



*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-1) Level 3 Data Products

TSIS_SSI_L3_12HR
TSIS_SSI_L3_24HR
TSIS_TSI_L3_06HR
TSIS_TSI_L3_24HR

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Revision History

<i>Revision Date</i>	<i>Changes</i>	<i>Author</i>
09/27/2018	Original	James E. Johnson
09/04/2019	Version 02 updates	Michael Chambliss
06/21/2023	Version 03 TIM / Version 10 SIM updates	Stéphane Béland, Keira Brooks, Michael Chambliss, Luke Charbonneau, Courtney Peck, Steven Penton, Brandon Stone

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1. Introduction

This document provides basic information on using the International Space Station (ISS)–based Total and Solar Spectral Irradiance Sensor (TSIS-1) Level 3 (L3) data products. The TSIS-1 mission has concluded its prime (5-yr) mission (2018-2023) and is now in the extended mission stage (2023-2029).

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 200–2400 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 (24-hour) and 6-hour 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 (24-hour) and 12-hour averages. All TSIS-1 L3 data products hosted on the GES DISC are written in a tabular ASCII file format. These data products are listed in Table 1.

Table 1: TSIS-1 Level 3 (L3) Data Products

Short Name	Long Name	Data Product Link (redirects to latest data product version in GES DISC, see §5.2)
TSIS_SSI_L3_12HR	TSIS-1 SIM L3 SSI 12-Hour Means	https://doi.org/10.5067/TSIS/SIM/DATA313
TSIS_SSI_L3_24HR	TSIS-1 SIM L3 SSI 24-Hour Means	https://doi.org/10.5067/TSIS/SIM/DATA314
TSIS_TSI_L3_06HR	TSIS-1 TIM L3 TSI 06-Hour Means	https://doi.org/10.5067/TSIS/TIM/DATA305
TSIS_TSI_L3_24HR	TSIS-1 TIM L3 TSI 24-Hour Means	https://doi.org/10.5067/TSIS/TIM/DATA306

1.1.1 Instruments

TSIS-1 consists of two instruments, the Total Irradiance Monitor (TIM) and the Spectral Irradiance Monitor (SIM). The TSIS-1 SIM instrument is similar to that flown on the Solar Radiation and Climate Experiment (SORCE) mission, but with 3 channels instead of 2. The TSIS-1 TIM instrument is similar to that flown on the SORCE and TSI Calibration Transfer Experiment (TCTE) missions. The instruments measure the Sun from orbital sunrise to sunset (~15 orbits per day). Requirements are to acquire 24-hour 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 TSI across the entire solar spectrum. TIM is an ambient temperature, active cavity radiometer. TIM measures TSI to an estimated absolute accuracy of 100 ppm (0.01%). TIM measurements began on January 11, 2018. The TIM instrument scientist is Dr. Gregg Kopp¹.
- SIM is a three-channel solar spectral spectrometer that measures SSI from 200—2400 nm. The spectral resolution ranges between 0.25 nm in the UV (200 nm) through 38 nm in the near IR (~2000 nm). Absolute accuracy uncertainty, based upon ground calibration and on-orbit measurements, is ~0.4% (1 σ) from 200—460 nm, and ~0.25 % (1 σ) from 460—2400 nm. SIM measurements began on March 14, 2018. The SIM instrument scientist is Dr. Erik Richard¹.

The TSIS-1 LASP principal investigator is Dr. Thomas Woods¹, the TSIS-1 LASP project manager is Tom Patton¹, and the TSIS-1 GSFC Project Scientist is Dong Wu².

¹ Laboratory for Atmospheric and Space Physics (LASP)

² Goddard Space Flight Center (GSFC)

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 at 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 ~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 similar calibration algorithms. See the Algorithm Theoretical Basis Document ([ATBD](#)) for a full description of the TSIS-1 algorithms (available from links in [§5.2](#)).

1.3 Data Disclaimer

Users are asked to read all pertinent documents (data file headers, release notes, algorithm descriptions, 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 [§5.2](#)).

2. Data Organization

The TSIS-1 TSI data span the period from January 11, 2018, to the present. The TSIS-1 SSI data span the 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. Upon each new version, the entire dataset is reprocessed with new degradation corrections. TSIS-1 SIM introduces a new version every ~6 months, while TSIS-1 TIM only updates versions when new calibrations are required.

