ATom: CAM-chem/CESM2 Model Outputs Along Flight Tracks, 2016-2018

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Documentation Revision Date: 2021-11-17

Dataset Version: 1

Summary

This dataset contains CAM-chem (Community Atmosphere Model with Chemistry) model outputs along ATom flight tracks. CAM-chem is a component of the Community Earth System Model Version 2 (CESM2) and is used for simulations of global tropospheric and stratospheric atmospheric composition and for studies of chemistry-climate interactions. In general, CAM-chem uses the MOZART chemical mechanism, with various choices of complexity for tropospheric and stratospheric chemistry. For this dataset, CAM-chem used the MOZART-TS1 chemical mechanism, and the model was nudged to reanalysis meteorology from MERRA2.

There are four data files in netCDF (*.nc) format included in this dataset. Also, included are two companion files: one in comma-separated values (*.csv) format and one in Portable Document (*.pdf) format.

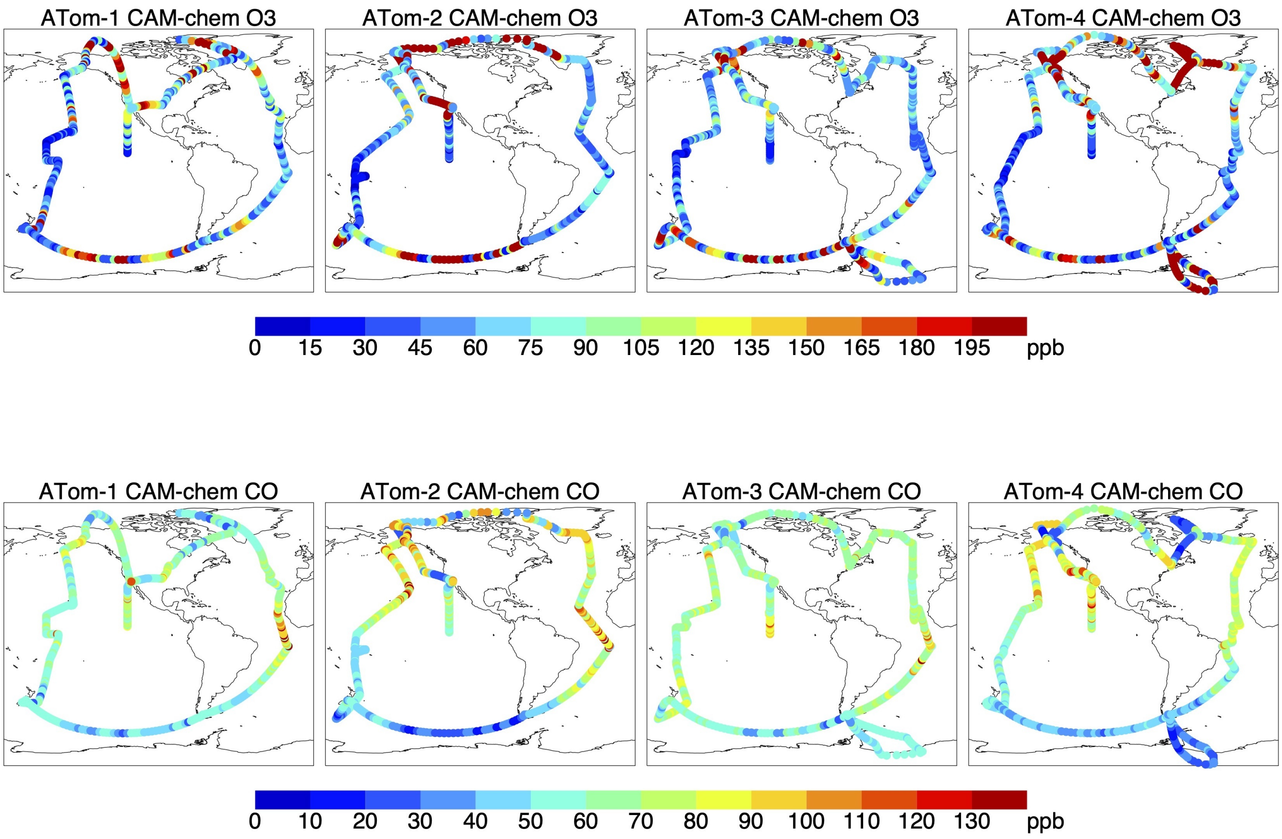

Figure 1. CAM-chem simulated concentrations of ozone (O3) and carbon monoxide (CO) along ATom flight tracks.

