TSIS / SORCE News

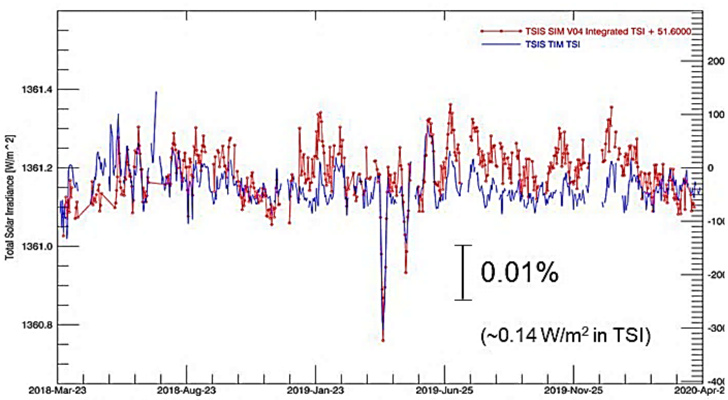
Total & Spectral Solar Irradiance Sensor / Solar Radiation & Climate Experiment

July-August 2020

TSIS-1 Update –

By Tom Woods – LASP, University of Colorado

TSIS-1 operations aboard ISS continue to be normal and we are happy to report that operations have continued with minimal impact from the COVID-19 pandemic. Scientists are anticipating that Solar Cycle 25 activity will be taking off soon, but solar activity is still low and at a similar level as the solar cycle minimum irradiance level in 2019.



TSIS-1 TSI comparison – TIM and SIM. Time series plot covering 23 March 2018 to 26 April 2020.

TSIS-2 Update –

By Erik Richard – LASP, University of Colorado

In preparation for a 2023 launch, GSFC has awarded the TSIS-2 spacecraft contract to General Atomics Electromagnetic Systems Group of San Diego, California. Unlike TSIS-1 on the International Space Station, TSIS-2 will be a free-flyer mission much like its predecessor, SORCE.

General Atomics is responsible for developing and testing the core spacecraft for TSIS-2; integrating the primary instrument into the observatory; and providing the functional, performance and environmental testing of the observatory. They will ship the spacecraft to the launch site and support launch operations, in-orbit performance verification, and operations of the mission operations center for three years, through the decommissioning of the TSIS-2 spacecraft. For the full NASA press release, see: https://www.nasa.gov/press-release/nasa-awards-total-and-spectral-solar-irradiance-sensor-2-spacecraft-contract.

SORCE Update –

By Laura Sandoval – LASP, University of Colorado

The SORCE contract has been extended to July 2021 due to COVID-19 delays in producing the final data products and Phase F documentation. We plan to have the SORCE SSI and TSI data products at GSFC by Dec. 2020. The final documentation and data products include:

Documentation and Software:

- Algorithm Theoretical Basis Documents (ATBDs with post-launch updates)
- SORCE Science Data Products Guide
- Version Release Notes
- Science Data Product Software, Validation, and Software Tools
- Peer Review Reports
- Lessons Learned
- Mission Operations Final Report

Data Products:

- TIM – Version 19, Level 3
- SIM – Version 28, Level 3
- SOLSTICE – Version 19, Level 3
- XPS – Version 12, Levels 3 and 4
- Combined SSI Data Product
- SIM Data Product with TSIS-SIM Absolute Calibration
- High-cadence Lyman-alpha and MgII SOLSTICE Data Products

The latest SORCE datasets are currently 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

FISM – Version 2 (FISM2)

By Phil Chamberlin – LASP, University of Colorado

Phil Chamberlin from CU/LASP recently released Version 2 of his **Flare Irradiance Spectral Model** (FISM2). FISM was originally released in 2005 (Chamberlin, Woods, and Eparvier, *Space Weather,* 2007, 2008), and FISM2 offers improved key features, such as: 1) more accurate modeling of spectral irradiance variations due to the solar cycle, solar rotation, and solar flares; 2) fills temporal, from 1947-present, and spectral, from 0-190 nm, gaps in the measurements of SORCE/XPS, SDO/EVE, and SORCE/SOLSTICE up to 190 nm and at 0.1 nm bins;

and 3) a much improved solar ultraviolet irradiance model over the first version released more than 15 years ago.

FISM2 still consists of both 'Daily' and 'Flare' products, where the 'Daily' is a single spectrum for the day from 1947-Present, the 'Flare' product is from 2003-Present at 60 second cadence, which can be extended down to 1981 upon request. FISM2 has been upgraded to 0.1 nm spectral bins and is available in the full spectral range from 0.01-190 nm. To be more compatible with many Ionosphere and Thermosphere models, such as WACCM/WACCM-X and TIME-GCM, two other daily and flare data products are being released already in "Stan Bands" wavelength binning (Solomon & Qian, 2005).

