CLM Simulated Solar-Induced Fluorescence, Niwot Ridge, Colorado, USA, 1998-2018

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Documentation Revision Date: 2019-12-04

Dataset Version: 1

Summary

This dataset provides results for simulations of solar-induced chlorophyll fluorescence (SIF) implemented within the terrestrial biosphere Community Land Model (CLM 4.5) for Niwot Ridge, Colorado, USA, from 1998-2018. The data include outputs from three model simulations designed to test the importance of non-photochemical quenching (NPQ), that is, the absorbed light energy dissipated as heat, in determining seasonal SIF.

Simulated SIF was compared to SIF measurements collected at the AmeriFlux US-NR1 subalpine forest site at Niwot Ridge using a tower-mounted scanning spectrometer system (PhotoSpec) and to measurements retrieved from the Global Ozone Monitoring Experiment-2 (GOME-2). These data are not provided with this dataset.

There are a total of three total data files in netCDF (*.nc) format.

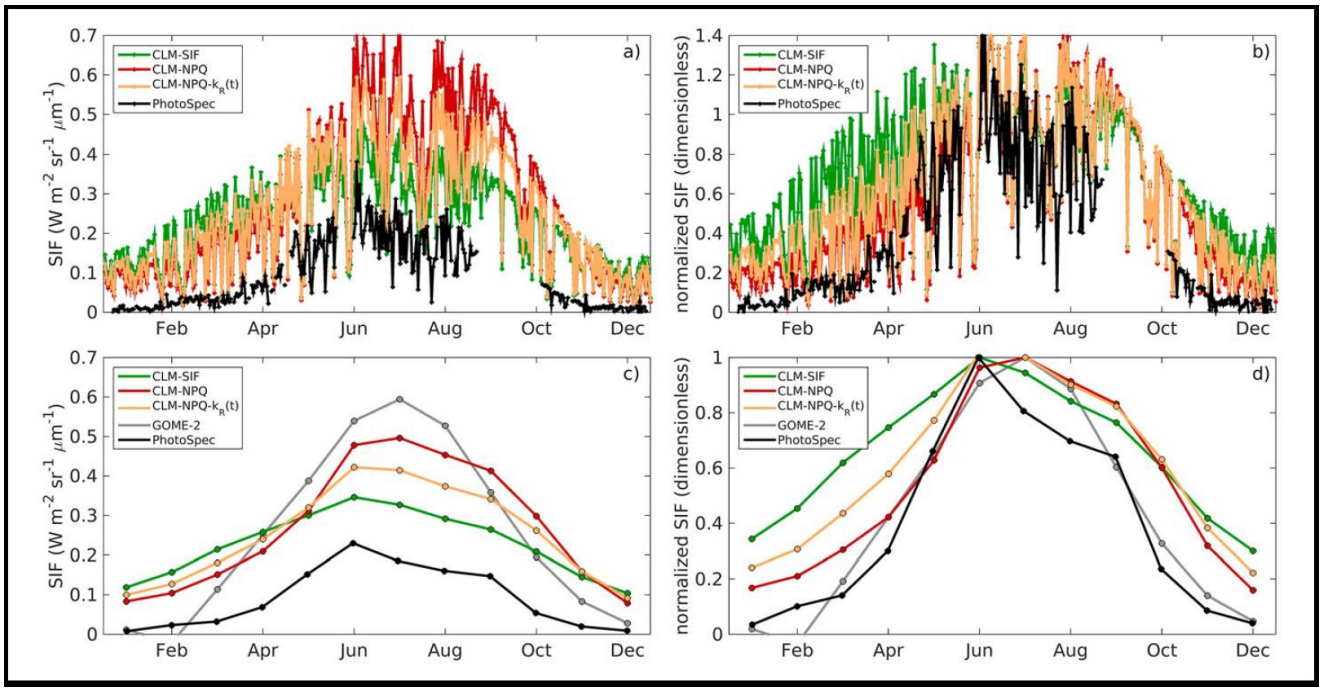

Figure 1. Simulated and observed seasonal patterns of canopy SIF (740 nm) for (a, c) absolute SIF and (b, d) normalized canopy SIF for CLM simulation year 2010. The CLM-SIF simulation considers reversible NPQ (kR) only, the CLM-NPQ simulation considers both reversible (kR) and sustained NPQ (kS), and CLM-NPQ-kR(t) considers kS and seasonal variation in kR. Both a satellite SIF product (GOME-2) and the PhotoSpec measurements are included for comparison. Figure from Raczka et al. (2019)

