NACP: Climate Data Inputs (3-hourly) for Community Land Model, Western USA, 1979-2015

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Documentation Revision Date: 2020-12-01

Dataset Version: 1

Summary

This dataset provides sub-daily, high-resolution, climate data inputs including temperature, precipitation, near surface specific humidity, incoming short-wave radiation, and near-surface wind speed over 11 states of the western USA. States included are Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. These data were derived for use in the Community Land Model (CLM v4.5) and are at 3-hourly temporal and 4 x 4 km spatial resolutions for the 1979 through 2015 time period. The source for observational data was METDATA (now called GRIDMET), at a daily resolution. Modeling efforts using these data estimated annual carbon stocks, fluxes, and productivity across the western United States.

The processing steps required to derive these climate input variables at the desired temporal (3-hourly) resolution for the CLM model and the results of the CLM modeling across the western United States are described in the related publication (Buotte, et al., 2019). The temporal downscaling details are also provided in a companion file here. The modeled annual estimates of forest carbon stocks, fluxes and productivity are archived in the related dataset Buotte et al. (2019; https://doi.org/10.3334/ORNLDAAC/1662).

There are 1,332 data files in NetCDF (.nc4) format with this dataset. The files provide data for the years 1979 through 2015 and are organized by variable and month of each year.

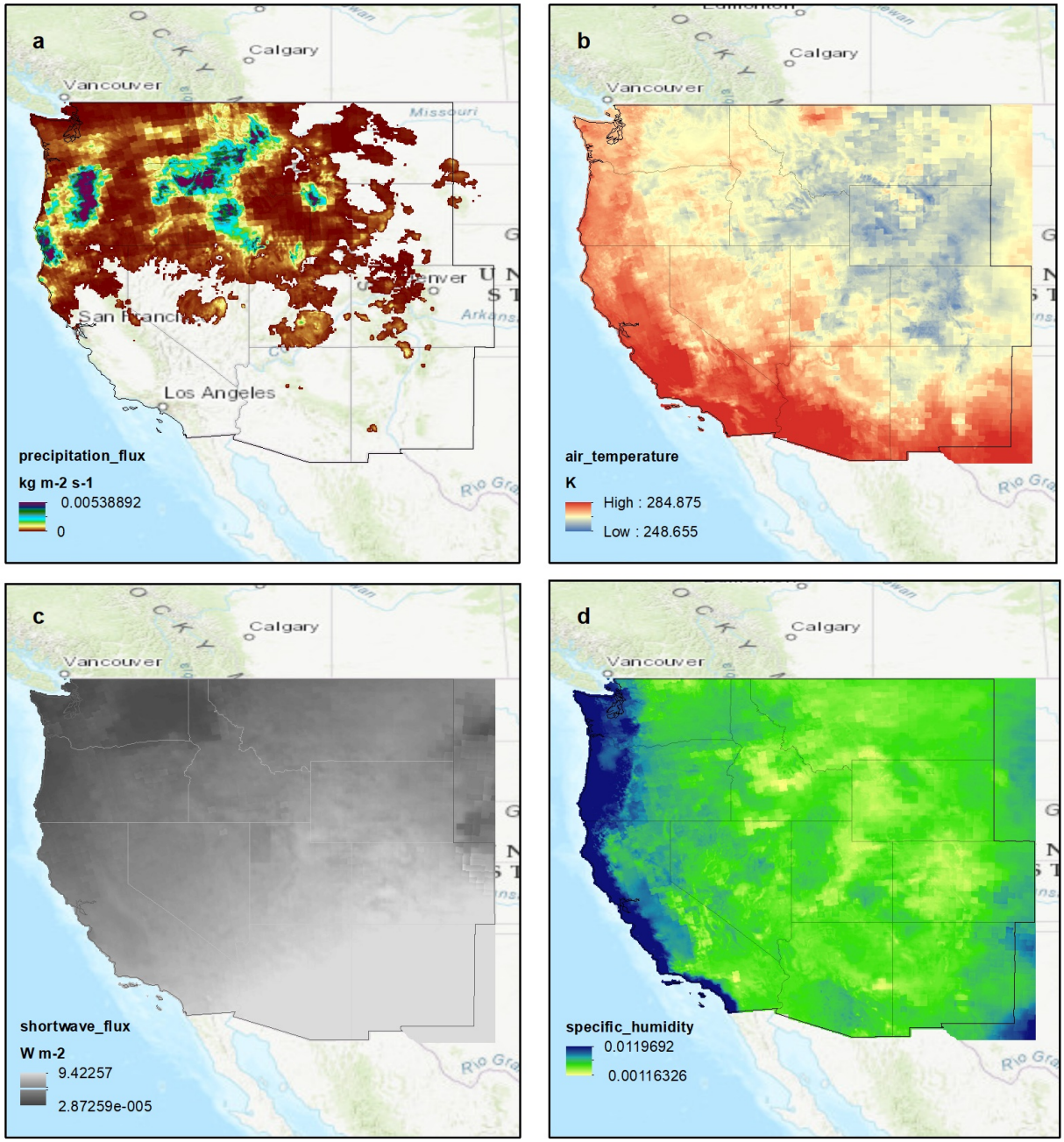

Figure 1. Four variables for the same 3-hour timestep, December 8, 2015, 12:00 AM to 3:00 AM, a) precipitation flux (kg m-2 s-1) b) air temperature (K) c) shortwave radiation flux (W m-2) d) specific humidity. Source: western_USA_precipitation_3hr_2015-12.nc4

Citation

Rupp, D., and P. Buotte. 2020. NACP: Climate Data Inputs (3-hourly) for Community Land Model, Western USA, 1979-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1682

Table of Contents

1. Dataset Overview

This dataset provides sub-daily, high-resolution, climate data inputs including temperature, precipitation, near-surface specific humidity, incoming short-wave radiation, and near-surface wind speed over 11 states of the western US, including Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The data were derived for use in the Community Land Model (CLM v4.5) and are at the CLM preferred temporal (3-hourly) and spatial (4 x 4 km) resolutions for the time period 1979 through 2015. The CLM was driven with observation-based and simulated gridded meteorological data at 1/24 degree. The source for observational data was METDATA and the source for the simulated data was MACAv2-METDATA, or MACA. Both METDATA and MACA are at a daily resolution and were disaggregated to a 3-hourly resolution. Modeling efforts using these data estimated annual carbon stocks, fluxes, and productivity across the western United States.

The processing steps required to derive these climate input variables from various sources at the desired temporal (3-hourly) and spatial resolutions for the CLM model, and the results of the CLM modeling across the western United States are described in a related publication (Buotte et al., 2019b).

