# TSIS / SORCE News

*Total & Spectral Solar Irradiance Sensor / Solar Radiation & Climate Experiment*

**April-May 2019**

## *2020 Sun-Climate Symposium –*

***Please mark your calendar today to join us in January 2020!*** Our focus topic for this 3.5-day symposium is ***"What is the Quiet Sun and What are the Subsequent Climate Implications?"*** This meeting is sponsored by the Sun-Climate Research Center – a joint venture between NASA GSFC and LASP at the University of Colorado.

***Call for Abstracts ☼ Due Nov. 15***

**The abstract form and submittal instructions are available on the website.** We encourage your participation and hope that you will send in an abstract and share this announcement with your colleagues. Invited speakers will be posted to the website as they accept. Join us for a great meeting in a beautiful location!

## Science Overview

What is the quiet Sun? Is it a time-invariant base level or is there secular variability in the Sun's radiative output? What do those alternate scenarios imply for Earth-climate responses? The current solar minimum provides an opportunity to answer these and related questions.

Observations of the Sun and Earth from space have revolutionized our view and understanding of how solar variability and other natural and anthropogenic forcings impact Earth's atmosphere and climate. For more than four decades the total and spectral solar irradiance and global terrestrial atmosphere and surface have been observed continuously, providing unprecedented high-quality data for Sun-climate studies. The 2020 Sun-Climate Symposium will convene experts from across the solar-terrestrial community, including the disciplines of climate research, atmospheric physics and chemistry, heliophysics, and metrology, to discuss solar and climate observations and models over both spacecraft-era and historical timescales.

***Tucson, Arizona***
***Jan. 27-31, 2020***

***http://lasp.colorado.edu/home/sorce/news-events/meetings/2020-scs/***

***Join us! Submit your abstract today!***

The sunset in beautiful Saguaro Natl. Park, just west of Tucson.

## Sessions and Descriptions

The agenda for this interactive meeting consists of invited and contributed oral and poster presentations. Eight sessions will focus on different science topics.

### *1. The Sunset of SORCE*

The NASA Solar Radiation and Climate Experiment has had many accomplishments and discoveries during its 16-year long mission. Amongst SORCE key results are the improved climate records of the total solar irradiance (TSI) and solar spectral irradiance (SSI) with the measurements from its instruments: TIM, SIM, SOLSTICE, and XPS. As recommended from the 2017 NASA Earth Science mission senior review, SORCE is being passivated (turned off) in January 2020 with the successful completion of overlapping the SORCE and Total and Spectral solar Irradiance Sensor (TSIS) missions. This session will highlight SORCE's achievements and lessons learned.

### *2. Recent/Space-Era Solar Cycles Timescales*

This session, spanning the "spacecraft era," is devoted to solar measurements and models covering the last few solar cycles. Abstracts relating to our current understanding of the quiet Sun are particularly welcome.

### *3. Solar Influence on the Atmosphere and Climate*

This session is devoted to the measured or modeled response of the Earth's atmosphere and climate to solar variability over the last few solar cycles.

### *4. Solar Variability and Climate Trends on Secular Times Scaless*

This session will discuss variability in the Sun and trends in climate records on long timescales. What have we learned about the ranges of total and spectral solar irradiance variability? What are the trends in proxies of solar activity and paleoclimate records, such as tree rings and cosmogenic isotopes, on multi-decadal to millennial timescales? What are the potential secular trends in the Sun based on stars? What are the associated impacts on Earth's climate that are estimated from these records?

### *5. Observational Predictions*

What are expectations for the next solar cycle and what are climate-change scenarios for the upcoming decades? What future measurements are expected to improve knowledge of Sun-climate connections?

### *6. A New Reference Spectra for Remote Sensing*

What solar spectra are being used by the model and remote sensing communities?

### *7. Looking Ahead – Future Observations of the Sun and Earth*

We will examine what is planned for the next generation of solar and terrestrial observations. We will also address new Sun and Earth observations, missions and implementation strategies for a next-generation observing system to meet the current and future challenges facing climate change studies.

