CMS: Hourly Carbon Dioxide Estimated Using the WRF Model, North America, 2010

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Documentation Revision Date: 2016-10-12

Data Set Version: V1

Summary

This data set contains estimated hourly CO2 atmospheric mole fractions and meteorological observations over North America for the year 2010 at a horizontal grid resolution of 27 km and vertical resolution from the surface to 50 hPa. The data are output from the Penn State WRF-Chem version of the Weather Research and Forecasting (WRF) model using lateral boundary conditions and surface fluxes from the CMS-Flux Inversion system.

The CO_2 atmospheric mole fractions have been used to simulate satellite XCO2. The meteorological observations are included to facilitate quantification of atmospheric transport uncertainty.

There are 365 WRF output data files in NetCDF (.nc4) format provided with this data set. An IDL program, illustrating location of specific latitude and longitude locations on the native Lambert Conformal grid, and a static grid information file are included as companion files.

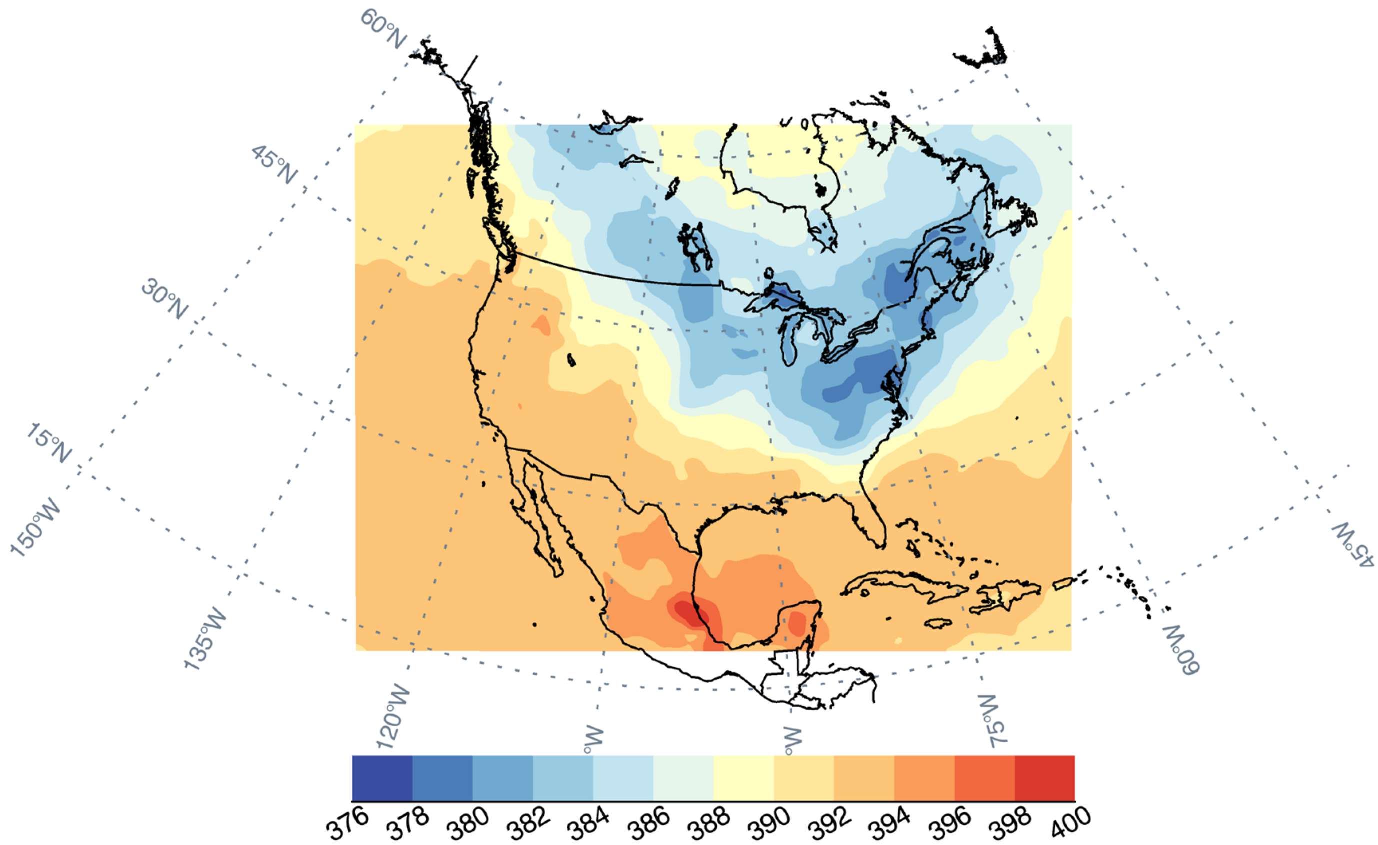

Figure 1. Mean daily daytime average CO2 concentration [ppm] in the boundary layer in June 2010 from the WRF model.

Citation

Lauvaux, T., and M. Butler. 2016. CMS: Hourly Carbon Dioxide Estimated Using the WRF Model, North America, 2010. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1338

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1. Data Set Overview

This data set contains estimated hourly CO_2 atmospheric mole fractions and meteorological observations over North America for the year 2010 at a horizontal grid resolution of 27 km and vertical resolution from the surface to 50 hPa. The data are output from the Penn State WRF-Chem version of the Weather Research and Forecasting (WRF) model [Lauvaux et al. 2012] using lateral boundary conditions and surface fluxes from the CMS-Flux Inversion system [Liu et al., 2014]. These mole fractions have been used to simulate satellite XCO2. The meteorological observations are included to facilitate quantification of atmospheric transport uncertainty. An IDL program, illustrating location of specific latitude and longitude locations on the native Lambert Conformal grid, and a static grid information file are included as companion files.

