TSIS / SORCE News

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

Sept. – Nov. 2020

TSIS-1 Update –

By Tom Woods and Tom Patton – LASP, University of Colorado

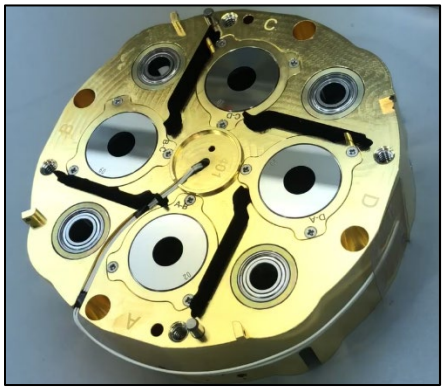
TSIS-1 operations aboard ISS continue to be normal, although solar observations have occasionally been impacted by ISS routine activities. Some of these ISS activities that affect data coverage for TSIS-1 observations occur regularly every month (reboost, Dragon undocking, etc.). For the August-October 2020 period, despite the challenges presented while operating on the ISS, TSIS-1 still managed to collect 93.5% of the available 24-hour data products."

TSIS-2 Update –

By David Gathright and Erik Richard – LASP, University of Colorado

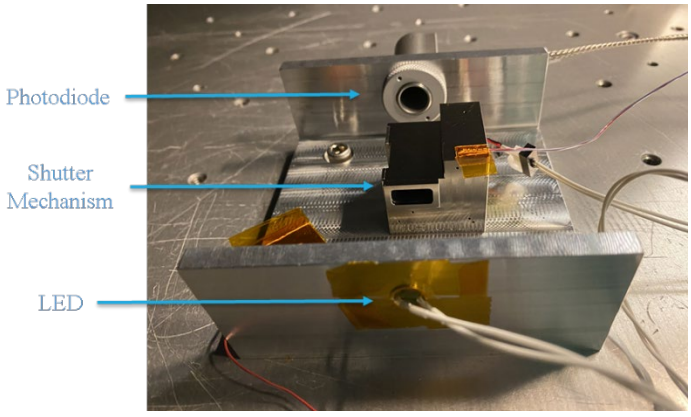
LASP is in full-swing designing and building the two sensors – Total Irradiance Monitor (TIM) and Spectral Irradiance Monitor (SIM) for TSIS-2, a successor to TSIS-1. The TSIS-2 instruments, which are near clones of the TSIS-1 instruments, passed their Heritage / Preliminary / Critical Design Review (the "triple review") at LASP in January 2020. Since then, the LASP team has been hard at work on building the instrument sensors and their companion Generic Channel Interface (GCI) electronics. The TSIS-2 payload will also include the TSIS-1 flight spare Fine Sun Sensor (FSS, serial number 007).

The TSIS-2 TIM instrument shutter housing with the precision apertures installed just returned from a critical aperture area measurement performed at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. This aperture area measurement is one of a number of tests and analyses performed to determine the overall accuracy of the instrument. LASP is also busy fabricating and testing other components of the TSIS-2 TIM instrument including the detector cones, detector head electronics board, and instrument case.



TSIS-2 TIM shutter housing with precision apertures installed.

Some components for the TSIS-2 SIM instrument were inherited from a "witness" instrument which began fabrication during the TSIS-1 development. The SIM team at LASP has been working hard at fabricating the rest of the SIM components and has begun testing subassemblies including the CCD, ESR/7.1 volt reference, and the three shutter motors. A full run-in of the three shutter mechanisms was successfully completed this summer, readying those elements for integration into the next higher-level assembly. For this run-in test, each shutter mechanism was installed in a fixture inside one of LASP's thermal vacuum test chambers. An LED and photodiode were used to determine the shutter motor performance, along with the shutter actuation voltage.



TSIS-2 SIM Shutter Mechanism Run-In Test setup.