### *8. Climate of the Desert Southwest*

This session is an opportunity for scientists to present their research on the climate attributes and recent trends unique to the Southwestern U.S. and in particular, the Arizona Sonoran desert. For example, changes in monsoon patterns, extreme events, and hydrology of the region are of particular interest.

## Confirmed Speakers (as of May 7)

The confirmed invited speakers listed below are in alphabetical order (not by session) and presentation titles are tentative. Abstracts will be posted online closer to the abstract deadline.

**Bo Andersen,** Norwegian Space Agency
*VIRGO, Solar Minimi and a Tribute to Claus Fröhlich*

**Don Anderson,** Johns Hopkins University, APL
*SORCE Programmatic History from a NASA Perspective*

**Robert Cahalan,** NASA GSFC, Retired
*SORCE Science History from the NASA Perspective*

**Christopher Castro,** Univ. of Arizona, Tucson
*Southwestern Climate and the Southern Arizona Monsoon*

**Serena Criscuoli,** Natl. Solar Observatory, Boulder, CO
*Models of Solar Spectral Irradiance Variability*

**David Crisp,** JPL / California Inst. of Technology
*The Impact of the TSIS-SIM Data on the OCO-2/OCO-3 Data Analysis*

**David Doelling,** NASA Langley Research Center
*The Importance of a Recommended Solar Spectra for the Satellite Remote Sensing Community as part of the GSICS Effort*

**Thierry Dudok de Wit,** Univ. of Orléans, LPC2E, France
*Response of Solar Irradiance to Sunspot-Area Variations*

**Parminder Ghuman,** NASA GSFC
*Earth Science Technology Office (ESTO) Invest*

**Brent Holben,** NASA GSFC
*AERONET Retrievals (NASA's Ground-based Satellite)*

**Lon Hood,** Univ. of Arizona, Tucson
*Top-Down Solar Influences on the Madden-Julian Short-Term Climate Oscillation and its Effects on Extratropical Weather and Climate*

**Philip Judge,** High Altitude Observatory, NCAR
*Overview: Stellar Activity and the Potential Behavior of the Sun over the Next Few Decades*

**Pradeep Kayshap,** Inst. of Physics, Univ. of South Bohemia, Ceske Budjejovice, Czech Republic
*Variability of Mg II Line in Quiet Sun and Coronal Hole*

**Judith Lean,** Naval Research Lab, Retired
*Sun-Climate Recent Results & Implications for the Future*

**Bob Meier,** George Mason University, Fairfax, VA
*GUVI / Solar Cycle Trends in the Integrated Solar EUV Energy Flux*

**Andrés Muñoz-Jaramillo,** Southwest Research Institute (SwRI), Boulder, CO
*Solar Cycle 25 Panel Predictions*

**Nuno Pereira,** Belgium Institute for Space Aeronomy
*Near Infrared Ground-based Spectrum*

**W. Dean Pesnell,** NASA GSFC
*How Good Can We Be at Predicting the Solar Cycle?*

**Karen Rosenlof,** NOAA Earth System Research Lab.
*Stratospheric Ozone Change and Its Influence on Climate*

**Gary Rottman,** LASP/University of Colorado, Retired
*SORCE Mission Highlights and Lessons "Forgotten"*

**Cornelius Csar Jude H. Salinas,** National Central University, Taoyuan City, Taiwan
*$CO_2$ Response*

**Werner Schmutz,** PMOD/WRC, Switzerland
*Updates on CLARA and PREMOS*

**Alexander Shapiro,** Max Planck Institute for Solar System Research, Goettingen, Germany
*Solar Variability over the Last Five Billion Years*

**Yolanda Shea,** NASA Langley Research Center
*CLARREO Pathfinder*

**Tom Stone,** USGS Astrogeology Science Center, Flagstaff, AZ
*The Need for a New Solar Irradiance Reference Spectrum in Lunar Irradiance Modeling, with a focus on GSICS Needs*