Project: Carbon Monitoring System (CMS)

The NASA Carbon Monitoring System (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 and will rapidly initiate generation and distribution of products both for user evaluation and to inform near-term policy development and planning.

Acknowledgements:

Funding for this project came from the NASA Carbon Monitoring System, NNX13AP34G, Quantification of the sensitivity of NASA CMS-Flux inversions to uncertainty in atmospheric transport.

2. Data Characteristics

Spatial Coverage: North American domain for WRF model

Spatial Resolution: Gridded data at 27 km horizontal resolution and 59 vertical layers from the surface to 50 hPa

Temporal Coverage: Data covers the period 2010-01-01 to 2010-12-31

Temporal Resolution: Hourly

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

Site	**Westernmost Longitude**	**Easternmost Longitude**	**Northernmost Latitude**	**Southernmost Latitude**
North America	-151	-41	63	13

Data File Information

There are 365 WRF output files in NetCDF (.nc4) format with this data set. There is one file for each day of the year in 2010.

The files provide hourly data for total CO2, geopotential, surface pressure, U and V components of wind, and temperature.

Data File Names:

The **WRF** output files are named as **wrfout_d01_2010-mm-dd.nc4**

where:

mm=month in year 2010,

dd=day of the month

Example file name: **wrfout_d01_2010-12-31.nc4**

Variables in the WRF Output Files:

Table 1. Output File Variables

Variable	**Units**	**Description**
TOTCO2	ppm	total CO2 (sum of contributions from all fluxes plus background)
PRESSURE	Pa	sum of base pressure and perturbation pressure
GEOPOTENTIAL	m2/s2	sum of base geopotential and perturbation geopotential
TEMPERATURE	K	potential temperature, the sum of perturbation temperature + 300K

PSFC	Pa	surface pressure
U	m/s	U component of wind
V	m/s	V component of wind

Spatial Data Properties Summary:

