Welcome & TSIS and SORCE Status Overview

Peter Pilewskie and Tom Woods

University of Colorado

Laboratory for Atmospheric and Space Physics

Welcome to the 2020 Sun-Climate Symposium

What is the Quiet Sun and
What are the Subsequent Climate Implications?

Agenda

Day	Time	Title
Tue	8:30 AM – 1PM	1. The Sunset of SORCE *Chairs: Tom Woods and Gary Rottman*
Tue	1 – 5 PM	2. Recent/Space-Era Solar Cycle Timescales *Chairs: Greg Kopp, Marty Snow, and Jae Lee*
Wed	8 – 11:25 AM	3. Solar Variability and Climate Trends on Secular Timescales *Chairs: Odele Coddington and Doug Rabin*
Wed	4 – 6PM	Poster Session / Reception
Thu	8 AM – Noon	4. Solar Influence on the Atmosphere and Climate *Chairs: Marty Snow, Jae Lee, and Greg Kopp*
Thu	1:25 – 4:55 PM	5. A New Reference Spectrum for Remote Sensing *Chairs: Erik Richard and Dong Wu*
Fri	8 – 9:15AM	6. Observational Predictions *Chairs: Doug Rabin and Odele Coddington*
Fri	9:15 – 11:25 AM	7. Looking Ahead – Future Observations of the Sun and Earth *Chair: Peter Pilewskie*

Wednesday Afternoon
12:30 – 4:00 PM UA Lab Tours
4:00 – 6:00 pm Poster Session / Reception

- 12:30 PM Depart Marriott to walk to Univ. of Arizona Campus
- 1:00 – 2:00 pm

  Group 1: Tree-Ring Lab

  Group 2: Caris Mirror Lab
- 2:00 – 2:30 PM Walk to the next tour (or back to Marriott if only doing 1 tour)
- 2:30 – 3:30 PM

  Group 1: Caris Mirror Lab

  Group 2: Tree-Ring Lab
- 3:30 pm Walk back to the Marriott
- 4:00 – 6:00 pm Poster Session / Reception

Thank you!

Organizing Committee

Stéphane Béland, Odele Coddington, Xiquan Dong, Jerry Harder, Greg Kopp, Jae Lee, Peter Pilewskie, Doug Rabin, Erik Richard, Marty Snow, Tom Woods & Dong Wu

And a special thank you to Vanessa George

Tucson: The Old Pueblo

One of the sunniest cities in the US, with over 350 days of sunlight.

Since 1972 has enforced a "dark sky" code to regulate outdoor lighting.

Tucson Gem and Mineral Show is one is the largest in the US with over 50,000 participants.

University of Arizona was founded in 1891, 21 years before Arizona became a state.

The Mighty Saguaro

Largest cactus in the United States.

Found exclusively in the Sonoran Desert.

Live to be 150-200 years old.

Can grow to 40-60 feet tall.

Can weigh between 3200-4800 pounds.

Most roots are only 4-6 inches deep.

Grows slowly - a 10 year old saguaro may be only a couple of inches tall!

Arms may take many decades to form.

Mount Lemmon:
Southernmost Ski Resort in North America

When the ice breaks on the Santa Cruz River …

The White Dove of the Desert
End of the world when cat catches mouse?
Mission San Xavier del Bac

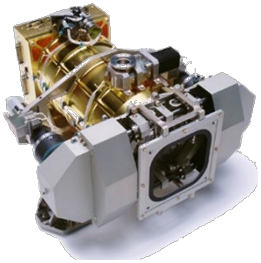
about 12 miles S. on I-19

SORCE TSIS

TSIS Makes Two Measurements

The ***Total and Spectral Solar Irradiance Sensor*** (TSIS) provides two measurements critical for understanding solar influences on Earth climate.

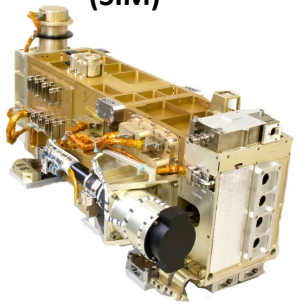
Total Irradiance Monitor (TIM)



Total solar irradiance (TSI)

- Earth's predominant energy source.
- The TSIS Total Irradiance Monitor (TIM) extends a 41-year long uninterrupted measurement record of TSI.
- ***TSIS-1 TIM first light on 11 Jan. 2018***
- ***TSIS-2 Launch Readiness Feb. 2023***

