ATom: L2 Halocarbons and Hydrocarbons from the UC-Irvine Whole Air Sampler (WAS)

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Documentation Revision Date: 2019-12-11

Dataset Version: 1

Summary

This dataset provides atmospheric concentrations of halocarbons and hydrocarbons measured by the UC-Irvine Whole Air Sampler (WAS) during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. The analysis of samples from the UCI WAS provides measurements of more than 50 trace gases, including C2-C10 NMHCs, C1-C2 halocarbons, C1-C5 alkyl nitrates, and selected sulfur compounds. Species were identified and measured using an established technique of airborne whole air sampling followed by laboratory analysis using gas chromatography (GC) with flame ionization detection (FID), and mass spectrometric detection (MSD). 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 47 files in comma-delimited text (ICARTT) format, with one data file per flight date.

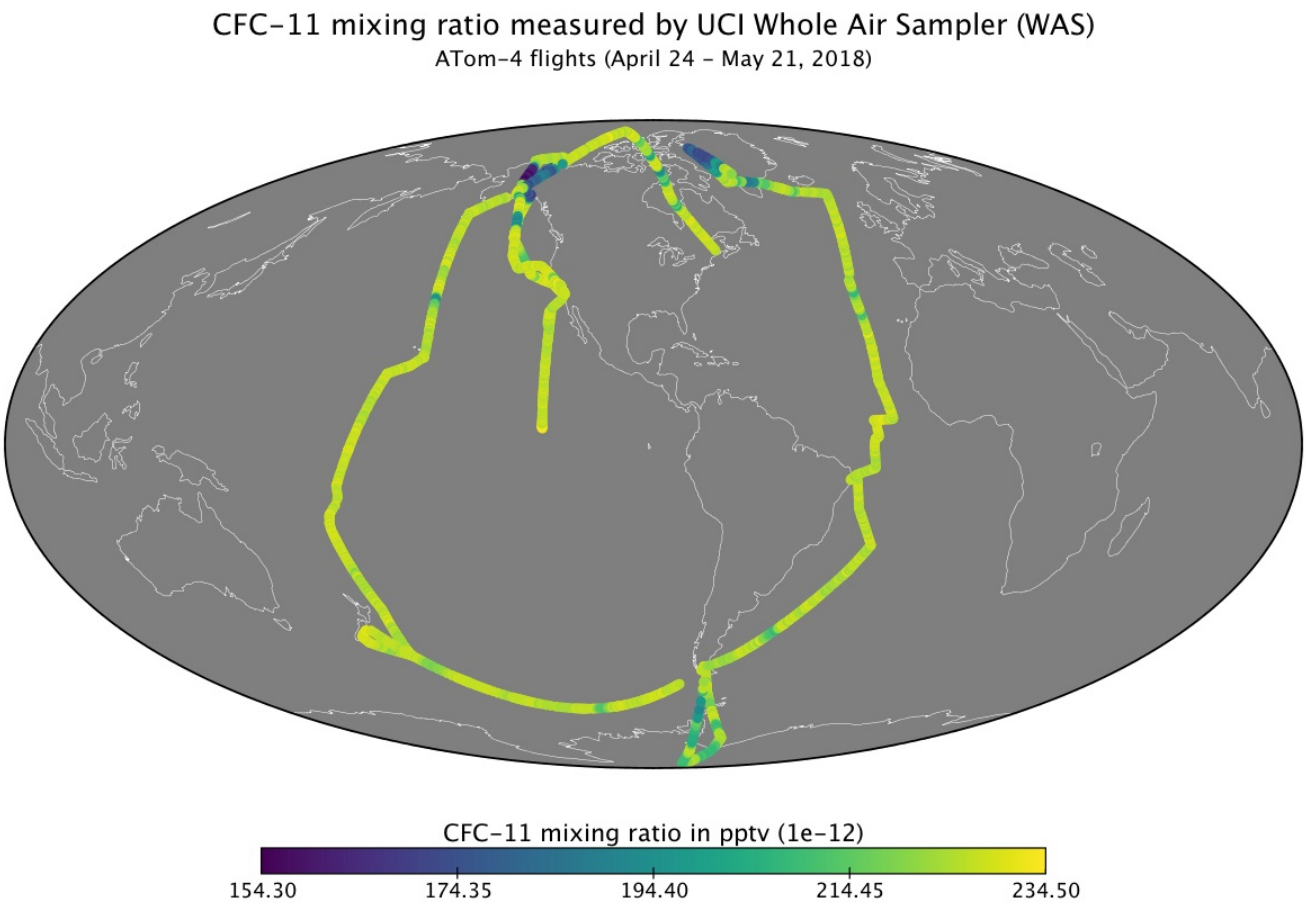

Figure 1. Mixing ratio of CFC-11 measured in WAS samples taken during Atom-4 flights in April-May 2018.

Citation

Barletta, B., B.C. Biggs, D.R. Blake, N. Blake, A. Hoffman, S. Hughes, S. Meinardi, N. Vieznor, and C.T. Woods. 2019. ATom: L2 Halocarbons and Hydrocarbons from the UC-Irvine Whole Air Sampler (WAS). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1751

Table of Contents

1. Dataset Overview

This dataset provides atmospheric concentrations of halocarbons and hydrocarbons measured by the UC-Irvine Whole Air Sampler (WAS) during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. The analysis of samples from the UCI WAS provides measurements of more than 50 trace gases, including C2-C10 NMHCs, C1-C2 halocarbons, C1-C5 alkyl nitrates, and selected sulfur compounds. Species were identified and measured using an established technique of airborne whole air sampling followed by laboratory analysis using gas chromatography (GC) with flame ionization detection (FID), and mass spectrometric detection (MSD). 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: Samples were open for approximately 30 to 90 seconds. About 160 samples were collected per flight.