2.1 File Naming Convention

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

<Mission>_<Measurement>_<Level>_<Cadence>_<Version>_<BeginDate>_<EndDate>.<Suffix>
where:

- Mission = name of the mission (always 'tsis')
- Measurement = 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')

File name example: `tsis_ssi_L3_c12h_v10_20180314_20230525.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 daily, or as they become available. Each product ASCII file contains a header section with metadata describing the product, followed by a column formatted table (see [§3.1](#)).

2.3 Key Science Data Fields

The primary science measurement in the SIM data products is solar spectral irradiance (SSI) given in $\text{W}/\text{m}^2/\text{nm}$. The primary measurement for TIM data products is total solar irradiance (TSI) in W/m^2 . Both measurements are normalized to a distance of 1AU. Figure 1 shows an example of TSIS-1 SIM SSI measurements, while Figure 2 shows the TSIS-1 TIM TSI record as of May-24-2023.

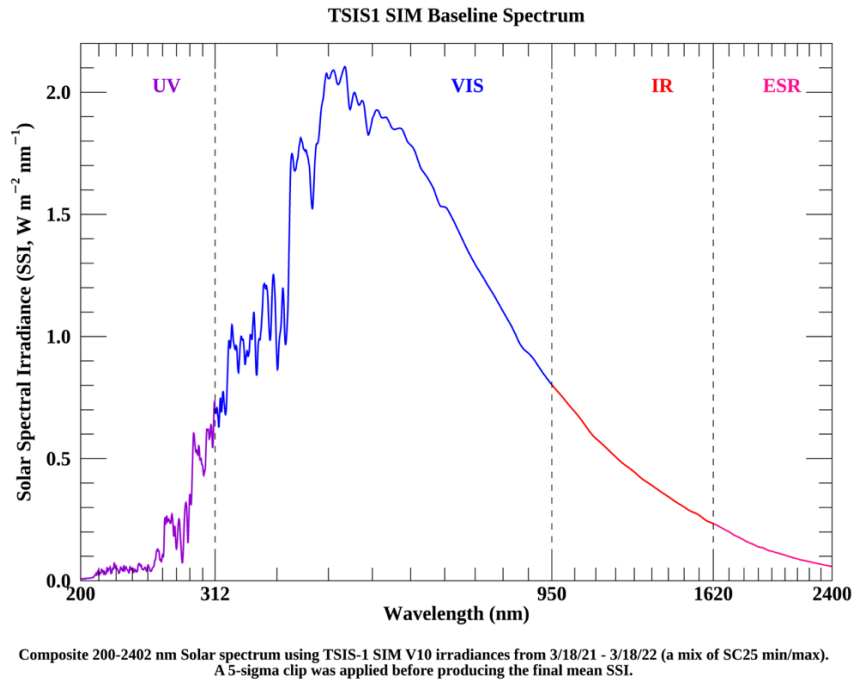


Figure 1 TSIS-1 SIM L3 SSI example, the V10 baseline (“filtering”) spectrum.

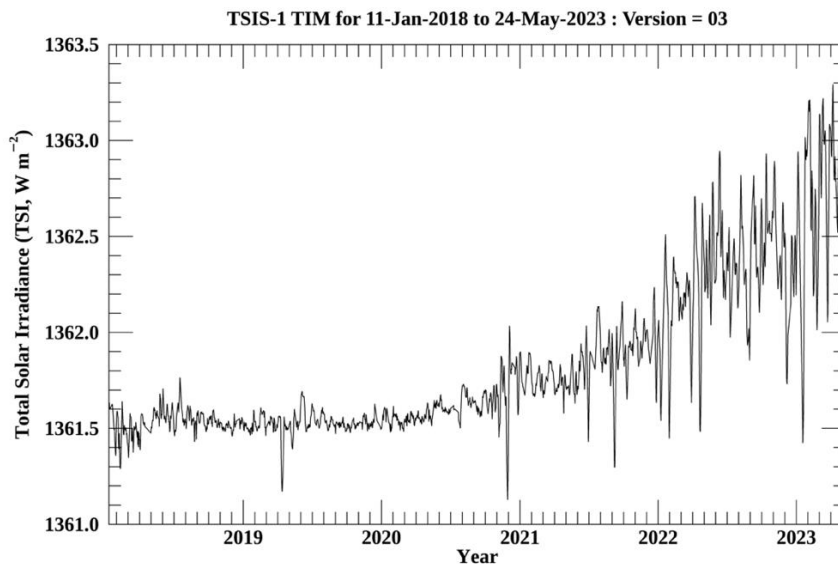


Figure 2: TSIS-1 TIM L3 TSI example. This is the 24-hour data product as of May-24-2023.