Citation

Raczka, B.M., A. Porcar-Castell, T. Magney, J. Lee, P. Kohler, C. Frankenberg, K. Grossmann, B.A. Logan, J. Stutz, P.D. Blanken, S.P. Burns, H.F. Duarte, X. Yang, J.C. Lin, and D.R. Bowling. 2019. CLM Simulated Solar-Induced Fluorescence, Niwot Ridge, Colorado, USA, 1998-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1720

Table of Contents

1. Dataset Overview

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Simulated SIF was compared to SIF measurements collected at the AmeriFlux US-NR1 subalpine forest site at Niwot Ridge using a tower-mounted scanning spectrometer system (PhotoSpec) and to measurements retrieved from the Global Ozone Monitoring Experiment-2 (GOME-2). These data are not provided with this dataset.

Project: Carbon Monitoring System (CMS)

The NASA Carbon Monitoring System (CMS) is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. The System will use the full range of NASA satellite observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. CMS will maintain a global emphasis while providing finer scale regional information, utilizing space-based and surface-based data and will rapidly initiate generation and distribution of products both for user evaluation and to inform near-term policy development and planning.

Related Publication:

Raczka, B., Porcar-Castell, A., Magney, T., Lee, J.E., Köhler, P., Frankenberg, C., Grossmann, K., Logan, B.A., Stutz, J., Blanken, P.D. and Burns, S.P., 2019. Sustained Nonphotochemical Quenching Shapes the Seasonal Pattern of Solar-Induced Fluorescence at a High-Elevation Evergreen Forest. Journal of Geophysical Research: Biogeosciences, 124(7), pp.2005- 2020. https://doi.org/10.1029/2018JG004883

Related Datasets: Leaf-level characteristics were measured at a conifer forest in Niwot Ridge, Colorado, including chlorophyll fluorescence (Bowling & Logan, 2019a) and needle pigment composition (Bowling & Logan, 2019b). The leaf-level data was used in part to help define and validate parameters within an earth system model that was used to simulate leaf and canopy level fluorescence (this dataset).

Bowling, D.R., and B.A. Logan. 2019a. **Conifer Needle Chlorophyll Fluorescence, Niwot Ridge, Colorado, USA, 2017-2018.** ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1722

Bowling, D., and B. Logan. 2019b. **Conifer Needle Pigment Composition, Niwot Ridge, Colorado, USA, 2017-2018.** ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1723

Acknowledgments:

This work was funded by NASA CMS grant NNX16AP33G and DOE Terrestrial Ecosystem Science grant DE-SC0010625.

2. Data Characteristics

Spatial Coverage: Niwot Ridge, Colorado

Spatial Resolution: point

Temporal Coverage: 1998-01-01 to 2019-01-01

Temporal Resolution: hourly

Study Area: (all latitudes and longitudes given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Niwot Ridge, CO	-105.5464	-105.54639	40.032912	40.032902

Data File Information

There are three total data files in netCDF (*.nc) format. All of the files have 41 variables as described within the files.

The naming convention of the files is CLM_**X**.nc.

CLM is the Community Land Model

X identifies a particular type of simulation with the following general abbreviations. Descriptions of the model simulations are below.

- SIF is Solar-Induced Fluorescence,
- NPQ is Non-Photochemical Quenching, and
- NPQ_Kr, where Kr refers to the reversible heat dissipation rate coefficient.

File Name	Description
CLM_SIF.nc	Output for the model formulation CLM-SIF. This does not account for seasonal varying (non-photochemical quenching) NPQ. It only accounts for reversible NPQ based upon (Flexas et al., 2002).
CLM_NPQ.nc	Output for the model formulation CLM-NPQ. This accounts for seasonally varying sustained NPQ at Niwot Ridge, and reversible NPQ as parameterized from measurements from a Scots Pine forest located in Hyytiala, Finland.
CLM_NPQ_Kr.nc	Output for the model formulation CLM-NPQ-Kr. This accounts for seasonal varying sustained NPQ at Niwot Ridge, and also accounts for seasonally varying reversible NPQ as parameterized from measurements from a Scots Pine forest located in Hyytiala, Finland.

