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NACP Site: Terrestrial Biosphere Model and Aggregated Flux Data in Standard Format

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Revision Date: August 28, 2013

Summary:

This data set provides standardized output variables for gross primary productivity (GPP), net ecosystem exchange (NEE), leaf area index (LAI), ecosystem respiration (Re), latent heat flux (LE), and sensible heat flux (H) from 24 terrestrial biosphere models for 47 eddy covariance flux tower sites in North America. Each model used standardized input data for each flux tower site (i.e., gap-filled, locally observed weather; land use history; and other site specific data) and followed standard model setup and spinup procedures. The files also contain gap-filled observations and total uncertainty estimates. The data set was compiled for the North American Carbon Project (NACP) Site-Level Synthesis for use in model inter-comparison and assessment of how well the models simulate carbon processes across vegetation types and environmental conditions in North America.

There is one compressed (.zip) file with this data set. When expanded, the .zip file contains model output data for one variable at one site. The model output and observations are available at the native half-hourly time step, or in daily, monthly, and annual frequencies, in ASCII format.

Data and Documentation Access:

Get Data: http:daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1183

Links to Related Data Products:

NACP Site: Tower Meteorology, Flux Observations with Uncertainty, and Ancillary Data [http:daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1178]
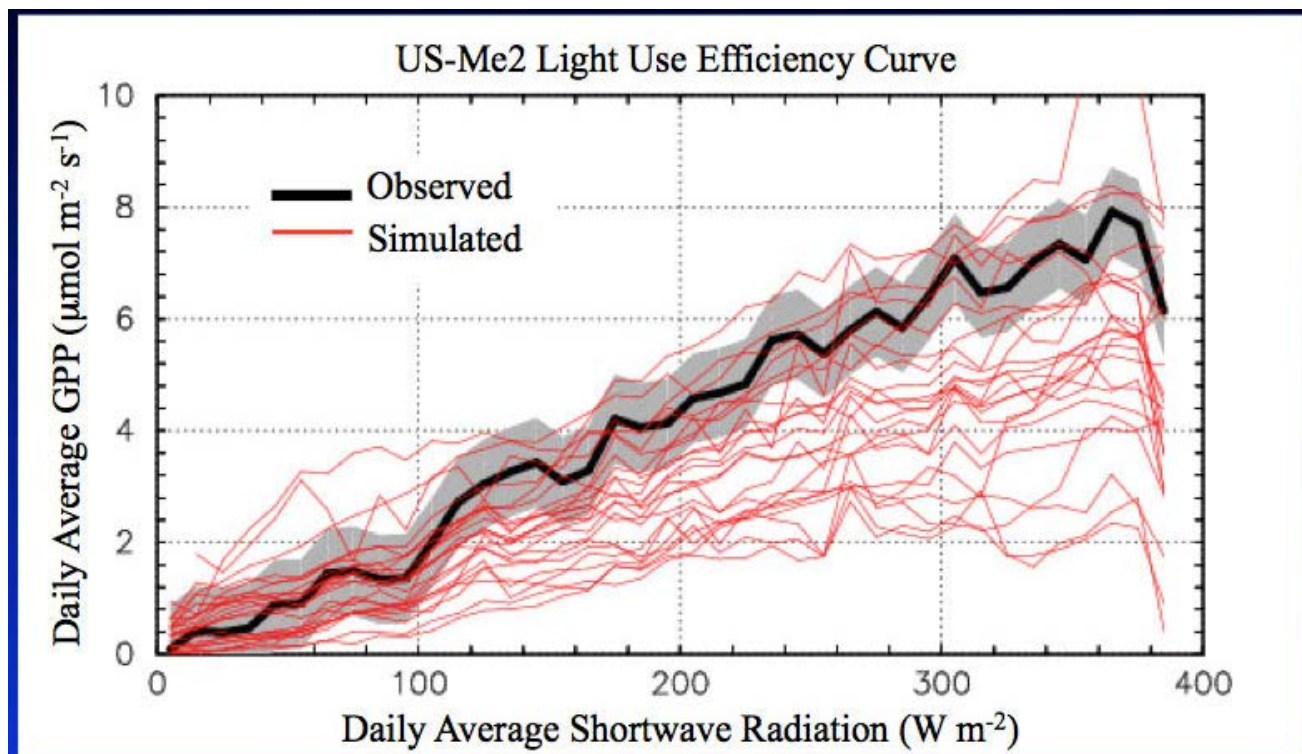NACP Site: Terrestrial Biosphere Model Output Data in Original Format