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 an ASCII data record. The ASCII data record formats are shown below Table 2 for SIM and Table 3 for TIM. Samples of the SIM/TIM ASCII headers are given [§7.1.1](#) (SIM) and [§7.1.2](#) (TIM).

Table 2: TSIS-1 SSI L3 Data Record Columns

Number	Name	Units	Type	Format
1	nominal_date_yyyymmdd ³	-	64-bit float	F11.2
2	nominal_date_jdn ²	-	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 (1 σ)	64-bit float	E15.8
8	measurement_precision	W/m ² /nm (1 σ)	64-bit float	E15.8
9	measurement_stability	W/m ² /nm (1 σ)	64-bit float	E15.8
10	additional_uncertainty	W/m ² /nm (1 σ)	64-bit float	E15.8
11	quality	-	16-bit integer	I6

Table 3: TSIS TSI L3 Data Record Columns

Number	Name	Units	Type	Format
1	nominal_date_yyyymmdd ²	-	64-bit float	F12.3
2	nominal_date_jdn ²	-	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 (1 σ)	32-bit float	E10.3
7	instrument_precision_1au	W/m ² (1 σ)	32-bit float	E10.3
8	solar_standard_deviation_1au	W/m ² (1 σ)	32-bit float	E10.3
9	measurement_uncertainty_1au	W/m ² (1 σ)	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 (1 σ)	32-bit float	E10.3
12	instrument_precision_true_earth	W/m ² (1 σ)	32-bit float	E10.3
13	solar_standard_deviation_true_earth	W/m ² (1 σ)	32-bit float	E10.3
14	measurement_uncertainty_true_earth	W/m ² (1 σ)	32-bit float	E10.3
15	provisional_flag (1: provisional, 0: final)	-	16-bit integer	I2

³ These nominal dates refer to the middle of the data acquisition time ranges.

Table 4: TSIS-1 SIM SSI L3 Data Quality Flags

Flag Value	Data Quality Flag Name	Description
1	MISSING_VALUE_FLAG	Indicates missing data items (observations). Missing data can also be identified by irradiance and uncertainty values of 0.0 (zero). Missing observations should be excluded from any data analysis.
2	FILL_VALUE_FLAG	Indicates data items that have been backfilled from previous measurements within one day.
512	BAD_HFSSB_POINTING	Indicates irradiance measurements for which a wavelength-dependent correction was applied to account for the HFSS-B(OFF) pointing anomaly that affected data obtained from 19 March to 19 May 2022.

Note that a quality value of 0 indicates that no data quality flag is associated with a particular spectral irradiance measurement and that data should be considered nominal.

3.2 GES DISC Metadata

The GES DISC metadata are contained in a separate XML formatted file having the same name as the data file with .xml in place of .txt. The GES DISC metadata .xml files can be accessed directly from the online archive. For example, the TSIS-1 TIM 24-hour V03 metadata can be found at https://acdisc.gesdisc.eosdis.nasa.gov/data/TSIS_Level3/TSIS_TSI_L3_24HR.03/.

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.
URL	URL to the relevant GES DISC data collection
GranuleID	Granule identifier, i.e. the name of the file.
Format	File format of the data file.
Total Size	Size of the data product, in bytes
Insert Time	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.
Production Time	Date and time the file was produced in format YYYY-MM-DDThh:mm:ss.sssssZ
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.
PGEVersion	Version of the Product Generation Executable (PGE)
ChecksumType	Type of checksum used.
ChecksumValue	The value of the calculated checksum.
SizeBytesDataGranule	Size of the file or granule in bytes.
PGEVersion	Version of the Product Generation Executable (PGE)
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
LocalVersionID	Provides the data product version (e.g., V03)
MeasuredParameter / Data Producer's Metadata	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 hosted at the GES DICS are arranged in a single file using a tabular ASCII text format which can be easily read into a spreadsheet application.