FISM2 incorporates more accurate, higher cadence measurements that have become available since the original FISM release. These new base data sets include:

0-6 nm:	SORCE / XPS, Level 4, V11
6-105 nm:	SDO / EUV Variability Experiment (EVE), Level 2, V06
115-190 nm:	SORCE / SOLSTICE, Level 3, V15

FISM2 is available now and open to all, while FISM1 will no longer be served or supported. There are two methods to get the FISM2 results as well as the detailed descriptions of the four different products:

LISIRD:
http://lasp.colorado.edu/lisird/ (search for 'FISM2')

FISM/EVE:
http://lasp.colorado.edu/eve/data_access/evewebdata/fism/

The FISM2 paper preprint is currently in review: Chamberlin, P. C., et al., 2020, The Flare Irradiance Spectral Model – Version 2 (FISM2), *Space Weather,* https://www.essoar.org/doi/abs/10.1002/essoar.10503732.1.

Abstract: The Flare Irradiance Spectral Model (FISM) is an important tool for estimating solar variability for a myriad of space weather research studies and applications, and FISM Version 2 has recently been released. FISM2 is an empirical model of the solar ultraviolet irradiance created to fill spectral and temporal gaps in the measurements, where these measurements are infrequent as they need to be made from space due to their absorption in the planetary atmospheres. FISM2 estimates solar ultraviolet irradiance variations due to solar cycle, solar rotation, and solar flare variations. The major improvement provided by FISM2 is that it is based on multiple new, more accurate instruments that have now captured almost a full solar cycle and thousands of flares, drastically improving the accuracy of the modeled FISM2 solar irradiance spectra. FISM2 is also improved to 0.1 nm spectral bins across the same 0-190 nm spectral range, and is already being used in research to estimate space weather changes due to solar irradiance variability in planetary thermospheres and ionospheres.

Every effort was made to verify and validate the FISM2 model, but if there are any questions regarding access, data products, FISM2 estimations, or science issues please contact Phil at Phil.Chamberlin@lasp.colorado.edu.

Joan Feynman – In Remembrance

From American Physical Society (APS) News, By Leah Poffenberger

Joan Feynman, an astrophysicist known for her discovery of the origin of auroras, died on July 21. She was 93.

Joan Feynman at a SORCE Science Meeting in Keystone, Colorado -- April 2010.

Over the course of her career, Feynman made many breakthroughs in furthering the understanding of solar wind and its interaction with the Earth's magnetosphere, a region in space where the planetary magnetic field deflects charged particles from the sun. As author or co-author of more than 185 papers, Feynman's research accomplishments range from discovering the shape of the Earth's magnetosphere and identifying the origin of auroras to creating statistical models to predict the number of high-energy particles that would collide with spacecraft over time. In 1974, she would become the first woman ever elected as an officer of the American Geophysical Union, and in 2000 she was awarded NASA's Exceptional Scientific Achievement Medal.

Feynman's choice in pursuing a career as a scientist was often at odds with the expectations for women, especially the expectations for a wife and mother, but she persisted to become an accomplished astrophysicist. During the 2018 APS April Meeting, where Feynman spoke at the Kavli Foundation Plenary Session, she recalled her mother discouraging her childhood interest in science, calling "women's brains too feeble," likely a common belief at the time.

"Joan Feynman made important contributions to physics," said APS President Philip Bucksbaum. "Her work on solar wind and the earth's magnetosphere led to the discovery of the cause of auroras. She also developed a method to predict sunspot cycles. Her efforts in the geophysics community for fair treatment of women, together with her own example as a leader in solar physics, helped to change society's attitudes in the mid-20th century about the contributions that women can make in physics."

Born in 1927, Feynman grew up in Queens, New York, alongside her older brother Richard, nine years her senior, who would eventually become one of the world's most well-known physicists. He would become Joan's first teacher and someone who fostered her inquisitive nature, believing her capable of learning all the math and science he could teach her. In her 2018 talk, Feynman recounted early memories of solving math problems for the unique reward of getting to pull her brother's hair and serving as his "lab assistant" at the age of five. A late-night trip to the golf course near the Feynman family home to see an aurora inspired Feynman's curiosity and would eventually guide her research.

For her fourteenth birthday, Richard gave Feynman a copy of *Astronomy* by Robert Horace Baker, a college-level physics text, that both taught her about physics and what was possible: Feynman credited a figure attributed to Cecilia Payne-Gaposchkin for proving to her that women could indeed have a career doing science.

Feynman would go on to receive a bachelor's degree from Oberlin College, and she attended Syracuse University, studying condensed matter theory and earning a PhD in 1958. By 1960, Feynman was married with two children and, having not secured the kind of research position she was looking for, she decided to take a break from physics to take on the role of homemaker.

