

SNS • SORCE News Source



Solar Radiation and Climate Experiment Monthly Newsletter

January 2018

2018 Sun-Climate Symposium –

*The State of the TSI and SSI Climate Records
at the Junction of the SORCE and TSIS Missions*

Lake Arrowhead, California
March 19-23, 2018



The evening sunset on beautiful Lake Arrowhead.

Our focus topic for this 3.5-day meeting is “**Multi-Decadal Variability in Sun and Earth during the Space Era.**” Sponsors are the SORCE mission and the Sun-Climate Research Center – a joint venture between NASA GSFC and LASP at the University of Colorado.

Sessions and Presenters

Below are the six sessions and the speakers within each session. A detailed description of each session is on the meeting website. You will also find the individual abstracts on the meeting website.

Registration Due – Feb. 9

<http://lasp.colorado.edu/home/sorce/news-events/meetings/2018-scs/>

Tuesday, March 20

Symposium Kick-off Keynote

Peter Pilewskie and Tom Woods, LASP, Univ. of Colorado, Boulder

TSIS / SORCE Status Overview

Session 1. The creation, significance, and application of accurate CDRs

Bruce Wielicki, NASA Langley Res. Ctr., Hampton, VA
Designing the Climate Observing System of the Future

Alexei Pevtsov, Natl. Solar Observatory, Boulder, CO
Continuity and Preservation of Long-Term Synoptic Observations of the Sun

Serena Criscuoli, Natl. Solar Observatory, Boulder, CO
Properties of Magnetic Elements Derived from HMI Data Compensated for Scattered-Light

Andrés Munoz-Jaramillo, SwRI, Boulder, CO
Uncertainty, Under-counting, and Survey Inconsistency: Overlooked Issues while Working with Sunspot Area Data

John Bates, John Bates Consulting, Inc., Arden, NC
Climate Data Records – History, Status, and Future

Charles Ichoku, NASA GSFC, Greenbelt, MD
Potential of Satellite SSI Measurements in Ground-based Remote Sensing of Atmospheric Aerosols and Trace Gases

Ann Windnagel, Natl. Snow and Ice Data Center in CIRES, University of Colorado, Boulder
Sea Ice Concentration CDR at the National Centers for Environmental Information

David Kratz, NASA GSFC, Greenbelt, MD
TSI Data for the CERES CDR and the FLASHflux Environmental Data Record

Wenda Cao (special guest), Big Bear Solar Obs., CA
Big Bear Solar Observatory – Cool Toys for Observing Our Warm Star

Session 2. The state of the TSI and SSI climate records near the end of the SORCE Mission

Werner Schmutz, PMOD/WRC, Davos Dorf, Switzerland
PREMOS/PICARD TSI Data Version 2 and New TSI Absolute Value from First Light of CLARA/NorSat-1

Claus Fröhlich, Davos Wolfgang, Switzerland
Twenty-One Years of Total Solar Irradiance from VIRGO on SoHO

Greg Kopp, LASP, University of Colorado – Boulder
The TIM Trilogy

Thierry Dudok de Wit, LPC2E, CNRS and University of Orléans, France
Methodology for Creating a TSI Composite

Erik Richard, LASP, University of Colorado – Boulder
TSIS SIM Solar Spectral Irradiance: First Light and Early Observations

Natalie Krivova, Max Planck Inst., Göttingen, Germany
Update on the SATIRE Model

Romaric Gravet, LPC2E, CNRS & Univ. of Orléans, France
Observational Constraints on Irradiance Models in the UV

Mija Lovric, University of Rome, Tor Vergata, Italy
The Solar UV Spectral Slope during the Last 270 Years

Odele Coddington, LASP, Univ. of Colorado – Boulder
The NOAA/NCEI Solar Irradiance CDR: Recent Advances and Comparisons with Independent Datasets

Tom Woods, LASP, University of Colorado – Boulder
Decoupling Solar Variability and Instrument Trends using the Multiple Same-Irradiance-Level (MuSIL) Analysis Technique

Margit Haberreiter, PMOD/WRC, Davos Dorf, Switzerland
The New Observational Solar Spectral Irradiance Composite, Updates and Related Activities