TSIS-1 SSI Products FORTRAN Format Specifier (V09 and later):
(F11.2,F11.2,F9.3,I3,I3,E15.8,E15.8,E15.8,E15.8,I6)

TSIS-1 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,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. The examples below show the data structures created in IDL using the LASP ASCII reader for SIM V10 and TIM V03.

```
IDL> SSI_v10=read_lasp_ascii_file("./tsis_ssi_L3_c24h_v10_20180314_20230402.txt")
IDL> help, SSI_v10
  SSI_V10          STRUCT      = -> <Anonymous> Array[6482424]
IDL > help,SSI_v10,/str
** Structure <11f04368>, 11 tags, length=72, data length=66, refs=2:
  NOMINAL_DATE_YYYYMMDD      DOUBLE      20180314.
  NOMINAL_DATE_JDN           DOUBLE      2458191.8
  WAVELENGTH                  FLOAT       200.015
  INSTRUMENT_MODE_ID         INT         86
  DATA_VERSION              INT         10
  IRRADIANCE_1AU             DOUBLE      0.0069391682
  INSTRUMENT_UNCERTAINTY     DOUBLE      2.9046544e-05
  MEASUREMENT_PRECISION     DOUBLE      9.1415812e-06
  MEASUREMENT_STABILITY     DOUBLE      2.6775007e-05
  ADDITIONAL_UNCERTAINTY    DOUBLE      0.0000000
  QUALITY                    UINT        0
```

```
IDL >tsi_v03=read_lasp_ascii_file('./tsis_tsi_L3_c24h_v03_20180111_20230525.txt')
IDL >help,tsi_v03
  TSI_V03          STRUCT      = -> <Anonymous> Array[1961]
IDL >help,tsi_v03,/str
** Structure <1f049e8>, 15 tags, length=88, data length=78, refs=1:
  NOMINAL_DATE_YYYYMMDD      DOUBLE      20180112.
  NOMINAL_DATE_JDN           DOUBLE      2458130.0
  AVG_MEASUREMENT_DATE_JDN   DOUBLE      2458129.7
  STD_DEV_MEASUREMENT_DATE   FLOAT       0.00640000
  TSI_1AU                    DOUBLE      1361.6282
  INSTRUMENT_ACCURACY_1AU     FLOAT       0.189800
  INSTRUMENT_PRECISION_1AU    FLOAT       0.00680000
  SOLAR_STANDARD_DEVIATION_1AU  FLOAT       0.0442300
  MEASUREMENT_UNCERTAINTY_1AU  FLOAT       0.194900
  TSI_TRUE_EARTH              DOUBLE      1407.7706
  INSTRUMENT_ACCURACY_TRUE_EARTH  FLOAT       0.196200
  INSTRUMENT_PRECISION_TRUE_EARTH  FLOAT       0.00680000
  SOLAR_STANDARD_DEVIATION_TRUE_EARTH  FLOAT       0.0457700
  MEASUREMENT_UNCERTAINTY_TRUE_EARTH  FLOAT       0.201500
  PROVISIONAL_FLAG           INT         0
```

5. Data Services

5.1 GES DISC Search

The GES DISC provides keyword, spatial, temporal, and advanced (event) searches through its unified search and download interface at <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://doi.org/10.5067/TSIS/SIM/DATA313> (redirects to GES DISC latest SSI 12-hour means)
<https://doi.org/10.5067/TSIS/SIM/DATA314> (redirects to GES DISC latest SSI 24-hour means)
<https://doi.org/10.5067/TSIS/TIM/DATA305> (redirects to GES DISC latest TSI 6-hour means)
<https://doi.org/10.5067/TSIS/TIM/DATA306> (redirects to GES DISC latest TSI 24-hour means)

The links provided above will redirect to the latest data releases. The actual DOIs are calculated based on the SIM or TIM version number, according to the following formulae:

$$\text{doi_number} = 2 * \text{sim_or_tim_version_number}$$

SSI 12-hour: DOI = https://doi.org/10.5067/TSIS/SIM/DATA3+doi_number-1

SSI 24-hour: DOI = https://doi.org/10.5067/TSIS/SIM/DATA3+doi_number

TSI 06-hour: DOI = https://doi.org/10.5067/TSIS/SIM/DATA3+doi_number-1

TSI 24-hour: DOI = https://doi.org/10.5067/TSIS/SIM/DATA3+doi_number

The TSIS-1 Algorithm Theoretical Basis Document (ATBD) can be found at:

http://docserver.gesdisc.eosdis.nasa.gov/public/project/TSIS/TSIS_Algorithm_Theoretical_Basis_Document_151430RevA.pdf

TSIS-1 SIM Release Notes, for all versions, can be found at <https://lasp.colorado.edu/tsis/data/ssi-data/sim-ssi-release-notes/>.

