CMS: Soil CO2 Efflux and Properties, Site Vegetation Measurements, Mexico, 2011-2012

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Summary

This data set provides the results of (1) monthly measurements of soil CO2 efflux, volumetric water content, and temperature, and (2) seasonal measurements of soil (porosity, bulk density, nitrogen (N) and carbon (C) content) and vegetation (leaf area index (LAI), litter and fine root biomass) properties in a water-limited ecosystem in Baja California, Mexico. Measurements and samples were collected from August 2011 to August 2012.

The study site was located in El Mogor, in the Valle de Guadalupe, Baja California, Mexico. The sampling area was 100 x 50-m with 50 sampling points at intervals ranging between 5 and 10 m. The enhanced vegetation index (EVI) was also derived for a 2 x 2-km area centered on the study site from the MODIS Land Product Subsets (MOD13Q1) to supplement the monthly measurements of vegetation dynamics.

There are three comma-separated data files (*.csv); one for monthly data, one for the seasonal measurements, and one with monthly EVI data. A shapefile (.shp) with the sampling points and seasonal data as attributes is included.

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Figure 1. El Mogor, in the Valle de Guadalupe, Baja California, Mexico.

Citation

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Data Set Overview

Project: Carbon Monitoring System (CMS)

Investigators**:** Elievf Leon, Rodrigo Vargas, Stephen Bullock, Eulogio Lopez, Alan Rodrigo Panosso, and Newton La Scala Jr.

The 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.

This data set provides monthly measurements of soil CO2 efflux, volumetric water content (5 cm), porosity, density, temperature, nitrogen (N), and carbon (C) content, leaf area index (LAI), belowground fine root measurements, and litter biomass measurements.

The study site was located in El Mogor, in the Valle de Guadalupe, Baja California, Mexico. The sampling area was 100 x 50-m with 50 sampling points at intervals ranging between 5 and 10 m. The enhanced vegetation index (EVI) was also derived for a 2 x 2-km area centered on the study site from the MODIS Land Product Subsets (MOD13Q1) to supplement the monthly measurements of vegetation dynamics.

Data Characteristics

Spatial Data

Spatial Coverage

A 100 x 50-m sampling area at El Mogor, in the Valle de Guadalupe, Baja California, Mexico

Spatial resolution

The sampling area was 100 x 50-m with 50 survey points at intervals ranging between 5 and 10 m.

Temporal Coverage

Plant litter and soil samples were collected at the end of the dry season (September 2011) and at the middle of the wet season (February 2012); LAI measurements were also made during those two months in 2011 and 2012. Soil CO2 efflux, volumetric water content, and temperature were measured monthly between September 2011 and August 2012.

Temporal resolution

Monthly

Study Area (All latitudes and longitudes are given in decimal degrees)

Study Area	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Ground Elevation above Sea Level (m)
El Mogor, in the Valle de Guadalupe, Baja California, Mexico	-116.60505	-116.60405	32.030134	32.0294	406

Data File Information

There are three comma-separated data files (.csv) and one shapefile (.shp) with this data set:

CMS_soil_co2_efflux_monthly.csv

CMS_soil_co2_efflux_seasonal.csv

CMS_EVI_data.csv

CMS_soil_co2_efflux_seasonal.zip

Table 1. File description for CMS_soil_co2_efflux_monthly.csv

The data are monthly measurements made at the 50 points during and between September 2011 and August, 2012. pH was only measured in September 2011.

Column	Descriptions	Units/Format
ID	Location ID	Text
X_coor	X coordinate in Universal Transversal Mercator projection	Meters

Y_coor	Y coordinate in Universal Transversal Mercator projection	Meters
Z_utm	Universal Transversal Mercator (UTM) projection zone in the North=11	Numeric
Datum	The Datum is WGS84	Text
Year	Year of measurements	yyyy
Month	Month of measurements	mm
SVWC	Soil volumetric water content (5 cm)	m3 m-3
FCO_2	Soil CO2 efflux	mol m-2 s-1
Ts	Soil temperature (10 cm)	Degrees C
Soil_pH	Soil pH measurements made one time during the study at each of the 50 locations. The measurements were taken September 2011	Numeric

Table 2. File description for CMS_soil_co2_efflux_seasonal.csv

The data are for measurements made at the 50 points during the months of September 2011 and February 2012.

