SNS • SORCE News Source

Solar Radiation and Climate Experiment Monthly Newsletter **Aug. – Nov. 2016**

AGU News: Tom Woods Presenting the Parker Lecture –

SORCE PI Tom Woods has been selected to deliver the Parker Lecture at the 2016 Fall AGU Meeting. His talk (SH24A-01) is entitled *"**Spectroscopic Exploration of Solar Flares**"* and it will be based on some SORCE data. Details are on the AGU website at:
https://agu.confex.com/agu/fm16/meetingapp.cgi/Paper/121728

The Parker Lecture is part of the prestigious Bowie Lecture program of AGU. It is one of the highest honors accorded to members of the Space Physics and Aeronomy (SPA) section of AGU. The Eugene Parker Lecture honors the life and work of solar astrophysicist, Professor Eugene Parker.

Tuesday, Dec. 13, 4 pm
Moscone West 2022/2024

Abstract: Professor Eugene Parker has educated and inspired the heliophysics community since the 1950s about the Parker spiral path for the solar wind, magnetic reconnection throughout the heliosphere, and coronal heating by nano-flares. Solar flares, as well as their often eruptive companions called coronal mass ejections (CMEs), have been studied for decades. While most of these studies involve imaging the Sun, observations of the Sun as a star (full-disk irradiance) have also revealed interesting results through exploring the spectral variability during flare events. Some of the new results from such studies include understanding the flare variability over all wavelengths from the energetic X-rays to the visible, discovering and classifying different flare phases, using coronal dimming measurements to predict CME properties of mass and velocity, and exploring the role of Parker's nano-flares in continual heating of active regions.

Fall AGU Meeting, Dec. 12-16, San Francisco, CA
http://fallmeeting.agu.org/2016/

Other SORCE-Related Sessions and Presentations at AGU –

While you are planning your schedule for the upcoming AGU Meeting, Dec. 12-16, in San Francisco, please make note of other SORCE-related talks and posters (listed in date order).

A11I-0133. Continuing the Solar Irradiance Data Record with TSIS
Monday, 12 December, 8:00 am, Poster Hall
Authors: P. Pilewskie, G. Kopp, E. Richard*, O. Coddington, T. Woods, D. Wu

SH13A- 2285. Improving Solar Soft X-Ray (SXR) Irradiance Results from Broadband Photometers with New SXR Spectral Measurements from a CubeSat
Monday, 12 December, 1:40 pm, Poster Hall
Authors: T. Woods*, A. Caspi, P. Chamberlin, L. Didkovsky, F. Eparvier, A. Jones, J. Mason, C. Moore, S. Solomon, R. Viereck

SH13A-2286 Modeling the Soft X-Ray During Solar Flares
Monday, 12 December, 1:40 pm, Poster Hall
Authors: C. Leaman*, T. Woods, C. Moore, J. Mason

P13A-1919 The Response of High Energy Photoelectrons in The Mars Atmosphere to Variable Solar Input
Monday, 12 December, 1:40 pm, Poster Hall
Authors: I. Mills*, F. Eparvier, E. Thiemann, D. Mitchell

A24C-02. Impacts of spectral solar irradiance on inter-sensor radiometric calibrations
Tuesday, 13 December, 4:15 pm, Moscone West 3010
Authors: D. Wu*, A. Marshak, J. Lee, Y. Yang, S. Marchenko, M. DeLand, N. Krotkov, P. Pilewskie, T. Woods, J. Harder, E. Richard

SH42B-04. Total Solar Irradiance changes between 2010 and 2014 from the PREcision MOnitor Sensor absolute radiometer (PREMOS/PICARD)
Thursday, 15 December, 11:05 am, Moscone West 2009
Authors: W. Schmutz, G. Cessateur*, W. Ball, W. Finsterle, B. Walter

[**SA51B-2425. Estimating Exospheric Hydrogen Density Using Lyman-a Solar Irradiance Measurements from SOLSTICE**]
Friday, 16 December, 8 am, Poster Hall
Authors: Z. Pierrat*, M. Snow, J. Machol

[**SA51B-2424 Dancing to the MUSSIC: Steps towards creating a Multisatellite Ultraviolet Solar Spectral Irradiance Composite**]
Friday, 16 December, 8 am, Poster Hall
Authors: M. Snow*, J. Machol, E. Richard

[**SA51B-2426 8 years of Solar Spectral Irradiance Observations from the ISS with the SOLAR/SOLSPEC Instrument**]
Friday, 16 December, 8 am, Poster Hall
Authors: L. Damé*, D. Bolsée, M. Meftah, A. Irbah, A. Hauchecome, S. Bekki, N. Pereira, G. Cessateur, M. Marchand, R. Thiéblemont, T. Foujols