User Note:

To perform a conversion from leaf-level SIF (variable FSIF) (W m-2) to canopy-level SIF (740 nm, W m-2 um-1 sr-1), use the following:

leaf-level SIF * (6.197 / 15.5) = canopy level SIF

3. Application and Derivation

Remotely-sensed SIF has the potential to improve estimates of carbon uptake across complex terrain. These data will contribute to a more mechanistic understanding of the linkage between SIF and GPP for use in terrestrial biosphere models.

4. Quality Assessment

The Niwot Ridge SIF simulations were compared to a SIF product derived from the Global Ozone Monitoring Experiment-2 (GOME-2) satellite measurements (Köhler et al., 2015), and measurements collected at the co-located US-NR1 using a tower-mounted scanning spectrometer system (PhotoSpec), which is described in Raczka et al. (2019). See Figure 1.

5. Data Acquisition, Materials, and Methods

Site Description

The AmeriFlux US-NR1 subalpine forest site at Niwot Ridge was chosen as the focal site for the research. The site is located in the Rocky Mountains of Colorado and consists primarily of temperate evergreen species of lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). The forest is approximately 120 years old as a result of forest-thinning performed in the early 1900s.

For details of model configurations, outputs, and comparisons see Raczka et al. (2019). Following is a very brief synopsis.

Model Descriptions

The Community Land Model, Version 4.5 (CLM 4.5) was used to perform leaf-level fluorescence simulations. To address the role of sustained non-photochemical quenching (NPQ) in generating SIF, three models were constructed:

- one model had a default NPQ parameterization (CLM-SIF) that ignored contributions from sustained NPQ,
- a second model had a site-specific NPQ parameterization (CLM-NPQ) that accounted for both reversible and sustained NPQ, and
- a third model (CLM-NPQ-kr(t)) had a formulation that is similar to CLM-NPQ but includes a seasonal-varying representation of reversible NPQ.

Measurements to quantify seasonality of non-photochemical quenching (NPQ) were not available at Niwot Ridge, so continuous pulse amplitude modulated (PAM) fluorometry measurements from Hyytiälä, Finland, were used to parameterize the NPQ rate coefficients for the Niwot Ridge model simulations through a relation with mean air temperature.These parameterizations where used in CLM-NPQ and CLM-NPQ-kr(t) models.

Simulated vs. Measured SIF Comparisons

Solar-induced fluorescence (SIF) measurements were collected at US-NR1 using a tower-mounted scanning spectrometer system (PhotoSpec) installed in June 2017 and operated continuously between the nadir position to approximately 45 degrees from nadir. 24-hour daily averages of the filtered hourly median values of the PhotoSpec observations in the far-red spectrum (745-758 nm) were used to estimate the canopy average for comparison against model simulations. These data are not provided with this dataset. Comparisons are shown in Figure 1.

6. Data Access

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

CLM Simulated Solar-Induced Fluorescence, Niwot Ridge, Colorado, USA, 1998-2018

Contact for Data Center Access Information:

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

7. References

Flexas, J., Escalona, J. M., Evain, S., Gulías, J., Moya, I., Osmond, C. B., & Medrano, H. (2002). Steady-state chlorophyll fluorescence (Fs) measurements as a tool to follow variations of net CO_2 assimilation and stomatal conductance during water-stress in C_3 plants. *Physiologia Plantarum*, 114(2), 231– 240. https://doi.org/10.1034/j.1399-3054.2002.1140209.x

Köhler, P., Guanter, L., & Joiner, J. 2015. A linear method for the retrieval of sun-induced chlorophyll fluorescence from GOME-2 and SCIAMACHY data. Atmos. Meas. Tech., 8(6), 2589–2608. https://doi.org/10.5194/amt-8-2589-2015

Raczka, B., Porcar-Castell, A., Magney, T., Lee, J.E., Köhler, P., Frankenberg, C., Grossmann, K., Logan, B.A., Stutz, J., Blanken, P.D. and Burns, S.P., 2019. Sustained Nonphotochemical Quenching Shapes the Seasonal Pattern of Solar-Induced Fluorescence at a High-Elevation Evergreen Forest. Journal of Geophysical Research: Biogeosciences, 124(7), pp.2005- 2020. https://doi.org/10.1029/2018JG004883

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CARVE Data Viewer
Soil Moisture Visualizer
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