L2 Daily Solar-Induced Fluorescence (SIF) from ERS-2 GOME, 1995-2003

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Documentation Revision Date: 2025-01-28

Dataset Version: 1

Summary

This dataset provides Level 2 Solar-Induced Fluorescence (SIF) of Chlorophyll estimates derived from the Global Ozone Monitoring Experiment (GOME) instrument on the European Space Agency's (ESA's) European Remote-Sensing 2 (ERS-2) satellite. Each file contains daily raw and bias-adjusted solar-induced fluorescence on an orbital basis (land pixels only), at a resolution of 40 km x 320 km, along with quality control information and ancillary data. Data is provided for the period from 1995-07-01 to 2003-06-22. The GOME SIF product is inherently noisy due to low signal levels and has undergone only a limited amount of validation. This dataset includes both Version 1 and Version 2 files. Version 2 includes new fields such as SIF uncertainties, longitude-latitude corners, and data coverage over ocean. In addition, the SIF bias adjustment differs between Versions 1 and 2. The data are provided in NetCDF format.

This dataset includes 5654 files in netCDF (*.nc) format, with one file per day from 1 July 1995 to 22 June 2003. Note that not all days are provided (~86 dates are missing).

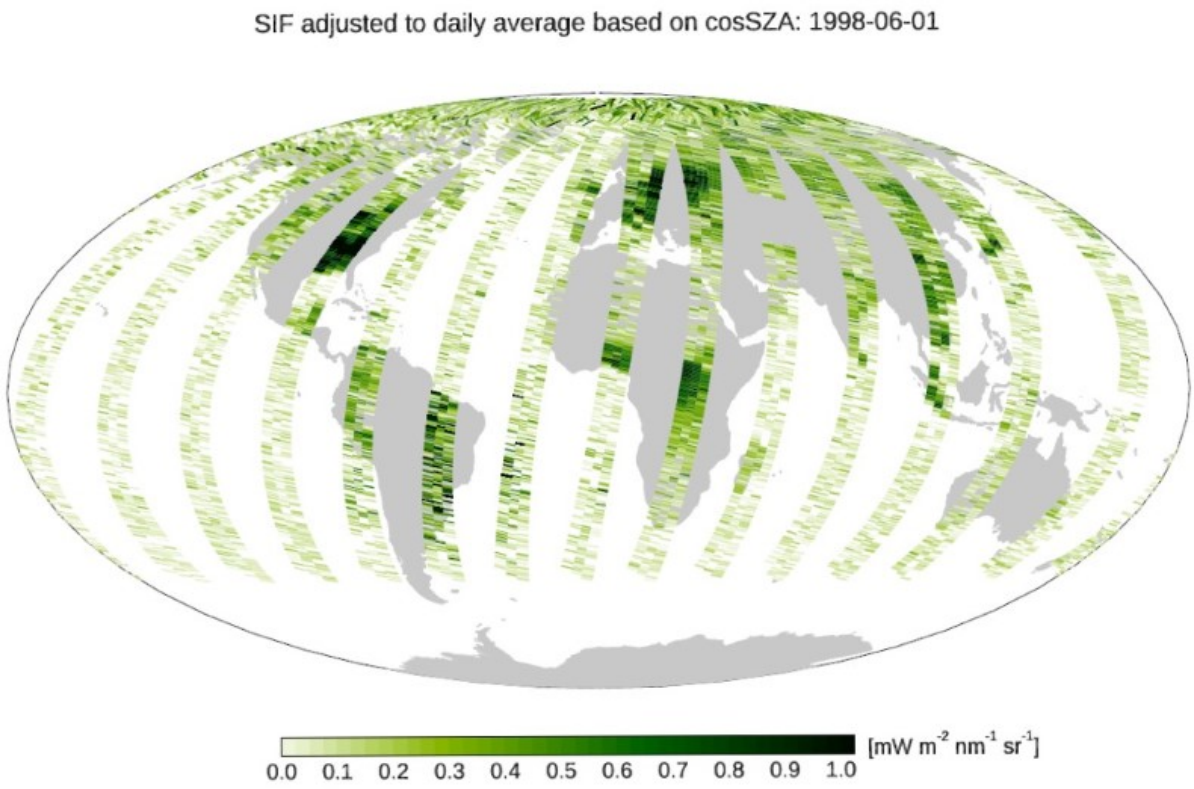

Figure 1: Solar-induced fluorescence (SIF) derived along ERS2 GOME orbital tracks on 1 June 1998.

