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User guide

Global High-Resolution Estimates of SIF from Fused SCIAMACHY and GOME-2, 2002-2018

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Summary

This dataset provides global solar-induced chlorophyll fluorescence (SIF) estimates at a 0.05-degree resolution (approximately 5 km at the equator) for each month from August 2002 through December 2018. SIF data (740 nm) was retrieved from the SCanning Imaging Absorption spectroMeter for Atmospheric CHartography (SCIAMACHY) and Global Ozone Monitoring Experiment 2 (GOME-2) instruments onboard the MetOp-A satellite and was downscaled to 0.05 degree using Random Forest algorithm and harmonized with cumulative distribution function (CDF) matching technique. The uncertainty of the SIF estimates was also quantified and is provided. Validation of the harmonized product showed that it retained high spatial and temporal consistency with the original SCIAMACHY and GOME-2 SIF retrievals and had good correlations with independent airborne and ground-based SIF measurements. The dataset will inform on the synergy between satellite SIF and photosynthesis and research on drought, yield estimation, and land degradation evaluation.

There are 197 data files in netCDF (*.nc) format included in this dataset.

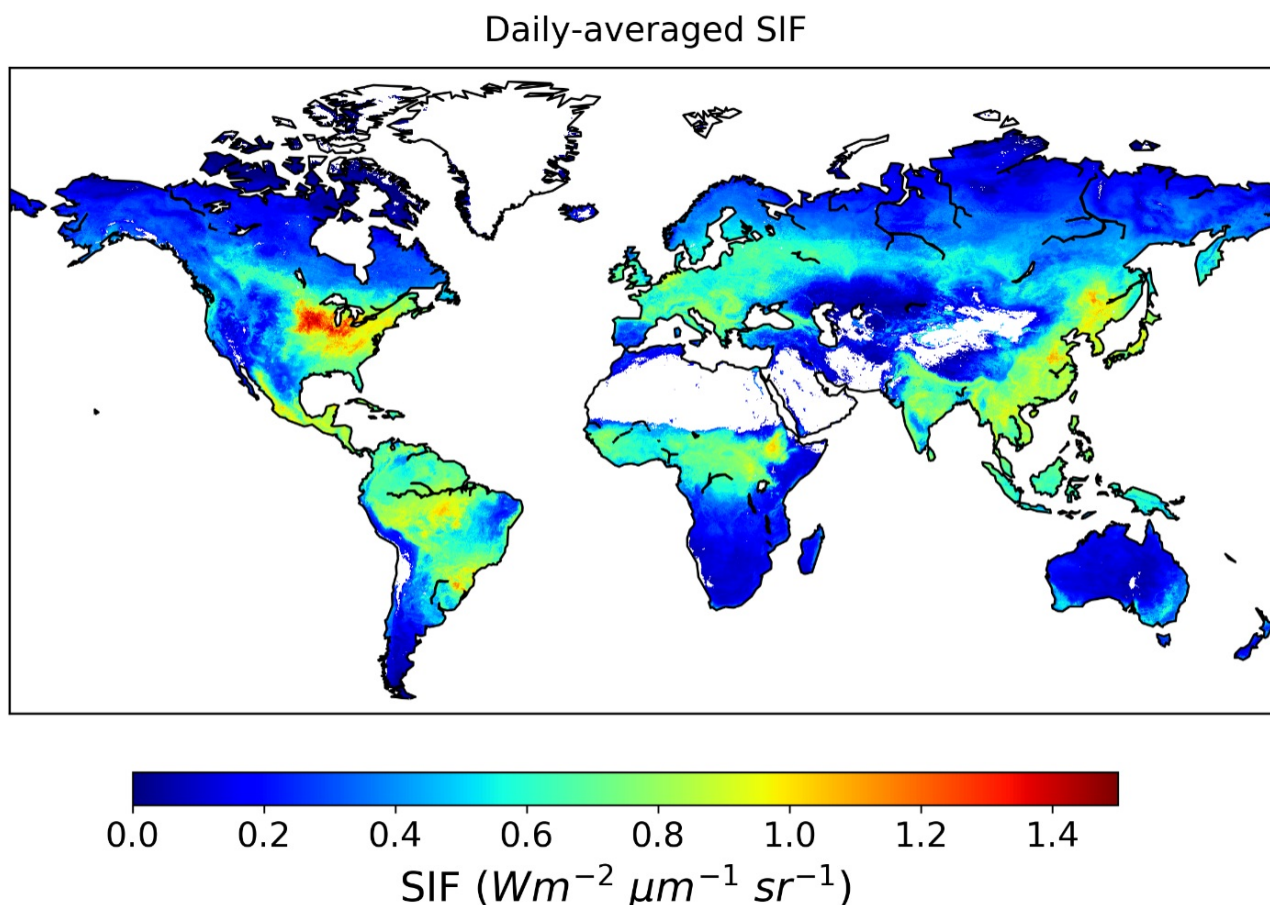


Figure 1. Daily-corrected SIF at 740 nm for August 2015. The highest SIF values during this time period were observed in agricultural sectors in the Northern Hemisphere.

Citation

Wen, J., P. Koehler, G. Duveiller, N.C. Parazoo, T. Magney, G. Hooker, L. Yu, C.Y. Chang, and Y. Sun. 2021. Global High-Resolution Estimates of SIF from Fused SCIAMACHY and GOME-2, 2002-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1864>

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1. Dataset Overview