Missing data or data not provided are represented as -9999. pH was only measured in September 2011.

Column	Descriptions	Units/Format
ID	Location ID	text
X_coor	X coordinate in Universal Transversal Mercator (UTM) projection	m
Y_coor	Y coordinate in UTM projection	m
Z_utm	UTM zone (North)	numeric
Datum	World Geodetic System 1984 (WGS84)	text
Year	Year of measurement	yyyy
Month	Month of measurement	mm
RootBio	Root biomass (0-10 cm)	g m-2
SVWC	Soil volumetric water content (5 cm)	m3 m-3
FCO_2	Soil CO2 efflux	mol m-2 s-1
Ts	Soil temperature (10 cm)	degrees C
SoilDens	Soil density	g m-3
LAI	Leaf Area Index	numeric
SoilPoro	Soil Porosity	percent
Litter	Litter biomass	g m-2
Soil_N	Percentage of N in soil. Collected only in February and is assumed to be the same for September	percent
Soil_C	Percentage of C in soil. Collected only in February and is assumed to be the same for September	percent
Soil_pH	Soil pH measurements made one time during the study at each of the 50 locations. The measurements were taken September 2011	Numeric

Table 3. File description for CMS_EVI_data

Column	Descriptions	Units/format

Year	Year of measurements	yyyy
Month	Month of measurements	mm
EVI_Ave	Enhanced Vegetation Index from MODIS products (MOD13Q1) Monthly average (This product is acquired two times by month and the number is the average of these two measurements).	Numeric
EVI_SD	Enhanced Vegetation Index from MODIS products (MOD13Q1) Standar deviation (The number is the estándar deviation of EVI_Ave).	Numeric

Shapefile description: CMS_soil_co2_efflux_seasonal.zip

This shapefile contains five files (*.shx, *.dbf, *.prj, *.sbx, and *.shp).

Extent:

Top: 32.030134

Bottom: 32.0294

Left: -116.605051

Right: -116.604048

Parameters of the shapefile:

Geometry Type: Point

Projection:

Transverse_Mercator

Projected Coordinate System: UTM_Zone_11N

Geographic Coordinate System: GCS_WGS_1984

Datum: D_WGS_1984

Prime Meridian: Greenwich

False Easting: 500000.00000000

False_Northing: 0.00000000

Central_Meridian: -117.00000000

Scale_Factor: 0.99960000

Latitude_Of_Origin: 0.00000000

Angular Unit: Degree

Linear unit: Meter

Attributes:

FID: Internal feature number; sequential unique whole numbers that are automatically generated. Sampling points and seasonal data are included as attributes.

Shape: Feature geometry

Application and Derivation

This study adds to the increasing evidence that soil CO2 efflux dynamics in water-limited ecosystems are more complex than previously thought (when compared to temperate ecosystems), and require a better understanding to accurately represent them in global change models.

Quality Assessment

It is likely that higher spatial resolution is needed for previously observed controls of soil CO2 efflux such as: soil texture (Cable et al., 2008), different soil organic matter fractions (Almagro et al., 2013), soluble carbon pools (Scott-Denton et al., 2003), and litter decomposition rates (Stoyan et al., 2000).

Data Acquisition, Materials, and Methods

The study site is located at 406 m.a.s.l. in the Valle de Guadalupe, Baja California, Mexico and has a semiarid Mediterranean climate, with warm-dry summers and cool-wet winters. The mean annual temperature is 17 degrees C and mean annual precipitation is 309 mm (average of years 1980-2009). Rainfall typically occurs during the cool-wet winters (November-April) with mean monthly temperatures of 11-14 degrees C and monthly precipitation of 18-63 mm. Meanwhile, the warm-dry months (May-October) have mean monthly temperatures of 16-21 degrees C and monthly precipitation of 1-6 mm. Soils are shallow (approximately 30 cm of depth) and developed from granitic parent material. Soil texture is sandy loam (75% sand,14% silt, and 11% clay).