The break was short-lived, as Feynman grew depressed from the drudgery of keeping a home and caring for two small children. In 1962, at the advice of a therapist, she went in search of employment, securing 3 job offers at Columbia University's Lamont-Doherty Earth Observatory. At Lamont, where she worked part-time, Feynman began her research into Earth's magnetosphere, identifying its shape.

In 1971, Feynman accepted a job at the NASA Ames Research Center, where she developed a way to detect solar coronal mass ejections from the sun by searching for the presence of helium in solar wind. She would go on to hold positions at the High Altitude Observatory at the National Center for Atmospheric Research in Boulder, Colorado; the National Science Foundation; and Boston College. In 1985, Feynman accepted a position at the Jet Propulsion Laboratory (JPL) in Pasadena, California, where she would conduct research until her retirement.

As part of her research at JPL, Feynman identified the mechanism that leads to the formation of auroras and developed a statistical model to determine the number of high-energy particles expelled from coronal mass injections that would hit a spacecraft during its lifetime. After her retirement from a senior scientist position in 2003, Feynman continued to conduct research on the impact of solar activity on the early climate of the Earth and the role of climate stabilization in the development of agriculture.

"Joan Feynman leaves a legacy of exemplary scientific research, having made important contributions to our understanding of the solar wind, the earth's magnetosphere, and the origin of auroras," said APS CEO Kate Kirby. "Despite being discouraged to pursue science by women in her family, she persevered, and her accomplishments serve as an inspiration to women who wish to pursue a career in science."

Always quick to smile, Joan Feynman enjoying a SORCE Science Meeting field trip to the Lowell Observatory in 2011.

Joan Feynman will be remembered for her enthusiastic participation in the SORCE Science Meetings through the years. Just months after SORCE's launch in 2003, Joan attended her first SORCE Meeting in Sonoma, CA in December 2003. We were fortunate to have her join us at our latest meeting in Tucson, AZ, in January 2020. In Tucson she was acknowledged as part of an elite group who had attended 10 or more of our science meetings. Not only did we enjoy learning about Joan's new science results at these SORCE Science Meetings, we also got probing questions from her and interesting discussions that followed. We will miss her!

2020 AGU – Atmospheric Sciences

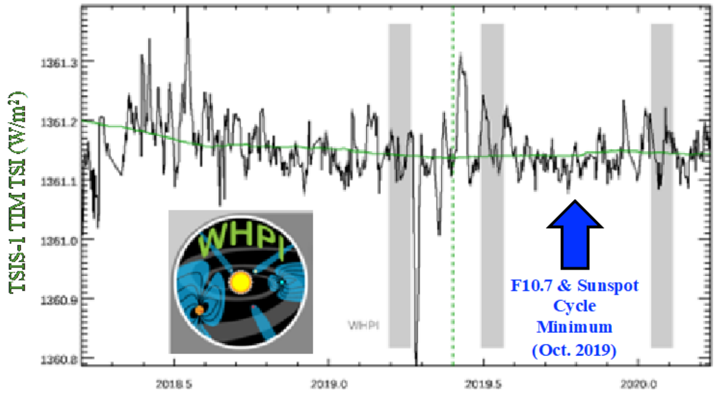
San Francisco, CA
Dec. 7-11, 2020
https://www.agu.org/Fall-Meeting
Early-Bird Registration: Oct. 30

TSIS and SORCE scientists have a session accepted for the 2020 Fall AGU Meeting, "Shaping the Future of Science." The format of this year's meeting in San Francisco, Dec. 10-14, is virtual, but it promises to be just as interactive as previous years. The final science program will be out in September. Please register and join us!

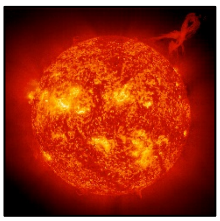
Fall AGU Session A102
Sunset of SORCE, Sunrise of TSIS: sun-climate changes over two solar cycles

Conveners: Tom Woods (primary) 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 solar cycle minimum for the solar variability indictors of the F10.7 and sunspot number appears to be in October 2019, whereas the TSI record from TSIS-1 TIM indicates a solar minimum earlier in 2019 for the 13-month smoothing (green line).



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. We solicit contributions on solar variability measurements, causes, and models and their contributions to Earth-climate studies.

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 2020-2021 meetings/workshops:

2020-2021

AGU Fall Meeting, San Francisco, CA (mostly virtual), Dec. 7-11, 2020

International Radiation Symposium (IRS), Thessaloniki, Greece – postponed to 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 June 28-July 2, 2021

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

Relax for your Labor Day holiday!

Or not…