



## *SORCE Team Submits Extended Mission Proposal –*

For several weeks the SORCE scientists have been busy preparing the SORCE Senior Review Proposal for SORCE’s extended mission. This proposal is required by each of the 12 current NASA’s Earth Science Division (ESD) mission teams nearing the end of their mission lifetimes. The 5-year SORCE mission, launched in January 2003, is looking for extended funding starting in January 2008.



All four SORCE instruments and the spacecraft continue to perform essentially flawlessly, and this exceptional performance is expected for the duration of the extended mission. SORCE spacecraft parameters such as orbit decay rates and battery life are more than adequate to support the mission for at least another 10 years.

As a PI-led mission, SORCE has achieved unprecedented scientific and programmatic success during the core mission, within the budget originally proposed. Data products are delivered and analyzed rapidly; flexible mission management ensures that all goals are accomplished even as serendipitous science is fully explored, and there is extensive student involvement at every step. SORCE is thus a paradigm of efficient, creative, low cost, space mission operation. It benefits from strong and effective institutional support, stable personnel with broad experience in instrument development, spacecraft operation and data reduction and distribution, effective financial management acquired from multiple past space mission successes, and ready access to University students. Together, these factors ensure that an extended SORCE mission will be equally successful and productive as the core emission. The SORCE team is eager to implement an extended mission!

The Senior Review Panel’s task is to identify those missions most contributing to NASA science goals or the nation’s operational goals, and to recommend appropriate funding levels for continued operation and production of standard data products. Additional and/or

enhanced data products will also be discussed. The review panel will be meeting face-to-face with team members from each of the 12 missions in late April.

## *New SORCE Data Products –*

The SORCE Science Data System (SDS) performs all science data production activities. It consists of the hardware and software components necessary to generate, manage, and distribute all SORCE standard science data products. ***The SORCE SDS routinely produces total solar irradiance and solar spectral irradiance data products on a daily basis.*** The Science Data System utilizes raw spacecraft and instrument telemetry, routinely-maintained calibration data, and other ancillary information to produce and distribute a variety of data products that have been corrected for all known instrumental and operational effects.

### Summary of SORCE Data Products

(available from <http://lasp.colorado.edu/sorce/>)

Product	Temporal Res.	Instr.	Spectral Coverage	Data Level	Data Vers.
TSI	Daily and 6-Hour	TIM	All $\lambda$	3	7
SSI	Daily	XPS	0.1-27 nm	3, 4	8
		SOLSTICE	115-310 nm	3	9
		SIM	310-2400 nm	3	12
Hi-Cadence XUV	5-minute	XPS	0.1 – 40 nm	4	8
Space Weather Mg II	Several per day	SOLSTICE	280 nm	2	9

SORCE provides routine daily measurements of TSI, SSI from 0.1 to 27 nm and 115 to 2400 nm, and other solar-irradiance derived products that support the atmospheric, climate, and space weather communities. TSI data products are formulated using measurements made by the SORCE TIM instrument, and are available in both daily average or 6-hour average formats. The SSI data products, including the Mg II index, are comprised of measurements made by the SORCE spectral instruments (XPS, SOLSTICE, and SIM). Routine calibration and validation is required to maintain the high quality of the solar irradiance data products. These efforts are ongoing.

Data processing is performed automatically with the production of data through Level 3 two to five days after the data are retrieved from the spacecraft, allowing for telemetry retransmissions and receipt of definitive spacecraft or-

bital ephemerides from NORAD. TSI and SSI data products are made available to the public immediately after they are produced by the data processing system, following automated quality checks.

The data products are available by direct download or interactive access to the **SORCE** website at <http://lasp.colorado.edu/sorce>, and are formally delivered to the GES DISC on a daily basis for long-term archival. Dissemination of **SORCE** data products via the **SORCE** website at LASP enhances convenience for users as data access methods are tailored to those most

functional for retrieving **SORCE** solar irradiance data. The **SORCE** project at LASP catalogs and maintains a full archive of data products, making various and flexible data access interfaces possible that are intended to provide added convenience to end-users. Configuration management of data is built into the **SORCE** data system, owing to integration of the **SORCE** data processing and dissemination components. The interactive Available Data Summary / Data Access Table below appears on the **SORCE** website. We encourage your feedback on how we can make the **SORCE** data more accessible.