The instruments are on schedule to start initial pre-environmental calibrations in late 2021 (SIM) and early 2022 (TIM).

The TSIS-2 mission was established by NASA Headquarters and directed to GSFC. In July of 2020, GSFC awarded General Atomics-Electromagnetic Systems Group the contract to build the TSIS-2 spacecraft and provide 3

years of on-orbit mission operations. The TSIS-2 spacecraft will be integrated in GA's Centennial, CO spacecraft development facility. Since that award, GSFC, GA, and LASP have been working to fill in the details for the project and are currently working toward mission-level PDR.

The TSIS-2 instruments will collect the most detailed solar irradiance measurements to date of how much radiation the Sun emits, continuing the 40+ year Total Solar Irradiance (TSI) and 17+ year Spectral Solar Irradiance (SSI) record.

SORCE Phase F Update –

By Laura Sandoval – LASP, University of Colorado

After 17 years of observations the NASA's Solar Radiation and Climate Experiment (SORCE) was commanded into a planned passivation state in February 2020. Since then the team has been busy working on the final documentation, software, and data products as part of the Phase F data archiving activities. SORCE SSI and TSI data products and version documentation are on schedule for delivery to the NASA GES DISC in December 2020. This includes TIM V19, SIM V27, SOLSTICE V18, and XPS V12 (more on this later in the newsletter); combined SSI data product; SIM data product with TSIS-SIM absolute flux re-calibration; and high-cadence Lyman-alpha and MgII SOLSTICE data products. Additionally, the team will deliver post-launch Algorithm Theoretical Basis Documents (ATBDs); Science Data Products Guide; Science Data Product Software, Data Product Validation Documentation and Software Tools; Peer Review Reports; Lessons Learned; and a final Mission Operations Report. Nice work everyone involved in wrapping-up this outstanding mission!

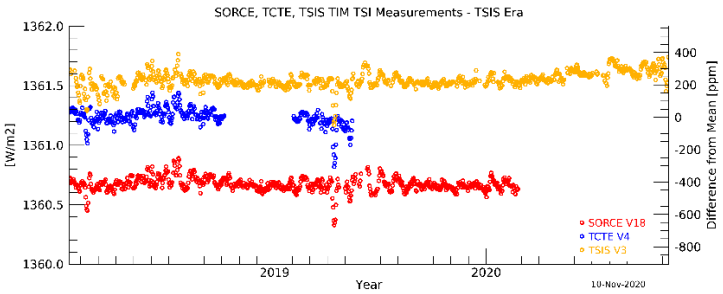
As always, the latest SORCE datasets are available at:
LISIRD http://lasp.colorado.edu/lisird/sorce/
SORCE http://lasp.colorado.edu/home/sorce/data/
NASA https://disc.gsfc.nasa.gov/datasets?keywords=SORCE&page=1

Final SORCE Data Releases

By Stéphane Béland, Brandon Stone, Mike Chambliss, Steven Penton, Joshua Elliott – LASP, University of Colorado

TIM – Version 19

SORCE TIM V19 is in the final processing steps and should be publicly available by the end of November. Notably, Version 19 has updated servo gain calibration and cavity degradation calibration, along with data quality improvements. The release notes are at: https://lasp.colorado.edu/home/sorce/data/tsi-data/tim-tsi-release-notes/.



Total Solar Irradiance as measured by SORCE, TCTE and TSIS-1 TIM instruments since the start of the TSIS-1 mission. The absolute TSI values are within each instrument's uncertainties.

SIM – Version 27

Version 27 (V27) of the SORCE-SIM calibrated spectral irradiances, the final project data release, was released on November 9, 2020. V27 includes improved diode temperature and degradation corrections, and updated prism degradation corrections. New features in this release are a spacecraft-pointing irradiance correction (Fig. SIM-1), a two epoch, time-dependent, IR channel temperature correction (Fig. SIM-1), and the inclusion of irradiance uncertainties and data quality. See Figure SIM-2 for a comparison of the integrated SSI to SORCE-TIM V19. SORCE-SIM Release notes can be found at: https://lasp.colorado.edu/home/sorce/instruments/sim/sorce-sim-data-products-release-notes/. Current work is focusing on providing a new data product with a TSIS-SIM absolute flux calibration.

