ATom: Comprehensive Aerosol Properties, 2016-2018, Version 2

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Documentation Revision Date: 2022-09-22

Dataset Version: 2

Summary

This dataset contains comprehensive measurements of aerosol microphysical, chemical, and optical properties derived for both dry and ambient conditions from in situ measurements made during the four ATom campaigns. The dataset includes composition-resolved size distributions the integrated mass of sulfate, organics, nitrate, sea salt, dust, black carbon, and other compounds in coarse and fine fractions; extinction and absorption coefficients from each species at both dry and ambient conditions; asymmetry parameters; Angstrom exponents; and fitted lognormal functions to describe the size distribution. Optical parameters are calculated for 10 wavelengths from the near UV to the near IR, and size distributions range from 3 nm to 50 um in diameter. One file contains these data at 1-minute time intervals. Another file contains a subset of these data averaged into 1-km vertical bins for each vertical profile the aircraft made, as well as composition-resolved integrated aerosol optical depth derived from each profile. The concentration of cloud condensation nuclei is calculated for 5 supersaturations.

This is Version 2 of this dataset. In Version 2, two variables in ATom_aerosol_profiles.nc are corrected by fixing an error in the calculation for stratospheric aerosol optical depth, and new variables are also included in ATom_60s_aerosol_data.nc. For additional details see Section 8, Dataset Revisions.

This dataset includes two data files in NetCDF format and one companion file in comma-separated values (CSV) format.

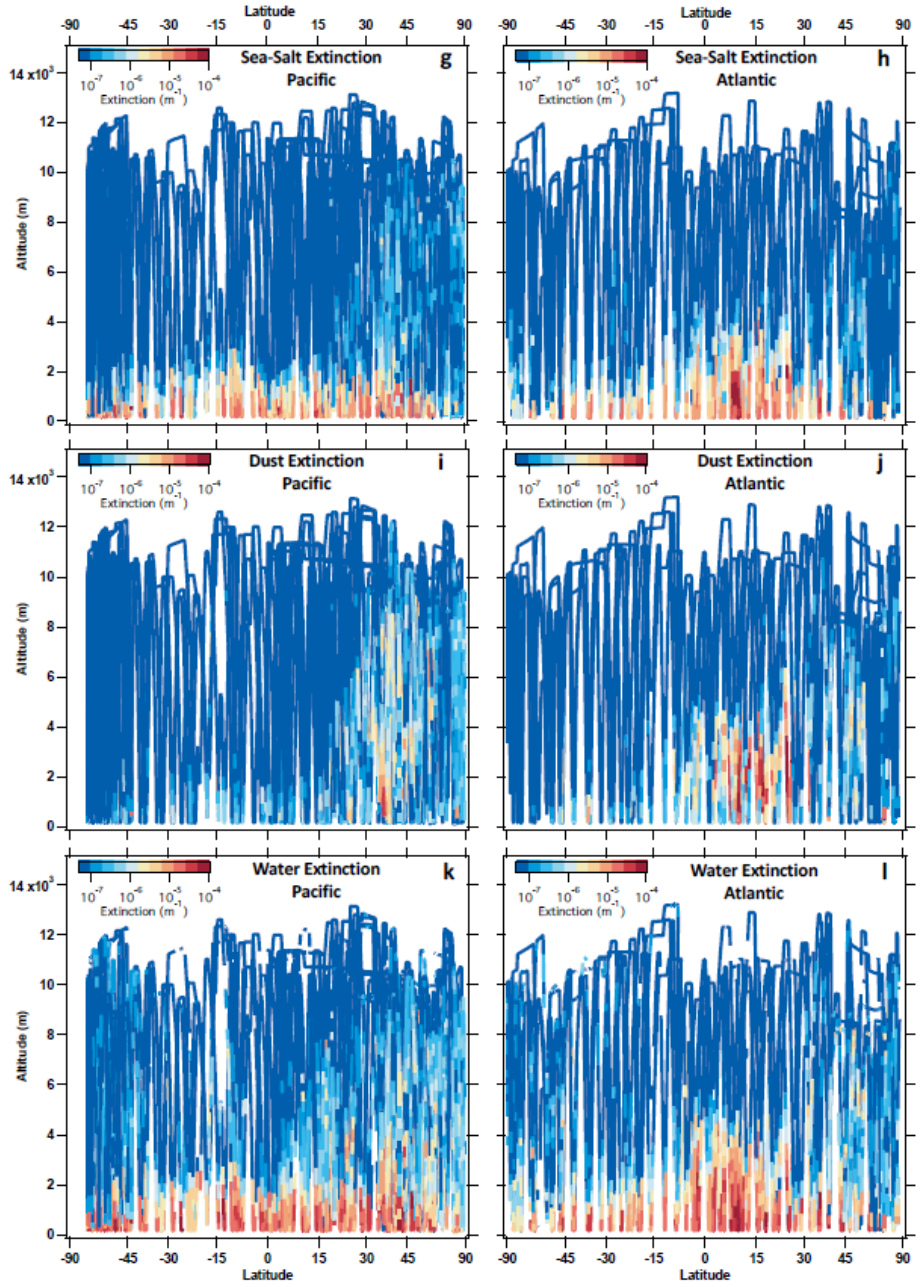

Figure 1. Aerosol extinction across ATom campaigns. Sea salt is shown in (g) and (h), dust in (i) and (j), and water in (k) and (l). Source: Brock et al., 2021