Sergey Marchenko, SSAI and NASA GSFC, MD
Improved Long-Term Spectral Irradiance Record from Aura/OMI

Luc Damé, LATMOS, France
New Solar Reference Spectrum SOLAR-ISS and Variability from SOLAR/SOLSPEC – Nine Years of Observations of Solar Cycle 24

Wednesday, March 21

Session 3. Next generation of solar and atmospheric observations

Elizabeth Weatherhead, NOAA and CIRES, Univ. of Colorado – Boulder
Optimizing Climate Observations for Targeted Results

Jeremy Werdell, NASA GSFC, Greenbelt, MD
The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) Mission: Status, science, advances

Dave Diner, JPL, California Inst. of Technology, Pasadena
Multi-Angle Imager for Aerosols (MAIA): Observations, measurements, and science

Dave Harber, LASP, Univ. of Colorado – Boulder
The Compact SIM (CSIM) and Compact TIM (CTIM) Instruments

Bill Swartz, Johns Hopkins University/APL, Laurel, MD
The RAVAN CubeSat Mission: On-orbit results

Wolfgang Finsterle, PMOD/WRC, Davos Dorf, Switzerland
Absolute Radiometers on Upcoming TSI and Future EO Missions

Charles Kankelborg, Montana State University, Bozeman
A FURST Look at the VUV Sun as a Star

Candace Carlisle and David Considine, NASA GSFC and NASA Headquarters
Total and Spectral solar Irradiance Sensor (TSIS) NASA Project Status

Thursday, March 22

Session 4. Impacts of solar variability on the terrestrial environment during Solar Cycle 24

Lesley Gray, University of Oxford, United Kingdom
Impact of the 11-Year Solar Cycle at the Earth's Surface

Gabriel Chiodo, Columbia University, New York, NY
Logged Correlation between the NAO and the 11-Year Solar Cycle: Forced response or internal variability?

Jae Lee, Univ. of Maryland, Baltimore County, Baltimore, MD
Solar Cycle Variations in Mesospheric Carbon Monoxide

Dong Wu, NASA GSFC, Greenbelt, MD
Long-Term Variations in Terra/MISR Angular Radiance Differences: Solar or Aerosol Influences on Polar Cloudiness?

Shuhui Wang, JIFRESSE, Univ. of California, Los Angeles, CA
The 11-Year Solar Cycle Signal in Global NO₂ Measurements from NDACC Stations

Gavin Schmidt, NASA GISS, New York, NY
Improvements in Coupled Ocean-Atmosphere Model Responses to Solar Activity

Liang Zhao, IAP, Chinese Academy of Science, Beijing
Responses of the East Asian Monsoon to Solar Cycle

King-Fai Li, Univ. of Washington, Seattle; and Univ. of California, Riverside
Quasi-biennial Oscillation and Solar Cycle Influences on Arctic O₃ Simulated by the WACCM4 Model

Alexander Ruzmaikin, JPL, California Inst. of Technology
The Solar Influence on the Earth's Climate at the Centennial Time Scale

Robert Leamon, University of Maryland, College Park; and NASA GSFC, Greenbelt, MD
Terminators: The Death of Solar Cycles and La Niña 2020

Session 5. Stellar variability and connections to the Sun

Jeffrey Hall, Lowell Observatory, Flagstaff, AZ
The Variability of Sun-like Stars

Travis Metcalfe, Space Science Institute, Boulder, CO
Magnetic Evolution of Sun-like Activity Cycles

Federico Spada, Max-Planck Inst., Goettingen, Germany
Modeling Intrinsic Luminosity Variations Induced by Internal Magnetic Field in the Sun and in Solar-like Stars

Veronika Witzke, Max Planck Inst., Göttingen, Germany
Long-Term Brightness Variability of Sun-like Stars

Alexander Shapiro, Max Planck Inst., Göttingen, Germany
How Typical is the Sun as a Variable Star

Richard Radick, Natl. Solar Observatory, Sunspot, NM
Activity and Variability Patterns for the Sun and Sun-like Stars

Adam Kowalski, Natl. Solar Observatory and Univ. of Colorado, Boulder
Magnetic Activity and Flares in the Near-UV Exoplanet Host Stars