The modeled annual estimates of forest carbon stocks, fluxes, and productivity are archived in a related dataset (Buotte et al., 2019a).

Project: North American Carbon Program (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. The NACP is supported by a number of different federal agencies. The central objective is to measure and understand the sources and sinks of Carbon Dioxide (CO2), Methane (CH4), and Carbon Monoxide (CO) in North America and in adjacent ocean regions.

Related Publications

Buotte, P.C., S. Levis, B.E. Law, T.W. Hudiburg, D.E. Rupp, and J.J. Kent. 2019b. Near-future forest vulnerability to drought and fire varies across the western United States. Global Change Biology, 25:290-303. https://doi.org/10.1111/gcb.14490

Buotte, P.C., B.E. Law, W.J. Ripple, and L.T. Berner. 2020. Carbon sequestration and biodiversity co-benefits of preserving forests in the western United States. Ecological Applications, 30(2):e02039. https://doi.org/10.1002/eap.2039

Related Dataset

The data products provided in the current dataset were input data for processing and modeling for Buotte et al. 2019a.

Buotte, P., S. Levis, and B.E. Law. 2019a. NACP: Forest Carbon Stocks, Fluxes and Productivity Estimates, Western USA, 1979-2099. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1662

Acknowledgment

This work was supported by the North American Carbon Program (grant USDA-NIFA-2014-35100-22066).

2. Data Characteristics

Spatial Coverage: Western United States, including the states Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming

Spatial Resolution: ~4 km

Temporal Coverage: 1979-01-01 to 2016-01-01

Temporal Resolution: 3-hourly

Site Boundaries: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
western United States	-124.813	-101.979	49.0208	31.1875

Data File Information

There are 1,332 data files in NetCDF (*.nc4) format with this dataset. The files are named western_USA_*variable*_3hr_*YYYY-MM*.nc4, where

- *variable* = precipitation, solar_radiation, or wind_temp_humidity,
- *YYYY* = 1979 through 2015, and
- *MM* = 01 through 12

Table 1. File names and number of files.

File Names	Number of Files
western_USA_precipitation_3hr_*YYYY-MM*.nc4	444
western_USA_solar_radiation_3hr_*YYYY-MM*.nc4	444
western_USA_wind_temp_humidity_3hr_*YYYY-MM*.nc4	444

Data File Details

For all files:
missing data: -9999
CRS: EPSG:4326, proj4:+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs.

Table 1. Variables in the data files. All data files include latitude, longitude, and time bounds.

Variable	Abbreviation	Units	Description
precipitation	pr	kg m-2 s-1	3-hourly average precipitation flux
shortwave radiation	rsds	W m-2	3-hourly average surface downwelling shortwave radiation
wind speed	wind_speed	m s-1	3-hourly average wind speed near the surface
air temperature	tas	K	3-hourly average air temperature
specific humidity	huss	dimensionless ratio	3-hourly average near-surface specific humidity

Companion Files

The companion file **Climate_Data_Disaggregation_Methods_CompanionFile.pdf** provides the methodology used to disaggregate the daily source data to the 3-hourly data provided in this dataset.

