ATom: L2 In Situ Measurements from Single Particle Soot Photometer (SP2)

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Documentation Revision Date: 2019-08-16

Dataset Version: 1

Summary

This dataset provides the refractory black carbon mass concentration at one-second resolution measured by the Single Particle Soot Photometer (NOAA SP2) instrument during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. The SP2 is a laser-induced incandescence instrument primarily used for measuring the black carbon mass content of individual particles.

There are 48 files in comma-separated text (ICARTT) format in this dataset.

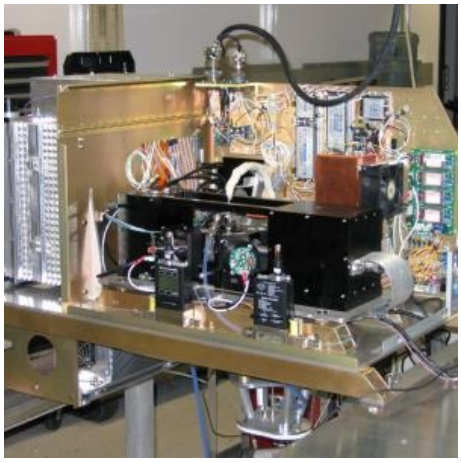

Figure 1. The NOAA SP2 instrument.

Citation

Schwarz, J.P., and J.M. Katich. 2019. ATom: L2 In Situ Measurements from Single Particle Soot Photometer (SP2). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1672

Table of Contents

1. Dataset Overview

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Project: Atmospheric Tomography Mission (ATom)

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 Data:

ATom: Merged Atmospheric Chemistry, Trace Gases, and Aerosols. Data from all ATom instruments and all four flight campaigns, including aircraft location and navigation data, merged to several different time bases: https://doi.org/10.3334/ORNLDAAC/1581

ATom Flight Track and Navigational Data. Flight path (location and altitude) data for each of the four campaigns provided in KML and csv format: https://doi.org/10.3334/ORNLDAAC/1613

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

Table 1: Flight campaign schedule

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: 1 second

Data File Information:

This dataset includes 48 files in comma-delimited text (ICARTT) format, with one file per flight date for all four ATom flight campaigns. Data files conform to the ICARTT File Format Standards V1.1. https://www-air.larc.nasa.gov/missions/etc/IcarttDataFormat.htm .

Files are named as SP2-BC_DC8_*YYYYMMDD*_R#.ict, where *YYYYMMDD* = the start date (in UTC time) of the flight and *R#* = file version or revision number.

Data Variables:

Data files contain one-second temporal averages of black carbon mass concentration reported in ng-BC/m3 (at 1013mb pressure and 273K temperature). Observed mass is scaled upward by a (flight-specific) factor, here 1.09, to represent the total rBC concentration in the mode. The scale factor is based on a single lognormal fit to the observed rBC size distribution from VALID DATA obtained over the entire flight (excluding airport pollution) over the detected range of 90-550nm assuming 1.8 g/cm^-3 void-free density. In-cloud, filter and unstable-flow data were removed. Final calibrations were applied and time synced to DLH H2O. Missing data are indicated by -9999.99.

Table 2: Variables in the data files **NAerosol_DC8_YYYYMMDD_RX.ict**.

Variable Name	Units	Description
UTC_start	seconds since midnight	time of observation (UTC)
BC_mass_90_550_nm	ng std m-3	Accumulation-mode refractory black carbon mass concentration (at 1013mb pressure and 273K temperature)

3. Application and Derivation

ATom builds the scientific foundation for mitigation of short-lived climate forcers, in particular methane (CH4), tropospheric ozone (O3), and Black Carbon aerosols (BC).

ATom Science Questions:

Tier 1

- What are chemical processes that control the short-lived climate forcing agents CH4, O3, 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

The authors estimate a 30 pct systematic uncertainty from flow and mass calibration and aspiration efficiency.

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.

SP2 Instrument:

The SP2 is a laser-induced incandescence instrument primarily used for measuring the BC mass content of individual particles. It is able to provide this data product independently of the total particle morphology and mixing state, and thus delivers detailed information not only about BC loadings, but also size distributions, even in exceptionally clean air. The instrument can also provide the optical size of individual particles containing BC, and identify the presence of coatings associated with the BC fraction (i.e. identify the BC's mixing state). Since its introduction in 2003, the SP2 has been substantially improved, and now can be considered a highly competent instrument for assessing BC loadings and mixing state in situ. More information can be found in Huang et al (2011), Schwarz et al (2010 and 2006).

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

Huang, X.-F., *et al.* (2011), Black carbon measurements in the Pearl River Delta region of China, *J. Geophys. Res., 116*. https://doi.org/10.1029/2010JD014933

Schwarz, J., *et al.* (2010), Global scale black carbon profiles observed in the remote atmosphere and compared to models, *Geophys. Res. Lett., 37*, L18812, https:/doi.org/10.1029/2010GL044372

Schwarz, J., *et al.* (2006), Single-particle measurements of midlatitude black carbon and light-scattering aerosols from the boundary layer to the lower stratosphere, *J. Geophys. Res., 111*, D16207, https://doi.org/10.1029/2006JD007076