Nina-Elisabeth Nemec, Max Planck Institute, Georg-August-University; Göttingen, Germany
Solar Brightness Variations as they would be Observed by Kepler Telescope

Miha Černetič, Univ. of Ljubljana, Slovenia; and Max Planck Inst., Göttingen, Germany
Fast Spectral Synthesis for a New Generation of Solar and Stellar Brightness Variability Models

Eric Wolf, LASP and ATOC, Univ. of Colorado – Boulder
Climate and Habitability of Earth-like Extrasolar Planets

Gary Rottman (special dinner guest speaker), LASP, University of Colorado – Boulder
How the Sun abandoned the Incas during the Maunder Minimum

Friday, March 23

Session 6. What are the expectations for the next solar minimum and Solar Cycle 25?

Scott McIntosh, NCAR / HAO, Boulder, CO
140 Years of the "Extended" SC: Predictability, Expectations for SUNSPOT Cycle 25...

Paul Charbonneau, Dépt. de Physique, Université de Montréal, Canada
Mechanisms of Solar Cycle Fluctuations

Leif Svalgaard, Stanford University, Stanford, CA
Prediction of Solar Cycle 25

Frank Hill, National Solar Observatory, Boulder, CO
Solar Cycle Activity Related to Local & Global Helioseismology

Ken Tapping, Natl. Research Council, Penticton, BC, Canada
Solar Behavioural Changes as Identified Through Comparison of F10.7 with Other Indices: An Update

Dick Mewaldt, Cal. Institute of Technology, Pasadena
Galactic Cosmic Ray Intensities During the Space Age and the Holocene

POSTER Presentations (2 sessions):

Logan S. Bayer, BASIS Flagstaff Charter School and Lowell Observatory, Flagstaff, AZ
The Solar-Stellar Spectrograph: A 25-year Retrospective

Stéphane Béland, LASP, Univ. of Colorado – Boulder
Update to the Whole Heliosphere Interval (WHI) Reference Spectrum

Francesco Berrilli, University of Rome, Tor Vergata, Italy
Impact of Solar Activity on Thermospheric Density during ESA's Gravity Mission GOCE

Odele Coddington, LASP, Univ. of Colorado – Boulder (SIST)
How does the Sun's Spectrum Vary: A Summary of NASA SIST Research Activities

Angela Cookson, San Fernando Observatory, California State University, Northridge
The Future of Full-Disk Photometry at the San Fernando Observatory

Angela Cookson, SFO, Cal. State University, Northridge
SFO Solar Indices, Irradiance Variation, and New TSI Composite – an Update

Serena Criscuoli, National Solar Observatory, Boulder, CO
Comparing Radiative Transfer Codes for Synthesis of Solar and Stellar Irradiance

Luc Damé, LATMOS, IPSL/CNRS/UVSQ, Guyancourt, France
The SoSWEET-SOUP (Solar, Space Weather Extreme Events and Stratospheric Ozone Ultimate Profiles) Dual Constellation Mission

Matthew DeLand, SSAI and NASA GSFC, Greenbelt, MD (SIST)
Creation of the V2 Composite Solar Spectral Irradiance Data Set

Leonid Didkovsky, SSL, Univ. Southern Cal., Los Angeles
A Long-Term Dissipation of the EUV He II (30.4) Segmentation in the Full-Disk Solar Images

Thierry Dudok de Wit, LPC2E, CNRS and University of Orléans, France
Identifying and Extracting Undocumented Trends from Solar Irradiance Records

Thierry Dudok de Wit, LPC2E, CNRS and University of Orléans, France

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

Joshua P. Elliott, LASP, Univ. of Colorado – Boulder
High-Spectral Resolution SORCE SOLSTICE Degradation Model and Improved Irradiance Data Products

Wolfgang Finsterle, PMOD/WRC, Davos Dorf, Switzerland
A Concept for the Measurement of the Earth Radiation Imbalance

Claus Fröhlich, Davos Wolfgang, Switzerland
New Characterization of the PMO6V Radiometer of VIRGO/SoHO

Romarie Gravet, LPC2E, CNRS and University of Orléans, France
How can the Sun Explain the Correlations between CaII and H α Emissions of Stars?

