National Aeronautics and Space Administration
Goddard Earth Science
Data Information and Services Center (GES DISC)

README Document for the Total and Solar Spectral Irradiance Sensor (TSIS) Level 3 Data Products

TSIS_SSI_L3_12HR
TSIS_SSI_L3_24HR
TSIS_TSI_L3_06HR
TSIS_TSI_L3_24HR

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1. Introduction

This document provides basic information on using the first Total and Solar Spectral Irradiance Sensor (TSIS-1) Level 3 data products.

1.1 Data Product Descriptions

The TSIS-1 instrument suite produces two primary data product types: Total Solar Irradiance (TSI) over all wavelengths, and Solar Spectral Irradiance (SSI) from 200 nm to 2400 nm. The TSI data products are derived using measurements made by the TSIS-1 Total Irradiance Monitor (TIM) instrument, and are available in both daily and 6-hourly means. The SSI data products are comprised of measurements made by the TSIS-1 Spectral Irradiance Monitor (SIM) instrument, and are available in both daily and 12 hourly means. Each of the TSIS-1 level 3 products are written in a tabular ASCII file format.

Table 1: TSIS Level 3 Products

ShortName	Version	LongName	DOI
TSIS_SSI_L3_12HR	02	TSIS SIM Level 3 Solar Spectral Irradiance 12-Hour Means	10.5067/TSIS/SIM/DATA303
TSIS_SSI_L3_24HR	02	TSIS SIM Level 3 Solar Spectral Irradiance 24-Hour Means	10.5067/TSIS/SIM/DATA304
TSIS_TSI_L3_06HR	02	TSIS TIM Level 3 Total Solar Irradiance 06-Hour Means	10.5067/TSIS/TIM/DATA303
TSIS_TSI_L3_24HR	02	TSIS TIM Level 3 Total Solar Irradiance 24-Hour Means	10.5067/TSIS/TIM/DATA304

1.1.1 Instruments

The TSIS suite consists of two instruments, the Total Irradiance Monitor (TIM) and the Spectral Irradiance Monitor (SIM).The TIM and SIM instruments are similar to those flown on the SORCE mission, and the TIM instrument on the TCTE mission. The instruments measure the Sun on orbital sunrise and sunset events (~15 orbits per day). Requirements are to acquire measurements at least 83 percent (66 percent threshold) of the time the Sun is visible as constrained by ISS viewing conditions and operations maneuvers.

- TIM measures the total solar irradiance (TSI) that is incident at the top of the Earth's atmosphere. TIM is an ambient temperature active cavity radiometer. TIM is expected to measure TSI to an estimated absolute accuracy of 100 ppm (0.01%). TIM began measurements on January 11, 2018. The science investigator for TIM is Dr. Gregg Kopp.

- SIM is a three channel solar spectral spectrometer which measures the solar spectral irradiance (SSI) between 200 and 2400 nm. The spectral resolution ranges between 2 nm (<0.28 µm), 5 nm (µ), and 45 nm (>0.4 µm). Absolute accuracy is about 2% in the visible (about 10% in the infrared). SIM measurements began March 14, 2018. The science investigator for SIM is Dr. Erik Richard.

The TSIS principle investigator (PI) is Dr. Peter Pilewskie.

1.1.2 Platform

TSIS-1 was successfully launched on December 15, 2017 from Cape Canaveral Air Force Station aboard a Space X Falcon rocket within a Dragon cargo container. After two days, the Dragon capsule docked to the International Space Station (ISS) after which TSIS-1 was installed on the ISS ExPRESS logistics carrier (ELC)-3 on December 30, 2018.

The orbit of the ISS can be characterized by the following:

- circular orbit with 403 km perigee and 409 km apogee
- inclination of 51.64 degrees
- period of an orbit is about 92.68 minutes
- number of orbits per day is 15.54

1.2 Algorithm Background

TSIS-1 continues the solar measurements made by its SORCE and TCTE predecessors, and uses basically the same algorithm. Please see the Algorithm Theoretical Basis Document (ATBD) for a full description of the TSIS algorithm (also available from links in section 5.2).

1.3 Data Disclaimer

Users are asked to read all pertinent documents (algorithm description, release notes, etc.) before using any of the data products. Users are also asked to cite the data products used in any publications. An example citation, in addition to documentation, can be found on each data product landing page (see links in section 5.2).