**Valerie Trouet,** Univ. of Arizona, Laboratory of Tree-Ring Research
*Reduced Caribbean Hurricane Activity during the Maunder Solar Minimum*

**Lisa Upton,** Space System Research Corp. (SSRC)
*Reconstructing Historical Sunspot Cycles with the Advective Flux Transport Model*

**Chi-Ju Wu,** Max Planck Institute for Solar System Research, Goettingen, Germany
*Long Term Cosmogenic Isotope Records*

## Location / Venue

**Tucson, Arizona** is most famous for its dramatic beauty! The Sonoran Desert covers this region with spectacular cacti – including the giant saguaro, a symbol of the American Southwest. They have captivated visitors for decades. To complement the legendary year-round sunshine and saguaro- and sunset-landscape, there are scenic mountain ranges surrounding the city. On the flip-side to itsr Old West heritage, Tucson offers a thriving visual and performing arts scene, not to mention the amazing restaurants (UNESCO designated City of Gastronomy). Once you immerse yourself in the laid-back atmosphere of Tucson, you may never want to leave!

We will be meeting at the ***Tucson Marriott University Park Hotel,*** a state-of-the-art full service conference facility near the University of Arizona campus.

## Logistics and Registration

Please visit the 2020 Sun-Climate Symposium website for logistical information, including maps and transportation options. Registration and lodging reservations will be available in June 2019.

http://lasp.colorado.edu/home/sorce/news-events/meetings/2020-scs/

***Please mark your calendar today to join us in January 2020 for this interesting symposium!***

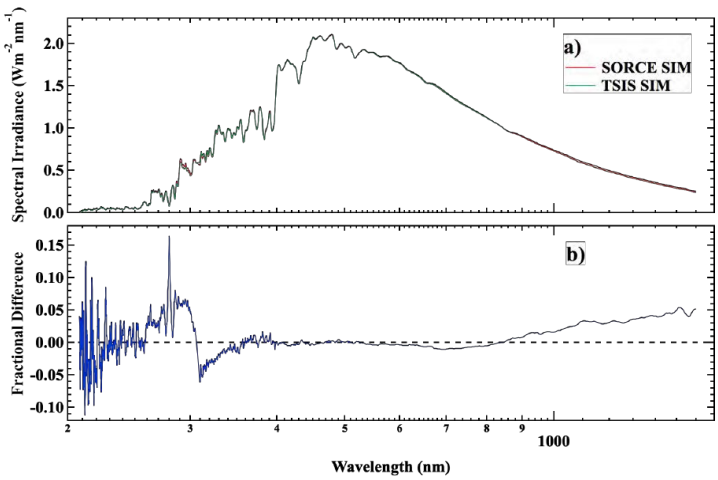
## *SORCE / TSIS Overlap –*

*By Stéphane Béland – LASP, University of Colorado*

An effort is underway, as part of the Solar Irradiance Science Team (SIST) NASA grant, to investigate the trend in the data from both TSIS and SORCE SIM instruments during the period of overlap between the two. The main goals of these efforts are:

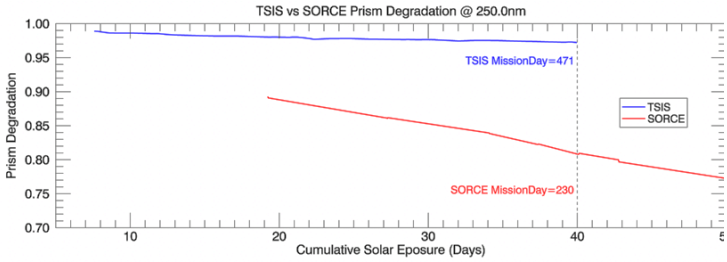
1. Identify the differences in absolute scale between the SORCE and TSIS SIM and take advantage of the high-fidelity absolute calibration of TSIS SIM to resolve the controversy of the absolute irradiance at 1.6-micron.
2. Estimate the SORCE and TSIS long-term stability over the full 200-2400 nm spectral range by applying a statistical methodology to analyze the differences in absolute scale, long-term drift, and potentially discontinuous jumps in the instrument irradiance scale.
3. Construct a Solar Cycle 23/24/25 irradiance composite from SORCE/TSIS/CSIM observations providing a valuable dataset with analytically derived stability estimates from a set of instruments with a common calibration and design heritage.