File Name	No Data Value	Data Type	Number of Bands	Spatial Properties
wrfout_d01_2010-01-01.nc4	none	float	23 (time)	Geographic Coordinate Reference: WGS 84 Projection: Lambert Conformal
wrfout_d01_2010-01-02.nc4 through wrfout_d01_2010-12-31.nc	none	float	24 (time)	Geographic Coordinate Reference: WGS 84 Projection: Lambert Conformal

Spatial Data Properties Detail:

Spatial Representation Type: Raster

Pixel Depth: 32 bit

Pixel Type: float

Number of Bands: first file 23, all others 24

Band Information: time (hours)

Raster Format: netCDF

No Data Value: none

Scale Factor: 1

Offset: none

Number Columns: 248

Column Resolution: 27 km

Number Rows: 182

Row Resolution: 27 km

Extent in the item's coordinate system:

North: 2470.5

South: -2470.5

West: -3348

East: 3348

Spatial Reference Properties Detail

Type: Projected

Geographic Coordinate Reference: WGS 84

Projection: Lambert Conformal

Open Geospatial Consortium (OGC) Well Known Text (WKT)

```
PROJCS["WGC 84 / WRF Lambert",
  GEOGCS["WGS 84",
    DATUM["World Geodetic System 1984",
      SPHEROID["WGS 84",6378137.0,298.257223563,
        AUTHORITY["EPSG","7030"]],
      AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0.0,
      AUTHORITY["EPSG","8901"]],
    UNIT["degree",0.017453292519943295],
    AXIS["Geodetic longitude",EAST],
    AXIS["Geodetic latitude",NORTH],
    AUTHORITY["EPSG","4326"]],
  PROJECTION["Lambert_Conformal_Conic_2SP"],
  PARAMETER["central_meridian",-96.0],
  PARAMETER["latitude_of_origin",40.0],
  PARAMETER["standard_parallel_1",30.0],
  PARAMETER["false_easting",0.0],
  PARAMETER["false_northing",0.0],
  PARAMETER["standard_parallel_2",60.0],
  UNIT["m",1.0],
  AXIS["Easting",EAST],
  AXIS["Northing",NORTH]]
```

Companion Files:

One IDL program (.pro) and one static grid file in NetCDF format (.nc) are included as companion files with this data set.

locater.pro: This IDL code provides the means for locating a specific latitude and longitude grid cell on a Lambert Conformal grid. This code requires both the static gridinfo file and a WRF output file to be in the same directory as this code. Additional documentation for file usage can be found in the comments in this code.

wrf_static_gridinfo.nc: This static grid file contains the surface elevation height above sea level (variable HGT) of each grid cell and the longitude and latitude vectors for the mass grid (for CO_2) and the wind grids.

3. Application and Derivation

The meteorological observations were included to facilitate quantification of the atmospheric transport uncertainty in CMS Flux. Mole fractions in these files can be used to simulate satellite XCO2 using native pressure level information provided or an averaging kernel of choice.

4. Quality Assessment

Uncertainty analysis will be provided in another CMS data product.

5. Data Acquisition, Materials, and Methods

The WRF model is designed to be used for weather forecasting and atmospheric research. The output archive files provided with this data set contain a subsample of variables from a WRF run using lateral boundary conditions from a CMS Flux Inversion for CO2 study. Meteorological observations were included to quantify the atmospheric transport uncertainty in CMS Flux.

The IDL code provides a means of locating a specific latitude and longitude grid cell on a Lambert Conformal grid. This code requires both the static grid info file and a WRF output file to be in the same directory as this code.

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

Lauvaux, T., et al. (2012), Constraining the CO_2 budget of the corn belt: exploring uncertainties from the assumptions in a mesoscale inverse system, Atmospheric Chemistry and Physics, 12, 337-354, doi: 10.5194/acp-12-337-2012.

Liu, J., et al. (2014), Carbon monitoring system flux estimation and attribution: impact of ACOS-GOSAT X_{CO2} sampling on the inference of terrestrial biospheric sources and sinks, Tellus B, 66, 22486, doi: 10.3402/tellusb.v66.22486.