

----- GENERAL INFORMATION -----

DATA TITLE: In situ, short-term soil carbon dioxide emissions at four sites

PROJECT TITLE: Multiple factors co-limit short-term soil carbon dioxide emissions

DATA ABSTRACT: These data describe measurements of soil CO₂ efflux collected from four locations over multiannual periods. Each flux measurement is coupled with measurements of surface-soil temperature and moisture that were collected at the same time and place. They also include remotely sensed enhanced vegetation index, and mean daily air temperature records collected by nearby weather stations. Flux measurements are presented as measured, in $\mu\text{mol cm}^{-2} \text{ s}^{-1}$, based on short-term measurements across sites, and captured site heterogeneity across seasons. Similar measurement protocols were used at each location, of which there were two in Iowa, USA; one in Wisconsin, USA; and one in Costa Rica. The principal experimental treatment in each site was land cover.

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ASSOCIATED PUBLICATIONS:

Raich JW, Kaiser MS, Dornbush ME, Martin JG, Valverde-Barrantes OJ (2023) Multiple factors co-limit short-term in situ soil carbon dioxide emissions. PLoS ONE 18(2): e0279839.

<https://doi.org/10.1371/journal.pone.0279839>

COLLECTION INFORMATION:

Time period(s): 2000 - 2008

Location(s): Costa Rica; Iowa USA and Wisconsin USA

----- FILE DIRECTORY -----

Filename: Raich_Kaiser_Dornbush_Martin_Valverde-Barrantes_2022.csv

- Comma-delimited (.csv) file containing all of the data.

Filename: journal_pone_0279839_g001.tif

- Figure 1 from Raich et al, 2023. Originally published in PLOS. Description follows:
Fig 1. Deviance residuals of the five tested models, based on all observed data. The main-effects model (mem) included only the main effects, without interactions: Tsoil, Tsoil2, VWC, VWC2, EVI and Tair. Horizontal lines divide each plot into positive and negative residuals, for ease of interpretation: the sample size for each is 8039.

Filename: journal_pone_0279839_g002.tif

- Figure 2 from Raich et al, 2023. Originally published in PLOS. Description follows:
Fig 2. Expected soil-CO₂ emissions across observed ranges of (A) surface-soil temperature; (B) surface-soil volumetric water content; (C) enhanced vegetation index (EVI); and (D) air temperature. Expected values are based on the main effects model applied to the observed environments (N = 8039).
Symbol colors represent locations: Bear Creek—orange; Chequamegon—purple; La Selva—green; and Rhodes Farm—yellow

Filename: journal_pone_0279839_g003.tif

- Figure 3 from Raich et al, 2023. Originally published in PLOS. Description follows:
Fig 3. Expected relationships between soil-CO₂ emissions and temperature at three levels of soil volumetric water content based on the main-effects model.
(A) Expected R_{soil} in relation to soil temperature at low, medium and high soil volumetric water contents. The temperature at maximum flux was 22.5°C regardless of soil water content. (B) The Q_{10} of emissions declined as temperature increased, but did not vary with water content. The plotted relationships show the midpoints of 10°C intervals, *i.e.*, the Q_{10} at $X = 2^\circ\text{C}$ is the ratio of the expected fluxes at 7 and -3°C. Note that the individual relationships for low, medium, and high water contents overlies one another. The horizontal dotted line identifies $Q_{10} = 1$, below which estimated fluxes were lower at warmer temperatures.

----- VARIABLES -----

Number Of Variables/Columns: 10
Number Of Cases/Rows: 8039
Missing Data Codes: no missing data

Name	Description	Values
Row	Row number	Integer, range 1-8039
Location	Name of study site	Text, 4 values only
Date	Measurement date	Format MM/DD/YYYY
Vegetation	Location-specific descriptor	Text. Descriptors include TemperateGrassland, TemperateForest, and TreePlantation
LandCoverType	Treatment-specific descriptor	Text. Descriptors vary within locations
Log(Rsoil)	Natural log of measured flux	Units, $\mu\text{mol m}^{-2} \text{s}^{-1}$
Tsoil(C)	Soil temperate in A horizon	Degrees Centigrade
Msoil(m3/m3)	Surface soil water content	Units $\text{m}^3 \text{m}^{-3}$
Tair(C)	Mean daily air temperature	Degrees Centigrade
EVI	Enhanced vegetation index	No units, range 0-1

----- METHODS AND MATERIALS -----

We gathered and analyzed measurements of soil carbon dioxide emissions that were collected over multiple years from four locations that varied in climate, soil type, and vegetation. Data came from designed, replicated-block experiments at two locations, and from observational comparisons at the other two. A baseline model that included only soil temperature, soil volumetric water content (VWC), and their interaction was effective in estimating R_{soil} at all four locations (Chi-squared $p < 0.0001$). Model fits, based on model log likelihoods and Akaike information criterion (AIC), improved continuously as additional covariates were added, including mean daily air temperature, remotely sensed enhanced vegetation index (EVI), and quadratic terms for soil temperature and soil VWC, despite substantial increases in model degrees of freedom. The addition of land cover, and its direct interactions with environmental variables, further improved model fits.

----- DATA COLLECTION METHODS -----

At each of four sites; La Selva, Costa Rica; Rhodes Farm, Iowa, USA; the Chequamegon National Forest in northern Wisconsin, USA; and Bear Creek, Iowa, USA; we measured soil- CO_2 emissions with LI-COR soil- CO_2 measurement systems (<https://www.licor.com/env/>) in parallel with concomitant measurements of surface-soil temperatures and surface-soil soil volumetric water contents.

----- LICENSING -----

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----- Change log -----

2023-02-28, MNO

- Changes to this file: added citation to article; added figures and captions from article; corrected Creative Commons license information.
- Changes to dataset: added article title and DOI to record, uploaded figure files.