Songyan Gu, National Satellite Meteorology Center, Beijing, China
Introduction to China FY-3 Satellite Plans and SSIM (Solar Spectral Irradiance Monitor)

Jerald Harder, LASP, University of Colorado – Boulder (SIST)
Construction of a SORCE-based SSI Record for Chemistry Climate Models

Jerald Harder, LASP, University of Colorado – Boulder
Morphology and Time Evolution of Dark Facular regions in Cycle 23 and 24

Cristoph Jacobi, PMOD/WRC, Davos Dorf, Switzerland
Earth Energy Imbalance Explorer (EAGER)

Andrew Jones, LASP, University of Colorado – Boulder
New Solar EUV Irradiance Measurements from GOES-16

Matthieu Kretzschmar, LPC2E, CNRS and University of Orléans, Orléans, France
An Empirical Model of the Variation of the Solar Lyman- α Spectral Irradiance

Mustapha Meftah, Université Paris Saclay, CNRS, LATMOS, Guyancourt, France
SOLAR/SOLSPEC Ultraviolet SSI Variability from 5 April 2008 to 15 Feb. 2017

Stergios Misios, University of Oxford, UK; and Aarhus University, Denmark
Observed and Modelled Influences of the 1-Year Solar Cycle on the Walker Circulation

Jin Qi, National Satellite Meteorological Center, Beijing, China
In-flight Performance of Solar Irradiance Monitor-II on-board FY-3C and its TSI data

Erik Richard, LASP, University of Colorado – Boulder (SIST)
Recalibration and Re-evaluation of the SORCE SIM Data Record

Laura Sandoval, LASP, University of Colorado – Boulder
The Latest SORCE-SIM Solar Spectral Irradiance Data Release and Initial Comparison with TSIS-SIM Measurements

Martin Snow, LASP, University of Colorado – Boulder
The Magnesium II Index: Continuing Progress on the Facular Proxy in the GOES-R Era

Martin Snow, LASP, University of Colorado – Boulder (SIST)
Solar Spectral Irradiance: Lyman Alpha, Magnesium II, and Sigma k proxiEs (SSIAMESE)

Ken Tapping, National Research Council, Penticton, BC, Canada
A Multi-Wavelength Solar Flux Monitor

Luis Eduardo Antunes Vieira, Instituto Nacional de Pesquisas Espaciais, São Paulo, Brazil
Estimate of the Solar Luminosity Variability for Cycles 23 and 24

Bob Weber, Lower Peninsula, MI
The Solar Cycle Influence: How TSI and Insolation Warm and Cool the Ocean

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

Jia Yue, Hampton University, Hampton, VA
Solar Cycle and Trend Global Gravity Waves Derived from 14 Years of SABER Temperature Observations (2001-2015)

UCLA Lake Arrowhead Conference Center

This venue is a state-of-the-art full service retreat facility on the north shore of beautiful Lake Arrowhead in southern California. Meeting attendees will enjoy the fresh air and 42 acres of beautifully forested terrain tucked in the San Bernardino Mountain foothills (5000 ft.). See: For more information, visit their website at:

<http://lakearrowheadconferencecenter.ucla.edu/>.



Logistics and Registration

Please visit the 2018 Sun-Climate Symposium website for logistical information, including maps and transportation options. Registration, which includes lodging, meals, and meeting services, is available now.

Registration Deadline: Friday, Feb. 9

For more information, CLICK 
<http://lasp.colorado.edu/home/sorce/news-events/meetings/2018-scs/>



Sunset over the San Bernardino Mountains in southern Cal.

SORCE Extended Mission –

Good news – we have been granted funding through 2019. All NASA Earth Science Missions submit proposals for senior review every two years. SORCE successfully completed its 5-year core mission (Jan. 2003-Jan. 2008) and is currently in its 11th year of its extended mission.



It has achieved its primary mission goal of measuring total solar irradiance (TSI) and solar spectral irradiance (SSI) in the 0.1-27 nm and 115-2400 nm wavelength ranges with unprecedented accuracy and precision. The main objectives of the SORCE extended mission are very closely aligned with the original SORCE mission objectives, but have a new focus on overlap with TSIS-1 and measuring solar activity in solar cycle 24.