[**SA51B-2427. The SORCE Solar Spectral Irradiance Data and Degradation Models**]
Friday, 16 December, 8 am, Poster Hall
Authors: S. Béland*, J. Harder, M. Snow, T. Woods, B. Vanier, C. Lindholm, J. P. Elliott, L. Sandoval

[**SA51B-2430. Solar Total and Spectral Irradiance Reconstruction over Last 9000 Years**]
Friday, 16 December, 8 am, Poster Hall
Authors: C. Wu*, N. Krivova, S. Solanki, I. Usoskin

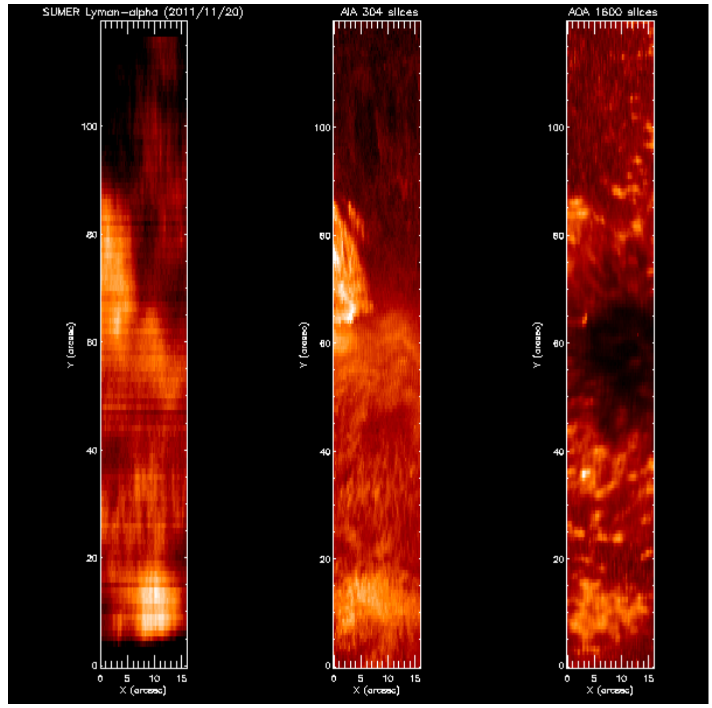
[**SA54A-02. The New Climate Data Record of Solar Irradiance: Comparisons with Observations and Solar Irradiance Models Over a Range of Solar Activity Time Scales**]
Friday, 16 December, 4:15 pm, Moscone West 2016
Authors: O. Coddington*, J. Lean, P. Pilewskie, E. Richard, M. Snow, G. Kopp, C. Lindholm

ISSI Project Team Meeting –

By Marty Snow – LASP, University of Colorado

SORCE scientist, Marty Snow, organized the 3rd Solar Heliospheric Lyman Alpha Profile Effects (SHAPE) Meeting at the International Space Science Institute (ISSI) in Bern, Switzerland, Sept. 19-21, 2016. SHAPE's goal is to study the evolution of the Lyman alpha line profile over the solar cycle. In particular, we are interested in understanding how the line shape impacts planetary atmospheres and the interplanetary medium. The international team is composed of both observers and modelers, both solar and interplanetary. The team is working on eight (8!) projects which should be published in the near future.

One of the projects is to create an empirical model of the Lyman alpha profile in irradiance from SUMER on-disk observations along with feature identification of solar images, then using SORCE SOLSTICE to validate the results. Here is a teaser image showing an observation from November 2011 comparing Lyman alpha to two SDO/AIA channels:

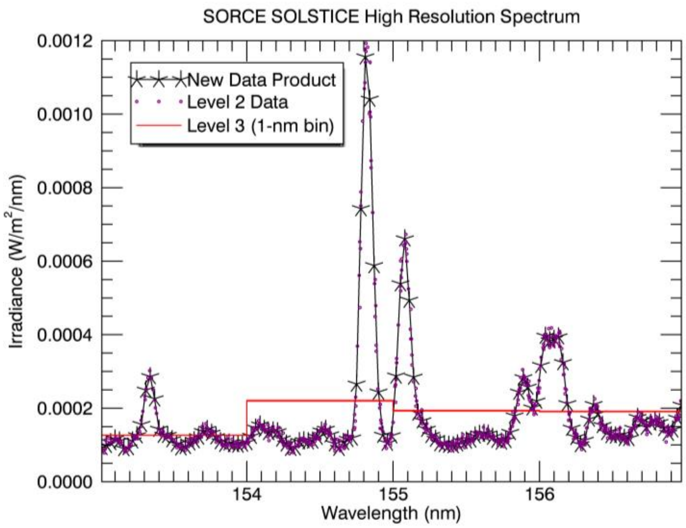


For further information on the team's activities, visit their website: http://www.issibern.ch/teams/shape/.

