**Date:** April 15, 2020

**Dataset Title:** Simulated CO2 tracer concentrations in the Northern Hemisphere from a tagged transport model GEOS-Chem v12.0.0

**Dataset Creators:** X. Lin, G. Keppel-Aleks, B.M. Rogers & L. Birch

**Dataset Contact:** Xin Lin (xinlinn@umich.edu), Gretchen Keppel-Aleks (gkeppela@umich.edu)

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**Key Points:**

- The aim of this study is to quantify the regional flux imprints on CO2 seasonal amplification in the Northern Hemisphere over the period 1980-2017, using a tagged tracer transport model prescribed with observation-constrained CO2 fluxes.

- The concentrations fields of 14 CO2 tracers were simulated in response to land fluxes from all vegetated areas and different tagged regions. The model output at the surface and two mid-troposphere levels (700 millibar and 500 millibar) are presented here.

**Research Overview:**

The amplitude of the atmospheric CO2 seasonal cycle has increased by 30–50% in the Northern Hemisphere since the 1960s, suggesting widespread ecological changes in northern extratropics. However, substantial uncertainty remains in the continental and regional drivers of this prominent amplitude increase. Here we present a quantitative regional attribution of CO2 seasonal amplification over the past four decades using a tagged tracer transport model prescribed with observation-constrained fluxes. We find that increasing seasonal carbon exchange in Siberia is the dominant contributor to large-scale CO2 amplification at the surface, while impacts from Arctic-boreal North America are smaller and geographically localized. These continental contrasts corroborate heterogeneous vegetation greening and browning trends from field and remote-sensing observations, providing independent evidence for regionally divergent ecological responses and carbon dynamics to rapidly changing global drivers. Over mid-latitudes and in the mid-troposphere of high latitudes, temperate ecosystems are the dominant contributor to CO2 amplification, albeit with considerable contributions from Siberia.

**Methodology:**

The data are model output from a tagged CO2 tracer transport model conducted with the GEOS-Chem version 12.0.0 (http://www.geos-chem.org, doi:

10.5281/zenodo.1343547). Thirteen land flux regions were defined and tagged in the model to separate their imprints on the long-term atmospheric CO2 seasonal amplification in the Northern Hemisphere. The model was run at a resolution of 2.0° in latitude by 2.5° in longitude with 47 vertical levels, prescribed with land carbon fluxes from the CO2 inversion CAMSv17r1 (available at https://apps.ecmwf.int/datasets/data/cams-ghg-inversions/) as boundary conditions. The model was driven by hourly meteorological fields from MERRA2 reanalysis (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/; available at http://geoschemdata.computecanada.ca/ExtData/GEOS_2x2.5/MERRA2/) at a timestep of ten minutes. The data contain the daily averaged concentrations of these CO2 tracers simulated by the model between 1980-01-01 and 2017-12-31, and sampled at the surface level and two mid-tropospheric levels (700 millibar and 500 millibar). The full model output is available on request to Xin Lin (xinlinn@umich.edu) and Gretchen Keppel-Aleks (gkeppela@umich.edu).

**Instrument and/or Software specifications:** NA

**Files contained here:**

We include a netCDF file that defines the 13 tagged regions in our simulation. The three zip files contain the simulated concentration fields for 14 CO2 tracers at the surface, 700mb and 500 mb, respectively. The files are described below:

**MASK_tagged_CO2_2x2.5_13tracers.nc**

This netCDF file defines the 13 tagged regions in the transport model simulation (See Fig. 1a in the paper). The delineation of these regions is based on continent and plant functional types (PFTs) from the Community Land Model version 5 (CLM5; http://www.cesm.ucar.edu/models/cesm2/land/) for the year 2000 (See details in SI Appendix, Fig. S1 in the paper). The tagged regions (and corresponding tracers) are defined as below (also see the long name of each variable in the file):