Figure 1. GPP Annual Bias, as shown in this light use efficiency (LUE) curve for the US-Me2 Flux Tower Site (Schaefer et al., 2012). The slope of the LUE curve drives the annual bias.

Data Citation:

Cite this data set as follows:

Ricciuto, D.M., K. Schaefer, P.E. Thornton, K. Davis, R.B. Cook, Shishi Liu, R. Anderson, M.A. Arain, I. Baker, J.M. Chen, M. Dietze, R. Grant, C. Izaurralde, A.K. Jain, A.W. King, C. Kucharik, Shuguang Liu, E. Lokupitiya, Y. Luo, C. Peng, B. Poulter, D. Price, W. Riley, A. Sahoo, H. Tian, C. Tonitto, and H. Verbeeck. 2013. NACP Site: Terrestrial Biosphere Model and Aggregated Flux Data in Standard Format. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1183

Table of Contents:

1. Data Set Overview:

Project: North American Carbon Project (NACP)

The North American Carbon Program (NACP) (Denning et al., 2005; Wofsy and Harriss, 2002) is a multidisciplinary research program to obtain scientific understanding of North America's carbon sources and sinks and of changes in carbon stocks needed to meet societal concerns and to provide tools for decision makers. Successful execution of the NACP has required an unprecedented level of coordination among observational, experimental, and modeling efforts regarding terrestrial, oceanic, atmospheric, and human components. The project has relied upon a rich and diverse array of existing observational networks, monitoring sites, and experimental field studies in North America and its adjacent oceans. It is supported by a number of different federal agencies through a variety of intramural and extramural funding mechanisms and award instruments.

MAST-DC organized several synthesis activities to evaluate and inter-compare biosphere model outputs and observation data at local to continental scales for the time period of 2000 through 2005. The synthesis activities have included three component studies, each conducted on different spatial scales and producing numerous data products: (1) site-level synthesis that examined process-based model estimates and observations at over 30 AmeriFlux and Fluxnet-Canada tower sites across North America; (2) a regional, mid-continent intensive study centered in the agricultural regions of the

United States and focused on comparing inventory-based estimates of net carbon exchange with those from atmospheric inversions; and (3) a regional and continental synthesis evaluating model estimates against each other and available inventory-based estimates across North America. A number of other NACP syntheses are underway, including ones focusing on non-CO_2 greenhouse gases, the impact of disturbance on carbon exchange, and coastal carbon dynamics. The Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) is the archive for the NACP synthesis data products.

NACP Site Synthesis

This data set is part of the NACP Site Synthesis which is divided into three separate data components: model driver data and observations (Data Set 1), the processed model output (Data Set 2), and the original model output (Data Set 3).

This data set (Data Set 2) provides the processed outputs of 24 terrestrial biosphere models (Schwalm et al., 2010) for model inter-comparison and assessment of how well the models simulate carbon process across vegetation types and environmental conditions at 47 eddy covariance flux tower sites in North America. Standardized files have been generated from the models for the following output variables: gross primary productivity (GPP), net ecosystem exchange (NEE), leaf area index (LAI), ecosystem respiration (Re), latent heat flux (LE), and sensible heat flux (H). Each file contains output from the models for one variable at one site. These files also contain gap-filled observations and total uncertainty estimates from Barr et al. (2009; 2013b) and Schaefer et al. (2012). The data files are available at the native half-hourly time step, or in daily, monthly, and annual averages. The files are in ASCII format.