The spacecraft battery is the most likely life-limiting factor for the SORCE Mission, so all efforts have been made to ensure that it stays as healthy as possible. Mission Ops has successfully devised methods for the satellite to run without batteries. With proper management of spacecraft resources, we are confident that making good quality solar irradiance measurements

will continue throughout the extended mission timeframe. Obtaining overlapping irradiance measurements with the TSIS mission is critical, so SORCE's extension is essential.

Peter Pilewskie – 2018 AMS Fellow

Congratulations to Peter Pilewskie on his induction into the 2018 class of American Meteorological Society Fellows. Peter's lifelong dedication to delivering outstanding science is recognized with this prestigious honor. Peter is an active, undisputed world-class expert in atmospheric radiation, and he has made important contributions to both atmospheric radiative transfer and remote sensing.



The awards were presented at the 98th AMS Annual Meeting in Austin, Texas, on Wed., Jan. 10, in recognition to outstanding individuals and organizations of the weather, water, and climate community.

Peter is a professor in the Department of Atmospheric and Oceanic Sciences (ATOC) at the University of Colorado, as well as a Research Associate at CU's Laboratory for Atmospheric and Space Physics. Peter is also the PI of the new-born baby, TSIS-1. Congratulations Peter on this well-deserved honor!



The AMS Awards Ceremony on Wed., Jan. 10, 2018.

TSIS-1 Safely at ISS –

After years in the making, the Total and Spectral Solar Irradiance Sensor (TSIS-1) had a successful launch on Friday, Dec. 15, 2017. It was a beautiful site from Kennedy Space Center! The Dragon capsule with all of the

precious cargo arrived to the International Space Station on Sunday, Dec. 17, and it was captured by NASA astronauts using a robotic arm. Days later it was taken out of the Dragon and mounted on the top of the ISS for optimum solar pointing activities. Both SIM and TIM are in the process of instrument commissioning, and normal operations will start at the beginning of March.

After delivering all of its goods, the Dragon departed the ISS in mid-January and return to Earth with a full load of research and hardware. The ISS has been in operation for over 17 years. In an effort to drive down launch costs, this is the first time SpaceX has flown a recycled rocket with a recycled capsule.

LASP at the University of Colorado is leading the TSIS effort with PI Peter Pilewskie, PM Brian Boyle, and instrument scientists Erik Richard (SIM) and Greg Kopp (TIM). Similar to SORCE, LASP will be handling the mission operations for TSIS, and science data from the TIM and SIM instruments should be available in about 2 months. Stay tuned for interesting science!

TSIS, a 5-year mission, is a 2-instrument package comprised of the Total Irradiance Monitor (TIM), which measures the total solar irradiance from outside of Earth's atmosphere, and the Spectral Irradiance Monitor (SIM), which measures solar spectral irradiance from 200-2400 nm. The TSIS TIM and SIM are heritage instruments to those currently flying on SORCE and both instruments are essential to understanding the energy input to the climate system. TSIS will continue the 39-year TSI record and extend the newer 14-year SORCE SSI record, insuring continuity of the solar irradiance Climate Data Records into the future.



The Falcon 9 launch, Dec. 15, 2017. Photo credit: NASA.

SORCE's 15th Birthday!

SORCE celebrated its 15th birthday on **Thursday, Jan. 25!** Wow, pretty great for a 5-year mission!



Happy Birthday SORCE!

To celebrate this special occasion LASP hosted a reception with birthday cake followed by a science seminar entitled “**The SORCE Mission Celebrates Fifteen Years**” featuring brief talks by PI Tom Woods, instrument scientists Marty Snow and Jerry Harder, and Emily Pilinski from mission operations.



Wearing SORCE and Hawaiian attire (it's a SORCE thing from way back – pre-launch), Tom Woods, Neil White, and Tom Sparn (left to right), enjoyed the cake celebration.