SHAPE team members (left to right): Marty Snow (CU/LASP), Eric Quémerais (LATMOS), Ed Thiemann (CU/LASP), Vlad Izmodenov (Moscow State U.), John Clarke (Boston U), Werner Curdt (MPI, Göttingen), and Margit Haberreiter (PMOD/WRC). Team members not shown: Olga Katushkina (Moscow State U.), Randy Gladstone (SwRI), Matthieu Kretzschmar (U. Orleans/CNRS), and Frank Eparvier (CU/LASP).

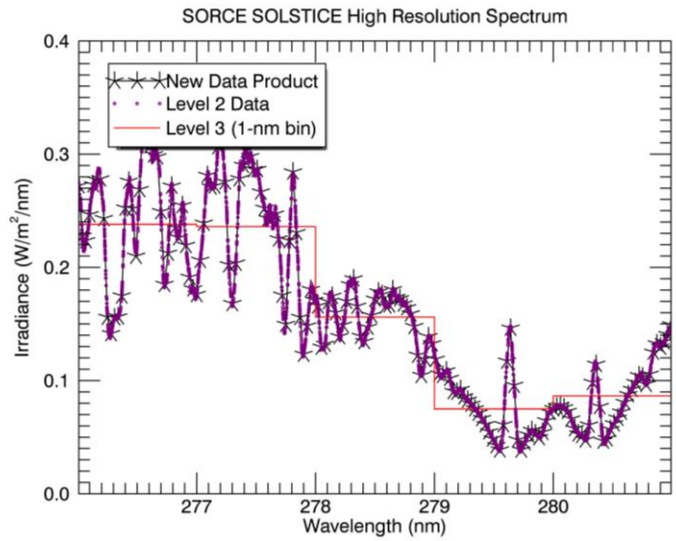
SOLSTICE High Resolution –

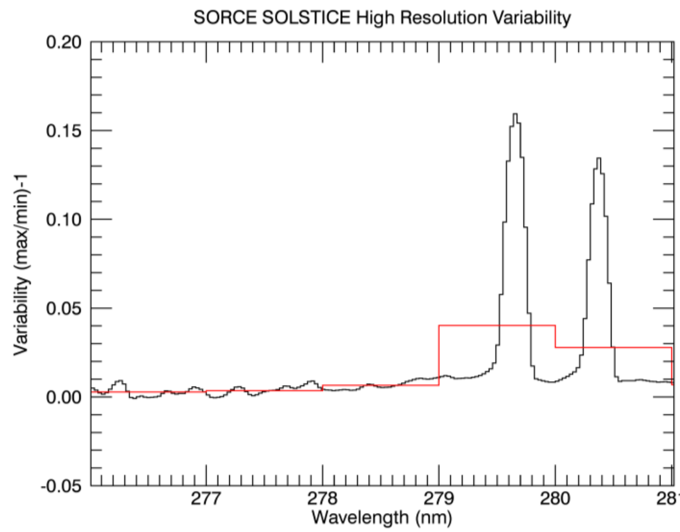
By Marty Snow – LASP, University of Colorado



Example of new high-resolution SOLSTICE spectrum. The red shows the Level 3 1-nm binned data product which had been previously available.

We are releasing a new data product for SOLSTICE. Instead of binning the daily spectrum to 1-nm intervals, users can now download the full-resolution spectrum for each day. The individual spectral scans are combined and a mean spectrum for the day is fit with a spline. The instrument has a spectral resolution of 0.1-nm, and each scan takes samples every 0.03-nm, i.e. three samples per slit width. Doppler shifts due to spacecraft motion slightly offset these scans, thus improving the statistical sampling. The new data product evaluates the spline fit every 0.03-nm, revealing details of the solar spectrum that had previously been obscured by binning. At the time the SORCE mission was proposed, it was assumed that 1-nm intervals were sufficient for state of the art climate models. Today's models are more advanced, and may be able to take advantage of the full SOLSTICE resolution. The following figure shows a portion of the solar spectrum including the Magnesium II cores and the spectral variability over one rotation in August 2014. The full resolution spectrum shows the variability concentrated in the line cores.





SOLSTICE spectrum high-resolution spectrum near the Mg II cores. The bottom plot shows the variability as a function of wavelength over one solar rotation in August 2014.