Table 1. NACP Site-Level Synthesis - First-priority sites (36 sites). These sites have forcing and flux with uncertainty data but not all sites provided ancillary data.

FLUXNET Site Code	Full Name	Period of Record[1]	Flux w/ Uncertainty Data	Ancillary Data	State/Prov	Type[2]
US-ARM	ARM – Southern Great Plains	2000-2006	yes	yes	OK	CRO
US-Ne1	Mead – Irrigated maize	2001-2006	yes	yes	NE	CRO
US-Ne2	Mead – Irrigated maize/soybean	2001-2006	yes	yes	NE	CRO
US-Ne3	Mead – Rainfed maize/soybean	2001-2006	yes	yes	NE	CRO
US-IB1	Fermi Lab – Maize/soybean rotation	2005-2007	yes	yes	IL	CRO
CA-Let	Lethbridge Grassland	1997-2006	yes	yes	AB	GRA
US-Var	Vaira Ranch	2001-2007	yes	yes	CA	GRA
US-Shd	Shidler	1997-2001	yes	yes	OK	GRA
US-IB2	Fermi Lab – Prairie	2004-2007	yes	yes	IL	GRA
CA-Oas	BERMS – Old Aspen	1997-2006	yes	yes	SK	DBF
US-Ha1	Harvard Forest – EMS Tower	1991-2006	yes	yes	MA	DBF
US-Dk2	Duke Forest – Hardwood	2003-2005	yes	yes	NC	DBF
US-UMB	University of Michigan Biological Station (UMBS)	1998-2006	yes	yes	MI	DBF
US-MMS	Morgan Monroe State Forest	1999-2006	yes	yes	IN	DBF
US-WCr	Willow Creek	1998-2006	yes	no	WI	DBF
US-MOz	Missouri Ozark	2004-2007	yes	yes	MO	DBF
CA-Man	BOREAS – Northern Study Area, Old Black Spruce	1994-2006	yes	yes	MB	ENFB
CA-Obs	BERMS – Old Black Spruce	2000-2006	yes	yes	SK	ENFB
CA-Ojp	BERMS – Old Jack Pine	2000-2006	yes	yes	SK	ENFB
CA-Qfo	Quebec – Mature Black Spruce	2004-2006	yes	yes	QB	ENFB
CA-Ca1	Campbell River – Mature Douglas-fir	1998-2006	yes	yes	BC	ENFT
US-Dk3	Duke Forest – Loblolly Pine	1998-2005	yes	yes	NC	ENFT
US-Ho1	Howland Forest – Main Tower	1996-2004	yes	yes	ME	ENFT
US-Me2	Metolius – Intermediate-aged Ponderosa Pine	2002-2007	yes	yes	OR	ENFT

US-NR1	Niwot Ridge	1998-2007	yes	yes	CO	ENFT
CA-TP4	Turkey Point – Mature	2002-2007	yes	yes	ON	ENFT
US-PFa	Park Falls / WLEF	1997-2005	yes	yes	WI	MF
US-Syv	Sylvania Wilderness Area	2001-2006	yes	yes	MI	MF
CA-Gro	Groundhog River Station	2004-2006	yes	yes	ON	MF
US-Ton	Tonzi Ranch	2001-2007	yes	yes	CA	WSA
US-SO2	Sky Oaks – Old	1998-2006	yes	yes	CA	SHR
US-Brw	Barrow	1998-2006	yes	yes	AK	TUN
US-Atq	Atqasuk	1999-2006	yes	yes	AK	TUN
CA-Mer	Eastern Peatland – Mer Bleue	1999-2006	yes	yes	ON	WET
US-Los	Lost Creek	2000-2006	yes	no	WI	WET
CA-WP1	Western Peatland – LaBiche River	2003-2007	yes	no	AB	WET

Table 2. NACP Site-Level Synthesis - Second-priority sites (11 chronosequence sites). All second-priority sites have forcing data but not all sites have flux with uncertainty data and none provided site ancillary data.