TSIS-1 TIM Release Notes, for all versions, can be found at <https://lasp.colorado.edu/tsis/data/tsi-data/tim-tsi-release-notes/>.

5.3 Direct Download

The latest version of the TSSI-1 SIM and TIM L3 data products are available for users to download directly using: https://acdisc.gesdisc.eosdis.nasa.gov/data/TSIS_Level3/

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 Related Publications/References

Coddington, O., Lean, J., Pilewskie, P., Snow, M., Richard, E., Kopp, G., Lindholm, C., DeLand, M., Marchenko, S., Haberreiter, M., Baranyi, T., 2019. Solar Irradiance Variability: Comparisons of Models and Measurements. *Earth and Space Science* 6, 2525-2555. <https://doi.org/10.1029/2019EA000693>

Coddington, O.M., Richard, E.C., Harber, D., Pilewskie, P., Woods, T.N., Chance, K., Liu, X., Sun, K., 2021. The TSIS-1 Hybrid Solar Reference Spectrum. *Geophysical Research Letters* 48, e91709. <https://doi.org/10.1029/2020GL091709>

Coddington, O. M., Richard, E. C., Harber, D., Pilewskie, P., Woods, T. N., Snow, M., et al. (2023). Version 2 of the TSIS-1 Hybrid Solar Reference Spectrum and extension to the full spectrum. *Earth and Space Science*, 10, e2022EA002637. <https://doi.org/10.1029/2022EA002637>

Harder, J., Béland, S., Penton, S.V., Richard, E., Weatherhead, E., Araujo-Pradere, E., 2022. SORCE and TSIS-1 SIM Comparison: Absolute Irradiance Scale Reconciliation. *Earth and Space Science* 9, e2021EA002122. <https://doi.org/10.1029/2021EA002122>

Kopp, G., Lawrence, G., 2005. The Total Irradiance Monitor (TIM): Instrument Design. *Solar Physics* 230, 91–109. <https://doi.org/10.1007/s11207-005-7446-4>

Kopp, G., Heuerman, K., Lawrence, G., 2005. The Total Irradiance Monitor (TIM): Instrument Calibration. *Solar Physics* 230, 111–127. <https://doi.org/10.1007/s11207-005-7447-3>

Mauceri, S., Richard, E., Pilewskie, P., Harber, D., Coddington, O., Béland, S., Chambliss, M., Carson, S., 2020. Degradation Correction of TSIS SIM. *Sol Phys* 295, 152. <https://doi.org/10.1007/s11207-020-01707-y>

Richard, E., Harber, D., Coddington, O., Drake, G., Rutkowski, J., Triplett, M., Pilewskie, P., Woods, T., 2020. SI-traceable Spectral Irradiance Radiometric Characterization and Absolute Calibration of the TSIS-1 Spectral Irradiance Monitor (SIM). *Remote Sensing* 12, 1818. <https://doi.org/10.3390/rs12111818>

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>

[LISIRD](#) (LASP Interactive Solar Irradiance Datacenter)

- SSI 12-hour: https://lasp.colorado.edu/lisird/data/tsis_ssi_12hr
- SSI 24-hour: https://lasp.colorado.edu/lisird/data/tsis_ssi_24hr
- TSI 06-hour: https://lasp.colorado.edu/lisird/data/tsis_tsi_6hr
- TSI 24-hour: https://lasp.colorado.edu/lisird/data/tsis_tsi_24hr

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 (TSIS-1)

