NACP MsTMIP: Global 0.5-degree Model Outputs in Standard Format, Version 1.0

Get Data

Documentation Revision Date: 2019-02-11

Dataset Version: 1

Summary

This data set provides global gridded estimates of carbon, energy, and hydrologic fluxes between the land and atmosphere from 15 Terrestrial Biosphere Models (TBMs) in a standard format. Model estimates are at monthly and yearly time steps for the period 1900 to 2010, with a spatial resolution of 0.5 degree x 0.5 degree globally, excluding Antarctica.

The 15 TBMs are models in the Multi-scale Synthesis and Terrestrial Model Intercomparison Project (MsTMIP): BIOME-BGC, CLM, CLM4VIC, CLASS-CTEM, DLEM, GTEC, ISAM, LPJ, ORCHIDEE, SIB3, SIBCASA, TEM6, TRIPLEX-GHG, VEGAS, and VISIT.

There are 1,484 files in netCDF v4 format with this data set. Each file contains all time steps of a single variable output from one of five simulations by each model. Note that not all models performed all simulations. MsTMIP defined a list of required/optional variables to be generated by each model.

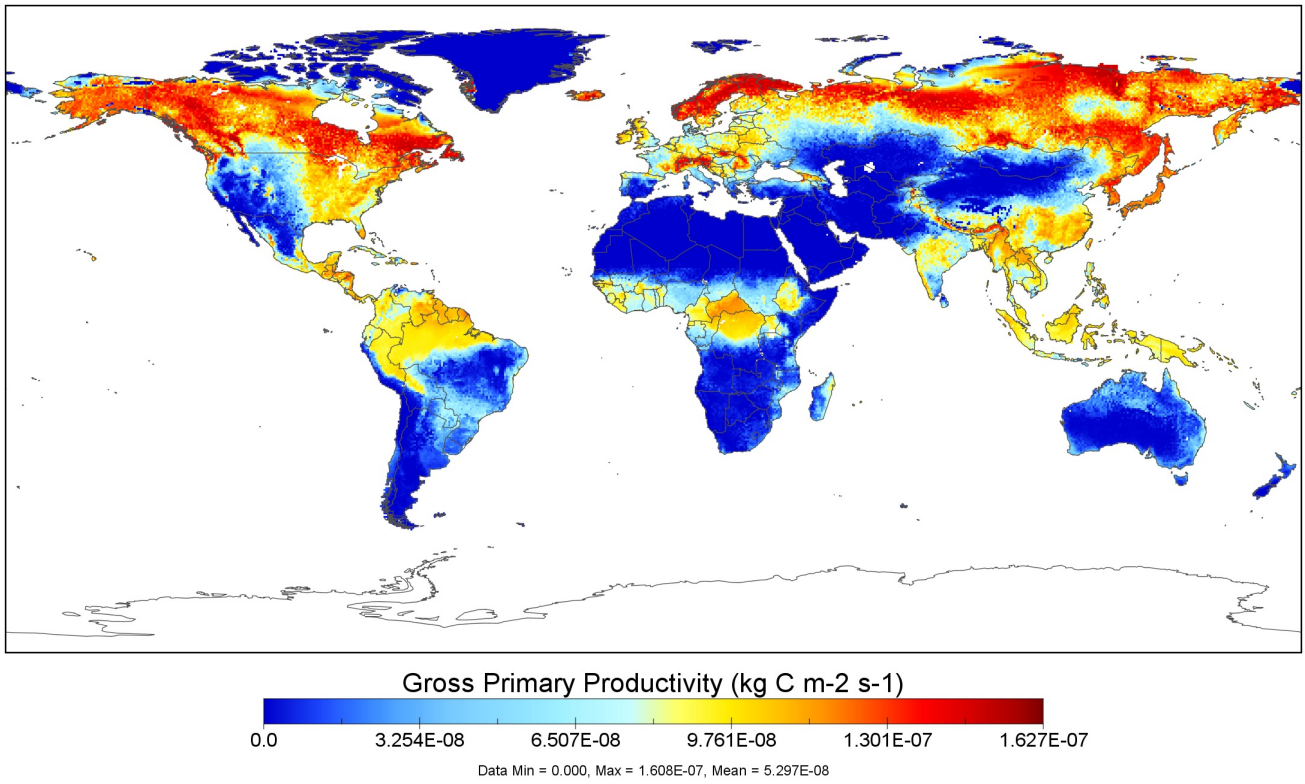

Figure 1. Global monthly 0.5-degree Gross Primary Productivity (GPP) in July 2010 from model LPJ-wsl's SG3 simulation.

Citation

Huntzinger, D.N., C.R. Schwalm, Y. Wei, R.B. Cook, A.M. Michalak, K. Schaefer, A.R. Jacobson, M.A. Arain, P. Ciais, J.B. Fisher, D.J. Hayes, M. Huang, S. Huang, A. Ito, A.K. Jain, H. Lei, C. Lu, F. Maignan, J. Mao, N.C. Parazoo, C. Peng, S. Peng, B. Poulter, D.M. Ricciuto, H. Tian, X. Shi, W. Wang, N. Zeng, F. Zhao, Q. Zhu, J. Yang, and B. Tao. 2018. NACP MsTMIP: Global 0.5-degree Model Outputs in Standard Format, Version 1.0. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1225

Table of Contents

1. Dataset Overview

Project: North American Carbon Program (NACP)

Fifteen global Terrestrial Biosphere Models (TBMs) participating in the MsTMIP project ran simulations with MsTMIP benchmark reference driver data sets (Wei et al., 2014; Liu et al., 2014). The models' results were processed to semantically map original outputs, provided by the modeling teams, to the required MsTMIP set of variables. Additional