We currently have 262 concurrent spectra from TSIS and SORCE over 374 days covering the overlap period from 2018/03/14 to 2019/02/24. The top panel of the figure below shows the comparison between SORCE and TSIS spectral irradiance averaged over this time period. The lower panel shows the fractional difference between the spectra.




There is substantial agreement between the two instruments but also some notable differences.

- Integrated over 208-1600 nm, the two instruments agree to 0.6% (SORCE = 1214.57, TSIS = 1207.16).
- SORCE is systematically high by ~ 4% in the 260 to 300 nm range for the UV photodiode.
- Excellent agreement over 400-850 nm of ~0.3%.
- Infrared > 850 nm is systematically high and is attributed to inadequate calibration capabilities available during the time of the SORCE preflight calibration.




The figure above shows the amount of degradation seen in both TSIS and SORCE SIM at 250nm after 40 days of cumulative solar exposure on the primary channel. The extra efforts in the design and fabrication of TSIS to minimize the amount of potential contaminants have paid off as we are seeing a loss in transmission of about 3% compared to over 20% for SORCE SIM at that wavelength for the same amount of solar exposure.

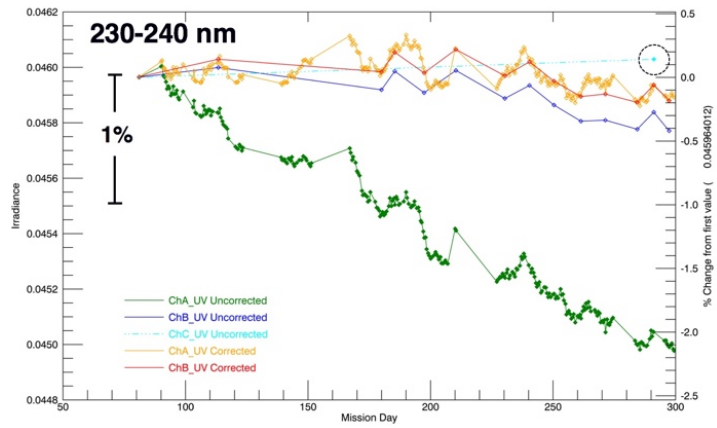
# *TSIS SSI Overview*

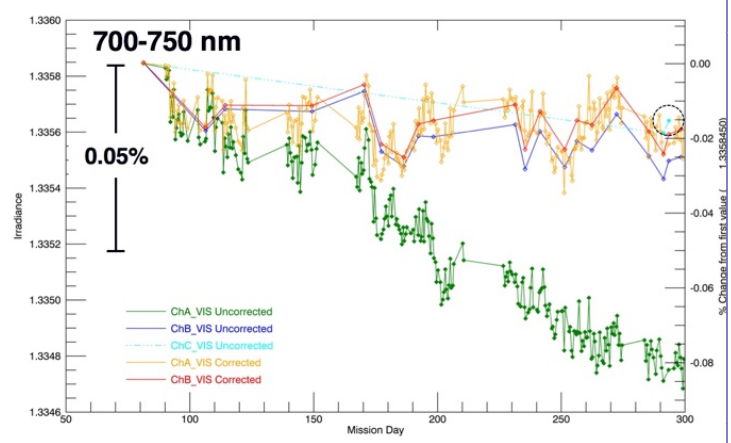
*By Erik Richard – LASP, University of Colorado*

On Sept. 17, 2018 we had our first TSIS SSI data release. It covered the first 6 months since the start of normal operations on March 14; released data included through Sept. 12. At the time of this initial release, we did not have a SIM C calibration yet; that calibration scan was scheduled for the week of Oct. 2-5, around TSIS Mission Day 290. So all degradation corrections in the first release are based solely on SIMA-SIMB exposure calculations to correct spectral degradations. After the September 2018 data release we obtained our first SIM C calibration scan. This allowed us to validate the present SIMA-SIMB degradation corrections. The figure in the right column shows the first release of the TSIS SIM corrected irradiance data compared to the first SIM C irradiance values.

