ATom: L2 Measurements from the Programmable Flask Package (PFP) Whole Air Sampler

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Dataset Version: 1

Summary

This dataset provides mole fractions of atmospheric trace gases measured by the Programmable Flask Package (PFP) Whole Air Sampler during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. The PFP whole air sampler provides a means of automated or manual filling of glass flasks. The sampler is designed to remove excess water vapor from the sampled air and compress it without contamination into ~1-liter volumes. These flasks are analyzed at the NOAA's Global Monitoring Division laboratory for trace gases and at the INSTAR's Staple Isotope Lab laboratory for isotopes of methane. Analysis of standardized PFP samples can measure more than 60 trace gases including N2O, SF6, H2, CS2, OCS, CO2, CH4, CO, CFCs, HCFCs, HFCs, Solvents, Methyl Halides, Hydrocarbons and Perfluorocarbons. The ATom mission 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 4 seasons from 2016 to 2018.

This dataset includes 48 files in comma-delimited text (ICARTT) format, with one data file per flight date.

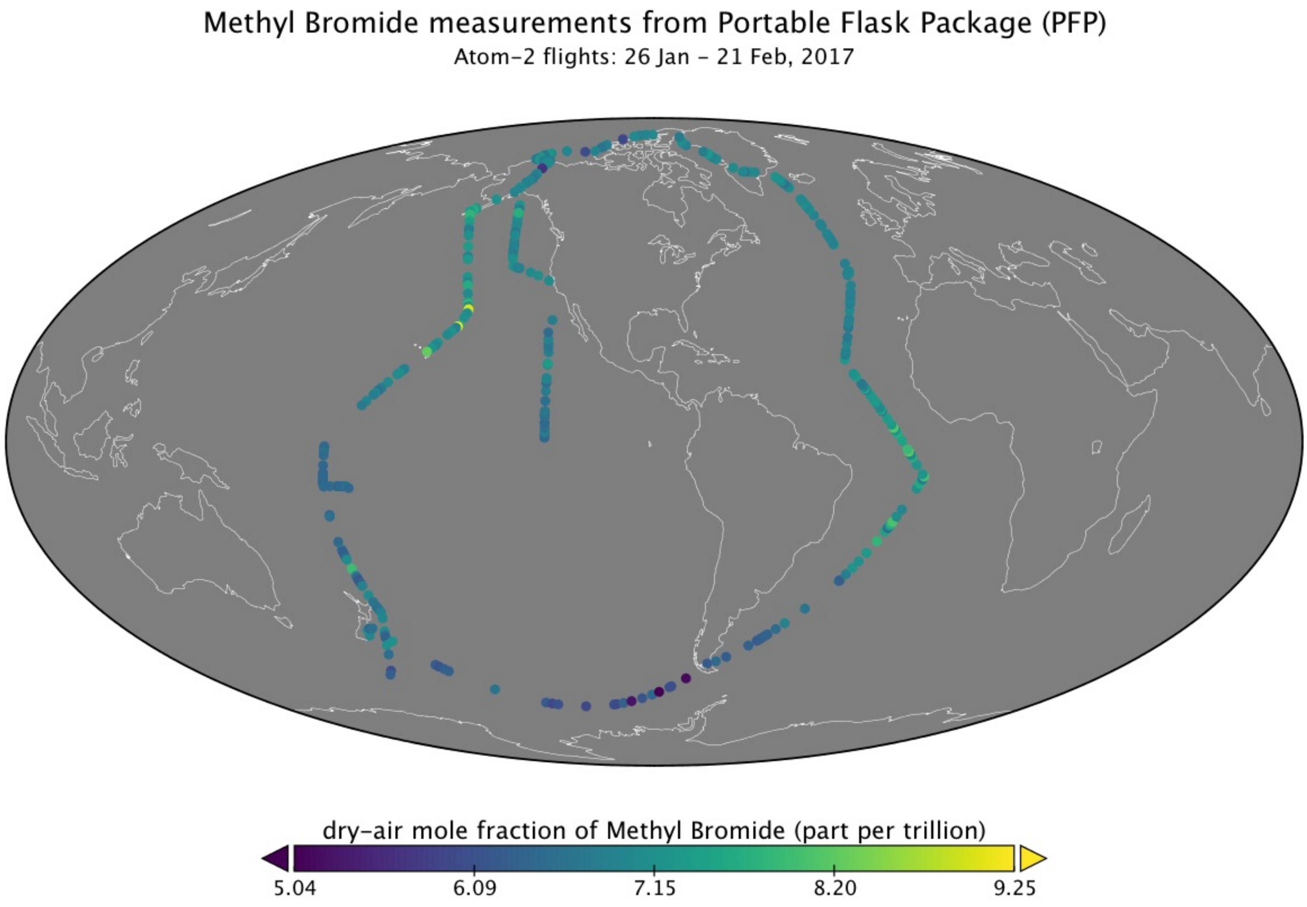

Figure 1. Dry-air mole fraction of Methyl Bromide measured in PFP samples taken during Atom-2 flights in January-February 2017.

Citation

Montzka, S.A., F.L. Moore, and C. Sweeney. 2019. ATom: L2 Measurements from the Programmable Flask Package (PFP) Whole Air Sampler. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1746

Table of Contents

1. Dataset Overview