checks included sign convention, limits (e.g., negative values for GPP), and whether model outputs conformed to the spatiotemporal resolution and simulation protocol of MsTMIP. The model output data provided with this data set includes carbon, energy, and hydrologic fluxes between the land and atmosphere at monthly and yearly time steps. Refer to Table 1 in Section 2 of this document for additional model information.

NACP: The North American Carbon Program (NACP) 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.

The NACP Multi-scale synthesis and Terrestrial Model Intercomparison Project (MsTMIP) is a formal model intercomparison and evaluation effort focused on improving the diagnosis and attribution of carbon exchange at regional and global scales (Huntzinger et al. 2013). The MsTMIP experimental design includes simulations run at two spatial resolutions (0.5 and 0.25-degree) and for two spatial domains (globally and regionally over North America) in order to assess model performance at scales relevant to carbon management and climate change predictions. MsTMIP builds upon current and past synthesis activities, and has a unique framework designed to isolate, interpret, and inform understanding of how model structural differences impact estimates of carbon uptake and release.

Acknowledgements

MsTMIP Phase 1 was funded by NASA's Terrestrial Ecology Program (Grant NNX11AO08A). During Phase 1, data management for MsMTIP was conducted by MAST-DC, with funding from NASA's Terrestrial Ecology Program (NASA Grant NNH10AN68I). This is a contribution of the North American Carbon Program.

Related Data Sets

Wei, Y., S. Liu, D.N. Huntzinger, A.M. Michalak, N. Viovy, W.M. Post, C.R. Schwalm, K. Schaefer, A.R. Jacobson, C. Lu, H. Tian, D.M. Ricciuto, R.B. Cook, J. Mao, and X. Shi. 2014. NACP MsTMIP: Global and North American Driver Data for Multi-Model Intercomparison. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1220.

Liu, S., Y. Wei, W.M. Post, R.B. Cook, K. Schaefer, and M.M. Thornton. 2014. NACP MsTMIP: Unified North American Soil Map. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1242.