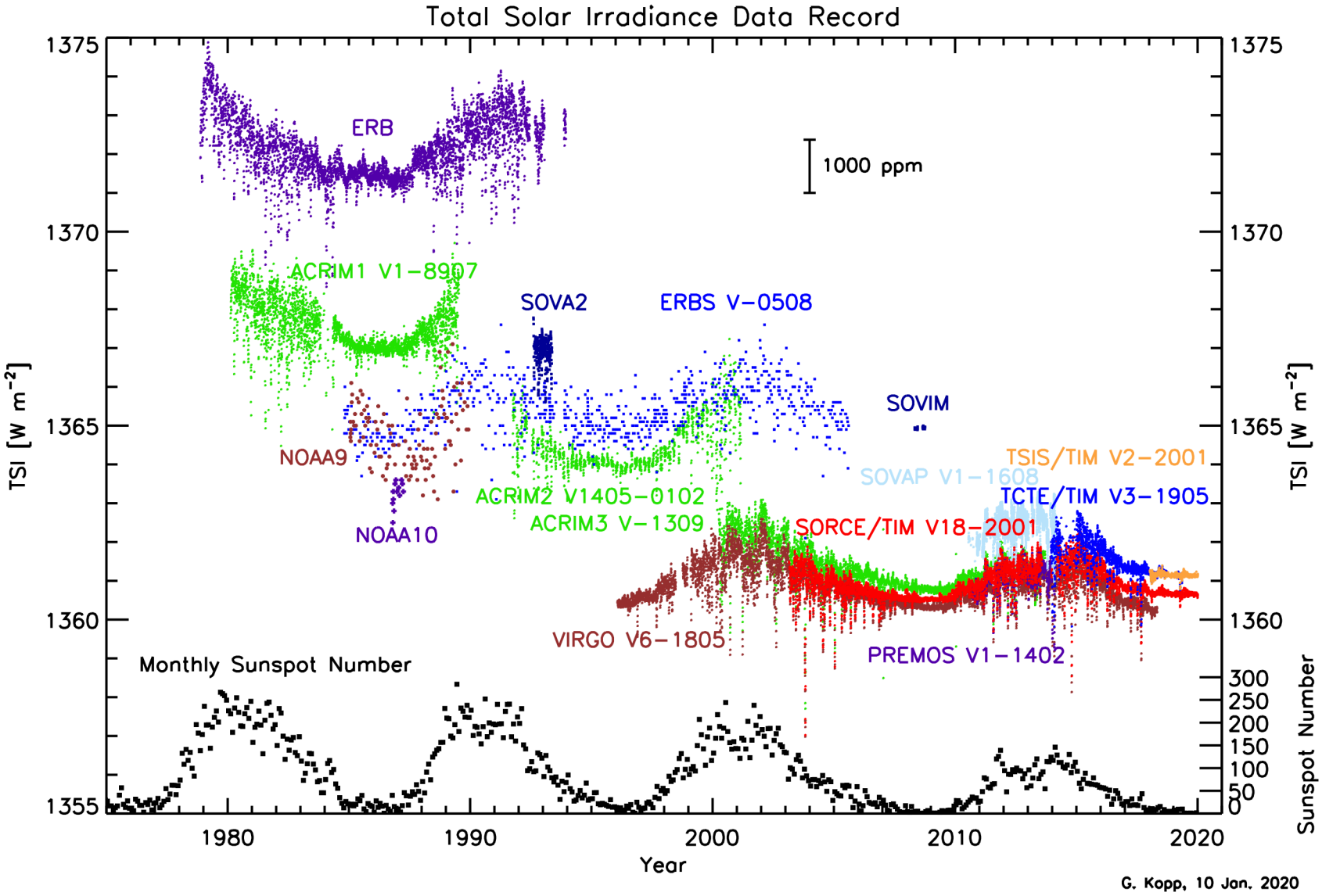
Spectral Irradiance Monitor (SIM)



Solar spectral irradiance (SSI)

- Measured by the TSIS Spectral Irradiance Monitor (SIM).
- Identifies the regions of atmosphere that are affected by solar variability and the mechanisms of response.
- ***TSIS-1 SIM-1 first light on 5 Mar. 2018***
- ***TSIS-2 Launch Readiness Feb. 2023***