This dataset provides mole fractions of atmospheric trace gases measured by the Programmable Flask Package (PFP) Whole Air Sampler during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. The PFP whole air sampler provides a means of automated or manual filling of glass flasks. The sampler is designed to remove excess water vapor from the sampled air and compress it without contamination into ~1-liter volumes. These flasks are analyzed at the NOAA's Global Monitoring Division laboratory for trace gases and at the INSTAR's Staple Isotope Lab laboratory for isotopes of methane. Analysis of standardized PFP samples can measure more than 60 trace gases including N2O, SF6, H2, CS2, OCS, CO2, CH4, CO, CFCs, HCFCs, HFCs, Solvents, Methyl Halides, Hydrocarbons and Perfluorocarbons. The ATom mission 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 4 seasons from 2016 to 2018.

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

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: Each flask was open for ~10-12 seconds. Twenty-four flasks were captured per flight.

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.

File names are structured as PFP_DC8_**YYYYMMDD**_R**#**.ict, where **YYYYMMDD** is the start date (in UTC time) of the flight, and R**#** is the file version or revision number.

Data Variables

Missing data are indicated by -999.99.

Table 2. Variables in the PFP data files.

Name	Units	Description
Start_UTC	seconds	seconds since midnight UTC
Stop_UTC	seconds	seconds since midnight UTC
CO2_PFP	ppm	carbon dioxide, dry-air mole fraction, micro mole per mole
CH4_PFP	ppb	methane, dry-air mole fraction, nano mole per mole
CO_PFP	ppb	carbon monoxide, dry-air mole fraction, nano mole per mole
N2O_PFP	ppb	nitrous oxide, dry-air mole fraction, nano mole per mole
SF6_CCGG_PFP	ppt	sulfur hexafluoride dry-air mole fraction, pico mole per mole, measured by electron capture detection in carbon cycle group
H2_PFP	ppb	hydrogen, dry-air mole fraction, nano mole per mole