Seminar abstract: On January 25, 2003, NASA's Solar Radiation and Climate Experiment spacecraft was launched into space on a Pegasus XL launch vehicle that carried four instruments: the Total Irradiance Monitor (TIM), Solar Stellar Irradiance Comparison Experiment (SOLSTICE), Spectral Irradiance Monitor (SIM), and Extreme Ultraviolet Photometer System (XPS). The primary objective for SORCE is to measure important solar input to Earth's radiation budget and to relate how solar variability influences our atmosphere and climate. SORCE has now contributed to fifteen years of precise measurements for the important sun-climate records of the Total Solar Irradiance (TSI) and Spectral Solar Irradiance (SSI). This presentation will provide an overview of the SORCE mission, some science highlights, and the phoenix-rebirth story for the SORCE operations.

John (Juan) M. Fontenla –

October 28, 1948 - January 11, 2018



Juan Fontenla died at home in Simpsonville, SC on January 11, 2018 while surrounded by his wife Graciela and his two sons Santi and Juan.

He was born in Buenos Aires, Argentina, and he completed his Ph.D. in Physics in 1986 from the University of Buenos Aires. He has worked on solar instrumentation and astrophysical plasma models at the

Institute for Astronomy and Space Physics (IAFE, Buenos Aires, Argentina), NASA Marshall Space Flight Center (MSFC, Huntsville, AL), NCAR High Altitude Observatory (HAO, Boulder, CO), University of Colorado Laboratory for Atmospheric and Space Physics (LASP, Boulder, CO), and NorthWest Research Associates (NWRA, Boulder, CO). He has made numerous contributions to the study of the sun and stars during his 37-year career. Even during his time working on commercial software development in 1996-2002, he created his sophisticated model of the solar radiation that he named the Solar Radiation Physical Model (SRPM). He is perhaps best known for the SRPM and the application of this model for studying the solar spectral irradiance variability for the NASA Solar Radiation and Climate Experiment (SORCE) mission. He is a member of the American Geophysical Union (AGU), the American Astronomical Society (AAS), and the International Astronomical Union (IAU). You can post condolences for his family and friends at his obituary website at: <https://cannonbyrd.com/john-manuel-fontenla/>.

2017 AGU Meeting Summary –

It was a busy week for SORCE scientists at the 2017 Fall AGU Meeting in New Orleans, LA, Dec. 11-15. They contributed in several different sessions focusing on solar irradiance measurements and modeling.

SORCE-related AGU oral presentations included:

Tom Woods (LASP): Measurements of the Solar Spectral Irradiance Variability over Solar Cycles 21 to 24.

Matt DeLand (SSAI): Status of the NASA Solar Irradiance Science Team (SIST) program.

SORCE-related AGU poster presentations included:

Matthieu Kretschmar (LPC2E): An empirical model of the variations of the solar Lyman alpha spectral irradiance.

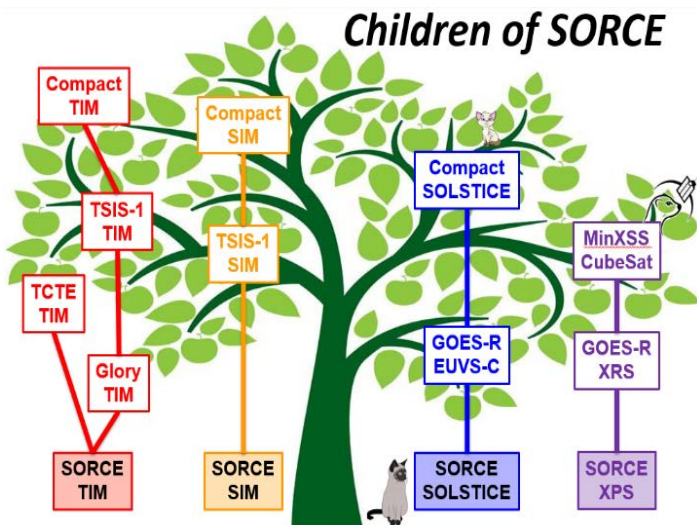
Jae Lee (GSFC): Solar cycle variations as observed by MLS carbon monoxide.



Tom Woods kicked-off a special seminar to celebrate SORCE's 15 birthday.



Emily Pilinski gave a nice overview of amazing work that LASP Mission Operations has done keeping SORCE alive and well. Emily has been a key team member watching over SORCE's battery status.



A visual of the "children of SORCE". Wow!



Stéphen Béland (LASP): The latest SORCE solar spectral irradiance data release: inter-comparison and a first look at TSIS SIM measurements.