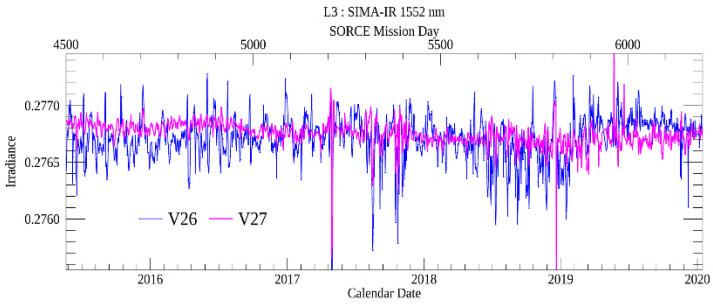


Figure SIM-1: V27 (pink) irradiance at 1552 nm (IR diode) versus V26 (blue). The V27 pointing ("roll") correction greatly reduces outliers. The V27 IR two-epoch temperature correction (breakpoint at SD5685) greatly improves irradiance measurement stability.

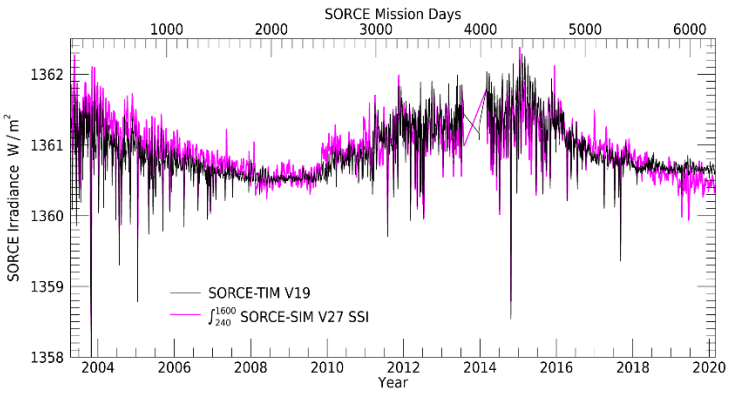
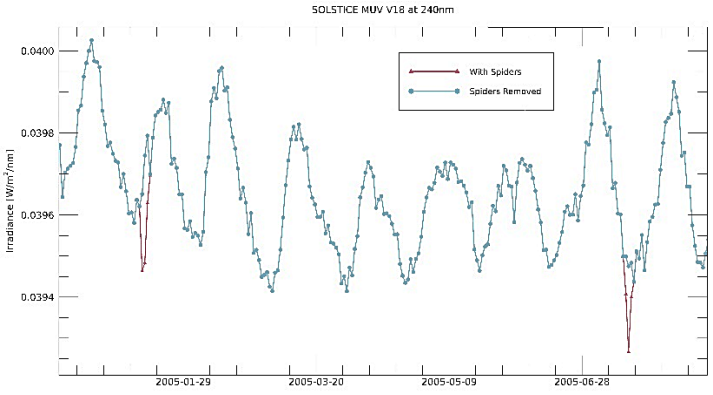