Vegetation at El Mogor is characterized by a mixture of chaparral and less-sclerophyllous species with a mean height of 1 m. The species with the greatest ground cover at the study site include Adenostoma fasiculatum, Ornithostaphylos oppositifolia, Cneoridium dumosum, Salvia apiana, and Lotus scoparius.

Sampling area

A 100 x 50-m sampling area was established within a representative location of the ecosystem in September 2011. Fifty survey points were marked within the 0.5-ha grid with intervals ranging between 5 and 10 m. At each of these points, litter, soil samples, and fine roots (<5 mm) were collected, and soil temperature and moisture, soil CO2 efflux, and leaf area index (LAI) were measured.

Belowground biomass and soil analyses

Plant litter and soil samples were collected at the end of the dry season (September 2011) and at the middle of the wet season (February 2012). Samples were taken within a 20-cm radius of the soil CO2 collars at each one of the 50 survey points (Leon et al., 2014).

- First, plant litter was collected from 30-cm2 micro-plots. Litter was cleaned by hand to remove small rocks and soil aggregates, and the clean litter samples were oven dried (65 degrees C for 48 h) to calculate total litter biomass.
- After removing the litter, soil samples were taken with a soil core (8 cm diameter) to a depth of 10 cm (502.6 cm3).
    - ♦ Soil samples were transported to the laboratory and
        - ◊ first analyzed for soil density and pH.
        - ◊ Soil samples were ground to pass through a 250-mm sieve, and analyzed via dry combustion for total carbon and nitrogen using a Thermo Finnigan Flash EA1112 N/C analyzer (Thermo Scientific, USA).
    - ♦ A second set of soil samples were air-dried, sieved through a 2-mm mesh, and all fine roots (dead and alive) were hand-picked from the sieved soil and the sieve using forceps.
        - ◊ The largest fine roots had a diameter of 5 mm, however, over 90% of them were <2 mm in diameter.
        - ◊ Fine roots were washed with deionized water to clean attached soil and then oven dried (65 degrees C for 48 h) to determine the dry weight.

Soil CO2 efflux, volumetric water content, and temperature measurements

Soil CO2 efflux was measured monthly at the 50 sampling points using a LI-8100 (Licor, Lincoln, NE) and a 10-cm survey chamber (model 8100-102; using 10-cm diameter PVC collars inserted into the soil). Changes in soil CO2 concentrations within the soil chamber were measured for 2 min to calculate soil CO2 efflux rates at each sampling point. Soil volumetric water content (VWC, using Theta Probe type ML2x) and soil temperature were measured at 10 cm depth inside each soil collar. All measurements were done between 9 and 11 am to avoid large changes in temperature during the day, and after at least 3 days of a precipitation event to avoid bias on higher soil moisture rates.

Vegetation parameters

Leaf area index (LAI) was measured monthly at the 50 sampling points using a LAI-2200 (Licor, Lincoln, NE). LAI measurements were carried out under diffuse sky conditions early in the morning (between 6 and 7 am) using a 90 degree view cap to avoid the appearance of the operator on the sensor and to block direct light. The operator stood between the sensor and the rising sun at all times following protocols for Mediterranean ecosystems with open canopy (Ryu et al., 2010).

Enhanced vegetation index (EVI) was calculated using MODIS Land Product Subsets for a 2 x 2-km area around the study site to complement the temporal patterns of vegetation dynamics (Huete et al., 2002). Average EVI was calculated for the four MODIS pixels for 8-day temporal resolution within this area. These data were derived from MODIS products generated from Collection 5 from the Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC 2011). Temporal interpolation was used to replace pixels that had quality control flags indicating poor quality.