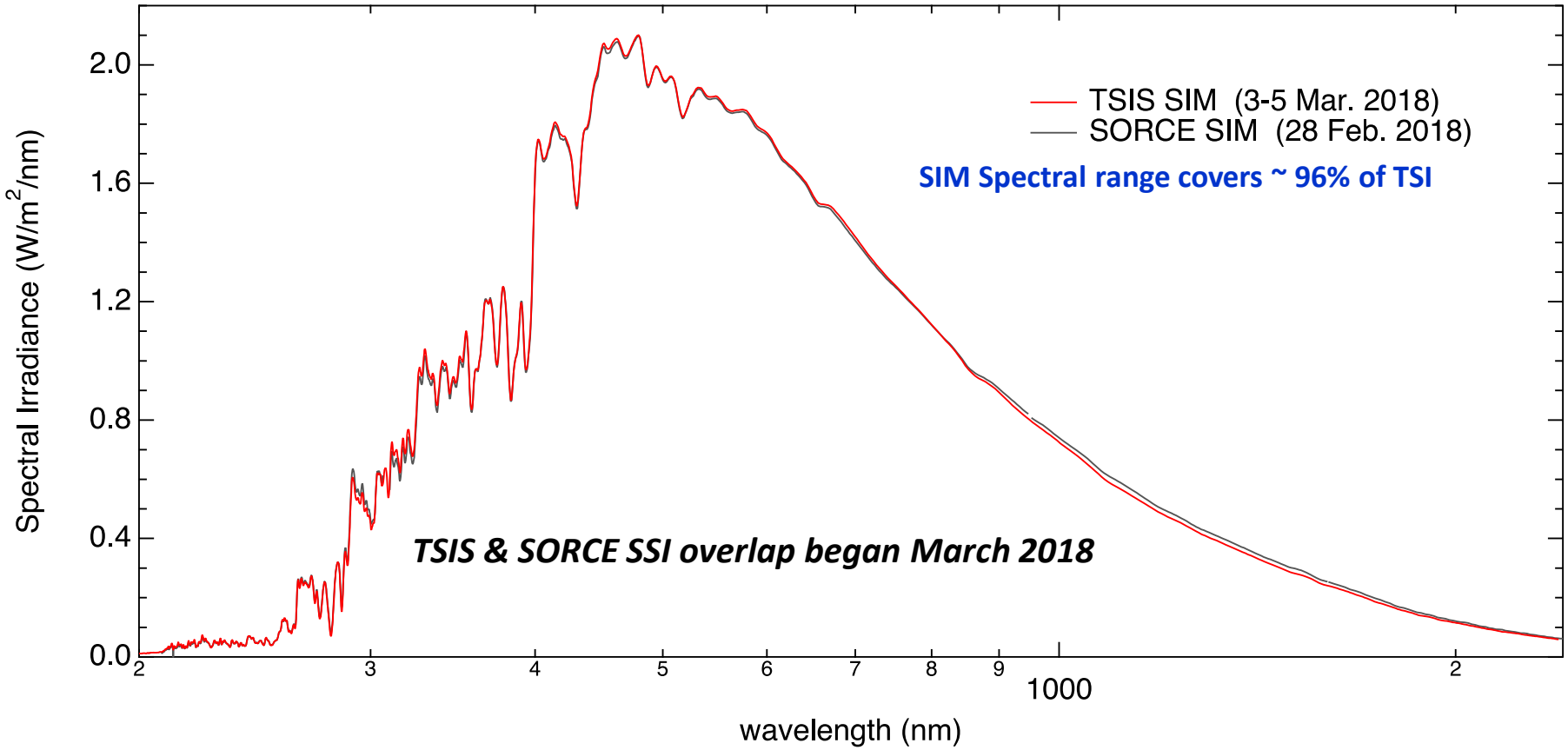
The Total Solar Irradiance Data Record



TSIS-1 SIM First Light Comparison

Reference Spectrum	205-2390 (W/m^2)	+ 52 W/m^{2*}	TIM TSI (W/m^2)	% Diff.
ATLAS-3	1333	1386	1362-1360	+1.76-1.88
SIRS-WHI	1323	1375	1362-1360	+0.95-1.1
TSIS SIM	**1307.6**	**1359.6**	**1360.6**	**-0.08**

