



2014 SORCE Science Meeting Summary –

“Variability in the Sun and Climate over the SORCE Mission – A look back at what we’ve learned over 11 years”

The SORCE team continued its series of science meetings in Cocoa Beach, Florida, Jan. 28-31, 2014. This year’s 3.5-day meeting provided an opportunity to review what has been learned in the past 11 years during the SORCE mission and take an in-depth look of the SORCE Mission top ten achievements published in the Jan.-Feb. 2013 issue of NASA’s *The Earth Observer* (Vol. 25, Issue 1). There were six oral sessions to explore this theme, as well as an afternoon poster session which spanned all topics of the meeting.



For SORCE Meeting attendees – a rare Cocoa Beach sunset in uncharacteristically rainy Florida .
Photo by Marty Snow.

Most of the presentations are available on the SORCE Meeting website:

<https://tinyurl.com/m94dsze> ([http://lasp.colorado.edu/home/sorce/...](http://lasp.colorado.edu/home/sorce/)).

2014 SORCE Meeting Key Questions:

1. *How much have the TSI and SSI varied over the SORCE mission, starting near maximum for SC 23 and currently near maximum for SC 24?*
2. *What has been learned from connecting the SORCE TSI and SSI measurements to the long-term TSI and SSI records?*
3. *What has been learned from comparing TSI and SSI measurements to solar proxies and irradiance model predictions?*
4. *How have Earth’s atmosphere and climate changed over the SORCE mission?*
5. *What are the dominant processes and pathways for solar forcing in Earth’s environment?*
6. *How have the extended SC minimum in 2007-2009 and lower SC 24 maximum affected climate differently than during the earlier SC 23?*
7. *How can these Sun-climate results be effectively applied for reconstructions to the past and for future climate change predictions?*
8. *What are the key science results and lessons learned from the SORCE mission?*
9. *How will the TSI, SSI, and Sun-climate records continue in the future?*

Introduction and Meeting Overview

Discerning the role of the Sun in climate variations on time scales of decades is a challenging task. Climate forcing is well correlated with variations in the Sun's energy output. This is well established for total and UV irradiance using high-precision, space-based solar measurements spanning more than two decades. When the Sun is near the maximum of its activity cycle, it is about 0.1% brighter overall, with much greater changes at UV wavelengths. *SORCE* and other missions measure these variations of the total solar irradiance (TSI) and solar spectral irradiance (SSI) with unprecedented accuracy, precision, and spectral coverage across the UV, visible, and IR. Many interesting and perhaps even conflicting perspectives were presented at this meeting.



^^ Session 1 keynote speaker Robert Cahalan from NASA GSFC spoke about the many aspects of solar influences on the climate and the role of *SORCE* data. He identified nine topics that relate both to findings from *SORCE* and technological advances leveraged for the *TSIS* mission needed to continue and improve total and spectral irradiance critical climate record.

Session 1. Role of the Sun in Climate Change during the *SORCE* Mission, featured seven talks and went right to the heart of the fundamental purpose of *SORCE* – namely the role that the Sun plays in the Earth climate particularly as observed in SC 23 and SC 24. Speakers included Robert Cahalan, Josefino Comiso, Cassandra Bolduc, Marty Mlynczak, Will Ball, Aimee Merkel, and Werner Schmutz for Anna Shapiro.



>> Josefino Comiso, NASA GSFC, presented his research on *Sea Ice Changes in Recent Decades*.



<< Aimee Merkel from LASP/CU talked about *Further Evidence of SC Variability in Middle Atmospheric Ozone and the Importance of Incorporating SSI in Atmospheric Modeling*.

>> *SORCE* PI Tom Woods kicked off the *SORCE* Meeting with an overview of the meeting objectives and an update on the *SORCE* Mission, including the satellite and instrument health.





Session 2. Solar Spectral Irradiance (SSI) Measurements was dedicated to understanding the state of SSI measurements and the discussion covered very broad wavelength ranges and diverse observational methods and platforms. Time series and spectra from several spectrometers used for direct solar measurements were discussed along with the findings of Earth-viewing spectrometers and filter radiometers. In summary, when concurrent data are available these instruments produce excellent short-term agreement for multiple solar rotations, but agreement on the longer SC time scale still shows significant disagreement. Keynote speaker Tom Woods (LASP/CU) kicked off the session and was followed by Jeff Morrill (NRL), Gérard Thuillier (LATMOS), Christian Muller (Belgium Inst. for Space Aeronomy), Werner Schmutz (PMOD/WRC), Gaël Cessateur (PMOD/WRC), Jerry Harder (LASP/CU), Matt DeLand (SSAI), and David Bolsée (Belgium Inst. for Space Aeronomy).