FLUXNET Site Code	Full Name	Period of Record[1]	Flux w/ Uncertainty Data	Ancillary Data	State/Prov	Type[2]
CA-SJ1	BERMS – Jack Pine, 1994 harvest	2002-2005	yes	no	SK	ENFB
CA-SJ2	BERMS – Jack Pine, 2002 harvest	2003-2006	yes	no	SK	ENFB
CA_SJ3	BERMS – Jack Pine, 1975 harvest	2004-2005	yes	no	SK	ENFB
CA-Ca2	Campbell River – Douglas-fir clearcut	2001-2006	yes	no	BC	ENFT
CA-Ca3	Campbell River – Douglas-fir juvenile	2002-2006	yes	no	BC	ENFT
US-Me3	Metolius – Ponderosa Pine, young #2	2004-2005	yes	no	OR	ENFT
US-Me4	Metolius – Ponderosa Pine, old-growth	1996-2000	no	no	OR	ENFT
US-Me5	Metolius – Ponderosa Pine, Young #1	1999-2002	yes	no	OR	ENFT
CA-TP1	Turkey Point – Young	2003-2007	no	no	ON	ENFT
CA-TP2	Turkey Point – Seedling	2003-2007	no	no	ON	ENFT
CA-TP3	Turkey Point – Middle-aged	2003-2007	no	no	ON	ENFT

Notes (apply to both tables):

[1] Start-end years in the gap-filled weather data. Partial years (from flux data record) have been extended to complete years of surface weather data to simplify model forcing.

[2] Types were assigned for convenience in this project, to identify combination of vegetation type and climate zone as an aid in site selection. These type names are not intended to match the IGBP classification assigned in other databases.

Class: CRO = crop; GRA = grassland; ENFB = evergreen needleleaf forest – boreal; ENFT = evergreen needle leaf forest – temperate; DBF = deciduous broadleaf forest; MF = mixed (deciduous/evergreen) forest; WSA = woody savanna; SHR = shrubland; TUN = tundra; and WET = wetland.

An additional 11 flux tower sites, which lack ancillary and biological data templates, were identified as third-priority sites (see Figure 1) but were not used as part of the model-data comparison.

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Note: See Table 2 in Schaefer et al. (2012) for a summary of model characteristics and references.

2. Data Description:

This data set contains standardized, processed output from 24 terrestrial biosphere models for 47 flux tower sites in North America. The output variables are: gross primary productivity (GPP), net ecosystem exchange (NEE), leaf area index (LAI), ecosystem respiration (Re), latent heat flux (LE), and sensible heat flux (H). The data files also contain gap-filled observations and total uncertainty estimates from Barr et al. (2009) and Schaefer et al. (2012). Data are provided at the native half-hourly time step, daily, monthly, and annual averages. The data files are in ASCII format.

2.1. Spatial Coverage

Site: North America

Site boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
North America	-170	-50	84	10

2.2. Spatial Resolution

Point (lat/lon) centered around flux tower

2.3. Temporal Coverage

1998-2007

2.4. Temporal Resolution

Half-hourly, daily, monthly, and annual averages

2.5. Time Variable

Standardized files are in local standard time (LST) with the timestamp representing the beginning of the averaging period. To match this standard, model output has been time-shifted when necessary

2.6. Data File Information

Table 3. Data Files

FILE AND FOLDER NAMES			
COMPRESSED FILE NAME	FILE FOLDER NAMES	DATA FILE FOLDER NAMES FOR EACH SITE	DATA FILES FOR EACH SITE
NACP_Site_Model_Flux_Std_Fmt.zip	GPP_47_site_model_output	*_GPP	*_GPP_annual.txt
			*_GPP_daily.txt
			*_GPP_halfhourly.txt
			*_GPP_monthly.txt
	H_47_site_model_output	*_H	*_H_annual.txt
			*_H_daily.txt
			*_H_halfhourly.txt
			*_H_monthly.txt
	LAI_47_site_model_output	*_LAI	*_LAI_annual.txt
			*_LAI_daily.txt
			*_LAI_halfhourly.txt
			*_LAI_monthly.txt
	LE_47_site_model_output	*_LE	*_LE_annual.txt
			*_LE_daily.txt
			*_LE_halfhourly.txt
			*_LE_monthly.txt
	NEE_47_site_model_output	*_NEE	*_NEE_annual.txt
			*_NEE_daily.txt
			*_NEE_halfhourly.txt
			*_NEE_monthly.txt
	Re_47_site_model_output	*_Re	*_Re_annual.txt
			*_Re_daily.txt
			*_Re_halfhourly.txt
			*_Re_monthly.txt