Integrated SSI contribution outside 205-2390 nm

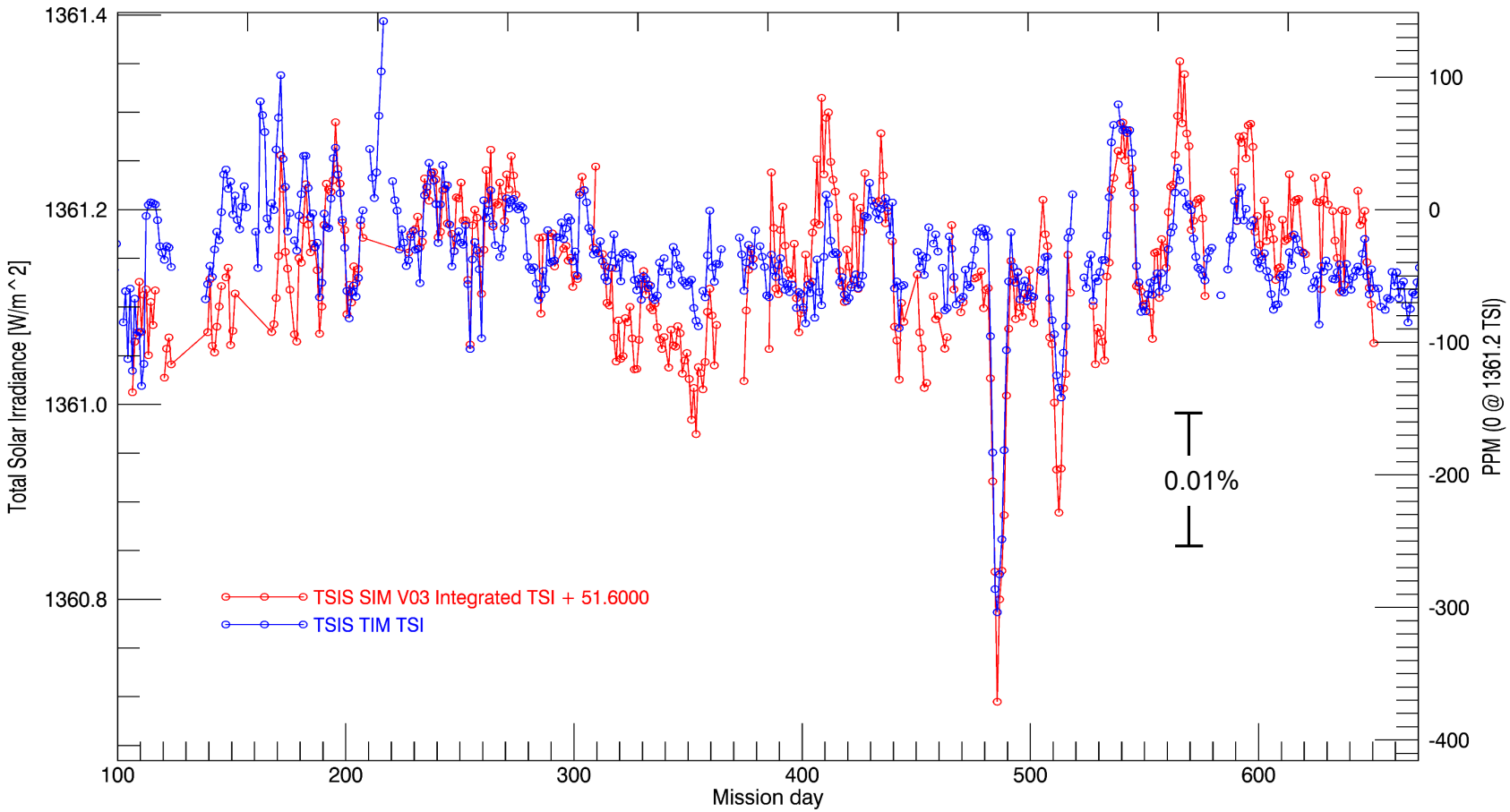


On-orbit integrated stability performance

Comparison of the TSIS TIM TSI daily averages with the Integrated (200 – 2400 nm) spectrum TSIS SIM daily values. (TSI stability correction better than 10 ppm / yr.)

- A constant offset of 51.7 W/m^2 is added to account for the ~4% of spectral irradiance not measured by SIM (wavelengths < 200 nm and > 2400 nm)

✓ Stability agreement better than 100 ppm (<0.01%) over the whole mission to date.



TSIS-1 Highlights

- TSIS-1 TIM validates the SORCE and TCTE calibration scales.
  - SORCE TIM reduced uncertainties from prior TSI measurements by approximately one order of magnitude.
  - SORCE TIM established a new TSI of 1361 W m^{-2}.
- TSIS-1 SIM reduces uncertainties from SORCE SIM by approximately one order of magnitude in the visible and even more in the near-infrared.
- NASA achievements in advancing our understanding of solar irradiance from SORCE to TSIS-1 summarized in the 30th anniversary edition of *The Earth Observer*.

SORCE
Mission Status

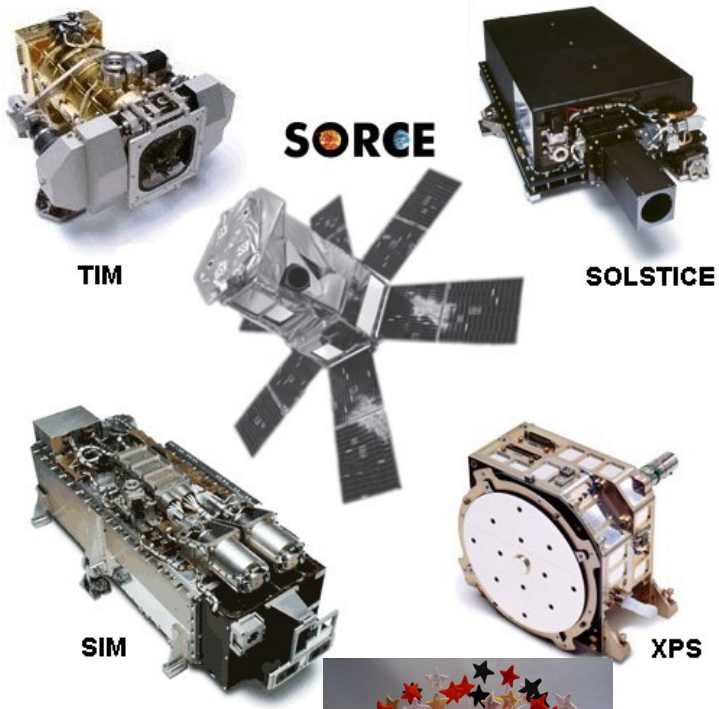
Tom Woods
LASP / University of Colorado

SORCE Mission Overview

A Mission of Solar Irradiance for Climate Research

- **SORCE Measurements**
  - Total Solar Irradiance (TSI)
  - Solar Spectral Irradiance (SSI)
    - 1-34 nm and 115-2400 nm
  - Important Earth science measurements for studying radiative forcing, dynamics, and photochemistry in atmosphere
- **SORCE Mission**
  - Launched in January 2003
  - Its mission has been extended to overlap with ISS-TSIS in 2018-2019
  - Spacecraft and instruments are making routine daily measurements in its Day-Only Operations (DO-Op) mode (due to battery issues)