MASK_CO2tr2: Mask for North American Arctic ecosystems (NA_Arc)
MASK_CO2tr3: Mask for European Arctic ecosystems (EU_Arc)
MASK_CO2tr4: Mask for Siberian Arctic ecosystems (SIB_Arc)
MASK_CO2tr5: Mask for North American Boreal ecosystems (NA_Bor)
MASK_CO2tr6: Mask for European Boreal ecosystems (EU_Bor)
MASK_CO2tr7: Mask for Siberian Boreal Evergreen ecosystems (SIB_BorEn)
MASK_CO2tr8: Mask for Siberian Boreal Deciduous ecosystems (SIB_BorDn)
MASK_CO2tr9: Mask for Northern Hemisphere Mid-latitude Natural ecosystems (NH_MidNat)
MASK_CO2tr10: Mask for Northern Hemisphere Tropical Natural ecosystems (NH_TropNat)
MASK_CO2tr11: Mask for Southern Hemisphere Tropics (SH_Trop)

MASK_CO2tr12: Mask for Southern Hemisphere Extratropics (SH_ExTrop)
MASK_CO2tr13: Mask for Northern Hemisphere Tropical Croplands (NH_TropCrop)
MASK_CO2tr14: Mask for Northern Hemisphere Mid-latitude Croplands (NH_MidCrop)

**CO2_surface.zip**

This zip file contains 14 netCDF files that store daily concentration fields at the surface for 14 CO2 tracers from the tagged transport model simulation. These files are extracted from the simulated 3-D tracer concentration fields at the surface level. Note that the unit for each variable is 10^(-9) mol/mol. The variables are defined as below:

CO2tr1: CO2 tracer concentrations simulated from land fluxes from all vegetated areas (i.e. the sum of 13 tagged regions)
CO2tr2: CO2 tracer concentrations simulated from land fluxes from NA_Arc
CO2tr3: CO2 tracer concentrations simulated from land fluxes from EU_Arc
CO2tr4: CO2 tracer concentrations simulated from land fluxes from SIB_Arc
CO2tr5: CO2 tracer concentrations simulated from land fluxes from NA_Bor
CO2tr6: CO2 tracer concentrations simulated from land fluxes from EU_Bor
CO2tr7: CO2 tracer concentrations simulated from land fluxes from SIB_BorEn
CO2tr8: CO2 tracer concentrations simulated from land fluxes from SIB_BorDn
CO2tr9: CO2 tracer concentrations simulated from land fluxes from NH_MidNat
CO2tr10: CO2 tracer concentrations simulated from land fluxes from NH_TropNat
CO2tr11: CO2 tracer concentrations simulated from land fluxes from SH_Trop
CO2tr12: CO2 tracer concentrations simulated from land fluxes from SH_ExTrop
CO2tr13: CO2 tracer concentrations simulated from land fluxes from NH_TropCrop
CO2tr14: CO2 tracer concentrations simulated from land fluxes from NH_MidCrop

**CO2_700mb.zip**

This zip file contains 14 netCDF files that store daily concentration fields at 700 millibar for 14 CO2 tracers from the tagged transport model simulation. These files are extracted from the simulated 3-D tracer concentration fields at 700 millibar. Note that the unit for each variable is 10^(-9) mol/mol. The definition of variables is the same as in CO2_surface.zip.

**CO2_500mb.zip**

This zip file contains 14 netCDF files that store daily concentration fields at 500 millibar for 14 CO2 tracers from the tagged transport model simulation. These files are extracted from the simulated 3-D tracer concentration fields at 500 millibar. Note that the unit for each variable is 10^(-9) mol/mol. The definition of variables is the same as in CO2_surface.zip.

**Related publication(s):**

Lin, X., et al. (2020). Siberian and temperate ecosystems shape Northern Hemisphere atmospheric CO2 seasonal amplification. Submitted to PNAS, in revision.

**Use and Access:**



**To cite data:**

Lin, X., Keppel-Aleks, G., Rogers, B.M., Birch, L. (2020). Simulated CO2 tracer concentrations in the Northern Hemisphere from a tagged transport model GEOS-Chem v12.0.0 [Data set]. University of Michigan - Deep Blue Data Repository. https://doi.org/10.7302/rp59-rw53