Citation

Joiner, J., Y. Yoshida, P. Koehler, C. Frankenberg, and N.C. Parazoo. 2019. L2 Daily Solar-Induced Fluorescence (SIF) from ERS-2 GOME, 1995-2003. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1758

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1. Dataset Overview

This dataset provides Level 2 Solar-Induced Fluorescence (SIF) of Chlorophyll estimates derived from the Global Ozone Monitoring Experiment (GOME) instrument on the European Space Agency's (ESA's) European Remote-Sensing 2 (ERS-2) satellite. Each file contains daily raw and bias-adjusted solar-induced fluorescence on an orbital basis (land pixels only), at a resolution of 40 km x 320 km, along with quality control information and ancillary data. Data is provided for the period from 1995-07-01 to 2003-06-22. The GOME SIF product is inherently noisy due to low signal levels and has undergone only a limited amount of validation.

This dataset includes both Version 1 and Version 2 files. Version 2 includes new fields such as SIF uncertainties, longitude-latitude corners, and data coverage over ocean. In addition, the SIF bias adjustment differs between Versions 1 and 2.

Project: Solar Induced Fluorescence Earth Science Data Record

This project is developing a global, observation-based Earth System Data Record (ESDR) for quantifying global vegetation solar induced fluorescence (SIF) and photosynthesis gross primary productivity (GPP) from 1996-2020. It was funded under the 2017 Making Earth System Data Records for Use in Research Environments (MEaSUREs) call (17-MEASURES-0032).

Related Publication:

Joiner, J., L. Guanter, R. Lindstrot, M. Voigt, A.P. Vasilkov, E.M. Middleton, K.F. Huemmrich, Y. Yoshida, and C. Frankenberg. 2013. Global monitoring of terrestrial chlorophyll fluorescence from moderate-spectral-resolution near-infrared satellite measurements: methodology, simulations, and application to GOME-2. Atmospheric Measurement Techniques 6:2803–2823. https://doi.org/10.5194/amt-6-2803-2013

Acknowledgements:

This work was funded by the NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) program (grant NNH17ZDA001N-MEASURES, MEASURES-0032). European Space Agency (ESA) and the German Aerospace Centre (DLR), particularly Diego Loyola, provided the GOME data used here.

2. Data Characteristics

Spatial Coverage: Global

Spatial Resolution: 40 km x 320 km

Temporal Coverage: 1995-07-01 to 2003-06-22

Temporal Resolution: Daily

Data File Information

This dataset includes 5654 files in NetCDF format, with one file per day from 1995-07-01 to 2003-06-22. Note that not all days are provided (~86 dates are missing). Data are supplied in the CF-compliant trajectory data type.

This dataset holds both Version 1 (a preliminary release of Level 2 data) and Version 2 files. Version 2 includes new fields such as SIF uncertainties, longitude-latitude corners, and data coverage over ocean. The bias adjustment for *SIF_740* and *Daily_Averaged_SIF* variables are different for Version 1 and 2. However, the *SIF_Unadjusted* values are the same for the two versions.

File Naming Convention

Version 1 files are named as *NSIFv2.6.1.**YYYYMMDD**_v2.9.1_all.nc*, where ***YYYYMMDD*** represents the observation date.
Version 2 files are named as *NSIFv2.6.2.1.**YYYYMMDD**_v2.9.1_all.nc*, where ***YYYYMMDD*** represents the observation date.

Data version is indicated "NSIF**v2.6.1**" (V1) versus "NSIF**v2.6.2.1**" (V2).
Example filenames: NSIFv2.6.1.19950703_v2.9.1_all.nc and NSIFv2.6.2.1.19950703_v2.9.1_all.nc

Data Variables:

Each file contains the following variables as well as numerous ancillary variables (Latitude, Longitude, Cloud fraction, Instrument mode, Reflectance at 670nm, Reflectance at 780nm, Satellite height, Solar azimuth angle, Scan number, Sun glint, Surface pressure, Solar zenith angle, Sensor azimuth angle, and Sensor zenith angle). The missing data value is -9999 for all variables.

Variable Name	Description	Units
SIF_740	solar-induced fluorescence at 740nm	mW m^{-2} nm^{-1} sr^{-1}
Daily_Averaged_SIF	SIF adjusted to daily average based on cosSZA	mW m^{-2} nm^{-1} sr^{-1}
SIF_uncertainty	SIF estimated uncertainty	mW m^{-2} nm^{-1} sr^{-1}
SIF_Unadjusted	raw SIF no adjustment	mW m^{-2} nm^{-1} sr^{-1}

Variable Name	Description	Units
Quality_Flag	pixel retrieval quality flag	0 = bad, 1 = good_passed_all_QC_checks, 2 = good_and_passed_cloud_check

3. Application and Derivation

Measurements of solar-induced fluorescence of chlorophyll can provide information on the functional status of vegetation including light-use efficiency and global primary productivity that can be used for global carbon cycle modeling and agricultural applications.

4. Quality Assessment

GOME_F products are inherently noisy due to low signal levels. Users should expect to see negative values in both level 2 and level 3 data sets. When using level 2 data sets, users should retain those negative values and treat them like they would for any other noisy data set. For example, if fluorescence is zero, there should be a distribution of measurements centered about zero including negative values. Any attempts to remove negative values or force them to zero for the purpose of averaging will then bias results.