<< Jeff Morrill from NRL talked about a combined SUSIM / SBUV UV SSI dataset from 1991-2012.

>> There was plenty of interesting discussion during the *SORCE* Meeting breaks. Left to right: Natalie Krivova (Max-Planck, Germany), Will Ball (Imperial College, London), and Sami Solanki (Max-Planck).



>> And of course, we had a celebration for *SORCE*'s 11th birthday. Not bad for a 5-year mission! And thanks to the efforts of the LASP/CU Mission Ops team we are going strong into year 12! GO *SORCE*!



>> David Bolsée from Brussels presented *Accurate Determination of the TOA Solar Spectral NIR Irradiance Using a Primary Standard Source and Bouguer-Langley Technique.*



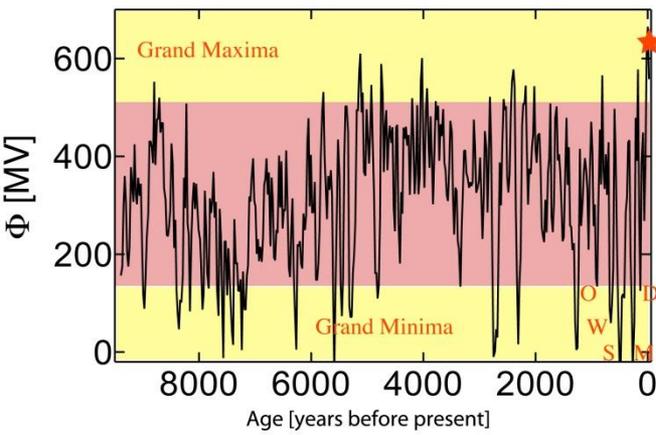
>> Christian Muller discussed *Full Solar Rotations Observed by the SOLAR Payload on the ISS in December 2012 and June 2013.*



The highlight of **Session 3. Decadal and Longer Sun-Climate Variations** on Wednesday morning, Jan. 29, was keynote speaker Roger-Maurice Bonnet from the International Space Science Institute (ISSI) in Bern, Switzerland. He highlighted the many factors that can cause climate change, ranging from natural effects, such as solar and volcanic activity, to anthropogenic effects related to increasing greenhouse gases (GH) and aerosols. He also presented a summary of climate change since 1900 with temperature increase of 1 C and sea level rise of 6 inches. The solar influence of these changes is thought to contribute about 7% of the total change. Other speakers in this session, Jürg Beer (Eawag), Dong Wu (NASA GSFC), Alexander Ruzmaikin (JPL), and Guoyong Wen (NASA GSFC, GESTAR) then went into further detail on the role of the Sun in climate change.



^^ Roger-Maurice Bonnet gave a fascinating talk entitled: *Review and Discussion of Past and Future Climates, of their Astronomical, Solar, and Anthropogenic Forcing. Strategies for Future Space and Modeling Research.*

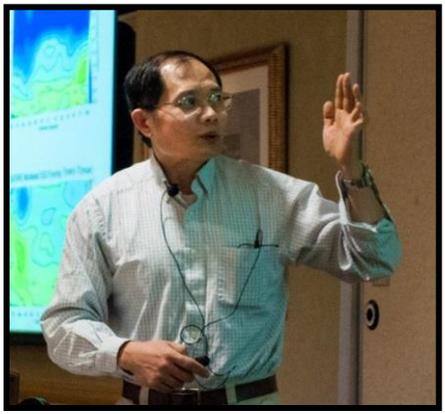


<< This plot by Jürg Beer shows solar modulation spanning the last 10,000 years from ice core records. The record shows multiple time periods of high solar activity, such as our current Modern Maximum, as well as several episodes of extended Grand minima conditions.



^^ Session 3 participants met during the break to continue the discussion. From left to right: Dong We, Jürg Beer, Joan Feynman, and session chair Gary Rottman.

>> Guoyong Wen shared his expertise in Climate Responses to Spectral Solar Forcing in GISS GCMAM.



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Dong Wu from NASA GSFC talked about the Oscillations in 35-Year MERRA Zonal Wind and Temperature.



<< After giving an excellent talk in the morning on *Sun-Climate Variations on Centennial Time Scales*, Alexander Ruzmaikin enjoyed the fresh local cuisine later that evening.