Citation

Emmons, L., F. Lacey, and R. Schwantes. 2021. ATom: CAM-chem/CESM2 Model Outputs Along Flight Tracks, 2016-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1878

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1. Dataset Overview

This dataset contains CAM-chem (Community Atmosphere Model with Chemistry), a component of the Community Earth System Model Version 2 (CESM2), model outputs along ATom flight tracks. CAM-chem is used for simulations of global tropospheric and stratospheric atmospheric composition and for studies of chemistry-climate interactions. In general, CAM-chem uses the MOZART chemical mechanism, with various choices of complexity for tropospheric and stratospheric chemistry. For this dataset, CAM-chem used the MOZART-TS1 chemical mechanism, and the model was nudged to reanalysis meteorology from MERRA2.

Project: Atmospheric Tomography Mission

The Atmospheric Tomography Mission (ATom) was a NASA Earth Venture Suborbital-2 mission. It studied the impact of human-produced air pollution on greenhouse gases and on chemically reactive gases in the atmosphere. ATom deployed an extensive gas and aerosol payload on the NASA DC-8 aircraft for systematic, global-scale sampling of the atmosphere, profiling continuously from 0.2 to 12 km altitude. Flights occurred in each of four seasons over a 4-year period.

Related Datasets

Wofsy, S.C., S. Afshar, H.M. Allen, E.C. Apel, E.C. Asher, B. Barletta, J. Bent, H. Bian, B.C. Biggs, D.R. Blake, N. Blake, I. Bourgeois, C.A. Brock, W.H. Brune, J.W. Budney, T.P. Bui, A. Butler, P. Campuzano-Jost, C.S. Chang, M. Chin, R. Commane, G. Correa, J.D. Crounse, P. D. Cullis, B.C. Daube, D.A. Day, J.M. Dean-Day, J.E. Dibb, J.P. DiGangi, G.S. Diskin, M. Dollner, J.W. Elkins, F. Erdesz, A.M. Fiore, C.M. Flynn, K.D. Froyd, D.W. Gesler, S.R. Hall, T.F. Hanisco, R.A. Hannun, A.J. Hills, E.J. Hintsa, A. Hoffman, R.S. Hornbrook, L.G. Huey, S. Hughes, J.L. Jimenez, B.J. Johnson, J.M. Katich, R.F. Keeling, M.J. Kim, A. Kupc, L.R. Lait, K. McKain, R.J. Mclaughlin, S. Meinardi, D.O. Miller, S.A. Montzka, F.L. Moore, E.J. Morgan, D.M. Murphy, L.T. Murray, B.A. Nault, J.A. Neuman, P.A. Newman, J.M. Nicely, X. Pan, W. Paplawsky, J. Peischl, M.J. Prather, D.J. Price, E.A. Ray, J.M. Reeves, M. Richardson, A.W. Rollins, K.H. Rosenlof, T.B. Ryerson, E. Scheuer, G.P. Schill, J.C. Schroder, J.P. Schwarz, J.M. St.Clair, S.D. Steenrod, B.B. Stephens, S.A. Strode, C. Sweeney, D. Tanner, A.P. Teng, A.B. Thames, C.R. Thompson, K. Ullmann, P.R. Veres, N.L. Wagner, A. Watt, R. Weber, B.B. Weinzierl, P.O. Wennberg, C.J. Williamson, J.C. Wilson, G.M. Wolfe, C.T. Woods, L.H. Zeng, and N. Vieznor. 2021. ATom: Merged Atmospheric Chemistry, Trace Gases, and Aerosols, Version 2. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1925

- Data from all ATom instruments and all four flight campaigns, including aircraft location and navigation data, merged to several different time bases.

Wofsy, S.C., and ATom Science Team. 2018. ATom: Aircraft Flight Track and Navigational Data. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1613

- Flight path (location and altitude) data for each of the four campaigns provided in KML and CSV formats.

2. Data Characteristics

Spatial Coverage: Global. Flights circumnavigate the globe, primarily over the oceans

Spatial Resolution: Point measurements

Temporal Coverage: Periodic flights occurred during each campaign

Deployment	Date Range
ATom-1	July 29 - August 23, 2016
ATom-2	January 26 - February 21, 2017
ATom-3	September 28 - October 28, 2017
ATom-4	April 24 - May 21, 2018

Temporal Resolution: 10 seconds

Data File Information

There are four data files in netCDF (*.nc) format included in this dataset. Also, included are two companion files: one in comma-separated values (*.csv) format and one in Portable Document (*.pdf) format. The netCDF files conform to the CF (Climate and Forecast) conventions. The files are named CESM _DC8_**YYYYMMDD_R#**.nc, where **YYYYMMDD** is the start date (in UTC time) of the flight, and **R#** is the file version or revision number.

The data files contain CAM-chem model outputs along the flight path. The companion file Data_Dictionary_ATom_CESM2.csv provides descriptions of data file variables and ATom_CESM2.pdf is a PDF version of this user guide.