Huntzinger, D.N., C.R. Schwalm, A.M. Michalak, K. Schaefer, Y. Wei, R.B. Cook, and A.R. Jacobson. 2014. NACP MsTMIP Summary of Model Structure and Characteristics. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1228.

Fisher, J.B., M. Sikka, D.N. Huntzinger, C.R. Schwalm, and J. Liu. 2016. CMS: Modeled Net Ecosystem Exchange at 3-hourly Time Steps, 2004-2010. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1315.

2. Data Characteristics

Spatial Coverage: Global (excluding Antarctica)

Spatial Resolution: 0.5 x 0.5 degree

Temporal Coverage: Data covers the period 1900-2010

Temporal Resolution: Monthly or yearly

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
global	-180	180	90	-90

Data Description

There are 1,484 files in netCDF v4 format with this data set; one file for each variable per simulation (five simulations) per model (15 models). Note that not all models performed all simulations. Each file contains global gridded data with 1,320 (for monthly data) or 110 (for yearly data) time intervals from 1901 to 2010. Open water pixels are set to -9999 (treated as fill value).

Data file naming convention:

MODELNAME_SIMULATIONCODE_TIMERESOLUTION_VARIABLENAME.nc4

Where

MODELNAME is one of the 15 models, defined in column “Model Name” of Table 1.

SIMULATIONCODE is one of the 5 simulations, defined in column “Simulation Name” of Table 2.

TIMERESOLUTION is either “Monthly” or “Annual”.

VARIABLENAME is one of the 45 variables, defined in column “Variable Name” column of Table 3.

Example file names:

BIOME-BGC_BG1_Monthly_HeteroResp.nc4

TEM6_SG3_Monthly_GPP.nc4

TRIPLEX-GHG_SG2_Annual_CarbPools.nc4

Table 1. MsTMIP Models

Model Name	**Institution**	**Country**
BIOME-BGC	NASA Ames Research Center	USA
CLASS-CTEM-N	McMaster University	Canada
CLM4	Oak Ridge National Laboratory	USA
CLM4VIC	Pacific Northwest National Laboratory	USA
DLEM	Auburn University	USA
GTEC	Oak Ridge National Laboratory	USA
ISAM	University of Illinois Urbana-Champaign	USA
LPJ-wsl	Laboratory for Climate and Environment Sciences	France
ORCHIDEE-LSCE	Laboratory for Climate and Environment Sciences	France
SiB3	NASA Jet Propulsion Laboratory	USA
SiBCASA	National Snow and Ice Data Center	USA
TEM6	Oak Ridge National Laboratory	USA
TRIPLEX-GHG	University of Quebec at Montreal	Canada
VEGAS2.1	University of Maryland, College Park	USA
VISIT	National Institute of Environmental Studies, Japan. This work was mostly conducted during a visiting stay at Oak Ridge National Laboratory	Japan; USA

Table 2. MsTMIP Global Simulations

Simulation Name	**Climate Forcing**	**Land-Use History**	**Atmospheric CO2**	**Nitrogen Deposition**

RG1	Constant	Constant	Constant	Constant
SG1	CRU+NCEP	Constant	Constant	Constant
SG2	CRU+NCEP	Time-varying	Constant	Constant
SG3	CRU+NCEP	Time-varying	Time-varying	Constant
BG1	CRU+NCEP	Time-varying	Time-varying	Time-varying