Session 4. was all about *TSI Measurements and Composites* with each presenter discussing the four currently-flying total solar irradiance (TSI) instruments – all beyond their mission lifetimes. *SORCE TIM* just started taking measurements after a break while the *SORCE* satellite transitioned into a new exciting “Hybrid” mode, *PREMOS* is due to be decommissioned at the end of February, *ACRIM3* is not currently acquiring measurements due to spacecraft battery issues, and the oldest of the four instruments – *VIRGO* – still operating. Fortunately, the November 2013 launch of the *TSI Continuity Transfer Experiment (TCTE)* will continue this climate data record into the near future. The hosting *US Air Force TCTE* spacecraft is intended only for an 18-month lifetime. The *Norwegian Satellite (NORSAT-1)*, scheduled for launch in late 2015 or early 2016, will be carrying a new *TSI* instrument to help continue this critical *TSI* record and will overlap with the future *TSIS* mission. Session speakers included: *Greg Kopp (LASP/CU)*, *Wolfgang Finsterle (PMOD/WRC)*, *Richard Willson (ACRIM PI)*, *Shashi Gupta (SSAI)*, *Jae Lee (Univ. of Maryland and NASA GSFC)*, and *Jean-François Cossette, (Univ. of Montreal)*.

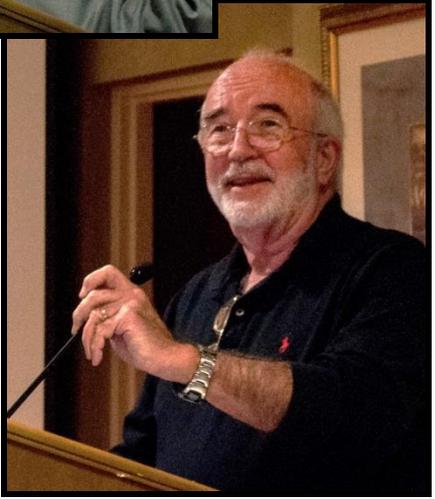


^^ Jae Lee talked about *Rotational Variations in TSI Observations.*



<< Shashi Gupta talked about the projection of *SORCE TSI* measurements 5-10 days forward for near real-time applications.

During a lunch hour between Sessions 1 and 2 a panel discussion, moderated by Tom Woods, was held to explore *Current and Future Plans for Sun-Climate Research.* Panel members *Madhulika Guhathakurta* and *Cheryl Yuhas* (both from *NASA Headquarters*), *Tom Sparn* from *LASP/CU*, and *Werner Schmutz (PMOD/Switzerland)* discussed the need for continued irradiance missions from the perspective of *NASA's Earth Science and Heliospheric Divisions* and within the *European community.* *Sparn* discussed a potential low cost means of continuing irradiance missions after the projected *TSIS* launch in 2017.



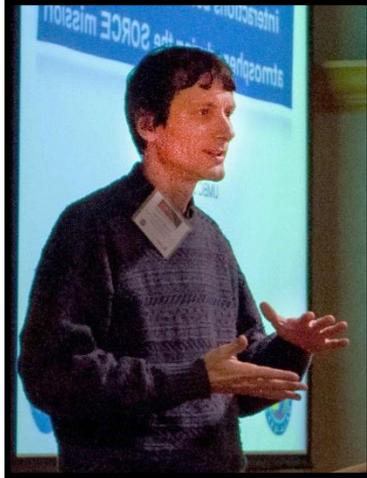
<< *ACRIM* Principal Investigator *Dick Willson* discussed the *ACRIM3 Characterization by the LASP/TRF and the TSI Database.*





<< Sami Solanki discussing the next generation of solar irradiance reconstruction models.

Left to right: >> Thierry Dudok de Wit, Tamás Várnai, and Micha Schöll.



>> Serena Criscuoli (left) and Mark Rast smile for the camera during a meeting break.



^^ Rich Stolarski discussed the impact of SSI variations on stratospheric composition.



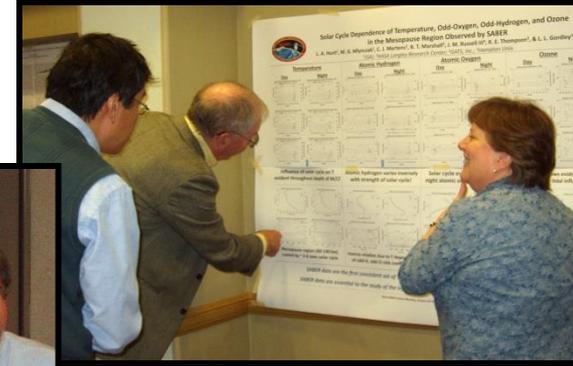
>> Matthieu Kretschmar talked about the European SOLID project.