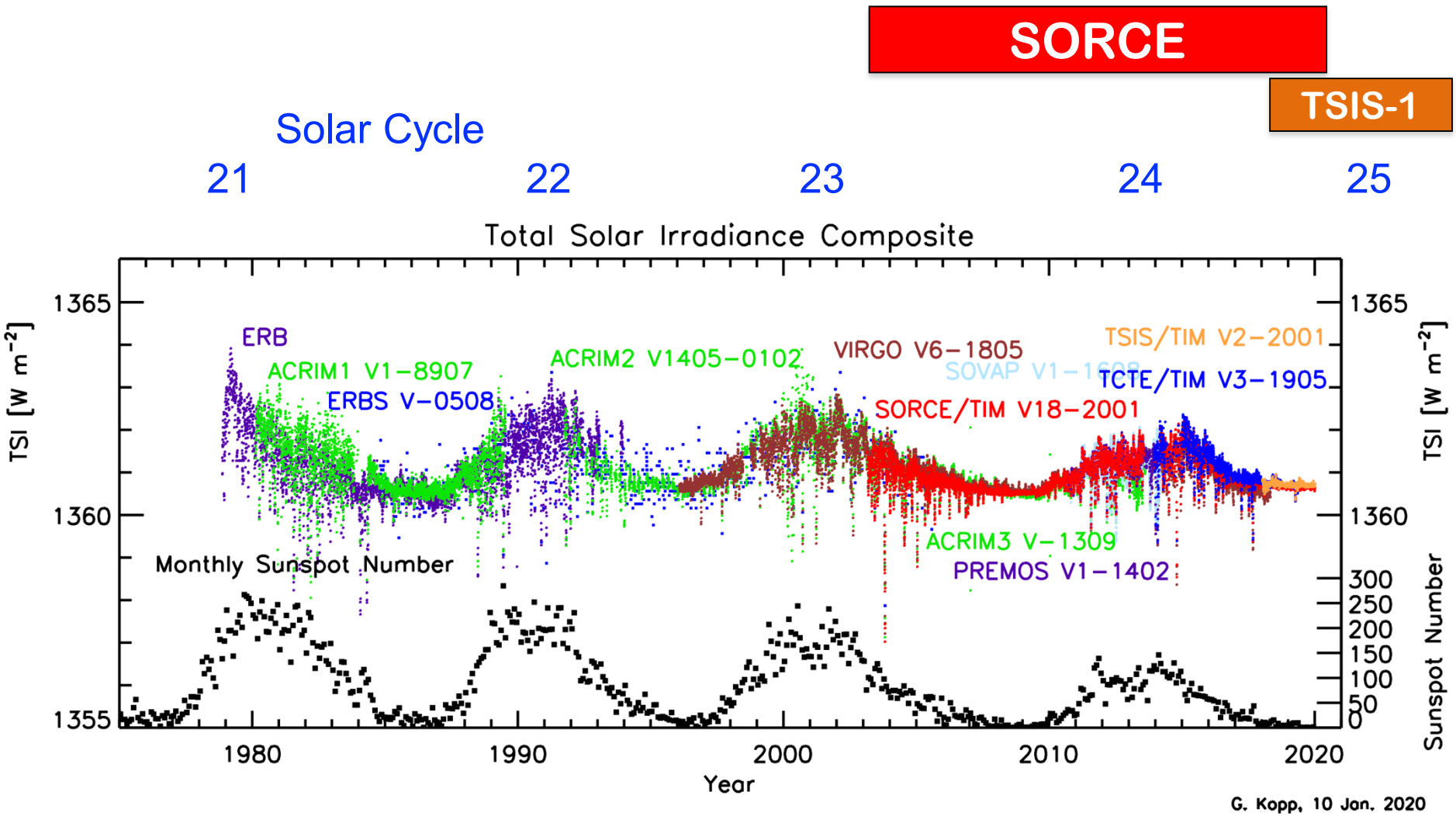
lasp.colorado.edu/home/sorce/



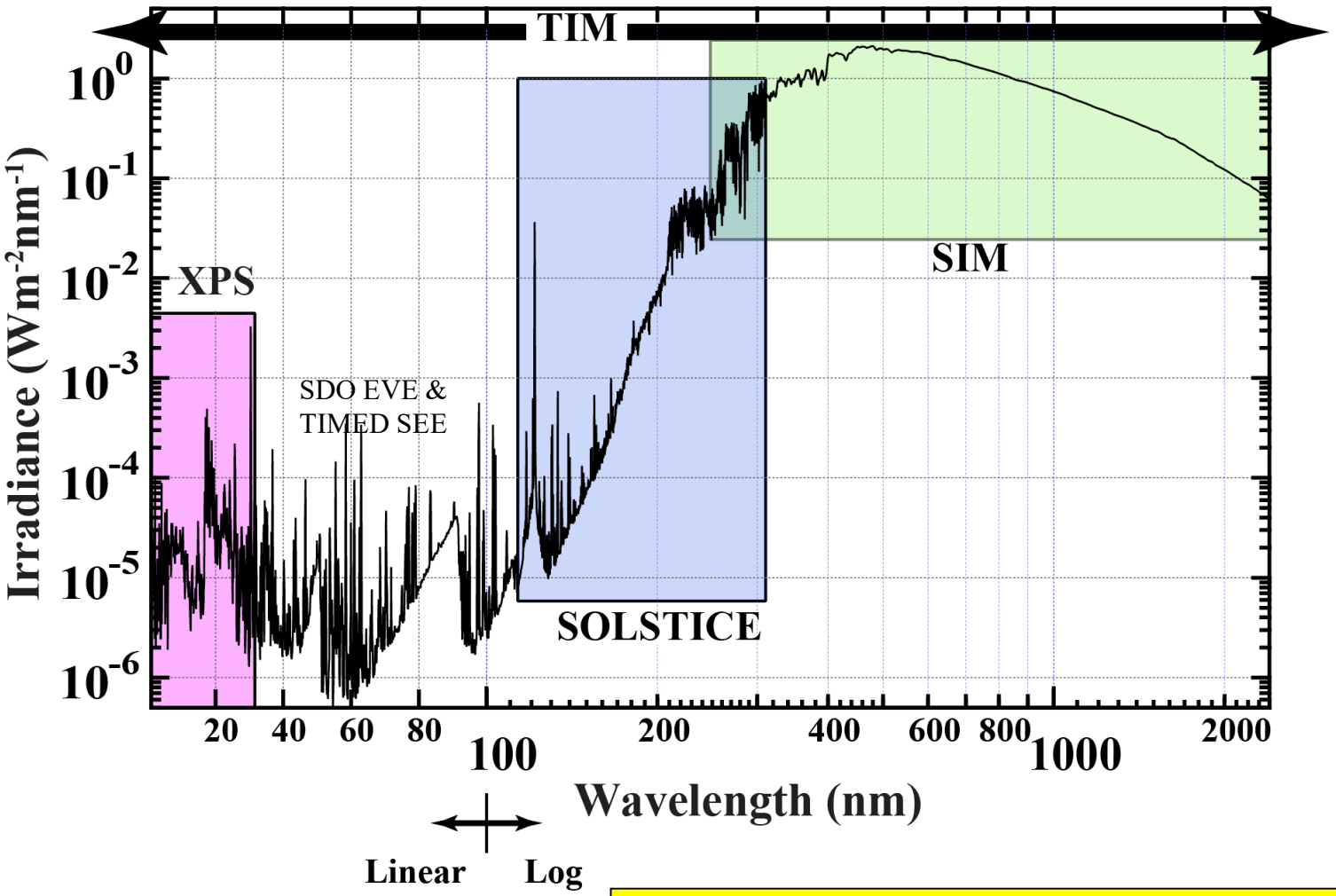
17-years in Orbit

SORCE TIM Extends the TSI Record