**Available Data Summary Table / Data Access**

([http://lasp.colorado.edu/sorce/data/data\\_product\\_summary.htm](http://lasp.colorado.edu/sorce/data/data_product_summary.htm))

Data Product	Instrument	Time Cadence	Spectral Coverage	Spectral Resolution	Level	Version	Data Info	Full Mission Data Download Files	Interactive Access	File Readers (Listed by Language)
Total Solar Irradiance (TSI)	TIM	Daily	All	N/A	3	7	?	172KB		IDL
	TIM	6-Hourly	All	N/A	3	7	?	676KB		IDL
Spectral Solar Irradiance (SSI)	Composite (XPS, SOLSTICE, SIM)	Daily	0.1-40nm & 115-2400nm	Varies (1-34nm)	3		?	17MB		IDL
	SIM	Daily	310-2400nm	Varies (1-34nm)	3	12	?	13MB  14MB		IDL
	SOLSTICE	Daily	FUV, 115-180nm	1nm	3	9	?	1MB  1.1MB		IDL
	SOLSTICE	Daily	MUV, 180-310nm	1nm	3	9	?	2MB  2.1MB		IDL
	XPS	Daily	0.1-27nm	Broadband	3	8	?	972KB  688KB		IDL
	XPS	6-Hourly	0.1-27nm	Broadband	3	8	?	3.8MB  2.6MB		IDL
	XPS	Daily	0.1-40nm	0.1nm	4	8	?	2.2MB		IDL
	XPS	5-minute	0.1-40nm	0.1nm	4	8	?	256MB		IDL
	XPS	Daily	0.1-40nm	1nm	4	8	?	508KB		IDL
Space Weather	Magnesium II (MgII)	as measured	280nm	core-to-wing	2	9	?	520KB  260KB		IDL

text file

zipped text file

IDL save file

zipped IDL save file

NetCDF

Zipped NetCDF

Interactive

**TIM**

The TIM daily and 6-hourly averaged data are processed and made available within 7 days of acquisition, with updated files released daily. These total solar irradiance data give both the Sun's radiative output normalized to 1 AU (for studies of solar variability) and the Sun's

input at the top of the Earth's atmosphere (for direct Earth climate studies). TIM stability has proven very predictable and is tracked on-orbit. Successive data versions have updated degradation corrections and gain calibrations. Although no large changes are expected, version 8 data will be available in the next months.

## SIM

The SIM data is reported daily in the wavelength range from 310-2400 nm. In the 310-1600 nm region the SIM data is available at each of the six spectral samples that define the instrument's resolution function, thus there is no binning of the spectral resolution. In the longer wavelength regime, 1600-2400 nm, the data is sampled with 2 data points per resolution element (slightly under-sampled) and smoothed with a 2-point Gaussian filter. Over the reported operation range of SIM, the instrument covers 95.5% of the TSI and the integrate option on the SSI Time Series Data Access web page allows the user to define their own integrated sub-band of spectral irradiance data. Degradation corrections are an on-going process for the spectral instruments, and the web page version represents the most current understanding of these corrections. At the present time, the degradation correction are valid to about 0.1 to 0.5% for the visible part of the spectrum and as the analysis of the data evolves, updated versions and release notes will reflect this new understanding.

A summary of the SIM data quality improvements released in March of 2007 in version 12 are:

- 1) Prism degradation based on SIM A/B comparisons.
- 2) Data range is extended back to 1 August 2003.
- 3) Improvements in error propagation.

Upcoming SIM data improvements for future versions include:

- 1) Degradation corrections made through a prism ray path model to account for geometric effects.
- 2) Extension of the data back to April of 2003.