Table 3. MsTMIP Variables

Variable Name	**Long Name**	**Units**	**Description**
AbvGrndWood	Above ground woody biomass	kg C m-2	Total above ground wood biomass
AutoResp	Autotrophic Respiration	kg C m-2 s-1	Autotrophic respiration rate
CarbPools	Size of each carbon pool	kg C m-2	Size of each carbon pool
CO2air	Near surface CO2 concentration	µmol mol-1	Near surface dry air CO2 mole fraction
Evap	Total Evapotranspiration	kg m-2 s-1	Sum of all evaporation sources, averaged over a grid cell
Fdepth	Frozen Layer Thickness	m	Total freeze depth; depth to zero centigrade isotherm in non-permafrost
Fire_flux	Fire emissions	kg C m-2 s-1	Flux of carbon due to fires
fPAR	Absorbed fraction incoming PAR	(-) *	Absorbed fraction incoming photosyntetically active radiation
GPP	Gross Primary Productivity	kg C m-2 s-1	Rate of photosynthesis
HeteroResp	Heterotrophic Respiration	kg C m-2 s-1	Heterotrophic respiration rate
LAI	Leaf Area Index	m2 m-2	Area of leaves per area ground
LW_albedo	Longwave Albedo	(-) *	Longwave Albedo
LWdown	Surface incident longwave radiation	W/m2	Surface incident longwave radiation

Lwnet	Net Longwave Radiation	W m-2	Incident longwave radiation minus the simulated outgoing longwave radiation, averaged over a grid cell
NEE	Net Ecosystem Exchange	kg C m-2 s-1	NEE=(HeteroResp+AutoResp) + Disturbance_Emissions + Product_Emissions – GPP
NEP	Net Ecosystem Productivity	kg C m-2 s-1	Net Ecosystem Productivity (NEP=GPP-(HeteroResp+AutoResp))
npool	Number Carbon Pools	na	Total number of carbon pools
NPP	Net Primary Productivity	kg C m-2 s-1	Net Primary Productivity (NPP=GPP-AutoResp)
nsoil	Number Soil Layers	na	Total number of soil layers
poolname	Name of each Carbon Pool	na	Name of each carbon pool (i.e., "wood," or Coarse Woody Debris")
Psurf	Surface pressure	Pa	Surface pressure
Qair	Near surface specific humidity	kg kg-1	Near surface specific humidity
Qh	Sensible heat	W m-2	Sensible heat flux averaged over a grid cell
Qle	Latent heat	W m-2	Latent heat flux, averaged over a grid cell
Qs	Surface runoff	kg m-2 s-1	Runoff from the landsurface and/or subsurface stormflow
Qsb	Subsurface runoff	kg m-2 s-1	Gravity drainage and/or slow response lateral flow. Ground water recharge will have the opposite sign.
Rainf	Rainfall rate	kg m-2 s-1	Rainfall rate
SnowDepth	Total snow depth	m	Total snow depth
SoilMoist	Average Layer Soil Moisture	kg m-2	Soil water content in each user-defined soil layer (3D variable). Includes the liquid, vapor and solid phases of water in the soil.
SoilTemp	Average Layer Soil Temperature	K	Average soil temperature in each user-defined soil layer (3D variable)
SoilWet	Total Soil Wetness	(-) *	Vertically integrated soil moisture divided by maximum allowable soil moisture above wilting point.
SW_albedo	Shortwave Albedo	(-) *	Shortwave albedo
SWdown	Surface incident shortwave radiation	W m-2	Surface incident shortwave radiation

SWE	Snow Water Equivalent	kg m-2	Total water mass of snow pack (ice plus liquid water)
SWnet	Net shortwave radiation	W m-2	Incoming solar radiation less the simulated outgoing shortwave radiation, averaged over a grid cell
Tair	Near surface air temperature	K	Near surface air temperature
Tdepth	Active Layer Thickness	m	Total thaw depth; depth to zero centigrade isotherm in permafrost
TotalResp	Total Respiration	kg C m-2 s-1	Total respiration (TotalResp=AutoResp+HeteroResp)
TotLivBiom	Total living biomass	kg C m-2	Total carbon content of the living biomass (leaves+roots+wood)
TotSoilCarb	Total Soil Carbon	kg C m-2	Total soil and litter carbon content integrated over the entire soil profile
Veg	Transpiration	kg m-2 s-1	Total Plant transpiration
Wind	Near surface module of the wind	m s-1	Near surface module of the wind
z_bottom	Soil Layer Bottom Depth	m	Depth from soil surface to bottom of soil layer
z_node	Soil Layer Node Depth	m	Depth from soil surface to layer prognostic variables; typically center of soil layer
z_top	Soil Layer Top Depth	m	Depth from soil surface to top of soil layer

*** (-)** is the MsTMIP convention to denote dimensionless variables.

Companion Files:

A complete crosswalk from originally uploaded model outputs to required post-processed MsTMIP variables is available in companion file MsTMIP_Version_1_Variables_Mapping.xlsx.

