradiance (SSI) from 200 to 2400 nm. Both temporal and spectral corrections for instrument degradation have been built on physical models based on comparison of two independent channels with different solar exposure. The present study derives a novel correction for SIM degradation utilizing the total solar irradiance (TSI) measurements from the Total Irradiance Monitor (TIM) on SORCE. The correction is applied to SIM SSI data from September 2004 to October 2012 over the wavelength range from 205 nm to 2300 nm. The change in corrected, integrated SSI agrees within 0.1 W m^{-2} (1 σ) with SORCE TIM TSI and independently shows agreement with the SATIRE-S and NRLSSI2 solar models within our uncertainties.

SOLAR/SOLSPEC Ultraviolet Solar Spectral Irradiance Variability from 5 April 2008 to 15 February 2017

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SOLAR, a spaceborne observatory on board the International Space Station (ISS) that had continuously monitored solar activity for the past nine years was switched off by the European Space Agency (ESA) on February 15, 2017. Its three instruments analyzed the complete spectrum of solar radiation, from extreme ultra-violet to infrared. SOLar SPECtrometer (SOLSPEC), one of these instruments, has performed accurate measurements of solar spectral irradiance (SSI) from the middle ultraviolet to the infrared (165 to 3088 nm). In-flight operations and performances of the SOLAR/SOLSPEC instrument, including corrections, will be presented for the 9 years of the mission. After an accurate calibration, we present the variability measured in the ultraviolet by SOLAR/SOLSPEC during the Solar Cycle 24.

Observed and Modelled Influences of the 11-Year Solar Cycle on the Walker Circulation

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The Walker circulation (WC) fluctuates on multi-decadal and inter-annual time scales under the influence of internal variability and external forcings. We provide observational evidence showing that the 11-yr solar cycle (SC) affects WC variability on decadal time scales. We observe a robust reduction of West-East sea-level pressure gradients in the Indo-Pacific during solar maxima and the following 1-2 years. This reduction is associated with westerly wind anomalies at the surface and throughout the equatorial troposphere in the western/central Pacific paired with an eastward shift of convective precipitation that brings more rainfall to the east. The observed weakening of the WC results from a thermodynamical response of global hydrology to surface warming, which is further amplified by atmosphere-ocean coupling. The observed solar modulation of the WC is supported by a set of climate-model simulations forced explicitly by the SC forcing. These findings give confidence in predictions of a weaker WC under global warming, given that the response of the WC to the SC heating is constrained by the same mechanism that weakens the WC owing to increasing greenhouse gas concentrations.

In-flight Performance of Solar Irradiance Monitor-II on-board FY-3C and its TSI Data

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The Solar Irradiance Monitor-II (SIM-II) is a key payload on-board FengYun-3C (FY-3C) polar-orbit meteorological satellite and aim to capture variation of solar energy at the whole waveband from the top of atmosphere with Total Solar Irradiance (TSI) product. It is designed for earth radiation budget research coupled with Earth Radiation Measurement (ERM) together as an instrument group. FY-3C/SIM-II has two significant improvements by adding sun tracking system and temperature control system comparing to SIM-I. The observation is traceable to World Radiometric Reference (WRR) by field calibration experiment before launch.

SIM-II has been on-orbit operated for more than 4 years since FY-3C was successful launched on Sep. 23, 2013. An assessment on instrument in-flight performance has been done by analyzing instrument parameters, corrected factors and especially on aging monitor. An optimization of product algorithm is developed based on this work. Total solar irradiance product from FY3C/SIM-II has been evaluated by comparing with SORCE/TIM and SOHO/VIRGO. The result shows a good consistency. In future, the first early-morning orbit satellite - FY-3E will have two solar irradiance instruments for total and spectral solar energy observation in the same platform.