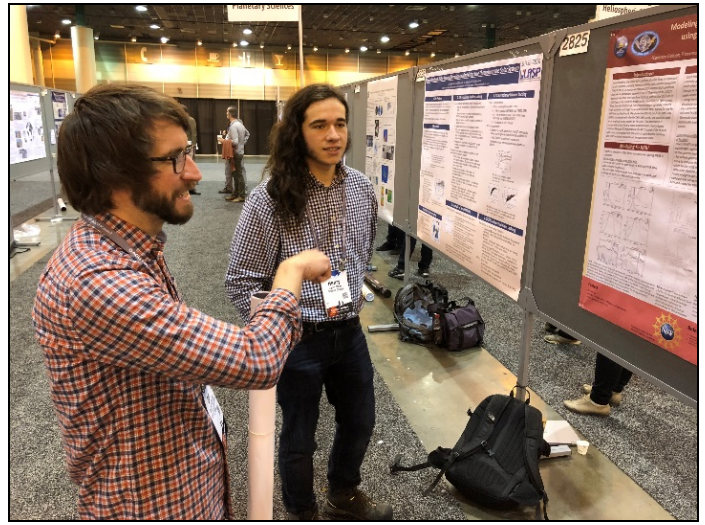
Joshua Elliott (LASP): XUV photometer system (XPS): new dark-count corrections model and improved data products.

Odele Coddington (LASP): A new revision of the solar irradiance climate data record incorporates recent research into proxies of sunspot darkening and the sunspot number record.

Martin Snow (LASP): Magnesium II index measurements from SORCE SOLSTICE and GOES-16 EUVS.

Erica Nathan (Colgate): Investigating flares and solar global oscillations in MgII from GOES-16 EXIS.

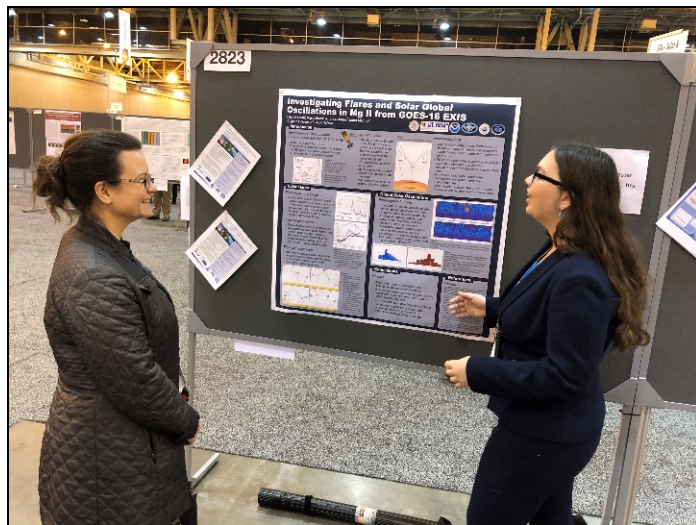
Henry Rook (Carleton): Modeling 13.3 nm Fe XXIII flare emissions using the GOES-R EXIS instrument.



Henry Rook (Carleton College) explains his REU project.



As always, a busy afternoon AGU poster session.



Erica Nathan (Colgate University) talks about the work she did as a SORCE REU student last summer.

Upcoming Meetings / Talks –

SORCE scientists will present papers or attend the following 2018 meetings/workshops:

2018

Long-Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles, Feb. 19-24, Jaipur, India

<https://www.iap.res.in/iaus340/>

Boulder Solar Day, March 15, Boulder, CO

Sun-Climate Symposium, March 19-23,

Lake Arrowhead, CA

<http://lasp.colorado.edu/home/sorce/news-events/meetings/2018-scs/>

EGU General Assembly, April 8-13, Vienna, Austria

<https://www.egu2018.eu/>

Space Weather Workshop, April 16-20, Westminster, CO

Triennial Earth-Sun Summit (TESS 2018), May 20-24,

Leesburg, VA, connect.agu.org/tess2018/home

Conference on Space Operations (SpaceOps 2018),

May 28-June 1, Marseille, France

<http://www.spaceops2018.org/>