SORCE Wants REU Students –

By Marty Snow, LASP, Univ. of Colorado

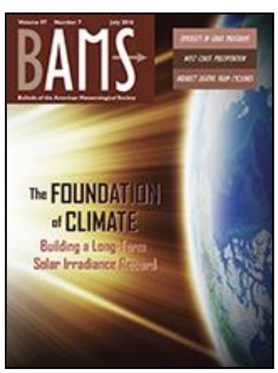
Each summer, the SORCE mission funds student research projects as part of the University of Colorado's Research Experience for Undergraduates (REU) program. For ten weeks, the students come to Boulder, Colorado to work with SORCE scientists on a research project involving measurements from SORCE. The program pays for the students' travel costs and housing, plus a $500/week stipend.

They begin their time at LASP with a one-week lecture series on Solar and Space Physics from experts in the field, and end with a student symposium where the REU students present their findings. Last year, two students worked on projects using SORCE data. One student analyzed the SOLSTICE Lyman alpha data to create a model of the exosphere. Hydrogen in the exosphere scatters Lyman alpha photons, and using measurements from different view angles throughout the orbit can constrain the exospheric density profile. Another student focused on validating models of solar soft x-ray irradiance by correlating their predictions with photoelectron measurements at Mars. Both of these students will present their results at AGU.

This year's projects will be just as interesting! Applications for the 2017 program are now being accepted, and we invite students from around the country to apply for a position to work on SORCE and other missions. We depend on professional scientists interested in SORCE science to recommend well qualified students to our program. Full details are available at http://lasp.colorado.edu/reu including all deadlines (application deadline is Feb. 1, 2017). For further information, please contact the REU Program Organizer, Marty Snow (snow@lasp.colorado.edu or 303-885-8689).

REU class of 2016 enjoying the sunshine in Boulder.

BAMS Features SORCE Research –



SORCE team member Odele Coddington's paper, "A Solar Irradiance Climate Data Record", that reports on a new climate data record for total and spectral solar irradiance from 1610 to the present, was featured on the cover of the July 2016 *Bulletin of the American Meteorological Society* (BAMS).

The full citation and link:
Coddington, O., J. Lean, P. Pilewskie, M. Snow, and D. Lindholm, 2016: A Solar Irradiance Climate Data Record. *Bull. Amer. Meteor. Soc.*, 97, 7, 1265–1282, doi: 10.1175/BAMS-D-14-00265.1. Web link: http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-14-00265.1

New Climate Records Released Are Based on SORCE Measurements

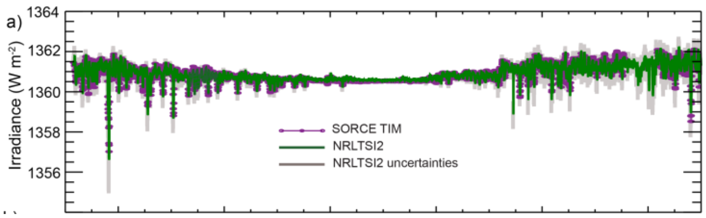
By Odele Coddington, LASP, Univ. of Colorado

In November 2015, a new Solar Irradiance Climate Data Record (CDR) consisting of total and spectral solar irradiance and their associated time- and wavelength-dependent uncertainties was presented to the public. The 400+ year climate data record extends from 1610 to present day and is operationally updated from LASP on a quarterly basis. The advances in the Naval Research Laboratory's (NRL) solar variability models used to create this long-term record are directly attributable to improved knowledge in the variability in the Sun's energy output obtained from SORCE observations. The overall approach of the Solar Irradiance CDR algorithm builds on, and advances, the original NRL models developed by Dr. Judith Lean over a decade ago and used in a variety of model simulations of climate and atmospheric change.

The Sun's power per unit area summed over all wavelengths – the total solar irradiance (TSI) – and the dispersion of this power across the electromagnetic spectrum – the solar spectral irradiance (SSI) – varies with changes in the flux of magnetic activity emerging from the Sun's interior into its atmosphere. These magnetic features manifest as dark spots on the visible surface of the sun called "sunspots" and as brighter features called faculae that accompany the sunspots. The presence of sunspots reduces the Sun's irradiance for most visible wavelengths while the faculae increase the Sun's irradiance. The net effects from these opposing features changes the Sun's irradiance over the 11-year cycle of magnetic activity when the enhanced facular emission at maximum solar activity exceeds that of the irradiance reduction from sunspots. On shorter time scales when the Sun's approximate 27-day rotation period alters the distribution of sunspots and facular features on the projection of the solar disk viewed at Earth, sunspots may reduce irradiance more than the facular features increase it.