3. Application and Derivation

The factors that influence the spatial and temporal evolution of carbon sources and sinks vary across the globe. However, the precision, as well as the spatial and temporal resolution, of available driver data varies greatly across regions. This data set provides modeled data from standardized driver data sets.

4. Quality Assessment

MsTMIP Version 1 contains all model results that have undergone basic screening. During screening every effort was made to semantically map original outputs provided by the modeling teams to the required MsTMIP set of variables. In addition to semantic checks, screening also included checks on sign convention, limits (e.g., negative values for GPP), as well as whether model output conforms to the spatiotemporal resolution and simulation protocol of MsTMIP. Screening results are provided in Section 5 of this document.

Inclusion in MsTMIP Version 1 does not imply that the model results themselves are error free; merely that basic thresholds for usability in scientific manuscripts have been met.

5. Data Acquisition, Materials, and Methods

The models' results were processed to semantically map original outputs, provided by the modeling teams, to the required MsTMIP set of variables. Additional checks included sign convention, limits (e.g., negative values for GPP), and whether model outputs conformed to the spatiotemporal resolution and simulation protocol of MsTMIP. The screened and processed outputs were then formatted as CF-compliant netCDF files.

The model output data provided with this data set includes carbon, energy, and hydrologic fluxes between the land and atmosphere at monthly and yearly time steps. Refer to Table 1 in Section 2 of this document for additional model information.

Driver Data

To ensure consistent and comparable model results, the models used MsTMIP benchmark reference driver data sets, including standard weather drivers, remotely sensed phenology, biome classification, land-use history, and disturbance for use by all participating modeling teams (Wei et al., 2014; Liu et al., 2014).

Model Screening

MsTMIP defined a list of required/optional variables to be generated by each model.

MsTMIP Version 1 contains all model results that have undergone basic screening. During screening every effort was made to semantically map original outputs provided by the modeling teams to the required MsTMIP set of variables.

A complete crosswalk from originally uploaded model outputs to required post-processed MsTMIP variables is available in companion file MsTMIP_Version_1_Variables_Mapping.xlsx.

- The color coding of the cell denotes presence (green) or absence (red) of required variables. Note that several variables are calculated using mass balance and many variables are reported with non-standard naming conventions. These are noted in the target cell. Original variables not part of the MsTMIP required list are not considered, apart from some instances where they are used for mass balance calculations.

Screening also included checks on sign convention, limits (e.g., negative values for GPP), as well as whether model output conformed to the spatiotemporal resolution and simulation protocol of MsTMIP. This screening was performed on a test subset of model variables: AutoResp, Evap, GPP, HeteroResp, NEE, NEP, NPP, TotalResp, and TotLivBiom. These are bolded entries in companion file MsTMIP_Version_1_Variables_Mapping.xlsx.

During this process special emphasis was placed on NEE. The MsTMIP protocol defines NEE as: Net Ecosystem Exchange = HeteroResp + AutoResp + Disturbance_Emissions + Product_Emissions - GPP; where Disturbance_Emissions is assumed to include fire flux and land use change emissions. Most models cannot simulate all NEE sub-processes. Similarly, several models cannot simulate all five MsTMIP global simulations. Any deviations from the protocol, e.g., missing NEE sub-process, simulation availability, and/or other issues, are noted below for each model.