Data File Details

There are no missing data, and thus no missing data values.

Descriptions of the terminology used in the "long_name" attribute in the netCDF files can be found at https://www-air.larc.nasa.gov/missions/etc/AtmosphericCompositionVariableStandardNames_V9.pdf.

3. Application and Derivation

ATom builds the scientific foundation for mitigation of short-lived climate forcers, in particular, methane (CH_4), tropospheric ozone (O_3), and Black Carbon aerosols (BC).

ATom Science Questions

Tier 1

- What are chemical processes that control the short-lived climate forcing agents CH_4, O_3, and BC in the atmosphere? How is the chemical reactivity of the atmosphere on a global scale affected by anthropogenic emissions? How can we improve chemistry-climate modeling of these processes?

Tier 2

- Over large, remote regions, what are the distributions of BC and other aerosols important as short-lived climate forcers? What are the sources of new particles? How rapidly do aerosols grow to CCN-active sizes? How well are these processes represented in models?
- What type of variability and spatial gradients occur over remote ocean regions for greenhouse gases (GHGs) and ozone depleting substances (ODSs)? How do the variations among air parcels help identify anthropogenic influences on photochemical reactivity, validate satellite data for these gases, and refine knowledge of sources and sinks?

Significance

ATom delivers unique data and analysis to address the Science Mission Directorate objectives of acquiring “datasets that identify and characterize important phenomena in the changing Earth system” and “measurements that address weaknesses in current Earth system models leading to improvement in modeling capabilities.” ATom will provide unprecedented challenges to the CCMs used as policy tools for climate change assessments, with comprehensive data on atmospheric chemical reactivity at global scales, and will work closely with modeling teams to translate ATom data to better, more reliable CCMs. ATom provides extraordinary validation data for remote sensing.

4. Quality Assessment

Uncertainty information is not available.

5. Data Acquisition, Materials, and Methods

Project Overview

ATom makes global-scale measurements of the chemistry of the atmosphere using the NASA DC-8 aircraft. Flights span the Pacific and Atlantic Oceans, nearly pole-to-pole, in continuous profiling mode, covering remote regions that receive long-range inputs of pollution from expanding industrial economies. The payload has proven instruments for in situ measurements of reactive and long-lived gases, diagnostic chemical tracers, and aerosol size, number, and composition, plus spectrally resolved solar radiation and meteorological parameters.

Combining distributions of aerosols and reactive gases with long-lived greenhouse gasses and ozone-depleting substances enables disentangling of the processes that regulate atmospheric chemistry: emissions, transport, cloud processes, and chemical transformations. ATom analyzes measurements using customized modeling tools to derive daily averaged chemical rates for key atmospheric processes and to critically evaluate Chemistry-Climate Models (CCMs). ATom also differentiates between hypotheses for the formation and growth of aerosols over the remote oceans.

Community Atmosphere Model with Chemistry

Community Atmosphere Model with Chemistry (CAM-chem) is a component of the Community Earth System Model Version 2 (CESM2) that modeled outputs along ATom flight tracks based on the 10s-merge data files. CESM2 is a fully-coupled, community, global climate model that provides state-of-the-art computer simulations of the Earth's past, present, and future climate states (Danabasoglu et al., 2020). CAM-chem is used for simulations of global tropospheric and stratospheric atmospheric composition. These results used the MOZART-TS1 chemical mechanism, and are nudged to MERRA2 meteorology, as described in Emmons et al., (2020). Additional information can be found at the NCAR's CESM2 website.

6. Data Access

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

ATom: CAM-chem/CESM2 Model Outputs Along Flight Tracks, 2016-2018

Contact for Data Center Access Information:

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

7. References

Danabasoglu, G., J.-F. Lamarque, J. Bacmeister, D.A. Bailey, A.K. DuVivier, J. Edwards, L.K. Emmons, J. Fasullo, R. Garcia, A. Gettelman, C. Hannay, M.M. Holland, W.G. Large, P.H. Lauritzen, D.M. Lawrence, J.T. M. Lenaerts, K. Lindsay, W.H. Lipscomb, M.J. Mills, R. Neale, K.W. Oleson, B. Otto-Bliesner, A.S. Phillips, W. Sacks, S. Tilmes, L. Kampenhout, M. Vertenstein, A. Bertini, J. Dennis, C. Deser, C. Fischer, B. Fox-Kemper, J.E. Kay, D. Kinnison, P.J. Kushner, V.E. Larson, M.C. Long, S. Mickelson, J.K. Moore, E. Nienhouse, L. Polvani, P.J. Rasch, and W.G. Strand. 2020. The Community Earth System Model Version 2 (CESM2). Journal of Advances in Modeling Earth Systems 12. https://doi.org/10.1029/2019MS001916

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