This dataset provides global solar-induced chlorophyll fluorescence (SIF) estimates at a 0.05-degree resolution (approximately 5 km at the equator) for each month from August 2002 through December 2018. SIF data (740 nm) was retrieved from the SCanning Imaging Absorption spectroMeter for Atmospheric CHartography (SCIAMACHY) and Global Ozone Monitoring Experiment 2 (GOME-2) instruments onboard the MetOp-A satellite and was downsampled to 0.05 degree using Random Forest algorithm and harmonized with cumulative distribution function (CDF) matching technique. The uncertainty of the SIF estimates was also quantified and is provided. Validation of the harmonized product showed that it retained high spatial and temporal consistency with the original SCIAMACHY and GOME-2 SIF retrievals and had good correlations with independent airborne and ground-based SIF measurements. The dataset will inform on the synergy between satellite SIF and photosynthesis and research on drought, yield estimation, and land degradation evaluation.

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

Wen, J., P. Köhler, G. Duveiller, N. C. Parazoo, T. S. Magney, G. Hooker, L. Yu, C. Y. Chang, and Y. Sun. 2020. A framework for harmonizing multiple satellite instruments to generate a long-term global high spatial-resolution solar-induced chlorophyll fluorescence (SIF). *Remote Sensing of Environment* 239:111644. <https://doi.org/10.1016/j.rse.2020.111644>

Related Datasets

Additional SIF-ESDR datasets are available on the ORNL DAAC [SIF-ESDR](#) project page.

Acknowledgments

This work was supported by the NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) program (grant NNX15AH95G, 17-MEaSUREs-0032)

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2. Data Characteristics

Spatial Coverage: Global

Spatial Resolution: 0.05 degree (approximately 5 km at the equator)

Temporal Coverage: 2002-08-01 to 2018-12-31

Temporal Resolution: Monthly

Study Area: Latitude and longitude are given in decimal degrees.

Site	Northernmost Latitude	Southernmost Latitude	Easternmost Longitude	Westernmost Longitude
Global	90	-90	180	-180

Data File Information

There are 197 files in netCDF (*.nc) format. The file naming convention is SIF005_YYYYMM.nc, where YYYYMM represents the year and month of data collection.

Table 1. File names and descriptions.

File Names	Description
SIF005_YYYYMM.nc	Each file provides daily corrected SIF at 740nm and its associated uncertainty.