Session 5. SSI Composites, Proxies, and Models was a full day of interesting talks. An important new result regarding solar proxies was the discussion of the 30 cm radio emission. When combined with the widely-used 10.7 cm radio flux, a greater fraction of solar facular variability is captured. The 30 cm radio measurements have been recorded on a daily basis since the mid 1950's, so they have almost the same duration as F10.7. The second topic in this session was about the next generation of TSI and SSI models. The current catalog of physics-based models are all based on a set of 1-D atmospheres to describe the various components of the solar disk. The solar magnetic field's only role in such models is to define the fraction of each type of atmosphere (quiet sun, active network, plage, etc.). The next generation of models may instead use 3-D magneto-hydrodynamic (MHD) calculations to produce radiance and irradiance models of the solar radiation output. Finally, the session included a series of talks about the European effort to create a composite SSI dataset. The SOLar Irradiance Data exploitation (SOLID) is a joint project by scientists from seven European countries. Their goal is not only to provide the scientific community with a composite SSI, but also to critically evaluate the uncertainties of all elements that go into creating that composite. Members of the SORC E team are also involved in this effort as both collaborators and data providers. Talks were given by Martin Snow (keynote, LASP/CU); Ken Tapping (NRC, BC, Canada); Rich Stolarski (Johns Hopkins Univ.); Tamás Várnai (GSFC); Margit Haberleiter (PMOD/WRC, Switzerland); Thierry Dudok de Wit, Matthieu Kretschmar, Anatoliy Vuiets, and Micha Schöll (all LPC2E, CNRS Univ. of Orléans, France); Natalie Krivova and Sami Solanki (both Max-Planck Inst., Germany); Serena Criscuoli (NSO, Sac-Peak); and Juan Fontenla (NWRA, Boulder, presented by Jerry Harder).

To conclude the third meeting day, a special **Poster Session** was held to highlight the many excellent scientific results. Attendees enjoyed refreshments while they wandered through the poster area and discussed their content with the authors. The poster session spanned all topics of the **SORCE Meeting**.

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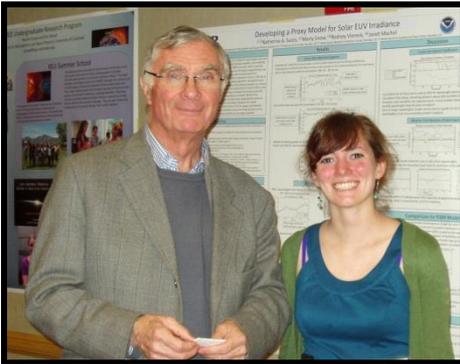
Linda Hunt (right) discusses her poster on SABER observations with Rich Stolarski (center) and Dong Wu (left).



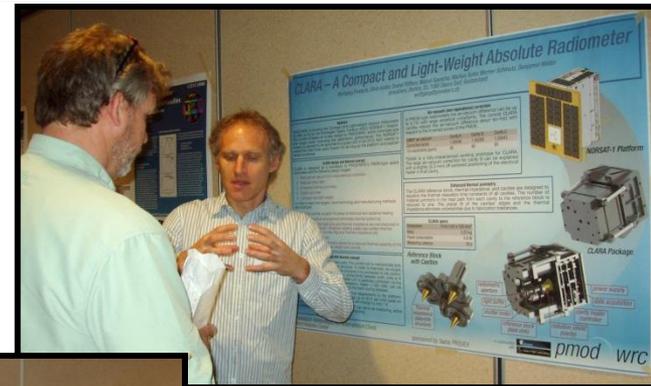
<< Tom Sparn discusses exciting new possibilities for launching small satellites to continue TSI and SSI measurements in the next 25 years.



<< LASP graduate student Wren Suess chats with Gerard Thuillier about her developing a proxy model for solar EUV irradiance using SORCE and GOES.



<< Doug Lindholm (center) from LASP talks about SORCE data processing with Angie Cookson and Guoyong Wen. Angie had a poster on ground-based Ca II K images.



^^ Wolfgang Finsterle (right) talks to Erik Richard about CLARA – a compact and lightweight absolute radiometer.