7.1 Sample TSIS-1 L3 ASCII Headers

7.1.1 TSIS-1 SIM: Sample L3 ASCII Header (V10, 24-hr, released 05/31/2023)

```
; TSIS-1 SIM Solar Spectral Irradiance V10
;
; ***SELECTION CRITERIA***
; date range: 20180314 to 20230402
; cadence: 24 hours
; spectral range: 200.0 to 2400.0 nm
; number of data: 3433728
; identifier_product_doi: 10.5067/TSIS/SIM/DATA320
; identifier_product_doi_authority: https://dx.doi.org/
; ***END SELECTION CRITERIA***
;
; ***DATA DEFINITIONS***, number = 11 (name, type, format)
; nominal_date_yyyyymmdd, R8, f11.2
; nominal_date_jdn, R8, f11.2
; wavelength, R4, f9.3 (nm)
; instrument_mode_id, I2, i3
; data_version, I2, i3
; irradiance_1AU, R8, e15.8 (W/m^2/nm)
; instrument_uncertainty, R8, e15.8 (W/m^2/nm, 1σ)
; measurement_precision, R8, e15.8 (W/m^2/nm, 1σ)
; measurement_stability, R8, e15.8 (W/m^2/nm, 1σ)
; additional_uncertainty, R8, e15.8 (W/m^2/nm, 1σ)
; quality, UI2, i6
; ***END DATA DEFINITIONS***
;
; Background on the Total and Spectral Solar Irradiance Sensor (TSIS-1)
;
; The Total and Spectral Solar Irradiance Sensor (TSIS-1) level 3 (L3) data product is constructed
; using measurements from the Total Irradiance Monitor (TIM) and Spectral Irradiance Monitor (SIM)
; instruments. The TIM instrument measures the total solar irradiance (TSI) that is incident at the
; outer boundaries of the atmosphere and the SIM instrument measures the solar spectral irradiance
; (SSI) from 200 nm to 2400 nm, which are combined into 12-hr and 24-hr solar spectra. The TSIS-1 data
; products are provided on a fixed wavelength scale, which has a variable resolution over the spectral
; range. Irradiances are reported at a mean solar distance of 1 AU and zero relative line-of-sight
; velocity with respect to the Sun.
;
; Table: Solar Spectral Irradiance (SSI) Measurement Summary.
;
; Measuring Instrument      SIM
; Temporal Cadence         Daily
; Detector Diodes          (200 nm to 1620 nm), ESR (1620 nm to 2400 nm)
; Instrument Modes         86 (UV), 85 (VIS), 84 (IR), 83 (ESR)
; Spectral Range           200 nm to 2400 nm
;
; The spectral irradiances are tabulated below ("DATA RECORDS"), with each row giving the nominal date
; (YYYYMMDD.D), nominal date (Julian Day), wavelength center (nm), instrument mode, data version,
; spectral irradiance @ 1au (irradiance_1AU, Watts/m^2/nm), instrument_uncertainty (Watts/m^2/nm),
; measurement_precision (Watts/m^2/nm), measurement_stability (Watts/m^2/nm), additional_uncertainty
; (Watts/m^2/nm), and a "quality" (data quality flag, DQF) value. The provided dates refer to the
; middle of the temporal windows in which data collection could have taken place and been included in
; this measurement. Measurement_stability is given as 0.00000000e+00 (0.0) at wavelengths longer than
; 1845 nm, where we do not currently calculate a degradation correction, and for all data that arrives
; after the bi-annual Channel-C calibration scans. The bi-annual Channel-C scans trigger a new data
; release version, so there could be up to six months of measurement stability values that are 0.0
; until determined during the creation of the next data release. Data quality flags (DQF) are assigned
; to each spectral measurement in the 'quality' column. The value in this column is the addition of
; all the bit-wise DQFs associated with a given measurement. Nominal data (no other conditions) has a
; DQF of '0'. The L3 TSIS-1 SIM DQFs are:
;
; VALUE (DQF)      CONDITION
; -----
; 1                Missing data
; 2                Backfilled data (from previous day)
; 512              Data taken with offset pointing; a spectral correction has been applied
;
; Data with the '512' bit set was taken from March 19, 2022 through May 19, 2022. During this period,
; the TSIS-1 SIM pointing was off by ~1 arcmin due to external contamination of the pointing system
; quad-diode (HFSSB). A wavelength-dependent correction has been applied to data during this period,
```

```
; and the corresponding additional irradiance uncertainties associated with this correction are given
; in the 'additional_uncertainty' column. Note that it is possible that multiple flags can be set on
; the same measurement. For example, a quality of '514' is backfilled data, and the data was taken
; during the offset pointing. Nominal, QUALITY=0, Backfilled, (QUALITY AND 2) != 0, and data taken
; during the HFSSB anomaly period, (QUALITY AND 512) != 0, are all considered valid data, suitable for
; scientific usage.
;
; Instrument_uncertainty, measurement_precision, measurement_stability, and additional_uncertainty are
; all in units of (Watts/m^2/nm).
;
; Each field (column) is defined and further described in the "DATA DEFINITIONS" section.
;
; An IDL file reader (https://lasp.colorado.edu/data/tsis/file\_readers/read\_lasp\_ascii\_file.pro) is
; available which will read this file and return an array of structures whose field names and types
; are taken from the "DATA DEFINITIONS" section.
;
; Erik Richard (2023), Level 3 (L3) Solar Spectral Irradiance Daily Means
; V010, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center
; (GES DISC), Accessed [Data Access Date] at https://dx.doi.org/10.5067/TSIS/SIM/DATA320
;
; For more information on the TSIS-1 instruments and data products, see:
; https://lasp.colorado.edu/home/tsis/
;
; This data file, release notes, and other TSIS-1 data products may be obtained from:
; https://lasp.colorado.edu/home/tsis/data/
;
; ***DATA RECORDS***, number =      3433728
```