d13CH4_PFP	per mil	deviation in the 13C/12C Stable Carbon Isotope Ratio in CH4 relative to Vienna Pee Dee Belemnite
d13CO2_PFP	per mil	deviation in the 13C/12C Stable Carbon Isotope Ratio in CO2 relative to Vienna Pee Dee Belemnite
HFC134a_PFP	ppt	1,1,1,2-tetrafluoroethane, dry-air mole fraction, pico mole per mole
HCFC22_PFP	ppt	chlorodifluoromethane, dry-air mole fraction, pico mole per mole
CFC12_PFP	ppt	dichlorodifluoromethane, dry-air mole fraction, pico mole per mole
CH3Cl_PFP	ppt	methyl chloride, dry-air mole fraction, pico mole per mole
HCFC142b_PFP	ppt	1-chloro-1,1-difluoroethane, dry-air mole fraction, pico mole per mole
H1211_PFP	ppt	bromodichlorofluoromethane (halon-1211), dry-air mole fraction, pico mole per mole
CH3Br_PFP	ppt	methyl bromide, dry-air mole fraction, pico mole per mole
CFC11_PFP	ppt	trichlorofluoromethane, dry-air mole fraction, pico mole per mole
HCFC141b_PFP	ppt	1,1-chloro-1-fluoroethane, dry-air mole fraction, pico mole per mole
CH3I_PFP	ppt	methyl iodide, dry-air mole fraction, pico mole per mole
CFC113_PFP	ppt	1,1,2-trichloro-1,2,2-trifluoroethane, dry-air mole fraction, pico mole per mole
CH2Cl2_PFP	ppt	dichloromethane, dry-air mole fraction, pico mole per
CHCl3_PFP	ppt	trichloromethane (chloroform), dry-air mole fraction, pico mole per mole
CH3CCl3_PFP	ppt	1,1,1-trichloroethane, dry-air mole fraction, pico mole per mole
CCl4_PFP	ppt	tetrachloromethane, dry-air mole fraction, pico mole per mole
CH2Br2_PFP	ppt	dibromomethane, dry-air mole fraction, pico mole per mole
C2Cl4_PFP	ppt	tetrachloroethylene, dry-air mole fraction, pico mole per mole
CHBr3_PFP	ppt	tribromomethane (bromorform), dry-air mole fraction, pico mole per mole
Benzene_PFP	ppt	C6H6, dry-air mole fraction, pico mole per mole
OCS_PFP	ppt	carbonyl sulfide, dry-air mole fraction, pico mole per mole
HCFC21_PFP	ppt	dichlorofluoromethane, dry-air mole fraction, pico mole per mole
HFC152a_PFP	ppt	1,1-difluoroethane, dry-air mole fraction, pico mole per mole
H2402_PFP	ppt	1,2-dibromo-1,1,2,2-tetrafluoroethane (halon-2402, dry-air mole fraction, pico mole per mole
HFC365mfc_PFP	ppt	1,1,1,3,3-pentafluorobutane, dry-air mole fraction, pico mole per mole
Propyne_PFP	ppt	C3H4, dry-air mole fraction, pico mole per mole
C2H5Cl_PFP	ppt	chloroethane, dry-air mole fraction, pico mole per mole
HFC227ea_PFP	ppt	1,1,1,2,3,3,3-heptafluoropropane, dry-air mole fraction, pico mole per mole
nPentane_PFP	ppt	normal pentane (C5H12), dry-air mole fraction, pico mole per mole
nHexane_PFP	ppt	normal hexane (C6H14), dry-air mole fraction, pico mole per mole
HCFC133a_PFP	ppt	1-chloro-2,2,2-trifluoroethane, dry-air mole fraction, pico mole per mole
CH2ClI_PFP	ppt	chloroiodomethane, dry-air mole fraction, pico mole per mole
CH2I2_PFP	ppt	diiodomethane, dry-air mole fraction, pico mole per mole
CH2BrCl_PFP	ppt	bromochloromethane, dry-air mole fraction, pico mole per mole
CH2ClCH2Cl_PFP	ppt	1,2-dichloroethane, dry-air mole fraction, pico mole per mole
Propane_PFP	ppt	C3H8, dry-air mole fraction, pico mole per mole
iPentane_PFP	ppt	isopentane (C5H12), dry-air mole fraction, pico mole per mole
iButane_PFP	ppt	isobutane (C4H10), dry-air mole fraction, pico mole per mole
nButane_PFP	ppt	normal butane (C4H10), dry-air mole fraction, pico mole per mole
CHBrCl2_PFP	ppt	bromodichloromethane, dry-air mole fraction, pico mole per mole
CH2BrI_PFP	ppt	bromoiodomethane, dry-air mole fraction, pico mole per mole
CH3CHCl2_PFP	ppt	1,1-dichloroethane, dry-air mole fraction, pico mole per mole
CHBr2Cl_PFP	ppt	dibromochloromethane, dry-air mole fraction, pico mole per mole

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

Uncertainty information was not provided.

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.

Programmable Flask Package Whole Air Sampler

The PFP whole air sampler provides a means of automated or manual filling of glass flasks, twelve per PFP. The sampler is designed to remove excess water vapor from the sampled air and compress it without contamination into ~1-liter volumes. These flasks are analyzed at the NOAA’s Global Monitoring Division laboratory for trace gasses and at the INSTAR’s Staple Isotope Lab laboratory for isotopes of methane. More than 60 trace gases found in the global atmosphere can be measured at mole fractions that range from parts-per-million (10^-6) down to parts-per-quadrillion (10^-15).

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