Data File Details

- Missing values are represented by -999.0.
- Coordinate reference system: "WGS84 - World Geodetic System 1984" (EPSG:4326)
- A mask was applied to non-vegetated regions (i.e., Water Bodies, Barren, and Permanent Snow and Ice according to MCD12C1.006 IGBP classification).

Table 2. Variable names and descriptions.

Variable Name	Units	Description
crs		Coordinate Reference System information
EVI_Quality		MODIS enhanced vegetation index quality flag; detailed flag information can be found in

		MOD13C2.006 User Manual Table 5 (see Section 5)
lat	degree north	Latitude at the center of the pixel
lon	degree east	Longitude at the center of the pixel
SIF_740_daily_corr	mW/m ² /nm/sr	Daily-corrected SIF at 740nm at a 0.05-degree resolution
SIF_740_daily_corr_SD	mW/m ² /nm/sr	Uncertainty of daily-corrected SIF at 740nm

3. Application and Derivation

This long SIF record will greatly enhance the synergy between satellite SIF and photosynthesis. This product has also been used in applications such as drought monitoring, yield estimation, land degradation evaluation, etc.

4. Quality Assessment

The infinitesimal jackknife method was used to estimate standard errors of random forest predictions. The estimation was accomplished by evaluating the covariance between certain predictions from each individual tree and the number of times each training sample appeared in a bootstrap sample for that tree (Wager et al., 2014; Ghosal and Hooker, 2018). Smaller covariance means the prediction was less affected by whether a certain training sample is in the bootstrapped sample or not, therefore, had less variance and thus less uncertainty.

5. Data Acquisition, Materials, and Methods

This dataset was produced based on the framework described in Wen et al. (2020) by fusing SIF retrievals from SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) and Global Ozone Monitoring Experiment 2 (GOME-2) onboard MetOp-A developed at German Research Center for Geosciences. First, the original Level 3 SIF retrievals of SCIAMACHY and GOME-2 (Köhler et al., 2015) were downsampled from their native resolutions to 0.05° using machine learning (ML) algorithms imposed by regionalization constraints to account for the varying relationships between predictors and SIF in space and time. Then the cumulative distribution function matching technique was applied to correct the offset between SIF retrieved from GOME2_005 and SIF retrieved from SCIAMACHY as inherited from the original instrumental discrepancies to generate a harmonized SIF time series. See Wen et al. (2020) for detailed methods.

Note that one main difference between the method used to create this dataset and the method described in Wen et al. (2020) is the predictors used. Wen et al. (2020) used MODIS 7-band BRDF-corrected reflectance (MCD43C4 v006) as predictors, which introduced missing values in some vegetated regions owing to missing values in the original predictors (i.e., MCD43C4 v006). To overcome this issue, the current dataset was generated using the same algorithm and model settings as the unpublished dataset, except that predictors were changed to use MODIS EVI from MOD13C2.006 (Didan, 2015), and PAR, 2 m air temperature, and VPD from MERRA-2 (v5.12.4; GMAO, 2015). The current dataset has been validated with the same metrics as in Wen et al. (2020), and no significant difference was discerned (CFIS R² = 0.73; tower SIF R² = 0.92; tower SIFyield R² = 0.95). Nevertheless, minor differences at fine spatial scale are expected between the two approaches owing to different predictors.

With EVI as one important input of the model, a quality flag layer was added, and it is recommended that users check this flag prior to analysis. This quality flag layer is collected from the MODIS EVI QC layer and detailed bit information can be found in MOD13C2.006 User Manual Table 5 (Didan, 2015; available at https://lpdaac.usgs.gov/documents/103/MOD13_User_Guide_V6.pdf). Users must extract the value of the desired bit(s) to match with the information in the table (see https://modis-images.gsfc.nasa.gov/tools_bit_interpretation.html).

6. Data Access

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

[Global High-Resolution Estimates of SIF from Fused SCIAMACHY and GOME-2, 2002-2018](#)

Contact for Data Center Access Information:

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

7. References

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