Multi-Scale Synthesis and Terrestrial Model Intercomparison Project (MsTMIP): Environmental Driver Data

North American Carbon Program

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Introduction

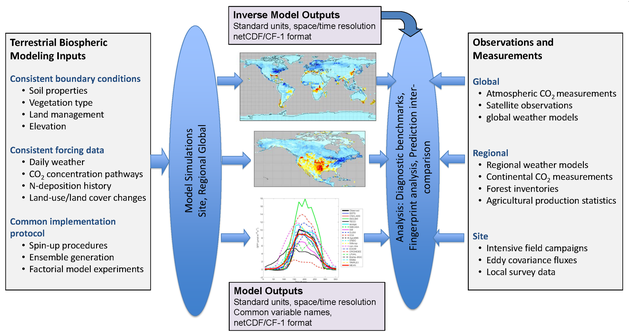
MsTMIP: The MsTMIP is a formal multi-scale synthesis, with prescribed environmental and meteorological drivers shared among model teams, and simulations standardized to faciliate comparison with other model results and observations through an integrated evaluation framework.

Phase I:

Quantify the contribution of model structural differences to variability across model estimates of land-atmosphere carbon exchange, thus providing the critical synthesis, benchmarking, evaluation, and feedback needed to improve the current state of the art in carbon cycle modeling.

Phase II:

Continue to mine of MsTMIP simulations for new types of information (i.e. state of physical environment, response to extremes), and enable a series of predictive/ forecasting simulations that use climate and emission scenarios defined by the IPCC and the CMIP5 model intercomparsion.



MsTMIP Project Phase I Overview

MsTMIP Phase I Simulations

- Global: half-degree resolution in global area
- North American: quarter-degree resolution in North America area (W:-170, S: 10, E:-50, N: 84)

Environmental Drivers for MsTMIP Phase I

To ensure consistent and comparable model results, the MsTMIP has assembled benchmark reference driver data sets for use by all participating modeling teams. Both MsTMIP core team and participating modeling teams work together to identify the best available environmental driver data sets for the purpose of MsTMIP simulations. Additional improvements were also made to the compiled environmental drivers. (Wei et al., 2014, doi:10.5194/gmd-7-2875-2014)

Category	Name	Spatial Extent	Spatial Resolution	Temporal Period	Temporal Resolution	Variables
Climate	CRU-NCEP	Global	0.5°	1901-2010	6-hourly	incoming longwave / shortwave radiation, air humidity, pressure, precipitation, temperature, wind speed
	NARR	NA	0.25°	1979-2010	3-hourly	
Biome	SYNMAP	Global, NA	0.5°, 0.25°	one time	one time	dominant biome, biome fraction
Phenology	GIMMSg	Global, NA	0.5°, 0.25°	one year	monthly	LAI, NDVI, fPAR
CO2	Enhanced GlobalView	Global, NA	0.5°, 0.25°	1700-2009	monthly	CO2 concentration
Nitrogen Deposition	Enhanced Dentener	Global, NA	0.5°, 0.25°	1860-2050	yearly	NHx-N Deposition, NOy-N Deposition
Soil	HWSD v1.1	Global	0.5°	one time	one time	soil layers, dominant soil type, clay/sand/silt fraction, pH, organic carbon, cation exchange capacity of the clay fraction, reference bulk density
	SSURGO (US) + SLC (CA) + HWSD v1.1 (MX)	NA	0.25°	one time	one time	
Land Use Change	Hurtt's + RCP4.5	Global, NA	0.5°, 0.25°	1700-2010	yearly	land use state map, land use transition
Land/Water Mask	Based on Climate data	Global, NA	0.5°, 0.25°	one time	one time	Global – based on CRU-NCEP NA – based on NARR

Climate

Global - CRUNCEP *Source: Nicolas Viovy*

- Climate Research Unit (CRU) + NCAR Reanalysis Project (NCEP)
- 6-hourly / 1901-2010
- Variables