(SIST) Recalibration and Re-evaluation of the SORCE SIM Data Record

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The SIST efforts funded are to support the development of improved SORCE SIM solar spectral irradiance (SSI) datasets. Based largely on the recent advances made in spectral characterization and calibration measurement facilities, we performed many parallel, full-spectrum characterizations and calibrations specific to the SORCE SIM optical components and performance parameters. These included direct measurements of SORCE flight witness detectors and optical materials or similar TSIS flight

candidates. These were analyzed and, in favorable cases, incorporated in updated calibration values to potentially reduce the overall systematic uncertainty of the SORCE SIM absolute SSI scale (especially in the ultraviolet and infrared) and provide a tie to the future TSIS SIM data record. The results showed that while some of these inputs were subtle in the performance changes (e.g. temperature coefficient updates), others have larger effects (e.g. diffraction and transmission corrections) that required further refinements to address quantitative uncertainty estimates.

With regard to longer term spectral and temporal stability corrections we were successful in implementing several unique approaches to begin to quantify the solar exposure related degradation correction sensitivity in the early mission SORCE SSI record. The approach involved refining the solar exposure ratios to address changes in the common spectral degradation factor degradation (exponential in exposure time) with the mission time. This was completed by constraints in the ratio of several integrated bands between SIM A and SIM B comparisons as well as a global constraint of the full integrated SIM irradiance to the SORCE TIM TSI over the mission. Overall this approach provided insight into the validity of some assumptions that are made in the two-channel degradation tracking methodology and the generation of a temporal and spectral function to correct the long-term solar exposure degradation. Efforts reported here focus on understanding the constraints on the early mission degradation and stability corrections and begin to quantify the differences in the measurement of the spectral degradation for long-term degradation corrections and the two-channel instrument model deficiencies.

The Latest SORCE-SIM Solar Spectral Irradiance Data Release and Initial Comparison with TSIS-SIM Measurements

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The Spectral Irradiance Monitor (SIM), the SOLar STellar Irradiance Comparison Experiment (SOLSTICE), and the XUV Photometer System (XPS) instruments on board the Solar Radiation and Climate Experiment (SORCE) mission have been taking daily Solar spectral irradiance (SSI) measurements since April 2003.

It is critical to accurately track the instrument degradation over time to be able to measure the small SSI variations with the solar cycle over the wavelength range covered by SORCE-SIM (220-2400nm). The instrument degradation is constantly being updated and the corresponding model has been refined over the years to account for changes and a better understanding of the instrument's behavior over time.

We present the latest data releases from the SORCE-SIM instrument, describing the improvements in the new datasets and the trends measured during Solar cycles 23 and 24. The SSI for SORCE-SIM and first light measurements from TSIS-SIM are compared as well.

The Magnesium II Index: Continuing Progress on the Facular Proxy in the GOES-R Era

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The Magnesium II core-to-wing ratio is an important proxy for solar magnetic activity, and it has been measured on a daily basis since 1978. The newest set of measurements are from the Extreme ultraviolet and X-ray Irradiance Sensors (EXIS) on the GOES-R series. The first EXIS was launched in late 2016 and will become operational later this year. The new measurement is at 3 second cadence and very high signal-to-noise ratio. This poster will show the capabilities of the new series of instruments and some initial results.

(SIST) Solar Spectral Irradiance: lyman Alpha, MagnEsium II, and Sigma k proxiEs (SSIAMESE)

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The topic of this Solar Irradiance Science Team was to continue the development of solar activity proxies. The three proxies are the Magnesium II index, Lyman alpha irradiance, and the sigma-k proxy derived from Calcium II images taken at the San Fernando Observatory. This poster will show the progress on each proxy and its role in solar spectral irradiance modeling.

TSIS-2 and Beyond

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A presentation of the ongoing work to establish the long term, low cost, approaches to continuous Solar monitoring for TSI and SSI. Current and projected technologies including instruments, spacecraft/accommodations and access to space are discussed. Innovative options for establishment an operational monitoring constellation that will provide a low annual cost and low risk approach to data collection of TSI and SSI with minimal political impact will be presented.