Users should be aware that the GOME data set provided here has undergone only a limited amount of validation (e.g., the algorithm applied to GOME-2 has been compared with ground-based data in Yang et al., 2015). Output of far-red retrievals from GOME-2 has been compared with the filling-in signal near 758 nm from the GOSAT TANSO-FTS instrument that is derived from a simpler algorithm (Joiner et al., 2013).

Version 2 files include estimates of SIF uncertainty.

See the references for more information.

5. Data Acquisition, Materials, and Methods

Level 2 SIF estimates were derived from reflectance measured by the Global Ozone Monitoring Experiment (GOME) instrument on the European Space Agency's (ESA's) European Remote-Sensing 2 (ERS-2) satellite.

This dataset holds both Version 1 (a preliminary release of Level 2 data) and Version 2 files. Version 2 includes new fields such as SIF uncertainties, longitude-latitude corners, and data coverage over ocean.

Known Algorithm and Instrumental Features:

1) Month to month (temporal) variations may incorporate instrumental and algorithmic effects.

2) All relevant retrievals are retained in level 2 data sets and quality control of level 2 is in the hands of the user (see below for further details). The GOME instrument has a relatively large footprint, approximately 40 km x 320 km at nadir in the nominal NADIR mode (see Figure 1). There are 3 pixels in the forward scan mode, giving a swath width of 960 km that provides global coverage in approximately three days. The pixel width in the nadir backscan mode is three times larger (40 km x 960 km) and has not been processed in the current data set. There is also a small swath mode on ~1-2 days per month with 40 km x 80 km pixels in forward scan mode and 40 x 240 km in the backscan mode. These data are provided in the L2 files. The instrument mode is also provided in the level 2 files for all pixels.

3) Due to the large pixels, clouds, and aerosols are present in nearly every observation. Although our retrieval approach can tolerate a small amount of cloud contamination, clouds will screen the surface signal from satellite view. Therefore, temporal and spatial variations in the data may also be due to cloud contamination. The cloud filtering approach is described in Joiner et al. (2012). For a more complete description of the errors, please see Joiner et al. (2013). Users may wish to apply additional cloud screening using the cloud fraction data field depending upon their application.

4) Some issues with data at very high solar zenith angles (in winter at high latitudes) have been noted (fluorescence is slightly positive or negative when it is expected to be zero). We have not included any data with SZA > 75 degrees.

5) There has been no attempt as of yet to reconcile the differences between the ERS-2 GOME SIF and SIF from GOME-2 on MetOp-A and –B satellites. There is a difference in calibration that causes differences between the data sets (GOME data have larger magnitudes than GOME-2). Users are advised to proceed with caution if both data sets are used together. Analysis of both data sets is ongoing; the data are provided on a best effort basis.

6) SIF values are sensitive to absolute calibration of the solar irradiances. The GOME instrument degraded during its lifetime. We are using the latest version of GOME level 1B data (radiances and irradiances) as is and as documented by Coldewey-Egbers et al. (2019). We have not analyzed the data for potential false trends caused by instrument degradation and therefore can NOT recommend use of these data for long-term trend analysis.

7) SIF values are provided over oceans for monitoring of biases. We have attempted to correct for a small zero-level offset problem in previous versions (Joiner et al., 2016). We provide both the corrected and uncorrected SIF_740 data fields. As the bias correction is not perfect, small biases still remain, particularly over high albedo (high radiance), non-vegetated surfaces such as the Sahara desert.

8) The quality control values are 2 for good retrievals with cloud fraction < 30%, 1 for good retrievals with cloud fraction > 30%, and 0 for retrievals not passing various quality control checks.

9) Estimated daily-averaged SIF values based on a single observation are provided. The estimates use an approximate clear sky PAR proxy (cosine of the solar zenith angle) at the observation time and a similar clear-sky PAR weighting for all other hours. This is similar to what is provided in other data sets.

10) The cross-track position (Scan_Number) is provided as a number 1-3. Numbers 1- 3 are in the forward scan and 4 are for the back scans. The Scanline number (Line_Number) is also provided.

11) Several fields, such as glint possibility (Glint), Reference Time and Delta Time, sun-satellite geometry, etc. are provided directly as given in the L1B GOME data. Please refer to Aberle et al. (2018) for more information.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

L2 Daily Solar-Induced Fluorescence (SIF) from ERS-2 GOME, 1995-2003

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

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8. Dataset Revisions

Version	Release Date	Revision Notes
1.0	2025-01-28	Version 2 files were added to the dataset. These files include new fields such as SIF uncertainties, longitude-latitude corners, and data coverage over ocean. The SIF bias adjustment differs between Versions 1 and 2.
1.0	2019-12-09	Initial publication, Version 1 files only.