Global Gridded 1-km Soil and Soil Heterotrophic Respiration Derived from SRDB v5

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Dataset Version: 1

Summary

This dataset provides global gridded estimates of annual soil respiration (Rs) and soil heterotrophic respiration (Rh) and associated uncertainties at 1 km resolution. Mean soil respiration was estimated using a quantile regression forest model utilizing data from the global Soil Respiration Database Version 5 (SRDB-V5) and covariates of mean annual temperature, seasonal precipitation, and vegetative cover. The SRDB holds results of field studies of soil respiration from around the globe. A total of 4,115 records from 1,036 studies were selected from SRDB-V5. SRDB-V5 features more soil respiration data published in Russian and Chinese scientific literature for better global spatio-temporal coverage and improved global climate-space representation. These soil respiration records were combined with global meteorological, land cover, and topographic data and then evaluated with variable selection using random forests. The standard deviation and coefficient of variation of Rs are included and were also derived from the same model. Global heterotrophic respiration was calculated from Rs estimates. The data are produced in part from SRDB-V5 inputs that cover the period 1961-2016.

Soil respiration (Rs) is the efflux of CO_2 from soils to the atmosphere as a result of autotrophic and heterotrophic processes belowground, and Rs is a large component of the global carbon cycle. Soil heterotrophic respiration (Rh) describes CO_2 efflux by decomposition of soil organic matter by microorganisms but excludes autotrophic respiration by plant roots.

There are four data files in GeoTIFF (*.tif) format included in this dataset.

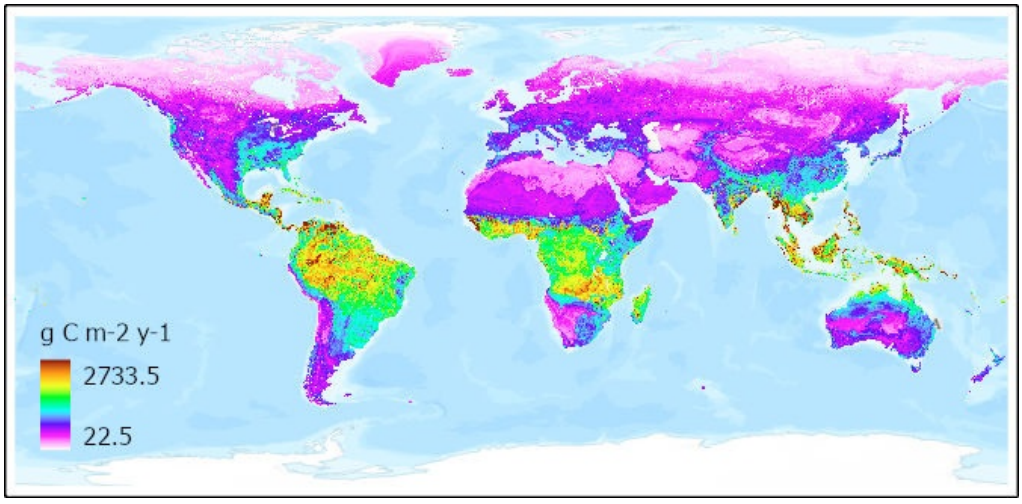

Figure 1. Mean global soil respiration derived from global Soil Respiration Database Version 5 (SRDB-V5). Units are g C m-2 y-1. Source: soil_Rs_mean.tif

Citation

Stell, E., D.L. Warner, J. Jian, B.P. Bond-Lamberty, and R. Vargas. 2021. Global Gridded 1-km Soil and Soil Heterotrophic Respiration Derived from SRDB v5. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1928

Table of Contents

1. Dataset Overview

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Project: Carbon Monitoring System

The NASA Carbon Monitoring System (CMS) program 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 uses 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 data products are designed to inform near-term policy development and planning.

Related Publication

Jian, J., Vargas, R., Anderson-Teixeira, K., Stell, E., Herrmann, V., Horn, M., Kholod, N., Manzon, J., Marchesi, R., Paredes, D., and Bond-Lamberty, B.: A restructured and updated global soil respiration database (SRDB-V5). Earth System Science Data 13:255–267. https://doi.org/10.5194/essd-2020-136

Stell, E., D. Warner, J. Jian, B. Bond-Lamberty, and R. Vargas. 2021. Spatial biases of information influence global estimates of soil respiration: How can we improve global predictions? Global Change Biology 27:3923–3938. https://doi.org/10.1111/gcb.15666

Related Dataset

Jian, J., R. Vargas, K.J. Anderson-Teixeira, E. Stell, V. Herrmann, M. Horn, N. Kholod, J. Manzon, R. Marchesi, D. Paredes, and B.P. Bond-Lamberty. 2021. A Global Database of Soil Respiration Data, Version 5.0. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/1827