Important User Note

It is important to remember that the model results provided in this data set are not original model outputs from participating models. Rather, outputs have undergone post-processing to match the MsTMIP protocol as much as possible. Steps in that processing are detailed below for each model and include semantic remapping of model outputs. Finally, inclusion in MsTMIP Version 1 does not imply that the model results themselves are error free; merely that basic thresholds for usability in scientific manuscripts have been met.

Screening and Post-Processing Details for Each Model

BIOME-BGC

SG2 and SG3 are not available.

For all simulations fixed land cover types are used.

For BG1 only constant N deposition is used.

For RG1 only 1801 to 1900 are simulated. This time period was mapped to 1901-2010 by using 1801-1810 as 1901-1910 and 1801-1900 as 1911-2010.

Net Ecosystem Exchange = HeteroResp+AutoResp+Fire_flux-GPP; land use change and product emissions are not simulated.

CLASS-CTEM-N

Units do not match protocol for Evap and some large outlying values present in carbon fluxes.

All carbon fluxes are capped at 1000 gC/m2/month. Values which exceeded this threshold were set to NA.

Barren/vegetated mask excludes high productivity vegetated areas.

Net Ecosystem Exchange = -Net Ecosystem Productivity; disturbance emissions (fire flux and land use change emissions) and product emissions are not simulated.

CLM4

Original NEP has units gC/m2/s; NEP was converted to kgC/m2/s during processing.

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions+Product_Emissions-GPP where Disturbance_Emissions includes fire flux and land use change emissions. Net Ecosystem Exchange also includes hrv_xsmrpool flux (maintenance respiration deficit).

CLM4VIC

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions+Product_Emissions-GPP where Disturbance_Emissions includes fire flux and land use change emissions. Net Ecosystem Exchange also includes hrv_xsmrpool flux (maintenance respiration deficit).

DLEM

DLEM simulates latitudinal bands -88.25 to +88.25 only; the missing bands were infilled as ocean or barren pixels.

The Net Ecosystem Exchange reported does not incorporate all reported simulated subcomponents. It is calculated using mass balance: Net Ecosystem Exchange = HeteroResp+AutoResp-GPP+Proddec+Lulc where Proddec is Product_Emissions and Lulc is annual land use change emissions. Lulc is first apportioned equally across all 12 months. DLEM does not simulate fire flux.

GTEC

BG1 is not available.

For RG1 only 1900 to 1999 are simulated. This time period was mapped to 1901-2010 by using 1900-1910 as 1901-1910 and 1900-1999 as 1911-2010.

Lat 90.75N and Lon: 81.25E is a bad pixel (e.g., GPP c.1 300 gC/m2/month for a tundra pixel). Pixel set to zero for all screened variables.

Net Ecosystem Exchange = HeteroResp+AutoResp+Product_Emissions-GPP; fire flux and land use change emissions are not simulated.

ISAM

HeteroResp flux original units in kgC/m2/week; units converted (using an average week/month ratio of 365/12/7) to kgC/m2/s during processing.

TotLivBiom (calculated using mass balance: C_leaf+C_rootc+C_rootf+C_stem [the sum of all live carbon pools]) units are kgC/m2/s (!); TotLivBiom is converted to kgC/m2 during processing.

The Net Ecosystem Exchange reported does not incorporate all reported simulated subcomponents. It was calculated using mass balance: Net Ecosystem Exchange = HeteroResp+AutoResp+Ld-GPP; where Ld is Disturbance_Emissions. Ld original units kgC/m2/month is converted to kgC/m2/s for this calculation. Fire flux and product emissions are not simulated.

LPJ-wsl

BG1 is not available.

A dynamic global vegetation model is used for natural vegetation (as opposed to the prescribed forcing data for land cover/use change), while the crop grid cell fraction is determined by the forcing data.

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions-GPP; where Disturbance_Emissions includes both fire flux and land use change emissions. Product emissions are not simulated. Net Ecosystem Exchange also includes grazing emissions.

ORCHIDEE-LSCE

BG1 is not available.