SORCE covers 17 years (40%) of the 42-year TSI Climate Record



SORCE Starts New SSI Record for Visible-NIR

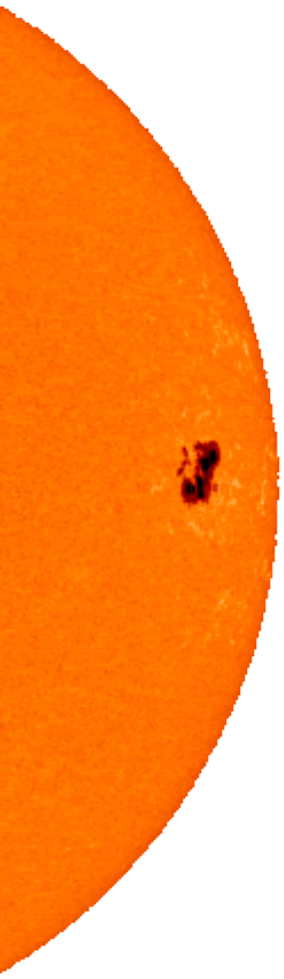


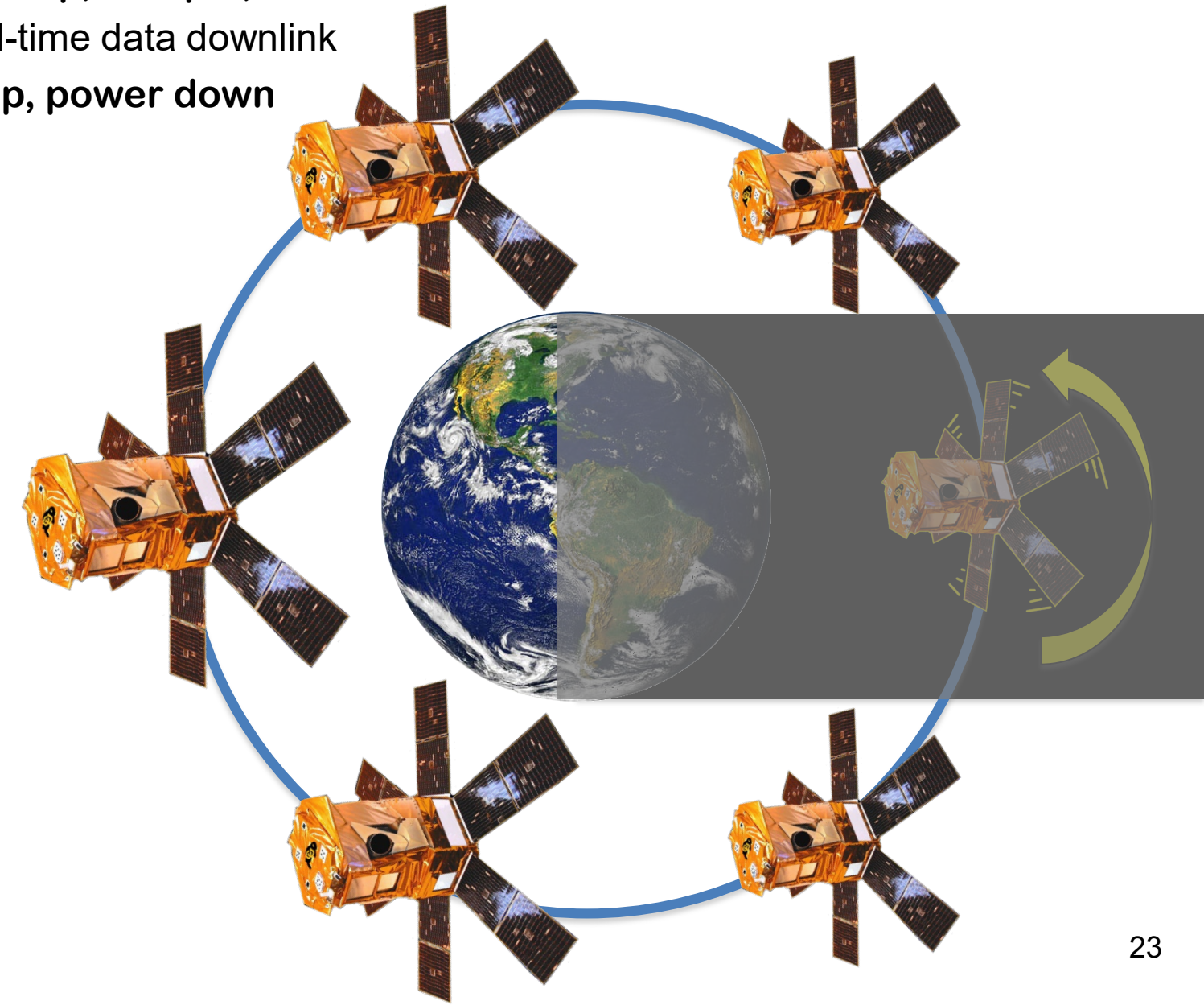