Note: * represents the 6-character tower codes used in the site lists (see Tables 1 and 2).

2.7. Companion File Information

Table 4. Companion Files

FILE NAME	DESCRIPTION
NACP_uncertainty_analysis.pdf	Methodology of estimating uncertainty
Richardson_gap_filling_2009.pdf	Explanation of algorithmic uncertainties in GPP/RE partitioning and gap filling of NEE, at annual and half-hourly time scales
site_information_basic.csv	Basic information about each flux tower site (site code, name, PI, affiliation, email, address, references, priority, biome, etc.)
site_information_extended.pdf	Summarizes site code, name, PI, affiliation, email, address, references, priority, biome, etc.
site_location_summary.csv	Summarizes all site location information required as input to all models: latitude, longitude, elevation, instrument height, biome, start and stop years, time zone shift to local standard time, and the flux time averaging period
site_synthesis_protocol_v7.pdf	Describes standardized site synthesis protocol
figures.zip	Plots representing diurnal and seasonal averages for the output variables

3. Data Application and Derivation:

This data product contributes to a multidisciplinary research program to obtain scientific understanding of North America's carbon sources and sinks and of changes in carbon stocks needed to meet societal concerns and to provide tools for decision makers. The data were generated as part of a NACP site-level synthesis to evaluate and inter-compare models and observation measurements across North America.

This data set contains standardized, processed outputs of 24 terrestrial biosphere models and was used to inter-compare model simulations and assess how well terrestrial biosphere models simulate carbon processes across vegetation types and environmental conditions at 47 eddy covariance flux tower sites in North America.

4. Quality Assessment:

The modeling teams used standard model input data derived from local observations, simulation setup procedures, model outputs, and analysis techniques to ensure a valid and fair comparison of model results against observations. Using standardized input, output, and analysis techniques also minimized setup and analysis time and allowed investigators to accurately gauge model and data uncertainty with minimal error and bias.

Overall, there was a very large spread in model performance. See discussions on model inter-comparisons and model-data comparisons in Dietze et al. (2011), Richardson et al. (2012), Schaefer et al. (2012), and Schwalm et al. (2010).

5. Data Acquisition Materials and Methods:

Participating modeling teams followed the NACP Site Synthesis Protocol <Site_Synthesis_Protocol_v7.pdf> which covers procedures, plans, and infrastructure for the site-level analyses. MAST-DC provided each modeling team with standardized model input data for each flux tower site. The input data included: gap-filled, locally observed weather; remotely-sensed phenology; land use history; and site description data. The input data are described and provided in a related data set, NACP Site: Tower Meteorology, Flux Observations with Uncertainty, and Ancillary Data (10.3334/ORNLDAAC/1178). To ensure consistency, each modeling team followed standard model setup and spinup procedures (see the NACP Site Synthesis Protocol). All models used their standard values for various biophysical parameters except LoTEC, which used optimized parameter values obtained through data assimilation (Ricciuto et al., 2011).

Included here is the latest version of processed model output (mid-December 2009). GPP, NEE, and Re files have been further updated in November 2012 to provide total uncertainty estimated by Schaefer et al. (2012). However, LE and H have not been updated, and only contain the random and u* threshold uncertainty summed in quadrature. Plots representing diurnal and seasonal averages for these output variables are also provided in the companion sub-directory.

6. Data Access:

This data set is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive Center:

Contact for Data Center Access Information:
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