2. Data Organization

The TSIS-1 TSI data span the time period from January 11, 2018 to the present. The TSIS-1 SSI data span the time period from March 14, 2018 to the present. Data are appended to each product's file periodically as data are processed and delivered to the archive.

2.1 File Naming Convention

The data product files are named according to the following convention:

<Mission>_<Measurment>_<Level>_<Cadence>_<Version>_<BeginDate>_<EndDate>.<Suffix>

where:

- Mission = name of the mission (always 'tsis')
- Measurment = name of the measurement type (either 'ssi' or 'tsi')
- Level = process level (always 'L3')
- Cadence = cadence in hours (either 'c06h', 'c12h', or 'c24h')
- Version = collection version number (currently 'v02')
- BeginDate = Date of first data measurement in format <YYYYMMDD>, where
    1. YYYY = 4 digit year (2018 – onward)
    2. MM = 2 digit month (01 – 12)
    3. DD = 2 digit day of month (01 – 31)
- EndDate = Date of last data measurement in format <YYYYMMDD>, where
    1. YYYY = 4 digit year (2018 – onward)
    2. MM = 2 digit month (01 – 12)
    3. DD = 2 digit day of month (01 – 31)
- Suffix = the file format (always 'txt', indicating tape binary data)

File name example: tsis_ssi_L3_c12h_v01_20180314_20180911.txt

2.2 File Format and Structure

The data for each product are arranged in a single file in a tabular ASCII text file which can be easily read into a spreadsheet application. New data are appended to the file on a daily basis (or as they become available). Each product data file contains a header section with metadata describing the product, followed by a column formatted table (see section 3.1).

2.3 Key Science Data Fields

The primary science data measurement in the TSIS SSI data products is the solar spectral irradiance given in W/m^2/nm, and in the TSIS TSI data products the total solar irradiance normalized at 1AU as well as at earth distance given in W/m^2.

Figure 1: Example of TSIS-1 solar spectral irradiance

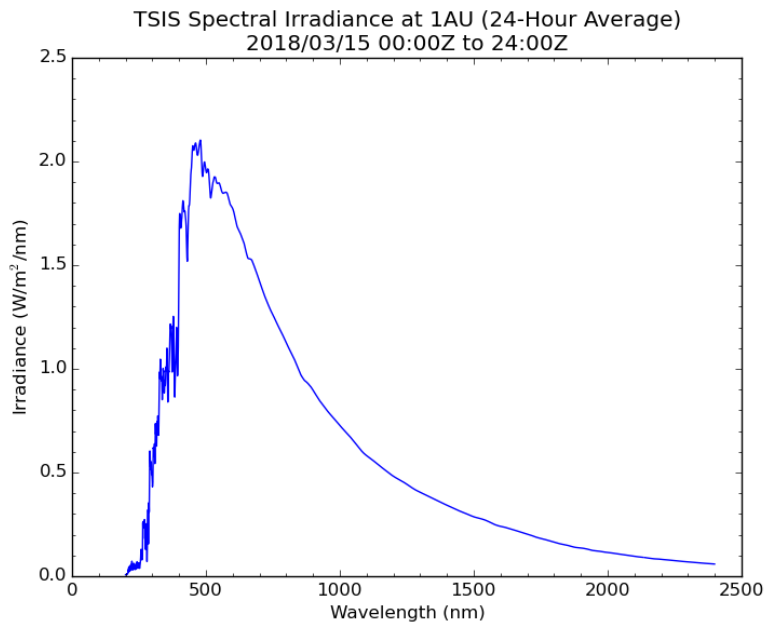
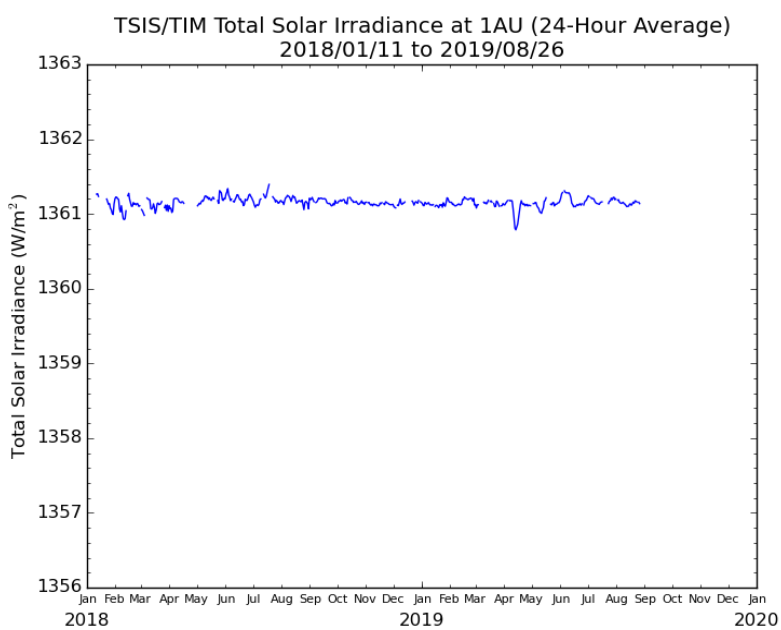