## SOLSTICE

Level 3 data from SOLSTICE is available on a daily basis from 115-310 nm. More than a dozen spectra at the full resolution of 0.1 nm are collected each 24-hour period. These measurements are then averaged and binned down to 1 nm intervals.

Newly reprocessed data (version 9) includes the following improvements:

- 1) Updated responsivities based on further analysis of the preflight calibration data. MUV irradiances increased by up to 5%, while the FUV irradiances changed by only about 2%.
- 2) Improved corrections for temperature changes in the instrument from an in-flight calibration experiment.
- 3) Degradation corrections for both FUV and MUV channels. The FUV analysis includes only stellar corrections, but the MUV channel includes a correction for changes in the field-of-view between solar and stellar modes. Analysis of instrumental changes is an ongoing effort, but the current corrections are accurate to about 0.5% per year.
- 4) Correction of the changed field-of-view in SOLSTICE A after the entrance slit anomaly of January 2006. The entrance aperture shifted by a few arc min-

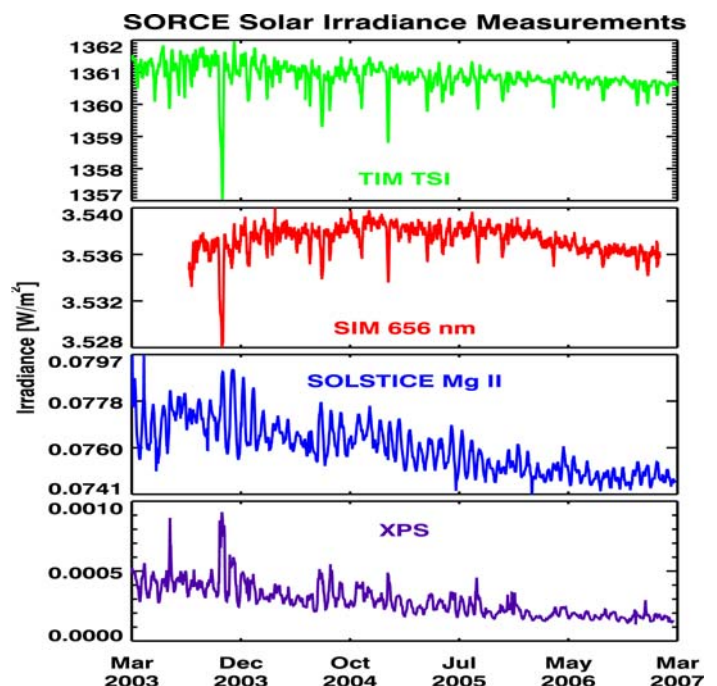
utes. The instrument's responsivity at this new position is different by a few percent at some wavelengths, and this new correction takes account of it.

## XPS

The two public data products, Level 3 and Level 4, are both derived from the XPS Level 2 data product that is the irradiance from each photometer in its inherent broadband (7-10 nm) and at the time cadence of individual measurements (10-60 sec). The XPS Level 3 data product is also the irradiance in the photometer's broadbands but averaged over 6-hour and 24-hour intervals within a UT day. The XPS Level 4 data product is at higher spectral resolution (0.1 nm) by scaling a combination of CHIANTI spectral models to match the XPS photometer currents (signal). The daily SORCE XPS Level 4 data products are also merged into a mission data file, both in daily (24-hour) averages and in 5-minute averages.

There are 3 significant improvements in the XPS version 8 data products that were released in March 2007.

- 1) The XPS responsivities were updated based on reanalysis of the XPS preflight calibration data. The version 8 irradiance level increased by 2-10% in the 0-17 nm range and increased by 45% in the 17-27 nm range.
- 2) New processing algorithms were developed to handle the new XPS observation sequences that started in December 2005. The new algorithms include updates for the procedures that obtain the dark and visible background signals and fused silica window transmissions.
- 3) The CHIANTI spectral model is now used for the XPS Level 4 data products. Prior to version 8, a simple empirical model that used the daily solar 10.7 cm radio flux as its input proxy was used to obtain higher spectral resolution results for XPS.