This is shown in the upper panel for a representative integrated UV region (230-240 nm) where we see the largest degradation due to solar exposure. SIM A uncorrected degradation is ~2% from first light values after 6 month of daily operations. The lower panel shows the Vis/IR integrated region from 700-750 nm where the SIM A channel has degraded only 0.08% due to exposure. After applying the degradation corrections based on the SIMA-SIMB calibrations, we are able to validate the corrected irradiances against the SIM C result. For the UV the corrected irradiance is within 0.2% of the SIM C value (circled). Inclusion of the SIM C calibrations that occur continue every 6-months will improve the degradation corrections applied to the final SSI product. For the 700-750 nm region the corrected SIM A irradiance agrees with the SIM C value (circled) to better than 100 ppm. Future data releases will incorporate SIM C calibrations as they are acquired.

As of March 2019, we have acquired the second operational SIM C calibration and are presently incorporating this into the second SIM data release scheduled for the end of May 2019.



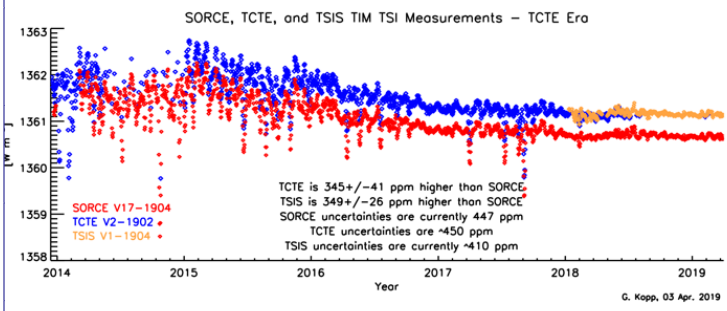

# *TSIS TSI Overview –*

*By Greg Kopp – LASP, University of Colorado*

The total solar irradiance (TSI) gives the net power driving the Earth's climate system. Variations in this radiant power from the Sun can thus cause climate change, so monitoring the TSI is critical for climate studies. The TSIS Total Irradiance Monitor (TIM) continues a 40-year-long space-based record of such measurements.

The TSIS/TIM acquired first light on 11 Jan. 2018, less than one month after launch. This instrument, a successor to the TIMs that are flying on the SORCE and TCTE missions, similarly uses four black cavities, each of which can absorb (and thereby quantify) the radiant power of incident sunlight. A precision aperture of known geometry in front of each cavity determines the area over which this sunlight is collected. The ratio gives radiant sunlight power per area, expressed for total solar irradiance (TSI) in W $m^{-2}$.

The SORCE/TIM established the now-accepted TSI value of 1360.5 W m$^{-2}$ representative of the 2008 solar minimum. The SORCE, TCTE, and TSIS TIMs show good agreement, with measurements from each being within their quoted uncertainties, as shown in the figure below. This and other TSI plots are updated regularly at: http://spot.colorado.edu/~koppg/TSI.




TSIS/TIM calibrations and data processing continue to be updated with on-orbit measurements. Version 1 of the TSIS/TIM Level 3 data provide daily and 6-hourly TSI values. These data are updated daily and available seven days in arrears for use in solar-variability and Earth-climate studies.