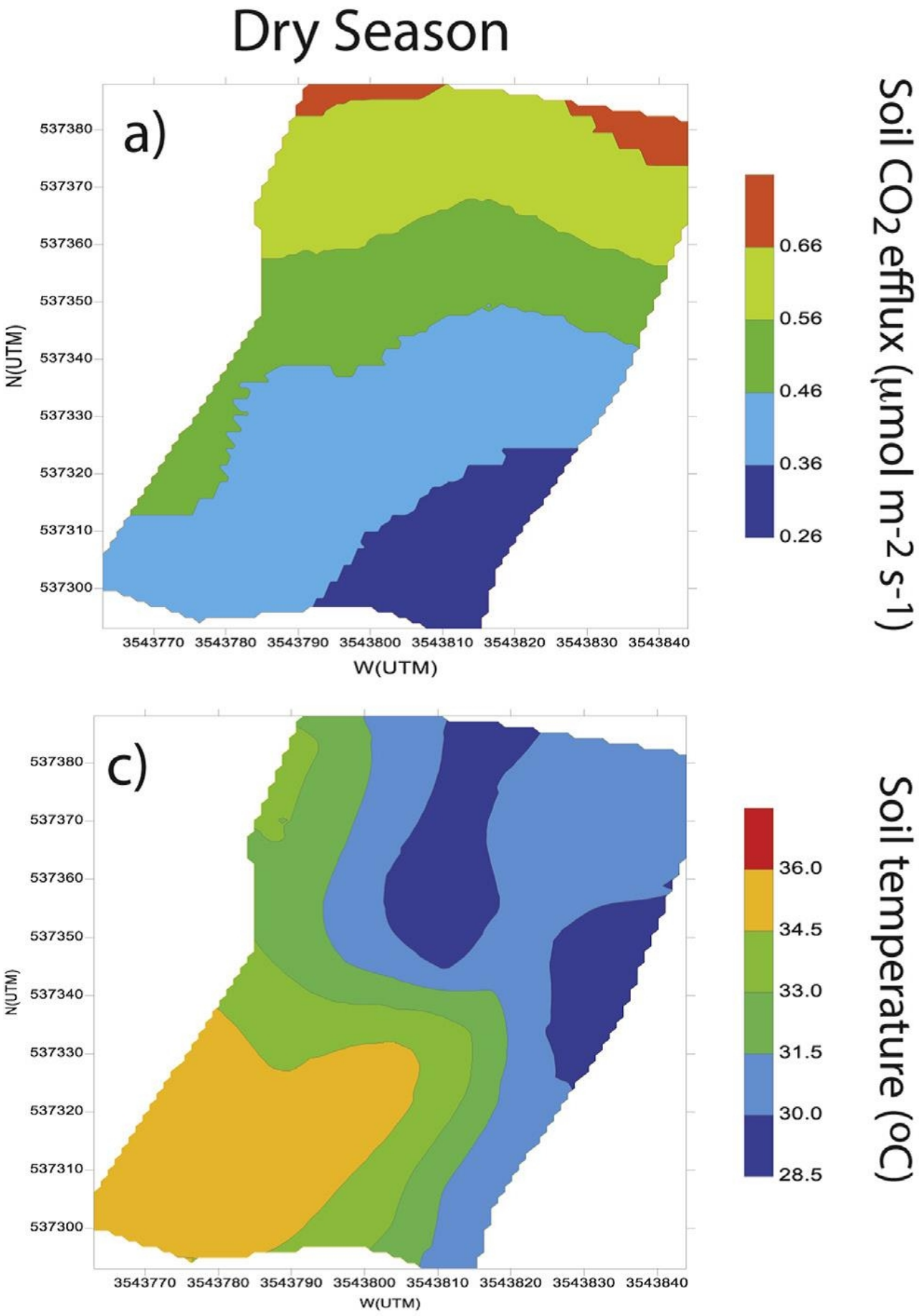
Dry Season
a)
537380
537370
537360
537350
537340
537330
537320
537310
537300
N(UTM)
3543770 3543780 3543790 3543800 3543810 3543820 3543830 3543840
W(UTM)
0.66
0.56
0.46
0.36
0.26
Soil CO2 efflux (µmol m-2 s-1)
c)
36.0
34.5
33.0
31.5
30.0
28.5
Soil temperature (oC)

Figure 2. Spatial patterns generated by ordinary kriging for the dry season (September) and the wet season (February). From Leon et al., 2014.

Data Access

This data is 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

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