Figure 2: Example of TSIS-1 total solar irradiance



3. Data Contents

The granularity of the data products is the entire mission.

3.1 Data Records

After the header section in each file, each row in the data table consists of a data record. The formats are shown in the tables below.

Table 2: TSIS SSI Columns

Number	Name	Units	Type	Format
1	nominal_date_yyyymmdd	-	64-bit float	F11.2
2	nominal_date_jdn	-	64-bit float	F11.2
3	wavelength	nm	32-bit float	F9.3
4	instrument_mode_id	-	16-bit integer	I3
5	data_version	-	16-bit integer	I3
6	irradiance	$W/m^2/nm$	64-bit float	E15.8
7	instrument_uncertainty	$W/m^2/nm$ (1σ)	64-bit float	E15.8
8	measurement_precision	$W/m^2/nm$ (1σ)	64-bit float	E15.8
9	measurement_stability	$W/m^2/nm$	64-bit float	E15.8
10	quality	-	16-bit integer	I4

Table 3: TSIS TSI Columns

Number	Name	Units	Type	Format
1	nominal_date_yyyymmdd	-	64-bit float	F12.3
2	nominal_date_jdn	-	64-bit float	F12.3
3	avg_measurement_date_jdn	-	64-bit float	F15.6
4	std_dev_measurement_date	-	32-bit float	F7.4
5	tsi_1au	W/m^2	64-bit float	F10.4
6	instrument_accuracy_1au	W/m^2 (1σ)	32-bit float	E10.3
7	instrument_precision_1au	W/m^2 (1σ)	32-bit float	E10.3
8	solar_standard_deviation_1au	W/m^2 (1σ)	32-bit float	E10.3
9	measurement_uncertainty_1au	W/m^2 (1σ)	32-bit float	E10.3
10	tsi_true_earth	W/m^2	64-bit float	F10.4
11	instrument_accuracy_true_earth	W/m^2 (1σ)	32-bit float	E10.3
12	instrument_precision_true_earth	W/m^2 (1σ)	32-bit float	E10.3
13	solar_standard_deviation_true_earth	W/m^2 (1σ)	32-bit float	E10.3
14	measurement_uncertainty_true_earth	W/m^2 (1σ)	32-bit float	E10.3
15	provisional_flag (1: provisional, 0: final)	-	16-bit integer	I2

3.2 Metadata

The metadata are contained in a separate XML formatted file having the same name as the data file with .xml in place of .txt.

Table 3-2: Metadata attributes associated with the data file.

Name	Description
ShortName	Short name of the data product.
LongName	Long name of the data product.
VersionID	Product or collection version.
GranuleID	Granule identifier, i.e. the name of the file.
Format	File format of the data file.
CheckSumType	Type of checksum used.
CheckSumValue	The value of the calculated checksum.
SizeBytesDataGranule	Size of the file or granule in bytes.
InsertDateTime	Date and time when the granule was inserted into the archive. The format for date is YYYY-MM-DD and time is hh-mm-ss.
ProductionDateTime	Date and time the file was produced in format YYYY-MM-DDThh:mm:ss.ssssssZ
PGEVersion	Version of the Product Generation Executable (PGE)
RangeBeginningDate	Begin date when the data was collected in YYYY-MM-DD format.
RangeBeginningTime	Begin time of the date when the data was collected in hh-mm-ss format.
RangeEndingDate	End date when the data was collected in YYYY-MM-DD format.
RangeEndingTime	End time of the date when the data was collected in hh-mm-ss format.
PlatformShortName	Short name or acronym of the platform or satellite
InstrumentShortName	Short name or acronym of the instrument
SensorShortName	Short name or acronym of the sensor
PSA	Block containing Product Specific Attribute (PSA) name and value pairs
MeasuredParameter	Block containing parameter name, QA percent missing and interpolated, as well as automatic, operational and scientific quality flag settings