Integrated SORCE 200-2423nm = 1324.49 Wm^{-2}
~ 97.3% of TSI

Infrared portion >2423nm ~ 36.32 Wm^{-2}

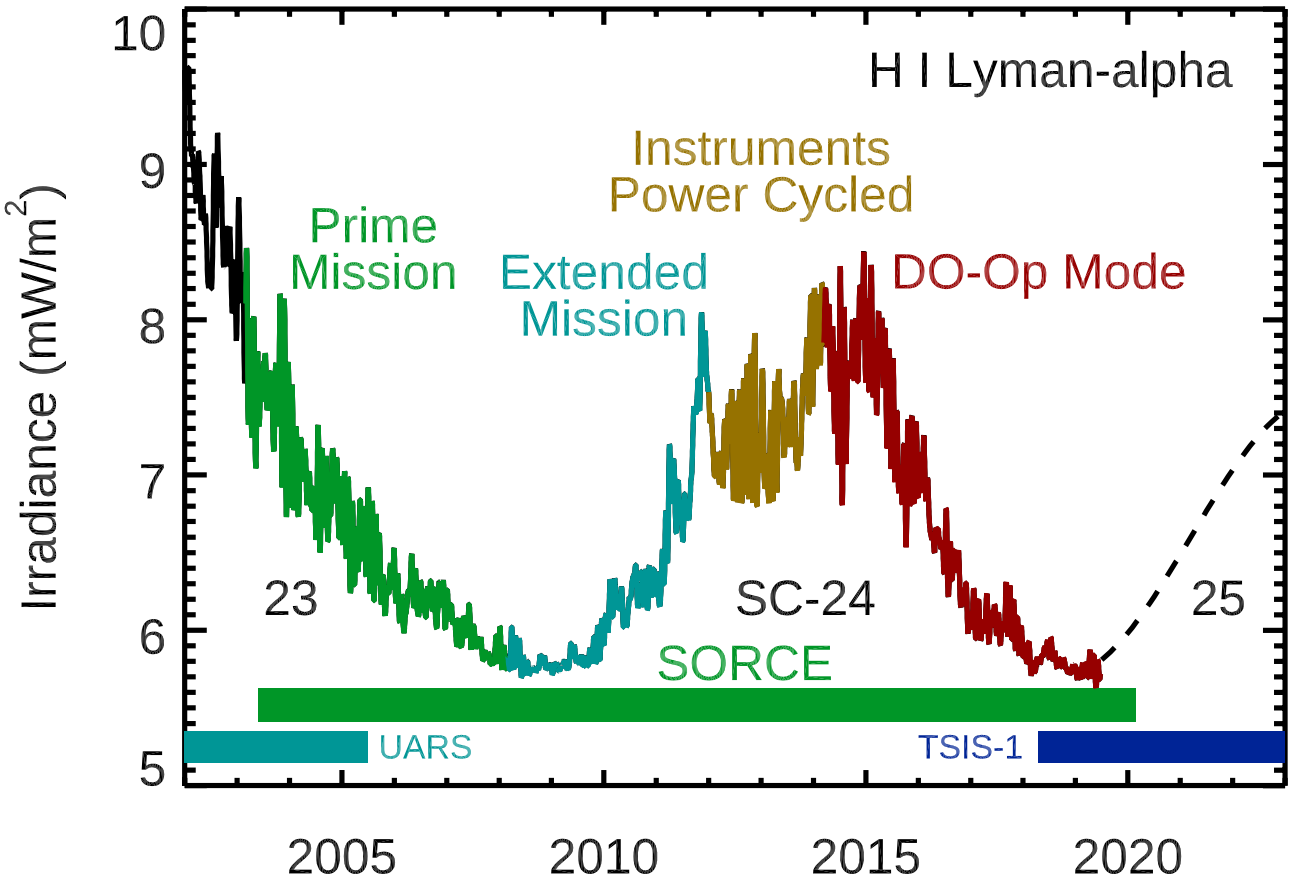
SORCE Day Only Operations (DO-Op) Since 2014