7.1.2 TSIS-1 TIM: Sample L3 ASCII Header (V03, 24-hr, released 05/28/2020)

```
; TSIS/TIM Total Solar Irradiance
;
; ***SELECTION CRITERIA***
; data_set_name: TSIS Level 3 Total Solar Irradiance
; date_range: 20180111 to 20230514
; cadence: 24 hours
; version: 3
; number_of_data: 1950
; ***END SELECTION CRITERIA***
;
; ***DATA DEFINITIONS***, number = 15 [field name, type, format, (Col. #, description)]
; nominal_date_yyyymmdd R8 f12.3 (Column 1: Nominal Data Time, YYYYMMDD)
; nominal_date_jdn R8 f12.3 (Column 2: Nominal Data Time, Julian Day Number)
; avg_measurement_date_jdn R8 f15.6 (Column 3: Average Data Time, Julian Day Number)
; std_dev_measurement_date R4 f7.4 (Column 4: Stdev of Average Data Time, days, 1σ)
; tsi_lau R8 f10.4 (Column 5: Total Solar Irradiance (TSI) at 1-AU, W/m^2)
; instrument_accuracy_lau R4 e10.3 (Column 6: Instrument Accuracy in 1-AU TSI, W/m^2, 1σ)
; instrument_precision_lau R4 e10.3 (Column 7: Instrument Precision in TSI at 1-AU, W/m^2, 1σ)
; solar_standard_deviation_lau R4 e10.3 (Column 8: Solar Standard Deviation in 1-AU TSI, W/m^2, 1σ)
; measurement_uncertainty_lau R4 e10.3 (Column 9: Total Uncertainty in TSI at 1-AU, W/m^2, 1σ)
; tsi_true_earth R8 f10.4 (Column 10: Total Solar Irradiance at Earth distance, W/m^2)
; instrument_accuracy_true_earth R4 e10.3 (Column 11: Instrument Accuracy at Earth distance, W/m^2, 1σ)
; instrument_precision_true_earth R4 e10.3 (Column 12: Instrument Precision at Earth distance, W/m^2, 1σ)
; solar_standard_deviation_true_earth R4 e10.3 (Column 13: Solar Standard Deviation in TSI at Earth, W/m^2, 1σ)
; measurement_uncertainty_true_earth R4 e10.3 (Column 14: Total Uncertainty in TSI at Earth
distance, W/m^2, 1σ)
; provisional_flag I2 i2 (Column 15: Provisional Flag, 1=provisional data, 0=final data)
; ***END DATA DEFINITIONS***
;
; ***FORTRAN FORMAT SPECIFIER***
; (f12.3, f12.3, f15.6, f7.4, f10.4, e10.3, e10.3, e10.3, f10.4, e10.3, e10.3, e10.3, i2)
; ***END FORTRAN FORMAT SPECIFIER***
;
;
; Background for the TSIS/TIM instrument and TSI measurements
;
; The TSIS Total Irradiance Monitor (TIM) measures the total solar
; irradiance (TSI), a measure of the absolute intensity of solar radiation
; integrated over the entire solar disk and the entire solar spectrum.
; The TSIS Level 3 TSI data products are the daily and 6-hourly mean
; irradiances, reported at both a mean solar distance of 1 astronomical
; unit (AU) and at the true Earth-to-Sun distance of date, and zero
; relative line-of-sight velocity with respect to the Sun. These products
; respectively indicate emitted solar radiation variability (useful for
; solar studies) and the solar energy input to the top of the Earth's
; atmosphere (useful for Earth climate studies).
;
; The TIM instrument has long-term repeatability with estimated uncertainties of
; approximately 0.014 W/m^2/yr (10 ppm/yr). Accuracy varies with time depending
; on instrument operating conditions and on-orbit effects, such as degradation
; due to solar exposure. Estimates of the TIM's time-dependent uncertainties are
; provided in the data file. The TSIS/TIM agrees well with the lower TSI values
; first reported by the SORCE/TIM and the follow-on TCTE/TIM. The TIM design
; allows less internal instrument scatter than predecessor TSI instruments, which
; caused erroneously high TSI values (Kopp & Lean 2011), as validated on the TSI
; Radiometer Facility (described by Kopp et al. 2007).
;
; The following paragraphs discuss the four different uncertainties reported
; with the TSI measurements.
;
; INSTRUMENT UNCERTAINTY reflects the instrument's relative standard