4. Reading the Data

The data for each product are arranged in a single file using a tabular ASCII text format which can be easily read into a spreadsheet application.

TSIS SSI Products FORTRAN Format Specifier:
`(F11.2,F11.2,F9.3,I3,I3,E15.8,E15.8,E15.8,E15.,I4)`

TSIS TSI Products FORTRAN Format Specifier:
`(F12.3,F12.3,F15.6,F7.4,F10.4,E10.3,E10.3,E10.3,E10.3,F10.4,E10.3,E10.3,E10.3,E10.3,I2)`

An IDL reader for the ASCII formatted data is available from the LASP TSIS team at:
http://lasp.colorado.edu/data/tsis/file_readers/read_lasp_ascii_file.pro

5. Data Services

5.1 GES DISC Search

The GES DISC provides a keyword, spatial, temporal and advanced (event) searches through its unified search and download interface:

https://disc.gsfc.nasa.gov/

5.2 Documentation

The data product landing pages provide information about these data products, as well as links to download the data files and relevant documentation:

https://disc.gsfc.nasa.gov/datacollection/TSIS_SSI_L3_12HR_02.html

https://disc.gsfc.nasa.gov/datacollection/TSIS_SSI_L3_24HR_02.html

https://disc.gsfc.nasa.gov/datacollection/TSIS_TSI_L3_06HR_02.html

https://disc.gsfc.nasa.gov/datacollection/TSIS_TSI_L3_24HR_02.html

5.3 Direct Download

These data products are available for users to download directly using HTTPS:

https://acdisc.gesdisc.eosdis.nasa.gov/data/TSIS_Level3/TSIS_SSI_L3_12HR.02/

https://acdisc.gesdisc.eosdis.nasa.gov/data/TSIS_Level3/TSIS_SSI_L3_24HR.02/

https://acdisc.gesdisc.eosdis.nasa.gov/data/TSIS_Level3/TSIS_TSI_L3_06HR.02/

https://acdisc.gesdisc.eosdis.nasa.gov/data/TSIS_Level3/TSIS_TSI_L3_24HR.02/

6. More Information

6.1 Contact Information

Name: GES DISC Help Desk
URL: https://disc.gsfc.nasa.gov/
E-mail: gsfc-help-disc@lists.nasa.gov
Phone: 301-614-5224
Fax: 301-614-5228
Address: Goddard Earth Sciences Data and Information Services Center
Attn: Help Desk
Code 610.2
NASA Goddard Space Flight Center
Greenbelt, MD 20771, USA

6.2 References

Kopp, G. and Lawrence, G., "The Total Irradiance Monitor (TIM): Instrument Design," Solar Physics, 230, 1, Aug. 2005, pp. 91-109.

Kopp, G., Heuerman, K., and Lawrence, G., "The Total Irradiance Monitor (TIM): Instrument Calibration," Solar Physics, 230, 1, Aug. 2005, pp. 111-127.

6.3 External Links

LASP TSIS-1 home page: http://lasp.colorado.edu/home/tsis/

NASA TSIS-1 mission page: https://www.nasa.gov/goddard/tsis-1

7. Appendices

7.1 Acronyms

EOS: Earth Observing System

ESDIS: Earth Science and Data Information System

GES DISC: Goddard Earth Sciences Data and Information Services Center

GSFC: Goddard Space Flight Center

ISS: International Space Station

L3: Level-3 Data

LASP: Laboratory for Atmospheric and Space Physics (University of Colorado, Boulder)

NASA: National Aeronautics and Space Administration

SIM: Spectral Irradiance Monitor

SSI: Solar Spectral Irradiance

TIM: Total Irradiance Monitor

TSI: Total Solar Irradiance

TSIS: Total and Solar Spectral Irradiance Sensor