- **Sunlight: power up, de-spin, solar observations**
  - TDRSS real-time data downlink
- **Eclipse: spin up, power down**



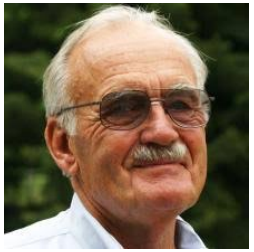


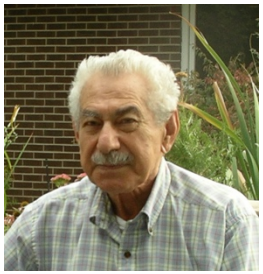
SORCE Observations Remain High Quality During Extended Mission



SORCE and TSIS-1 overlap has been highly successful.
SORCE passivation (turn-off) is planned for February 25, 2020.

Thanks SORCE Team !





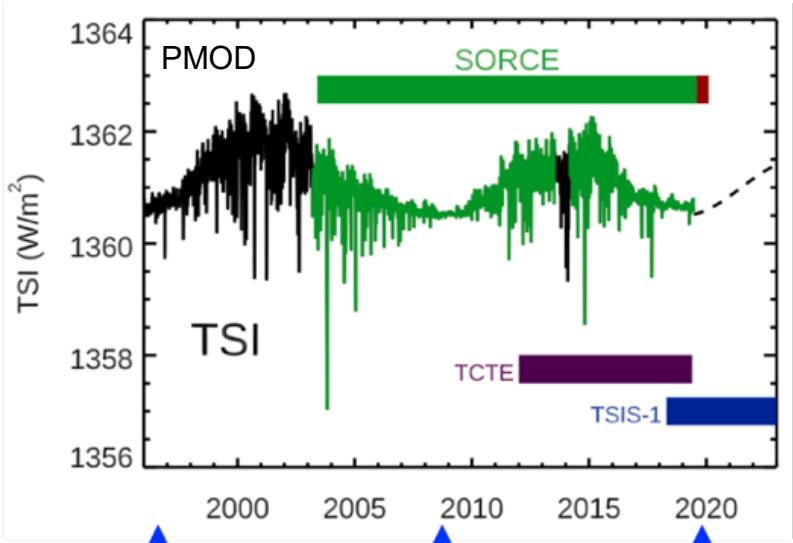
University of Colorado Boulder
LASP

NASA Goddard SPACE FLIGHT CENTER

NORTHROP GRUMMAN
Orbital ATK

SORCE supports all three Whole Heliosphere and Planetary Interactions (WHPI) Campaigns

How different is the new solar cycle minimum?



1360.623 W/m² (ref level) 1996/082

1360.507 W/m² (Δ -85 ppm) 2008/220

1360.613 W/m² (Δ -7 ppm) 2019/165

WHPI Campaigns:

1) Mar. 12 – Apr. 8, 2019
2) June 29– July 26, 2019
3) Jan. 6 – Feb. 2, 2020

http://whpi.hao.ucar.edu

Software to translate SORCE data to any planet:
plot_solar_code.zip
http://lasp.colorado.edu/lisird/tools

Session 1. The Sunset of SORCE

- Gary Rottman – SORCE Mission
- Bob Cahalan – SORCE Mission

<u>SORCE Instruments</u>

- Greg Kopp – SORCE TIM
- Jerry Harder – SORCE SIM
- Bill McClintock – SORCE SOLSTICE
- Tom Woods – SORCE XPS

- Sean Ryan – SORCE Operations
- Tom Sparn – SORCE Program