Accessing Solar Irradiance Data via LISIRD, *the LASP Interactive Solar Irradiance Datacenter*

Chris Pankratz, Anne Wilson, Martin Snow, Doug Lindholm, Thomas Woods, Tyler Traver, Donald Woodraska
chris.pankratz@lasp.colorado.edu

http://lasp.colorado.edu/lisird/

LASP Laboratory for Atmospheric and Space Physics, University of Colorado at Boulder
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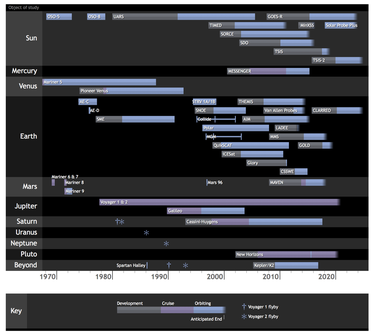
Overview

The Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado operates the LASP Interactive Solar IRradiance Datacenter (LISIRD), a centralized distribution site for solar irradiance data. With this site, we provide:



- **Solar irradiance models**, synthesized spectra, and associated results
- **Composite solar irradiance data products**, integrating measurements from different instruments, reference spectra, etc.
- **Flexible user-friendly interfaces** for locating, browsing, and downloading data products
- **Rapid data availability** for operational missions / projects
- Flexible options for data access and formats
- Web-based tools to facilitate basic data analysis and visualization
- Standards-based and service-oriented data access, filtering, and format transformation

LASP has been measuring solar irradiance for more than 30 years and has an extensive array of data available. LISIRD provides uniform access to these data, as well as selected other data sets served via LISIRD.

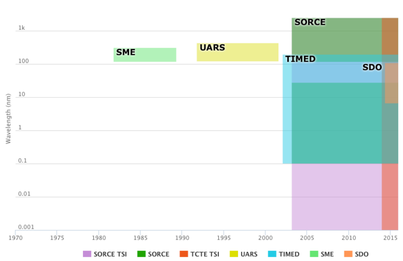
A new LISIRD Web Site is being readied, bringing an enhanced interactive plotting interface, additional standards-based access methods, new data sets, and more. This site is available for preliminary use at http://lasp.colorado.edu/lisird3

Solar Irradiance Measurements

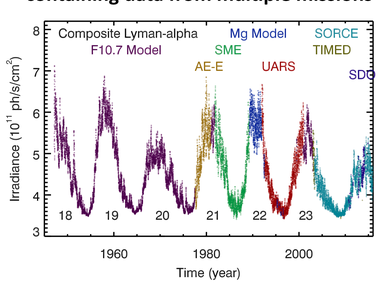
LISIRD serves a broad variety of solar irradiance measurements. Measurements are available from several space missions, including the full-disk Spectral Solar Irradiance (SSI) from ~0.1 nm to 2400 nm and Total Solar Irradiance (TSI). Together, these datasets provide solar data coverage spanning decades.

Spectral Region	Wavelength (nm)	Missions / Instruments
Soft X-ray (XUV)	0.1-30	SORCE-XPS, SNOE, TIMED-SEE, SDO-EVE
Extreme Ultraviolet (EUV)	30-115	TIMED-SEE, SDO-EVE
Far Ultraviolet (FUV)	115-180	SORCE-SOLSTICE, SME, UARS-SOLSTICE, TIMED-SEE, SDO-EVE (Lyman α)
Middle Ultraviolet (MUV)	180-310	SORCE-SOLSTICE, SME, UARS-SOLSTICE
Near Ultraviolet (NUV)	240-310	SORCE-SIM, UARS-SOLSTICE
Visible (VIS)	310-950	UARS SOLSTICE, SORCE-SIM
Near Infrared (NIR)	950-2400	SORCE-SIM
Total Solar Irradiance (TSI)	Bolometric	SORCE-TIM, TCTE-TIM

Solar Irradiance Measurements Timeline and Spectral Coverage



Composite Lyman-α time series containing data from multiple missions



LISIRD Data Access

The LISIRD website provides interactive web-based interfaces and programatic interfaces to support both data discovery and scriptable/bookmark-able access to several solar irradiance data sets, including **spectra and time series**.

Users can **dynamically explore** data and choose to download either complete datasets or subsets in a variety of formats.

Examples: TSI data from only the past year, or SSI for a particular wavelength range

A powerful and ***flexible web service interface*** (known as **LaTiS**) is also available, providing "programmatic" data access, subsetting, bookmark-able direct downloads, script support, and the ability to read data directly into an IDL data structure.

Key Features:

- Direct "to-your-tool" data support with IDL code snippets
- Several selectable output formats supported, including csv, txt, json, bin, dods. More are planned.
- Dynamic time reformatting, with multiple formats supported
- Support for directly serving data originating from external services, e.g. Virtual Observatories

We are continuing to add additional related data products (e.g. solar indices, other solar irradiance measurements and models served from other institutions) and tools to facilitate data comparison and data fusion.

Suggestions for other data sets and/or access capabilities are welcome.