Warner, D.L., B.P. Bond-Lamberty, J. Jian, E. Stell, and R. Vargas. 2019. Global Gridded 1-km Annual Soil Respiration and Uncertainty Derived from SRDB V3. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1736

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2. Data Characteristics

Spatial Coverage: Global

Spatial Resolution: ~1 km (0.00833 degrees)

Temporal Coverage: 1961-01-01 to 2016-06-01

Temporal Resolution: One-time estimate

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 four data files in GeoTIFF (*.tif) format included in this dataset. The GeoTIFF files were optimized for use in a cloud environment as described by https://www.cogeo.org.

Table 1. File names and descriptions.

File Names	Units	Description
soil_Rs_mean.tif	g m-2 y-1	Mean soil respiration expressed as grams carbon
soil_Rs_SD.tif	g m-2 y-1	Standard deviation of soil respiration expressed as grams carbon
soil_Rs_CV.tif	g m-2 y-1	Coefficient of variation of soil respiration expressed as grams carbon
soil_Rh_mean.tif	g m-2 y-1	Mean heterotrophic respiration in soil expressed as grams carbon

Data File Details

Missing values are represented by -9999. Each file contains 21600 rows and 43200 columns. The Coordinate Reference System is "WGS84" (EPSG:4326). The spatial resolution is 0.00833 degrees or approximately 1 km.

3. Application and Derivation

Soil respiration (Rs) is a large, but poorly understood portion of the global carbon cycle. Accurate estimates of soil respiration are needed to lower uncertainty in global climate projections. These data provide an updated spatially explicit estimate of Rs, and associated uncertainty, derived from the most comprehensive publicly available dataset, the global Soil Respiration Database (SRDB; Jian et al., 2021).

4. Quality Assessment

The standard deviation and coefficient of variation of mean soil respiration (Rs) are provided and were computed from a quantile regression forests model (Stell et al., 2021). Estimates of soil heterotrophic respiration (Rh) were calculated from the Rs estimates.

5. Data Acquisition, Materials, and Methods

Soil respiration (Rs) includes the efflux of CO_2 from soils to the atmosphere as a result of autotrophic and heterotrophic processes belowground, and Rs is a large component of the global carbon cycle. Soil heterotrophic respiration (Rh) describes CO_2 efflux by decomposition of soil organic matter by microorganisms but excludes autotrophic respiration by plant roots.

Estimates of soil respiration and soil heterotrophic respiration were computed from the global Soil Respiration Database (SRDB-V5; Jian et al., 2021) at a 1 km scale. SRDB holds results of field studies of Rs from around the globe (Bond-Lamberty and Thomson, 2010). A total of 4,115 records from 1,036 studies were selected from SRDB. These Rs records were combined with global meteorological, land cover, and topographic data then evaluated with variable selection using random forests. The best covariate predictors of Rs included mean annual temperature, mean annual MODIS enhanced vegetation index (EVI), and mean precipitation from four seasonal periods: November to January, February to April, May to July, and August to October. (Stell et al., 2021).

To make spatially explicit predictions of Rs, a quantile regression forest (QRF) model was trained using these covariates and SRBD data. The QRF was calibrated with five repetitions of a 10-fold cross-validation procedure, and the resulting model was applied to each 1 km grid cell across the globe. QRF provided conditional prediction distributions of Rs for each grid cell. The means of these distributions were used as a mean estimate for each grid cell. Likewise, cell-specific standard deviations and coefficients of variation were derived from these distributions.

Soil heterotrophic respiration (Rh) was calculated from mean Rs using the equation:

$$ln(Rh) = 1.22 + 0.73*ln(Rs)$$

See Stell et al. (2021) for details of this analysis.

6. Data Access

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

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Contact for Data Center Access Information:

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

7. References

Bond-Lamberty, B. and A. Thomson. 2010. A global database of soil respiration data. Biogeosciences 7:1915–1926. https://doi.org/10.5194/bg-7-1915-2010

Jian, J., R. Vargas, K.J. Anderson-Teixeira, E. Stell, V. Herrmann, M. Horn, N. Kholod, J. Manzon, R. Marchesi, D. Paredes, and B.P. Bond-Lamberty. 2021. A Global Database of Soil Respiration Data, Version 5.0. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/1827

Stell, E., D. Warner, J. Jian, B. Bond-Lamberty, and R. Vargas. 2021. Spatial biases of information influence global estimates of soil respiration: How can we improve global predictions? Global Change Biology 27:3923–3938. https://doi.org/10.1111/gcb.15666