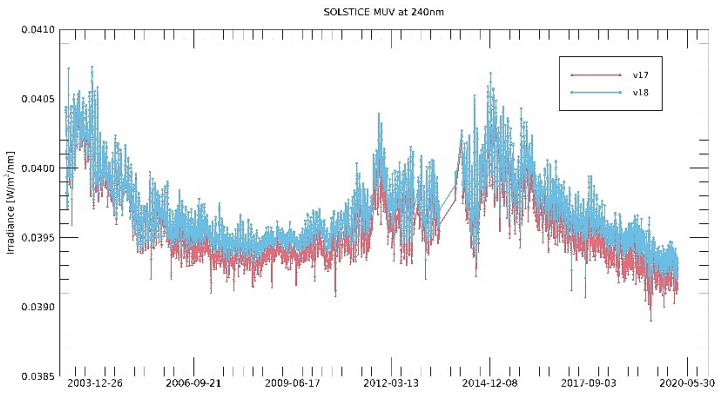
Figure SIM-2: SORCE-TIM V19 compared to Integrated SORCE-SIM V27 (240—1600 nm). The SIM values were adjusted to align during the C24-C25 solar minimum.



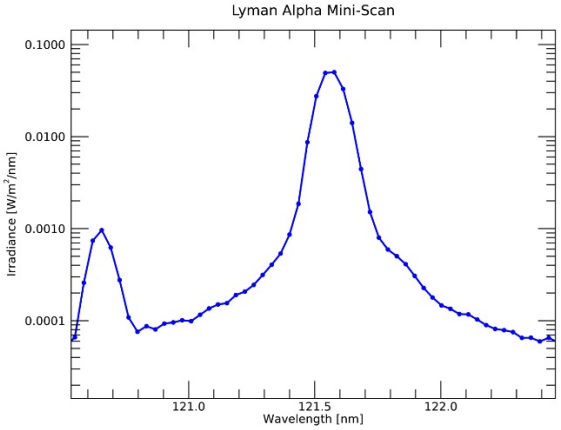
The SOLSTICE "spiders" correction is shown above. The data from SOLSTICE V17 (shown as red triangles) were affected by a systematic error occurred several times throughout the mission resulting in artificially low irradiance values. This has been corrected in the final version 18 (shown in cyan circles).

SOLSTICE – Version 18

SORCE SOLSTICE Version 18 will be released in December 2020, replacing Version 17. This version will include a new product derived from SOLSTICE data, a Lyman-alpha high cadence scan product. In addition, the Magnesium II index product has been broken into a per-scan version and a daily average version. We have implemented a new temperature correction, as well as a correction for systematic differences between "up" and "down" scans that occurs between scans collected when the grating drive is moving in each respective direction, a dark-counts calibration update, and an integration time fix. In addition, we fixed several systematic artifacts that occurred during the mission, involving an artificial apparent dip in brightness that we refer to as "spiders". An updated SOLSTICE A to SOLSTICE B cross-calibration has also been included in the final data product.



SOLSTICE V18 (cyan) compared to V17.

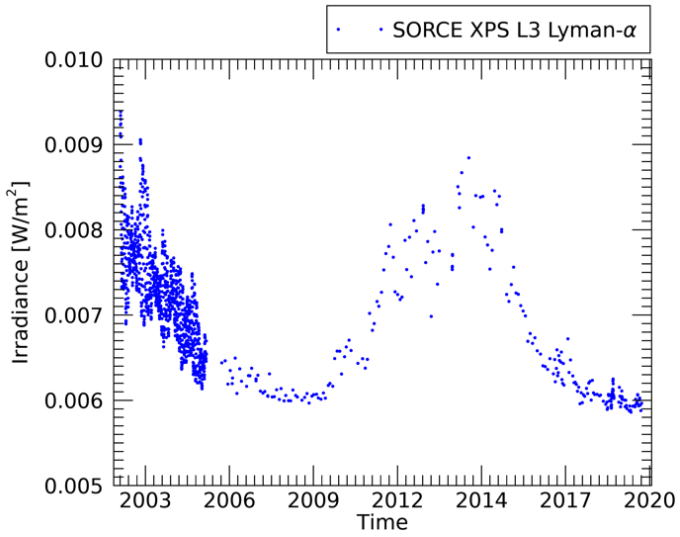


The new Lyman-alpha mini-scan product includes the full temporal and spectral resolution of each scan taken over the life of the mission. One such scan is shown above.