<< Deb Vane from JPL shared a poster with Cheryl Yuhas (GSFC) on process.



>> Jerry Harder (left) and Steve Platnick figure out the popcorn machine before tackling the posters.



Stephane Beland (center) from LASP explains SORCE SIM Data Version 19 to Gael Cessateur (right) and Matthieu Kretschmar.

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Session 6. Legacy of *SORCE* and Future Directions after *SORCE*, the final session of the meeting tackled the history and future of SSI AND TSI measurements. Gary Rottman started off with a keynote talk looking back with an excellent overview of the history of the solar irradiance observation programs since the 1970's and the series of events that eventually defined the *SORCE* mission. The follow-on solar irradiance observations to *SORCE* are the NOAA TSIS. The need and urgency for the TSIS launch is discussed in the NRC report for continuing TSI climate records as was presented by Graeme Stephens. Other talks were given by Peter Pilewskie and Mark Rast (both LASP/CU), Yukihiro Takahasi (Hokkaido Univ., Japan), Brian Soden (Univ. of Miami), Pål Brekke (Norwegian Space Centre), Graeme Stephens (JPL), and Steve Platnick (NASA GSFC).



>> Keynote speaker and original *SORCE* PI Gary Rottman reminds the audience of where we've come from and where we need to go yet.



^^ The need and urgency for the TSIS launch is discussed in the NRC report for continuing TSI climate records as was presented by Graeme Stephens.



<< Pål Brekke talked about the *NORSAT-1*: TSI, Space Weather, and Ship Detection.



>> Peter Pilewskie updated everyone on the status of the TSIS Mission.

The 11th *SORCE* Science Meeting was a great success, with 65 scientists and students from around the world gathered to present their finding so on solar irradiance and climate. The GSFC-LASP sun Climate Research Center (SCRC) will likely plan and host the next Sun-Climate meeting for some time in 2015. So stay tuned through the *SORCE* Newsletter for such a meeting announcement and for the latest news on the *SORCE* Mission. February has been a very good month for *SORCE*!

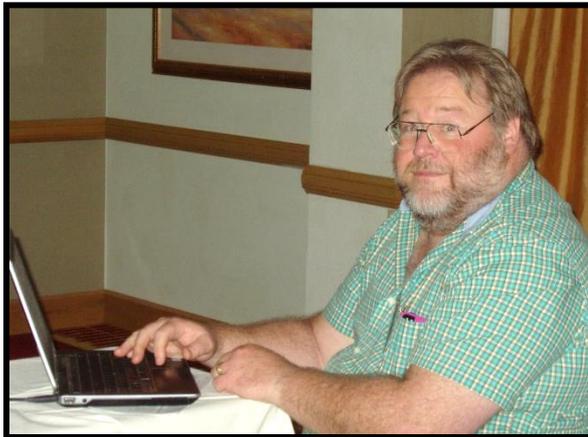
SORCE Science Dinner – Robert Cahalan Honored

During the SORCE Science Dinner Robert (Bob) Cahalan was honored for his many years as the SORCE Project Scientist. He has served in this position from the initial mission concept (1999) to launch (2003), and through a decade of successful measurements. The role of Project Scientist has been complex requiring an individual who is both knowledgeable and interested in the science objectives, but also an individual who effectively advocates the science and aggressively engages in the political battles to keep the mission on track.

SORCE has been very fortunate to have Bob onboard, advancing our understanding of Sun-climate models, global energy balance, and solar radiation. He is recognized for his pioneering theoretical and experimental advances in understanding the role of cloud structure in climate; and his leadership in three-dimensional atmospheric radiative transfer. He has researched global warming and climate change at NASA Goddard since 1979. In addition to SORCE Project Scientist, Bob is also the Project Scientist for the joint NASA-NOAA Total and Spectral Solar Irradiance Sensor (TSIS).



^^ SORCE PI Tom Woods thanks Bob Cahalan for his many years of service as the SORCE Project Scientists.



<< A special thanks to Marty Snow (LASP/CU) who took most of the photos in this newsletter. Wolfgang Finsterle and Vanessa helped out as well.

Reminder – Presentations are available

The complete 2014 SORCE Meeting details, including agenda, abstracts, summary, and most of the presentations, can be found online at: <http://tinyurl.com/m94dsze>.



2014 SORCE Science Meeting – Group Photo



The SORCE team extends a hearty thanks to all participants for making the 2014 SORCE Science Team Meeting a success!