3. Application and Derivation

This data product contributes to a multidisciplinary research program to obtain scientific understanding of North America's carbon sources, carbon sinks, and changes in carbon stocks. These climate data and the disaggregation methods could be useful to other climate modeling studies.

4. Quality Assessment

Data bias correction is described in the companion file **Climate_Data_Disaggregation_Methods_CompanionFile.pdf**, and in Buotte et al. (2019b). Refer to the data sources in Section 5 of this document for quality assurance pertaining to the source data.

5. Data Acquisition, Materials, and Methods

Overview

This dataset provides the climate data inputs including temperature, precipitation, vapor pressure deficit, incoming short-wave radiation, and wind speed that were used in the modeling described in a related publication (Buotte et al., 2019b) to estimate annual carbon stocks, fluxes, and productivity across the western United States with the Community Land Model (CLM v4.5). These modeled estimates of forest carbon stocks, fluxes, and productivity are archived in a related dataset (Buotte et al., 2019a).

The processing required to derive these climate input variables at the desired spatial (4 x 4 km) and temporal (3-hourly) resolutions for the CLM model is the focus of this methods section. For details of the data disaggregation methods, refer to the companion file **Climate_Data_Disaggregation_Methods_CompanionFile.pdf** and to Buotte et al. (2019b).

Input Source Data

The Community Land Model (CLM) requires a time series of several meteorological variables as input. These variables include temperature, precipitation, vapor pressure deficit, incoming short-wave radiation, and wind speed. The desired temporal resolution of these variables is 3-hourly. Input data sources are listed in Table 2.

The CLM was driven with observation-based and simulated gridded meteorological data at a spatial resolution of 1/24 degree x 1/24 degree (~ 4 km). The source for observational data was METDATA and the source for the simulated data was MACAv2-METDATA (MACA hereon). Both METDATA and MACA are at a daily resolution, so the daily data were disaggregated to a 3-hourly resolution using the following methodology.

Disaggregation Process

When first initialized, CLM needs to run long enough for the above and belowground carbon pools to reach a steady state. To accomplish this, CLM was run for 1,500 model years with bias-corrected 1901–1929 CRUNCEP climate data by disaggregating daily 1/24 degree x 1/24-degree (4 km x 4 km) data (Abatzoglou, 2013). The 1979–2014 climate data served as the reference for the CRUNCEP data bias correction. Both METDATA and MACA are also at a daily resolution and were disaggregated to a 3-hourly resolution (Buotte et al., 2019b).

The 3-hourly NARR data were used to disaggregate the daily METDATA to a 3-hourly resolution. The 3-hourly data from the “raw” (i.e., not downscaled) CMIP5 GCM simulations were used to disaggregate the downscaled daily MACA to a 3-hourly resolution. Briefly, the method consists of "rescaling" the 3-hourly GCM (or NARR) time series to be consistent with aggregate daily values, or maximum and minimum daily values, from MACA (or METDATA). Note that the example of MACA 3-hour disaggregation is used, though the METDATA 3-hourly disaggregation follows the identical method, other than the GCM data are used with MACA whereas NARR is used with METDATA.

Table 2. Input data sources

Observation-based gridded meteorological data (previously called METDATA, now called GRIDMET), daily, 1/24-degree resolution (Abatzoglou, 2013). Last accessed 2016-01-29. http://www.climatologylab.org/gridmet.html
North America Regional Reanalysis (NARR), three-hourly, 0.3-degree resolution (Mesinger et al., 2006). Accessed 2013-09-18 (data through 2012) and 2016-03-21 (data from 2013 through 2015). https://www.esrl.noaa.gov/psd/data/gridded/data.narr.html
Statistically downscaled global climate model simulations using the method of Multivariate Adaptive Constructed Analogs v.2 with METDATA as the training data (MACAv2-METDATA), daily, 1/24-degree resolution. Last accessed 2014-11-09. https://climate.northwestknowledge.net/MACA/
Global climate model (GCM) output from the Coupled Model Intercomparison Project Phase 5 (CMIP5) archive, three-hourly, various spatial resolutions (Taylor et al., 2012). Our study uses output from IPSL-CM5A-MR *r1i1p1* and MIROC5 *r1i1p1*, *historical* and *rcp85* experiments. Last accessed 2011-11-05. https://esgf-node.llnl.gov/search/cmip5/

6. Data Access

These data are 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

7. References

Abatzoglou, J.T., 2013. Development of gridded surface meteorological data for ecological applications and modelling. International Journal of Climatology, 33:121-131. https://doi.org/10.1002/joc.3413

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