The release notes will be found at the following website: https://lasp.colorado.edu/home/sorce/instruments/solstice/solstice-data-product-release-notes/.

XPS – Version 12

Version 12 has recently been released for SORCE XPS Level 3 data products, replacing V11. There are several improvements in XPS Version 12 for the trending of the sensor dark and visible signals over the mission, as well as improved degradation corrections over the mission using the final in-flight calibration data with redundant channels in January-February 2020.



SORCE XPS Lyman-alpha with improved degradation.

This final version for the XPS data archive also includes updated solar spectral models for the XPS Level 4 product. These XPS Version 12 data will be available soon from the SORCE data site at: https://lasp.colorado.edu/home/sorce/data/.

Marty Snow Going to SANSA–

After a 32-year career at CU/LASP, Marty Snow has accepted an offer to be the Research Chair in Space Weather for the South African National Space Agency (SANSA). His new position is located in Hermanus, SA with a start date of April 1.

This is an exciting opportunity for Marty to continue in one of the many areas he excels at – mentoring undergrads, grad students, and postdocs. Marty has been the PI of the hugely popular Research Experience for Undergraduates (REU) NSF program for the last 14 years, exposing students to the world of solar and space physics. He will also be doing outreach work for SANSA, educating the public on solar physics, as well as building international collaborations. And good news for his current colleagues – Marty will continue working on TSIS, SORCE, and GOES EXIS data remotely through his new position, with plenty of students and postdocs to help him.

Marty started at CU/LASP as a PhD student in 1989 under Jack Brandt in the Astrophysical, Planetary, and Atmospheric Science (APAS) Department, graduating in 1995. As a grad student he worked on stellar astronomy using the Hubble GHRS and on comet tails. He was hired full-time at LASP to work on calibration and analysis of SOLSTICE data from the UARS mission. One of Marty's many contributions to science since getting his PhD includes his work on providing the most accurate long-term solar spectral irradiance data base in the FUV and MUV from UARS and SORCE, focusing on Lyman-alpha and the Mg II index. We deeply appreciate his dedication to the UARS, SORCE, TSIS, and GOES projects and his many scientific results from those mission data sets. It has been fun working with you, and we look forward to our future collaborations.

We wish him the best in his next adventure! Hermanus is in a beautiful area of the world and he and his wife will surely enjoy the mountains, ocean, and wildlife (lots of whales and penguins!). We'll miss you Marty.

Elizabeth Weatherhead to Head the 2022 National Climate Assessment –

As reported in the *Washington Post* on Nov. 4, atmospheric scientist Elizabeth Weatherhead has been selected to lead the next National Climate Assessment, a federal climate change report due out in 2022. This key climate review, last updated in 2018, is the federal government's most definitive and comprehensive report on climate change and its consequences for the US.

Dr. Weatherhead is an expert in climate change – forecast verification and model analysis. Her environmental statistics techniques are used world-wide in assessing environmental trends, particularly in the context of long-term changes. Formerly with CU/CIRES and currently with Jupiter Intelligence, she will work through the U.S. Geological Survey collaborating with other federal agencies, as well as private industry, to oversee this study. Betsy genuinely appreciates the value of climate information which has her collaborating with economists regarding weather and climate in today's world.

Betsy is a co-investigator with the "SORCE/TSIS Overlap Analysis: Absolute Scale Comparison, Stability Estimates, and Cycle 23/24/25 Record Construction" project, which is part of NASA's Solar Irradiance Science Team (SIST). As an internationally recognized expert on the analysis of overlapping geophysical data sets, she has developed computer code that has been adapted to analyze the full spectral overlap between SORCE and TSIS. Her ability to extract meaningful uncertainties from data sets has helped the team to further explore SORCE and TSIS intercomparisons.