Data File Information

This dataset includes 47 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 WAS_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

Table 2. Variables in the data files WAS_DC8_**YYYYMMDD**_R**#**.ict. Missing data are indicated by -999. Samples below the lower limit of detection (LLOD) are denoted as -888.

Variable Name	Units	Description
Start_UTC	seconds	seconds since midnight UTC
Stop_UTC	seconds	seconds since midnight UTC
Mid_UTC	seconds	seconds since midnight UTC
OCS_WAS	pptv	
DMS_WAS	pptv	
CFC12_WAS	pptv	
CFC11_WAS	pptv	
CFC113_WAS	pptv	
CFC114_WAS	pptv	
HFC152a_WAS	pptv	

HFC134a_WAS	pptv	
HFC365mfc_WAS	pptv	
HCFC124_WAS	pptv	
HCFC22_WAS	pptv	
HCFC142b_WAS	pptv	
HCFC141b_WAS	pptv	
H1301_WAS	pptv	
H2402_WAS	pptv	
H1211_WAS	pptv	
CH3CCl3_WAS	pptv	
CCl4_WAS	pptv	
CHCl3_WAS	pptv	
CH2Cl2_WAS	pptv	
C2Cl4_WAS	pptv	
CH3Cl_WAS	pptv	
CH3Br_WAS	pptv	
CH3I_WAS	pptv	
CH2Br2_WAS	pptv	
CHBrCl2_WAS	pptv	
CHBr2Cl_WAS	pptv	
CHBr3_WAS	pptv	
CH2ClCH2Cl_WAS	pptv	
MeONO2_WAS	pptv	
EthONO2_WAS	pptv	
iPropONO2_WAS	pptv	
nPropONO2_WAS	pptv	
x2ButONO2_WAS	pptv	
x3PentONO2_WAS	pptv	
x2PentONO2_WAS	pptv	
x3Me2ButONO2_WAS	pptv	
Ethane_WAS	pptv	
Ethene_WAS	pptv	
Ethyne_WAS	pptv	
Propane_WAS	pptv	
Propene_WAS	pptv	
iButane_WAS	pptv	
nButane_WAS	pptv	
iPentane_WAS	pptv	
nPentane_WAS	pptv	
Isoprene_WAS	pptv	
nHexane_WAS	pptv	
nHeptane_WAS	pptv	
x2MePentane_WAS	pptv	
x3MePentane_WAS	pptv	
Benzene_WAS	pptv	
Toluene_WAS	pptv	
EthBenzene_WAS	pptv	
mpXylene_WAS	pptv	
oXylene_WAS	pptv	

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: Samples below the lower limit of detection (LLOD) are denoted as -888. The table below lists the LLOD for each species.

Variable Name	LLOD (pptv)
OCS_WAS	10
DMS_WAS	0.1
CFC12_WAS	10
CFC11_WAS	10
CFC113_WAS	1
CFC114_WAS	1
HFC152a_WAS	0.1
HFC134a_WAS	0.5
HFC365mfc_WAS	0.2
HCFC124_WAS	0.1
HCFC22_WAS	1
HCFC142b_WAS	1
HCFC141b_WAS	1
H1301_WAS	0.01
H2402_WAS	0.01
H1211_WAS	0.01
CH3CCl3_WAS	0.05
CCl4_WAS	0.1
CHCl3_WAS	0.05
CH2Cl2_WAS	0.1
C2Cl4_WAS	0.005
CH3Cl_WAS	1
CH3Br_WAS	0.1
CH3I_WAS	0.005
CH2Br2_WAS	0.01
CHBrCl2_WAS	0.005
CHBr2Cl_WAS	0.005
CHBr3_WAS	0.005
CH2ClCH2Cl_WAS	0.2

MeONO2_WAS	0.01
EthONO2_WAS	0.01
iPropONO2_WAS	0.01
nPropONO2_WAS	0.01
x2ButONO2_WAS	0.01
x3PentONO2_WAS	0.01
x2PentONO2_WAS	0.01
x3Me2ButONO2_WAS	0.01
Ethane_WAS	3
Ethene_WAS	3
Ethyne_WAS	3
Propane_WAS	3
Propene_WAS	3
iButane_WAS	3
nButane_WAS	3
iPentane_WAS	3
nPentane_WAS	3
Isoprene_WAS	3
nHexane_WAS	3
nHeptane_WAS	3
x2MePentane_WAS	3
x3MePentane_WAS	3
Benzene_WAS	3
Toluene_WAS	3
EthBenzene_WAS	3
mpXylene_WAS	3
oXylene_WAS	3

5. Data Acquisition, Materials, and Methods

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.

UC-Irvine Whole Air Sampler

More than 70 trace gases can be identified and quantified, including C2-C10 NMHCs, C1-C2 halocarbons, C1-C5 alkyl nitrates, and selected sulfur compounds. This is achieved using an established technique of airborne whole air sampling followed by laboratory analysis using gas chromatography (GC) with flame ionization detection (FID), electron capture detection (ECD), and mass spectrometric detection (MSD).

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:

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