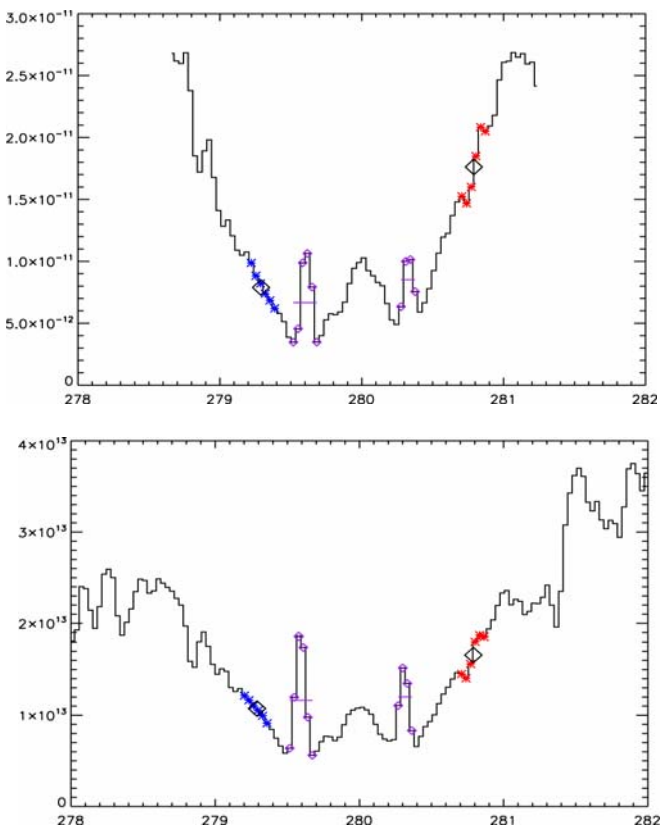


Sample plots available from the SORCE website:  
[http://lasp.colorado.edu/sorce/sorce\\_data\\_access/](http://lasp.colorado.edu/sorce/sorce_data_access/).

## Solar & Stellar Activity Cycle Size –

By Marty Snow, LASP, University of Colorado

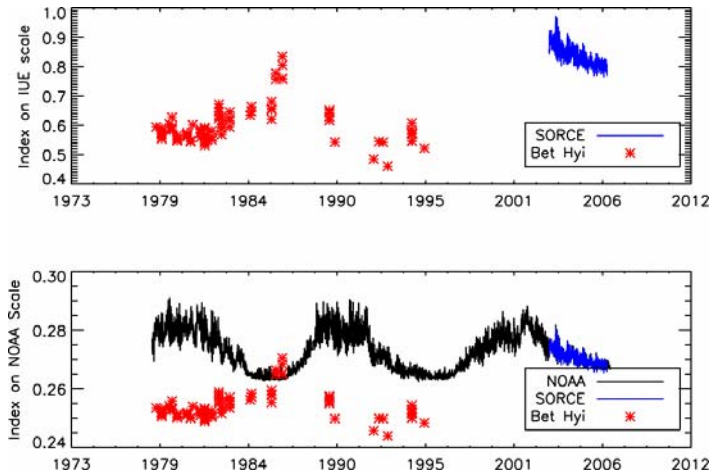
Stellar astronomers have observed activity cycles on other stars similar to the Sun's 11-year cycle. A recent project has used SOLSTICE data to scale the data for one such star to the solar cycle amplitude using the Mg II index. Beta Hyi is a G2 subgiant. It is more evolved than the Sun, but is about the same temperature. It has been observed using the International Ultraviolet Explorer (IUE) for many years. However, the spectra taken with IUE can't be used to make a Mg II index in the standard way because the data from the wings is saturated. Send in SOLSTICE!



**Figure 1.** Spectra of beta Hyi and the Sun at SOLSTICE spectral resolution (0.1nm). The blue and red points indicate the wing regions. The purple diamonds are the core emissions. These wings were chosen to avoid all saturated pixels in the IUE spectra.