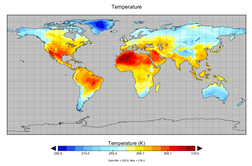
Name	Units	Description
lwdown	W/m2	Incoming Long Wave Radiation
press	Pa	Pressure
qair	g/g	Air Specific Humidity
rain	mm/6h	Total Precipitation in 6 hours period
swdown	W/m2	Incoming Short Wave Radiation
tair	K	Surface Air Temperature
uwind	m/s	U wind component
vwind	m/s	V wind component

North American - NARR

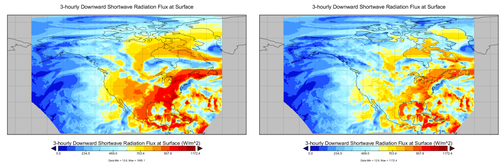
- North American Regional Reanalysis
- 3-hourly / 1979-2010
- Variables

Name	Units	Description
air.2m	K	3-hourly Air Temperature at 2m
apcp	kg/m2	3-hourly accumulated total precipitation at Surface
dlwrf	W/m2	3-hourly Downward Longwave Radiation Flux at Surface
dswrf	W/m2	3-hourly Downward Shortwave Radiation Flux at Surface
shum.2m	kg/kg	3-hourly Specific Humidity at 2m
rhum.2m	%	3-hourly Relative Humidity at 2m
wnd.10m	m/s	3-hourly Wind Speed at 10m

- NARR data was regridded from 32km in Lambert Conformal Conic projection to 0.25 degree in Geographic Lat/Lon
- NARR precipitation was rescaled using Global Precipitation Climatology Project (GPCP v2.1) data
- NARR shortwave radiation (dswrf) was reanalyzed using MTCLIM v4.3 algorithm



Temperature at 2m on 2000-07-26, 12pm – 6pm GMT



NARR 3-hourly (1979-05-18, 3pm-5pm GMT) downward shortwave radiation flux before (left) and after (right) reanalysis with MTCLIM algorithm

Biome Classification

SYNMAP *Source: Martin Jung*

The SYNMAP data set was produced by merging GLCC, GLC2000 and MODIS land cover products into a clearly defined plant functional type PFT scheme using fuzzy agreement. The SYNMAP product has improved characteristics for land cover parameterization of the carbon cycle models that reduces land cover uncertainties in carbon budget calculations.

The original global 1km SYNMAP data was aggregated to global half-degree and NA quarter-degree resolution with fraction of each of the 48 PFT types calculated.

Major Crops

Global half-degree and NA quarter-degree distribution of major crops (rice, soybean, wheat, and maize) were derived from Monfreda crop types data.

C3/C4 Grassland

The SYNMAP grassland was split into C3 and C4 grassland based on monthly temperature and precipitation data.

Potential Biome Classification

All pixels of anthropogenic classes (cropland and urban) in original SYNMAP data are masked out in the land cover classifications and subsequently filled by surrounding vegetation classes using a sequential filtering approach.

Phenology

GIMMSg

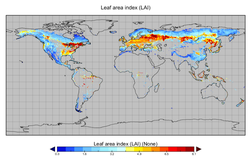
-Leaf Area Index (LAI)

-Normalized Difference Vegetation Index (NDVI)

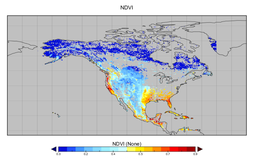
-Canopy absorbed fracton of PAR (fPAR)

Fusion with SYNMAP *Source: Kevin Schaefer*

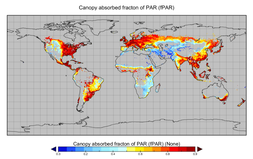
GIMMSg phenology data was enhanced to provide LAI, NDVI, and fPAR for each of the 48 PFT types in SYNMAP for each half-degree cell (for global) and quarter-degree cell (for NA).