Retirement News–

After almost 18 years at LASP, Vanessa George is retiring in early January 2021. Vanessa was hired a year before the 2003 SORCE launch to help out with general communications, writing, editing, proofreading, meeting and event coordination, miscellaneous reports, and to fill-in wherever needed.

From Vanessa, "This is bittersweet as I eagerly look forward to my next chapter in life. Getting this position at LASP opened up a whole new world to me (science!) and I was able to use my skills, learn a lot, and have a ton of fun! I will miss all of the great people in the solar community I've worked with – within CU/LASP and beyond."

The SORCE and TSIS science teams and the broader Sun-Climate community have all greatly benefited from her many contributions for these NASA missions through her newsletters, paper and report editing, and organization of the Sun-Climate Symposiums. These science conferences have brought together sun-climate researchers from all over the world. We have had 13 of these Sun-Climate Symposiums under her leadership, and she is laying the foundation for the next one to be in spring 2022 in Madison, WI. Vanessa's excellent organization of them, including finding interesting places for the meetings, and her lively and friendly personality have made these symposiums the most enjoyable meetings to attend every year. We thank you Vanessa for all that you have done for our projects, LASP, and the solar irradiance community. We wish you a long and enjoyable retirement with many fun adventures.

2020 AGU – Atmospheric Sciences

Dec. 1-17, 2020
https://www.agu.org/Fall-Meeting

The format of this year's AGU Meeting is totally virtual, but it promises to be just as interactive as previous years. The entire AGU science program is available at: https://www.agu.org/Fall-Meeting/Pages/Schedule-Program/Scientific-Program. Below are the session details for one particular session you won't want to miss! Please register and join us!

Fall AGU Session A237
Sunset of SORCE, Sunrise of TSIS: sun-climate changes over two solar cycles

Conveners: Tom Woods and Odele Coddington, LASP/Univ. of Colorado;
Jae Lee and Dong Wu, NASA/GSFC

Website:
https://agu.confex.com/agu/fm20/prelim.cgi/Session/103629

The **Oral Session A237** is on Wed., Dec. 16, 9:30-10:30 am (MT) and it is a 1-hour Question & Answer (Q&A) period. Each oral presentation is a 15-minute pre-recorded video that attendees are expected to watch before the Q&A period. During the 1-hour Q&A period, each oral presenter will have an opportunity to give a short (3 min.) overview. This will be followed with a 1-minute Q&A. Following the oral presentations for Session A237, there will be a general (open-microphone) Q&A period during the second half of the Q&A session.

Oral presentations in Session A237 include:

Erik Richard (invited), *SSI Measurements during Solar Minimum and into SC25: TSIS-1 SSI overlap with SORCE and CSIM-FD SSI*

Martin Snow, *Highlights from 17 years of SORCE SOLSTICE Observations of the Solar UV Irradiance*

Xianwen Jing, *Direct influence of SSI on the high-latitude surface climate: a surface radiation budget perspective*

Elizabeth Weatherhead, *Stability of Satellite Observations*

Greg Kopp (invited), *Changing of the Guard for TSI*

Jean-Philippe Montellet, *A New Methodology to Process the TSI observations using Machine Learning and Data Fusion*

Nicola Scafetta, *Modeling Quiet Solar Luminosity Variability from TSI Satellite Measurements and Proxy Models from 1980-2018*

Thierry Dudok de Wit, *1/f noise in irradiance records affects our understanding of trends in solar radiative forcing*

Samuel Amdur, *Using Bayesian hierarchical modeling of TSI to estimate uncertainty in solar forcing since the pre-industrial*

Theodosios Chatzistergos, *Reconstructing solar irradiance from Ca II K observations*

With the virtual format, the Session A227 **Poster Session** is on Wed., Dec. 16 over a 17-hour period (5 am-10 pm MT). There will be opportunities to chat with the poster presenters during that time, and we are also planning a focused time to chat for 8-9 am MT.