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions+Product_Emissions-GPP; where Disturbance_Emissions includes only land use change emissions. Fire flux is not simulated.

SiB3

BG1 is not available.

SiB3 lacks carbon pools.

Net Ecosystem Exchange = -Net Ecosystem Productivity; disturbance emissions (fire flux and land use change emissions) and product emissions are not simulated.

SiBCASA

BG1 is not available.

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions-GPP; where Disturbance_Emissions includes only land use change emissions. Fire flux and product emissions are not simulated.

TEM

RG1/SG1 has a different barren/vegetated mask than BG1/SG2/SG3 in the original model output. To harmonize the barren/vegetated mask for all simulations the BG1 mask was used for RG1/SG1 during processing.

Several model outputs contain bands, linear features, on a North-South axis, with missing or abnormally small values located in either North America (Quebec), South America (Colombia-Brazil-Peru), and/or Africa (longitude 15.25E from 31.75N to 25.75S). These were infilled using nearest neighbor interpolation. Banded output by simulation:

BG1, RG1, SG1, SG3: GPP, HeteroResp, NEE, NPP, SWE, TotLivBiom, TotSoilCarb

SG2: All variables

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions+Product_Emissions-GPP where Disturbance_Emissions includes fire flux and land use change emissions.

TRIPLEX-GHG

SG1 is not available.

For all simulations fixed land cover types were used.

Original model output saved as one file per variable per month. e.g., a single file contains every month of June from 1901 to 2010 for a given output field.

All carbon flux original units in gC/m2/mon/10000; these were converted to kgC/m2/s during processing.

Evap original units in mm/day; Evap were converted to kg/m2/s during processing.

Net Ecosystem Exchange = -Net Ecosystem Productivity; disturbance emissions (fire flux and land use change emissions) and product emissions are not simulated.

VEGAS2.1

BG1 is not available.

The prescribed forcing data for land cover/use change is not used for unmanaged land. Instead a dynamic global vegetation model was used. For managed land --crop/pasture fraction and wood harvest-- the prescribed forcing data was used.

Net Ecosystem Exchange = HeteroResp+AutoResp+Disturbance_Emissions+Product_Emissions-GPP where Disturbance_Emissions includes fire flux and land use change emissions.

VISIT

BG1 is not available.

For RG1 and SG1 Net Ecosystem Exchange values are identical.

RG1 contains a different set of variables; only GPP, NEE, CarbonPools1-3, and Evap are available.

Net Ecosystem Exchange = -Net Ecosystem Productivity; disturbance emissions (fire flux and land use change emissions) and product emissions are not simulated.

6. Data Access

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

NACP MsTMIP: Global 0.5-degree Model Outputs in Standard Format, Version 1.0

Contact for Data Center Access Information:

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

7. References

Huntzinger, D., Schwalm, C., Michalak, A., Schaefer, K., King, A., Wei, Y., Jacobson, A., Liu, S., Cook, R., Post, W., Berthier, G., Hayes, D., Huang, M., Ito, A., Lei, H., Lu, C., Mao, J., Peng, C., Peng, S., Poulter, B., Riccuito, D., Shi, X., Tian, H., Wang, W., Zeng, N., Zhao, F., and Zhu, Q.: The North American Carbon Program Multi-scale synthesis and Terrestrial Model Intercomparison Project–Part 1: Overview and experimental design, Geoscientific Model Development, 6, 2121-2133, 2013.

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Wei, Y., S. Liu, D.N. Huntzinger, A.M. Michalak, N. Viovy, W.M. Post, C.R. Schwalm, K. Schaefer, A.R. Jacobson, C. Lu, H. Tian, D.M. Ricciuto, R.B. Cook, J. Mao, and X. Shi. 2014. NACP MsTMIP: Global and North American Driver Data for Multi-Model Intercomparison. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1220.

8. Dataset Revisions

This dataset was modified on 4/22/2018 to update the citation information at the request of the authors. The data files were not modified.