Approximately 11-years of data from three instruments on the SORCE satellite were used to improve the NRL models of TSI and SSI, NRLTSI2 and NRLSSI2 respectively, which form the Solar Irradiance Climate Data Record. Both of these models have empirical relationships of the irradiance variability as related to sunspot and faculae indicators (proxies) that extend back to 1610, and these relationships are based on SORCE and other solar irradiance measurements. The SORCE TIM instrument detects changes in the TSI at unprecedented accuracy and stability. The TIM observations on SORCE and on the TSI Calibration Transfer Experiment (TCTE) contribute to what is now a 38+ year record of TSI observations from space. The SORCE SOLSTICE instrument measures SSI between 115 and 309 nm and the SORCE SIM instrument measures SSI between 310 nm to 2400 nm. SORCE SSI observations at wavelengths longer than 400 nm are the first ever spectrally resolved measurements of the Sun's irradiance from space and the observations at wavelengths shorter than 400 nm contribute to an existing record of satellite ultraviolet (UV) observations that is not as lengthy as the TSI record nor consistently sampled in time (or spectral resolution).

The figure below is an example of a comparison of the modeled TSI with SORCE TIM observations (v17 processing) between 2003 and 2014. NRLTSI2 results are highly correlated with SORCE TIM observations and explain much (92%) of the variability over this time period. Additional comparisons of modeled TSI and SSI with SORCE observations over solar rotational time scales, as well as comparisons of modeled TSI and SSI with the original model formulation can be found in the full article (Coddington et al., *Bull. Amer. Meteor. Soc.*, 97, 7, 1265-1282, July 2016).



Comparison of NRLTSI2 modeled output with SORCE TIM observations (v17) between 2003 and 2014. The NRLTSI2 uncertainties (grey shading) do not include the uncertainty due to the TSI absolute scale, which is approximately 350 ppm.

Deliverables: The NOAA National Center for Environmental Information (NCEI) is the definitive source of the Solar Irradiance CDR (https://www.ncdc.noaa.gov/cdr/atmospheric). Users may also directly download the data from LASP's LISIRD server (http://lasp.colorado.edu/lisird3/data/nrl2_files. Due to file size considerations, the NRLSSI2 data delivered to NOAA NCEI does not contain uncertainties; however, these uncertainties are available from LASP LISIRD. A summary of the data products delivered as the Solar Irradiance CDR and their operational update cadence are given in the following table.

Data Products delivered with the Solar Irradiance CDR

Product	Type	No. of wavelength bins	Time range, update cadence
TSI composite	Observational composite	—	1978–2014, periodic
TSI (daily and monthly avg)	NRLTSI2 model output	—	1882–2014, quarterly
TSI (yearly avg)	NRLTSI2 model output	—	1610–2014, yearly
SSI (daily and monthly avg)	NRLSSI2 model output	3,785 (variable width)	1882–2014, quarterly
SSI (yearly avg)	NRLSSI2 model output	3,785 (variable width)	1610–2014, yearly
SSI reference spectra	NRLSSI2 model output	99,884 (1-nm width)	Quiet sun Low, moderate, and high solar activity Maunder Minimum
Facular brightening and sunspot darkening indices	NRLTSI2/NRLSSI2 model input	—	1882–2014, quarterly

2017 EGU General Assembly –

Please note the sessions within the Solar Terrestrial Sciences at the upcoming 2017 EGU General Assembly, April 23-28, in Vienna, Austria (http://www.egu2017.eu/). The abstract deadline is **January 11, 2017** (13:00 CET). We look forward to seeing you in Vienna!

ST1 – Sun and Heliosphere
http://meetingorganizer.copernicus.org/EGU2017/sessionprogramme#ST1
ST3 – Ionosphere and Thermosphere
http://meetingorganizer.copernicus.org/EGU2017/sessionprogramme#ST3
ST4 – Space Weather and Space Climate
http://meetingorganizer.copernicus.org/EGU2017/sessionprogramme#ST4

The entire science program is available at:
http://meetingorganizer.copernicus.org/EGU2017/sessionprogramme.

Upcoming Meetings / Talks –

SORCE scientists will present papers or attend the following 2016-2017 meetings/workshops:

AGU Fall Meeting, Dec. 12-16, San Francisco, CA
https://fallmeeting.agu.org/2016/
AMS Annual Meeting, Jan. 22-26, Seattle, WA
https://annual.ametsoc.org/2017/
ISSI Team Meeting: Towards a Unified Solar Forcing Input to Climate Studies. Feb. 20-24, Bern, Switzerland
European Geosciences Union (EGU), General Assembly, April 23-28, Vienna, Austria, http://www.egu2017.eu/