The Solar Cycle Influence: How TSI and Insolation Warm and Cool the Ocean

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LASP SORCE TSI and the CDR Historical TSI data were analyzed to determine that the increasing trend in solar irradiance over 400 years from the long low period of the Maunder Minimum to the equally long Modern Maximum, was the primary source of energy responsible for the increase in ocean temperature since the LIA.

Earth’s ocean is determined to warm under rising solar activity or insolation over any duration- a week, month, year, solar cycle, or many consecutive cycles.

Equatorial ocean heat content and temperatures are observed as sensitive to and linear-lagged with daily TSI-insolation variation, from upwelled heat accumulation of sub-surface solar penetration from prior clear sky high insolation and/or rising or high TSI, such as during a cycle onset El Nino.

Decadal scale ocean warming and post-solar maximum El Nino events are calculated to occur after solar activity rises above an average of 120 sfu F10.7cm, statistically equivalent to 94 v2 SSN and 1361.25 W/m^2 SORCE TSI.

HadSST3 is found to be linearly sensitive to SORCE TSI at a rate of 0.5°C/W/year.

An empirical ‘F10.7-TSI-SST model’ was created using an F10.7cm-SORCE TSI regression model and the HadSST3-TSI sensitivity factor, predicated on the SWPC Solar Cycle 24 panel 2016 F10.7cm flux forecast, was used in December of 2015 to uniquely and successfully predict the 2016 HadSST3 fall to within 3% error.

Solar minimum La Nina events result from insufficient TSI over time, driving less equatorial evaporation, less cloud cover and precipitation that causes US drought, which is now forecasted for 2018-2020 using this model.

The ‘solar cycle influence’ is the accumulated terrestrial temperature effect from all solar cycle activity, which varies with the evolution of the solar magnetic field, is herein found to be the primary energy source for net warming or cooling, tropical evaporation, and subsequent extreme events.

Resolution of the Decadal Trend Differences between the ACRIM and PMOD Total Solar Irradiance Composite Time Series of Satellite Observations

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The interpretation of satellite observations of total solar irradiance (TSI) since 1978 is important for determining their implications for TSI as a driver of climate change. A logical conclusion requires resolution of the contention over whether the TSI composite time series that best reflects available results indicates an increasing trend from 1980 to 2000 and a decrease thereafter (in the ACRIM series), or a continuous decrease since 1980 (in the PMOD series). The key issue is the treatment of the TSI records during the 1989 – 1991 'ACRIM gap' when only lower precision Earth Observation Satellite overlapping results (from Nimbus7/ERB and ERBS/ERBE experiments) were available to connect the ACRIM1 and ACRIM2 observations. We find that an error in the PMOD interpretation of the Nimbus7/ERB results led them to incorrectly model the ACRIM gap observations. Correction of this error would cause the PMOD trend to agree very closely with the ACRIM composite series trends. Our analysis therefore supports a TSI increase during the 1980 to 2000 period followed by a long term decrease since. The implications of this result for TSI variability and its effect on climate are important since this trend and the climate changes of the period are correlated.

Solar Cycle and Trend of Global Gravity Waves Derived from 14 Years of SABER Temperature Observations (2001-2015)

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Gravity waves (GWs) are disturbances of the atmosphere with horizontal wavelengths of several kilometers to several thousand kilometers. GWs can be generated by many sources, e.g., wind jets, deep convection, and flow over topography. The global GW potential energy (PE) per unit mass is derived from SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) temperature profiles over the past 14 years (2002–2015). We find a significant positive trend of GW PE at around 50°N during July from 2002 to 2015. Both the monthly and the deseasonalized trends in of GW PE are significant near 50°S. Specifically, the deseasonalized trend of GW PE has a positive peak of 12–15% per decade at 40°S–50°S and below 60 km, which suggests that eddy diffusion is increasing in some places. The response of GW PE to solar activity is negative in the lower and middle latitudes. The response of GW PE to QBO (as indicated by 30 hPa zonal winds over the equator) is negative in the tropical upper stratosphere and extends to higher latitudes at higher altitudes. The response of GW PE to ENSO (as indicated by the MEI index) is positive in the tropical upper stratosphere.