LAI for Needle-leaf Evergreen Tree Area in June (Half-degree, Global)



NDVI for Grass Area in March (Quarter-degree, NA)



fPAR for Crop Area in October (Half-degree, Global)

Nitrogen Deposition

Dentener

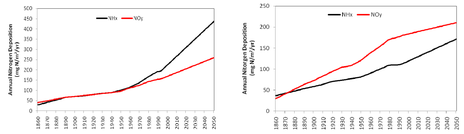
This data set provides global gridded estimates of atmospheric deposition of total inorganic nitrogen (N), NHx (NH_3 and NH_4+), and NOy (all oxidized forms of nitrogen other than N_2O), in mg N/m2/year, for the years 1860 and 1993 and projections for the year 2050.

Variables:

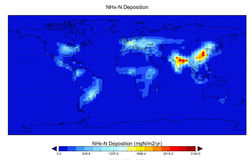
- NHx-N Deposition
- NOy-N Deposition

Annual Nitrogen Deposition *Source: Chaoqun Lu, Hanqin Tian*

The annual nitrogen deposition data (1860-2050) was interpolated from original Dentener's data. The annual variation of nitrogen deposition rate from 1890 to 1990 was controlled by EDGAR-HYDE 1.3 nitrogen emission data (Van Aardenne et al., 2001; http://gcmd.nasa.gov/records/GCMD_EDGAR_HYDE.html). Nitrogen deposition was assumed to increase linearly over the rest time periods (1990 - 2050)



Mean annual nitrogen deposition rate (mg N/m2/yr) across the land surface of global (left) and North America (right) during 1860-2050

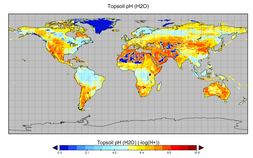


Global NHx-N Deposition in 1900

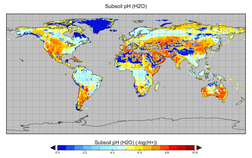
Soil

Global – Harmonized World Soil Database (HWSD)

- Two soil layers: topsoil (0-30cm) and subsoil (30-100cm)
- Soil parameters: CEC, Clay Fraction, Gravel Content, Organic Carbon, pH (H2O), Reference Bulk Density, Sand Fraction, Silt Fraction, USDA Texture Classification



Global Topsoil Water pH

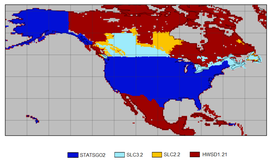


Global Subsoil Water pH

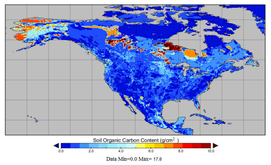
North American – Unified North American Soil Map (UNASM)

The US STATSGO2 data, Soil Landscape of Canada (v2.1 and v3.2), and HWSD v1.2 were harmonized and integrated together to provide a seamless North American soil database for the purpose of MsTMIP simulations.

- Multiple Soil layers: STATSGO2 (up to 11), SLC (up to 10), HWSD (up to 2)
- Soil parameters: CEC, Clay Fraction, Gravel Content, Organic Carbon, pH (H2O), Bulk Density, Sand Fraction, Silt Fraction, Soil Layers, Soil Layer Depth
- High-latitude soil organic carbon concentration was improved using Northern Circumpolar Soil Carbon Database (NCSCD).



Sources Distribution of UNASM



North American Soil Organic Carbon Content

Data Format

- CF-1.4 compatible netCDF format
- CRS: Sphere Geographic Lat/Lon, R=6371200 Coordinates: Lat/Lon for the center of pixels
- Calendar: proleptic_gregorian Leap Year: yes Time Unit: days since1700-01-01T00:00:00Z
- Bound information is provided for both coordinates and time dimensions
- cell_methods attributes used to identify the representation of a data value: sum/mean over spatial/temporal

Data Access & Citation

Data has been officially archived at Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC): http://dx.doi.org/10.3334/ORNLDAAC/1220.

For more information

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