Citation

Brock, C.A., K.D. Froyd, M. Dollner, C.J. Williamson, G.P. Schill, D.M. Murphy, N.L. Wagner, A. Kupc, J.L. Jimenez, P. Campuzano-Jost, B.A. Nault, J.C. Schroder, D.A. Day, D.J. Price, B.B. Weinzierl, J.P. Schwarz, J.M. Katich, S. Wang, L.H. Zeng, R. Webb, J.E. Dibb, E. Scheuer, G.S. Diskin, J.P. DiGangi, T.P. Bui, J.M. Dean-Day, C.R. Thompson, J. Peischl, T.B. Ryerson, I. Bourgeois, B.C. Daube, R. Commane, and S.C. Wofsy. 2022. ATom: Comprehensive Aerosol Properties, 2016-2018, Version 2. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2111

Table of Contents

1. Dataset Overview

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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 Publication

Brock, C.A., K.D. Froyd, M. Dollner, C.J. Williamson, G. Schill, D.M. Murphy, N.J. Wagner, A. Kupc, J.L. Jimenez, P. Campuzano-Jost, B.A. Nault, J.C. Schroder, D.A. Day, D.J. Price, B. Weinzierl, J.P. Schwarz, J.M. Katich, L. Zeng, R. Weber, J. Dibb, E. Scheuer, G.S. Diskin, J.P. DiGangi, T. Bui, J.M. Dean-Day, C.R. Thompson, J. Peischl, T.B. Ryerson, I. Bourgeois, B.C. Daube, R. Commane, and S.C. Wofsy. 2021. Ambient aerosol properties in the remote atmosphere from global-scale in-situ measurements. Atmospheric Chemistry and Physics 21:15023-15063. https://doi.org/10.5194/acp-21-15023-2021.

Related Datasets

Brock, C.A., K.D. Froyd, M. Dollner, C.J. Williamson, G.P. Schill, D.M. Murphy, et. al. 2021. ATom: Comprehensive Aerosol Properties, 2016-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1908.

- Brock et., (2021) is Version 1 of these data, and it is superseded by this dataset.

Wofsy, S.C., S. Afshar, H.M. Allen, E.C. Apel, E.C. Asher, B. Barletta, et. al. 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 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

- Flightpath (location and altitude) data for each of the four campaigns provided in KML and CSV format

Acknowledgments

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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

Campaign	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: 60 seconds

Data File Information

This dataset includes two data files in netCDF (*.nc) format and one companion file in comma-separated values (*.csv) format.

Table 1. Files names and descriptions.

File Name	Description
Data Files	
ATom_60s_aerosol_data.nc	Contains time-averaged data with aerosol optical, chemical, hygroscopic, and microphysical properties, key meteorological parameters, and gas-phase tracers CO and O_3
ATom_aerosol_profiles.nc	Contains aerosol optical, chemical, and microphysical properties averaged over 1 km vertical layers from 0–1 km to 12–13 km, as well as integrated aerosol optical depth
Companion File	

File Name	Description
Data_Dictionary_ATom_Aerosol_Properties.csv	Data dictionary containing descriptions of variables provided in the data files

Data File Details

No data values are represented as -999.0.

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

Measurements have been evaluated against available observations from AERONET sites and from in situ measurements of aerosol extinction and absorption made on the ATom-4 campaign (Brock et al., 2021). A rough estimate of aerosol optical depth (AOD) accuracy is ~30%.

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 GHGs and ODSs 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.

Instruments

Size distributions

1. Nucleation-mode aerosol size spectrometers (10 size-tuned condensation particle counters).
2. Ultra-high sensitivity aerosol size spectrometer (laser optical particle counter).
3. Laser aerosol spectrometer (laser optical particle counter).
4. Cloud and aerosol spectrometer (underwing open-path optical particle counter).

Composition

1. Modified Aerodyne high-resolution time-of-flight aerosol mass spectrometer.
2. Particle analysis by laser mass spectrometer (single-particle mass spectrometer).
3. Single-particle soot photometer (laser incandescence measurement of black carbon particle mass and coating thickness).
4. Spectral measurements of brown carbon absorption of aqueous extracts of aerosol filter samples using capillary waveguide spectrometry.

6. Data Access

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

ATom: Comprehensive Aerosol Properties, 2016-2018, Version 2

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov

- Telephone: +1 (865) 241-3952

7. References

Brock, C.A., K.D. Froyd, M. Dollner, C.J. Williamson, G. Schill, D.M. Murphy, N.J. Wagner, A. Kupc, J.L. Jimenez, P. Campuzano-Jost, B.A. Nault, J.C. Schroder, D.A. Day, D.J. Price, B. Weinzierl, J.P. Schwarz, J.M. Katich, L. Zeng, R. Weber, J. Dibb, E. Scheuer, G.S. Diskin, J.P. DiGangi, T. Bui, J.M. Dean-Day, C.R. Thompson, J. Peischl, T.B. Ryerson, I. Bourgeois, B.C. Daube, R. Commane, and S.C. Wofsy. 2021. Ambient aerosol properties in the remote atmosphere from global-scale in-situ measurements. Atmospheric Chemistry and Physics 21:15023-15063. https://doi.org/10.5194/acp-21-15023-2021.

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8. Dataset Revisions

Version	Release Date	Description
2.0	2022-09-22	Updates to both data files: • ATom_aerosol_profiles.nc: Variables 'tau' and 'tau_dry' were recalculated to fix a calculation error that was present in Version 1. The uncertainties of these variables remain the same. • ATom_60s_aerosol_data.nc: 10 new variables added ('sulf_fine', 'sulf_coarse', 'oa_fine','oa_coarse', 'dust_fine', 'dust_coarse', 'ss_fine', 'ss_coarse', 'alk_fine', 'alk_coarse'). They each have an estimated uncertainty of 30%.
1.0	2021-08-11	Initial release of two data files.