We have found that in the case of the Sun, almost all of the variability near 280 nm is confined to the Mg II emission cores. Taking wing reference irradiance levels just outside the cores can make a very workable Mg II core-to-wing index. However, this new index will need to be corrected to get it onto the standard NOAA scale. We convolved the IUE spectra with the SOLSTICE instrument function and then calculated a core-to-wing ratio for both datasets in the same way. Figure 1 shows the spectra from the Sun and beta Hyi. We then did a linear

correlation of this "IUE" index of the solar data to the NOAA solar data to determine the scaling factors. Figure 2 shows the results of this analysis.

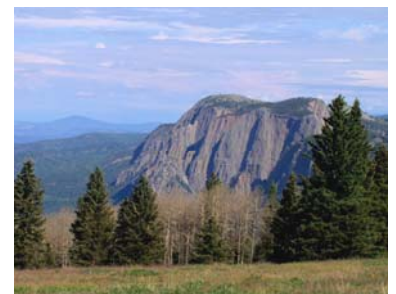


**Figure 2.** (top) Core-to-wing ratios for bet Hyi and the Sun using wing definitions as shown in Figure 1. The SORCE SOLSTICE data can then be used to correlate activity levels to the NOAA scale (bottom). The variability of bet Hyi is similar to the Sun in size, but is at a lower level than solar activity.

We can see that beta Hyi has a magnetic activity cycle that is about the same size as the Sun's in amplitude, but is at a lower strength level than the Sun. This is consistent with the subgiant star having a smaller chromosphere than the Sun. The cycle period for this star is perhaps about 12.5 years, although it is highly uncertain since only one activity peak has been observed. These results will be submitted to *Monthly Notices of the Royal Astronomical Society* in a short paper by Metcalfe *et al.* later this month.

## SORCE Science Meeting Plans –

The organizers of the next SORCE Science Team Meeting have started planning. With a focus on SORCE's 5<sup>th</sup> anniversary, the topic is **"SORCE's Past and Future Role in Earth Science Research"**.



Possible sessions include:

- Variability of the Solar Irradiance Over the Solar Cycle
- Atmospheric Chemistry Models Using Solar Variability
- Climate Models Using Solar Variability
- Models of Solar Processes Causing Variability Affecting Climate

We will be meeting in Santa Fe, New Mexico in February or March 2008. Additional information will be available on the SORCE website very soon –

<http://lasp.colorado.edu/sorce/news/meetings.htm>.

## **Fontenla et al. Paper Accepted –**

*By Jerry Harder, LASP, University of Colorado*

“Log-normal intensity distribution of the quiet-Sun FUV continuum observed by SUMER” by Juan Fontenla et al. has been accepted for publication in *Astronomy & Astrophysics*. Fontenla collaborated with Werner Curdt, Max-Planck-Institut für Sonnensystemforschung, and Gene Avrett of Harvard Smithsonian to explain the intensity distribution of bright ultraviolet regions that arise from small-scale solar features.

This study relates to SORCE measurements because the origins of solar variability in the ultraviolet part of the spectrum are an important question with implications for both Earth atmosphere / Earth climate studies and for solar physics. Studies of this kind will help to interpret the time series observations of the SORCE SOLSTICE and will help specify the role of network and active network as sources of solar UV irradiance variability, and their relationship with magnetic fields at scales smaller than a typical active region. These contributions have been controversial and are potentially important to the origins of this UV variability. Only detailed studies, like the one presented here, coupled with full Sun modeling, comparison with spatially resolved observations, and spectral irradiance measurements like the ones performed by SORCE can provide a definitive answer to these questions.

When this paper becomes available on-line, the link will be advertised.

# **310,260**

## **Hits to the SORCE Website**

*(Since 4/21/03, As of 3/23/07)*

## **Upcoming Meetings / Talks –**

*SORCE scientists plan to present papers or attend the following 2007 meetings:*

IUGG – July 2-13, Perugia, Italy

SPIE – Optical and Photonics, August 28-30,  
San Diego, CA

CALCON, Conference on Characterization and  
Radiometric Calibration for Remote Sensing,  
Sept. 10-13, Logan, UT

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