Programmatic Access Usage:

Most LISIRD data are available via a standard "RESTful" interface that supports specification of parameters, e.g.

http://server/latis/dataset.suffix?projection&selection&filter

where

suffix: type of output (e.g. csv, txt, bin)
projection: list of variables to return (e.g. "time,irradiance")
selection: relative constraint (*e.g.* time>=2012-01-01 or irradiance>1360.5)
filter: Optional operations/functions to be applied to the data (e.g. thin, binavg)

Examples:

Most recent 3-months of SORCE Lyman α
http://lasp.colorado.edu/lisird3/latis/sorce_ssi_l3.csv?wavelength=121.5&time>=2015-09-01

SORCE TSI during the 2003 Venus solar transit
http://lasp.colorado.edu/lisird3/latis/sorce_tsi_6hr_l3.csv?time>=2003-10-05&time<2003-11-24

UARS SOLSTICE solar spectra for 2/10/1991
http://lasp.colorado.edu/lisird3/latis/uars_solstice_ssi.csv?time,irradiance&time>=1991-02-10&time<1991-02-11

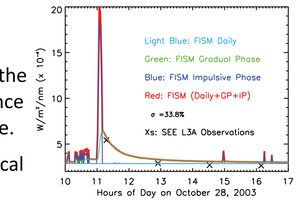
Cutting Edge Technology

See also poster IN13A-1814: "Interoperable Solar Data and Metadata via LISIRD 3" for details on the groundbreaking data management and interoperability technologies used.

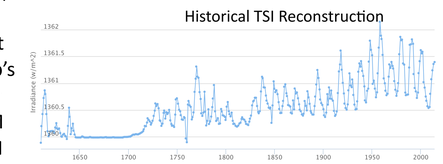
LISIRD3 uses a semantically enabled metadata repository, LEMR, to dynamically provide vetted, managed documentation about LISIRD datasets. Both LISIRD and LEMR provide interoperable, standards-based, service-oriented interfaces, usable by either interactive or automated tools.

Solar Models

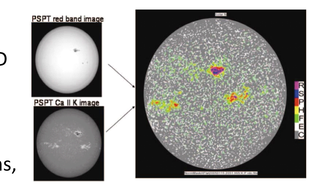
Solar models are crucial to understanding solar physics and its influences. On the LISIRD site, we provide composite, reconstructed, and/or synthesized spectra and time series based on the following solar models:



- **Flare Irradiance Spectral Model (FISM)**: LISIRD provides downloads of Phil Chamberlin's model of the EUV & FUV Solar spectrum on 1-minute time cadence to model the effects of flares on the solar irradiance.
- **Historical TSI**: LISIRD provides downloads of historical TSI for the last 400 years based on an historical TSI reconstruction by N. Krivova et al. (see references below), which is used in the IPCC AR5 Working Group I's Assessment Report. The values from this group's SATIRE model have been offset for agreement with recent SORCE-TIM values and replaced by SORCE-TIM annual average measurements from 2003 onward. The historical reconstruction provided via LISIRD is updated annually



- **Solar Radiation Physical Modeling (SRPM)**: LISIRD provides access to Juan Fontenla's SRPM model. SRPM uses daily images from the PSPT to determine the absolute contributions to the spectral irradiance at all visible and IR wavelengths, from the various features (plage, sunspots, penumbra, etc).



- **NRL Solar Spectral Irradiance Version 2 (NRLSSI2)**: jointly developed by Dr. Judith Lean at the Naval Research Laboratory (NRL) and Drs. Odele Coddington and Peter Pilewskie (LASP). Empirically derived using proxies of sunspot area and facular brightening, validated with SSI measurements. The NRLSSI model covers 115 nm to 100 µm with estimates of the solar spectral irradiance daily since 1950, monthly since 1882 and annually since 1610.

References

FISM:

1. Chamberlin, P. C., T. N. Woods, and F. G. Eparvier, Flare Irradiance Spectral Model (FISM): Flare component algorithms and results, Space Weather, 6, S05001, doi:10.1029/2007SW000372, 2008.
2. Chamberlin, P. C., T. N. Woods, and F. G. Eparvier, Flare Irradiance Spectral Model (FISM): Daily component algorithms and results, Space Weather, 5, S07005, doi:10.1029/2007SW000316, 2007.

Historical TSI: N.A. Krivova, L.E.A. Vieira, S.K. Solanki (2010). Journal of Geophysical Research: Space Physics, Volume 115, Issue A12, CiteID A12112. DOI:10.1029/2010JA015431.

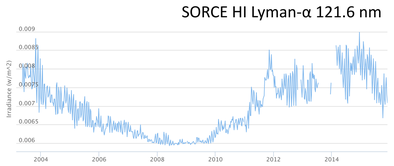
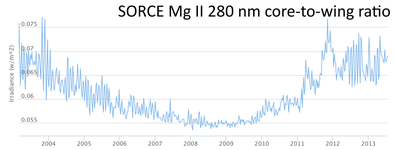
SRPM:

1. Fontenla, J.M., Avrett, E., Thuillier, G., and Harder, J., "Semi-empirical models of the solar atmosphere. I. The quiet and active-Sun photosphere at mid-resolution", ApJ, 639, 441-458 (2006)
3. Fontenla, J., Harder, J., "Physical Models of Spectral Irradiance Variations", MmSAI, 76, 826-833 (2005)
4. Harder, J., Fontenla, J., White, O., Rottman, G. and Woods, T., "Solar Spectral Irradiance Variability Comparisons of the SORCE SIM Instrument with Monitors of Solar Activity and Spectral Synthesis", MmSAI, 76, 735-742 (2005)
5. Fontenla, J.M. ., White , O.R. , Fox , P.A., Avrett , E.H., and Kurucz, R.L., "Calculation of Solar Irradiances I: Synthesis of the Solar Spectrum ", ApJ, 518, 480-499 (1999).

NRLSSI: Coddington, O., J. Lean, P. Pilewskie, M. Snow, and D. Lindholm (2015), A solar irradiance climate data record, BAMS, (accepted). Available in early online release from http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-14-00265.1.

Space Weather Data

LISIRD provides many data sets useful for space weather studies, including spectral line integrations.

There is a growing need for rapid availability space weather data.

LISIRD provides timely access to daily measurements from SORCE, TIMED-SEE, and SDO EVE including Lyman α (121.6 nm) and the Magnesium II index.