Poster presentations in Session A227 include:

Stephane Beland, *SORCE and TSIS comparison: absolute scale reconciliation*

Odele Coddington, *Development and Validation of the TSIS-1 Hybrid Solar Reference Spectrum (HSRS)*

Peter Breslin, *Time Analysis of the SORCE and TSIS similaritY (TASTY)*

Jae Lee, *Solar Diurnal Tide in the Mesosphere: Seasonality and Interannual variations as Observed by Aura/MLS and TIMED/SABER*

Dong Wu, *Interannual Variations of TOA Albedo over Arctic, Antarctic and Tibetan Plateau n 2000-2019*

Greg Kopp, *Historical Solar Irradiance Using the Updated Sunspot Record*

Gary Chapman, *The Effect of Sunspot Umbrae on the TSI*

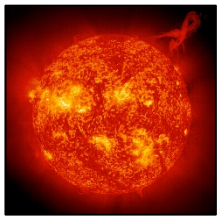
Debi Prasad Choudhary, *Four Solar Cycle Spectrum Variation of the Sun-as-a-Star*

Tom Woods, *An Improved SSI Composite Record*

Laura Sandoval, *NASA's SORCE Final Data Products of Solar Irradiance from 2003 to 2020*

Steven Penton, *End-of-Mission SORCE-SIM Data Release Improvements*

Joshua Elliott, *The Final SORCE SOLSTICE and XPS Calibrations and Data Products*



AGU Session Summary:

The 11-year solar cycle is now heading into cycle 25, and the minimum between cycles 24 and 25 appears to have occurred in late 2019 – early 2020. The magnitude of the Sun's irradiance, the solar cycle 24 variations, and the long-term variations between this recent minimum and the last cycle minimum in 2008-2009, are key inputs for atmosphere and climate modeling, energy balance modeling, and remote sensing for NASA's Earth Observing System. The NASA Solar Radiation and Climate Experiment (SORCE) mission ended on February 25, 2020 after completing more than 17 years of excellent observations of the total solar irradiance (TSI) and spectral solar irradiance (SSI) between 1 nm and 2400 nm. The new NASA Total and Spectral solar Irradiance Sensor (TSIS-1) observations began in early 2018 to continue the four-decade-long TSI climate data record, as well as continuing the SSI 200-2400 nm climate data record that SORCE initiated for the 400-2400 nm range. These TSI and SSI measurements, as well as those from the NASA Ozone Monitoring Instrument (OMI) and a couple of European Space Agency missions, are crucial observations for understanding the variations during the past two solar cycles and for the potential discovery of any secular trending between the two cycle minima in 2008-2009 and 2019-2020. This AGU session has presentations about solar variability measurements, causes, and models and their contributions to Earth-climate studies.

2020 Sun-Climate Symposium–

A summary of the 2020 Sun-Climate Symposium (Tucson, AZ, Jan. 2020) published by *The Earth Observer* in its July-August 2020 issue has been re-posted to the Symposium website: https://lasp.colorado.edu/home/sorce/news-events/meetings/2020-scs/.

Upcoming Meetings / Talks

With COVID-19 upon us, some of the meetings below are becoming virtual gatherings, postponed or canceled. TSIS/SORCE scientists are planning to present papers or attend the following 2020-2022 meetings/workshops:

2020-2021

AGU Fall Meeting (virtual), Dec. 1-17, 2020

International Radiation Symposium (IRS), Thessaloniki, Greece – June 14-18, 2021

New Developments and Applications in Optical Radiometry (NEWRAD), Boulder, CO – postponed to June 28-July 1, 2021 (tentative)

SDO Science Workshop, Vancouver, Canada – postponed to summer 2022 (virtual meeting will be held in 2021)

Whole Heliosphere and Planetary Interactions (WHPI) Workshop, Boulder, CO – postponed to 2021, date TBD

Sun-Climate Symposium – to be held in late spring 2022 (instead of Oct. 2021 as originally planned)