## SORCE / TSIS-1 / TCTE Update

The March-April issue of ***The Earth Observer,*** published by NASA, included an update on SORCE, TSIS-1, and TCTE in Steve Platnick's Editor's Corner. The four specific paragraphs start on page 3 in the left column (Some…) and go into the right column. It is a very nice summary! Visit:

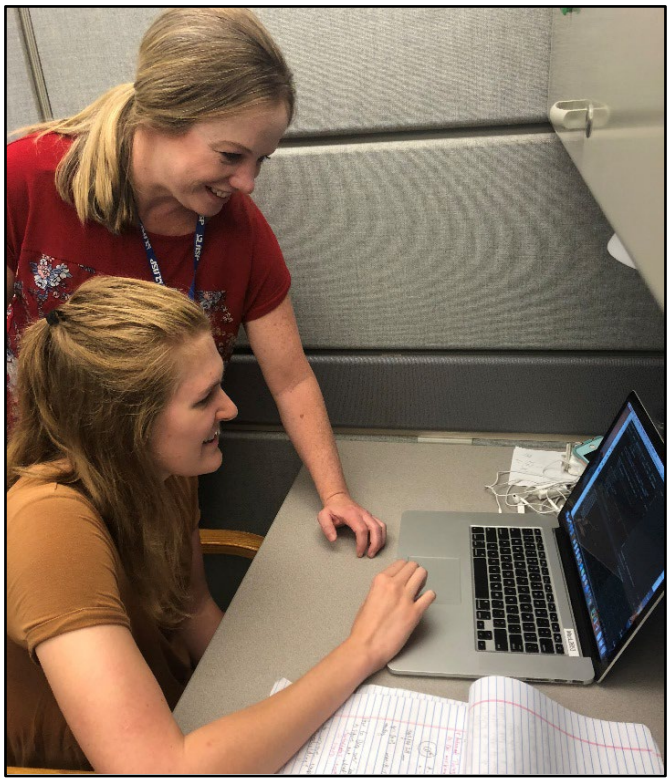
https://eospso.nasa.gov/earthobserver/mar-apr-2019

# *SORCE Selects Summer Undergrad Research Students –*

*By Marty Snow – LASP, University of Colorado*

Each summer, the SORCE mission funds student research projects in concert with the University of Colorado's Research Experience for Undergraduates (REU) program. For ten weeks (up from the 8 weeks in past years), 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.

This year the program will start the week of May 27th at LASP with a 1-week lecture series on Solar and Space Physics from experts in the field. The program will run through August 2nd, ending with a student symposium where the students present their findings. Marty Snow is the REU Program Organizer for the entire program which includes 21 REU students working interesting solar and space physics projects in several Boulder locations.



2018 REU mentor Laura Sandoval (LASP) helps one of the students analyze data.

For 2019, three SORCE-related projects were selected for the REU program. The project title, mentors, and the REU student selected are:

- ***Comparison of solar irradiance variability from ground and space-based observatories***
  Mentors: Serena Criscuoli (NSO) and Marty Snow (LASP)
  REU Student: Matt Kalscheur, University of Wisconsin-Madison
- ***Solar spectral irradiance: calibration and comparison***
  Mentors: Steve Penton, Stéphane Béland, and Marty Snow (LASP)
  REU Student: Joel Tibbets, Grinnell College
- ***P-SOLSTICE: solar inputs for planetary missions***
  Mentor: Josh Elliott (LASP)
  REU Student: Emma Lieb, Univ. of Colorado Boulder

## *Upcoming Meetings / Talks –*

*SORCE scientists will present papers or attend the following 2019-2020 meetings/workshops:*

**2019**

Solar Cycle 25 Prediction Panel, March 7, Boulder, CO
Boulder Solar Day, March 12, Boulder, CO
Earth Science Data System Working Group (ESDSWG), March 19-21, Annapolis, MD
Space Weather Workshop, April 1-5, Boulder, CO
European Geosciences Union (EGU), General Assembly, April 7-12, Vienna, Austria
AAS/ SPD, June 9-13, St. Louis, MO
GEM Workshop, June 25, Santa Fe, NM
Space Climate 7 Symposium, July 8-11, Canton Orford, Quebec County, Canada
IUGG General Assembly, July 12-18, Montreal, Canada
Solar Irradiance Science Team Meeting, Sept. 24-25, Gaithersburg, MD
AGU Fall Meeting, Dec. 9-13, San Francisco, CA

**2020**

**Sun-Climate Symposium, Jan. 27-31, Tucson, AZ**