; uncertainty (absolute accuracy) and includes all known uncertainties from
; ground- and space-based calibrations plus a time-dependent estimate of
; uncertainty due to degradation. This uncertainty varies slightly with measured
; instrument temperature and the time to the nearest on-orbit calibrations. This
; value is useful when comparing different TSI instruments reporting data from
; the same time range on an absolute scale.
;
; INSTRUMENT PRECISION reflects the TIM's sensitivity to a change in signal,
; and is useful for determining relative changes in the TIM TSI due purely
; to the Sun over timescales of two months or less (so that degradation
; uncertainty does not have a significant effect). This value of 5 ppm is
```

```

; constant, and indicates the instrument's noise level.
;
; High-cadence Level 2 data are averaged (un-weighted mean) to produce daily
; and 6-hourly averaged Level 3 data. The standard deviation of the Level 2
; values averaged to produce each Level 3 value is indicative of the solar
; variability during the reported Level 3 measurement interval, and is
; called the SOLAR STANDARD DEVIATION. This uncertainty redundantly includes
; -- but is generally much larger than -- the Instrument Precision. The Solar
; Standard Deviation is useful for estimating potential variations in TSI
; within the time range of a Level 3 data value, such as when comparing TIM
; TSI values with solar images or other TSI instruments reporting data at
; slightly different times.
;
; MEASUREMENT UNCERTAINTY is the net uncertainty of a reported Level 3 data
; value, and is the root sum square of Instrument Uncertainty and Solar
; Standard Deviation. Measurement Uncertainty is the value that should be
; used when comparing absolute scale TSI data from non-identical time ranges.
;
; RELEASE NOTES for the latest version of TIM Level 3 data may be found at:
; http://lasp.colorado.edu/home/tsis/data/tsi-data/release\_notes/tim-tsi-release-notes/
;
; The 1-AU and at-Earth TIM irradiances are tabulated below ("DATA RECORDS"),
; with each row giving the nominal and measurement dates, the reported
; irradiances, and estimated uncertainties. Each field (column) is defined
; and described in the "DATA DEFINITIONS" section above. An IDL file reader
; (read_lasp_ascii_file.pro) is available which will read this file and
; return an array of structures whose field names and types are taken from
; the "DATA DEFINITIONS" section.
;
; Details of the TIM design and calibrations are given in:
;
; 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.
;
; Citing the daily data:
;
; Kopp, G. (2020), TSIS TIM Level 3 Total Solar Irradiance 24-hour Means, version 03,
; Greenbelt, MD, USA: NASA Goddard Earth Science Data and Information Services Center (GES DISC),
; Accessed <Enter User Data Access Date> at https://doi.org/10.5067/TSIS/TIM/DATA306
;
; Citing the 6-hourly data:
;
; Kopp, G. (2020), TSIS TIM Level 3 Total Solar Irradiance 6-Hour Means, version 03,
; Greenbelt, MD, USA: NASA Goddard Earth Science Data and Information Services Center (GES DISC),
; Accessed <Enter User Data Access Date> at https://doi.org/10.5067/TSIS/TIM/DATA305
;
; This data file and other TSIS data products may also be obtained from:
; http://lasp.colorado.edu/tsis/data/
;
; For more information on the TSIS/TIM instrument and data, see:
; http://lasp.colorado.edu/tsis/data/tsi\_data/
;
; For news and general information about the TSIS mission, see:
; http://lasp.colorado.edu/tsis
;
; Columns:
; 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
; ***DATA RECORDS***, number = 1950

```