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ATom: L2 Measurements of In Situ Airborne Formaldehyde (ISAF)

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Summary

This dataset provides the atmospheric volume mixing ratio of formaldehyde measured during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. ATom deploys 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. The NASA In Situ Airborne Formaldehyde (ISAF) instrument, based at the Goddard Space Flight Center, measures formaldehyde on high-altitude NASA aircraft. The instrument uses laser-induced fluorescence (LIF) to obtain the high detection sensitivity needed to detect formaldehyde in the upper troposphere and lower stratosphere where abundances are 10 parts per trillion. LIF also enables a fast time response needed to measure the abundance of formaldehyde in the finely structured outflow of convective storms. These measurements of formaldehyde will be used elucidate mechanisms of convective transport and quantify the effects of boundary layer pollutants on the ozone photochemistry and cloud microphysics of the upper atmosphere.

This dataset includes 41 files in comma-delimited text (ICARTT) format, with one file per flight date for all ATom flights.

Atmospheric Formaldehyde (CH₂O) measured by ISAF ATom-3 flights (Sept 28 – Oct 28, 2017)

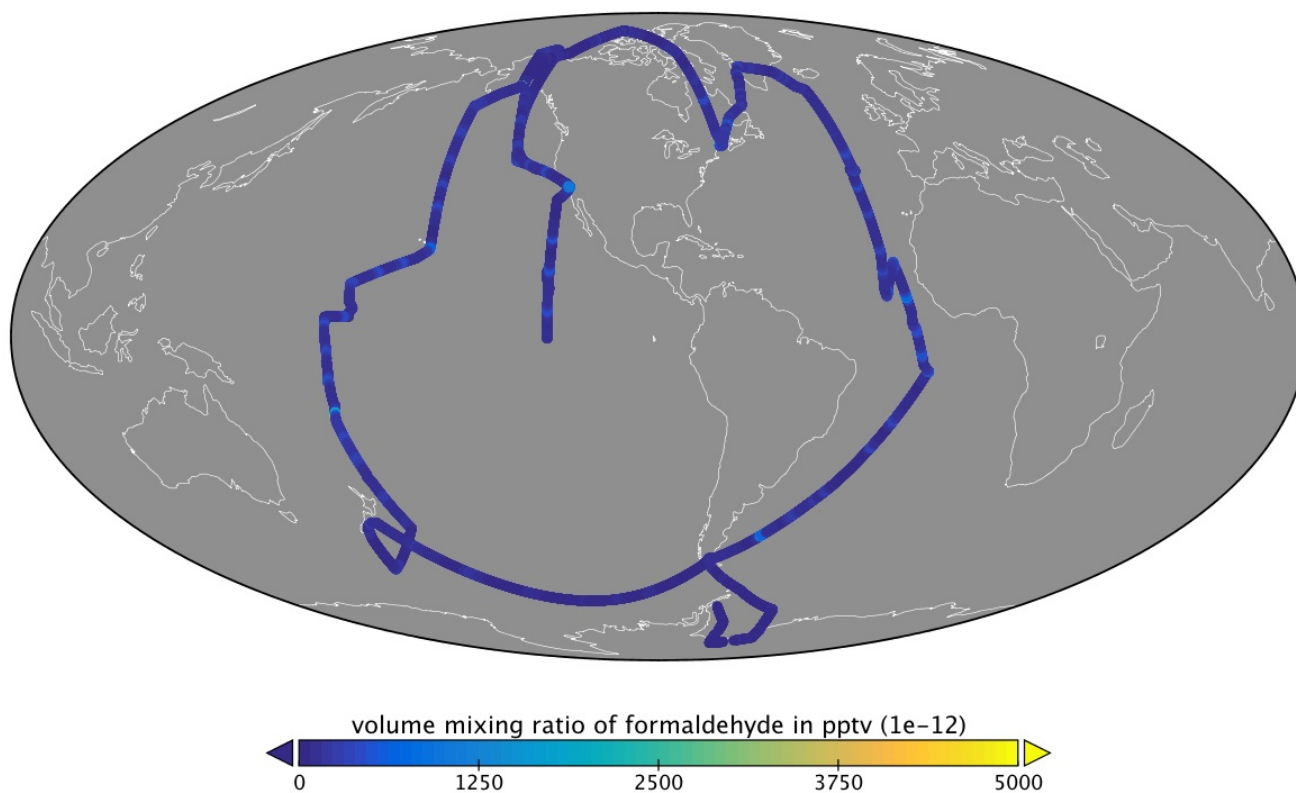


Figure 1. Measurements of atmospheric formaldehyde concentrations from the ISAF instrument during ATom-3 flights in 2017.

Citation

Hanisco, T.F., R.A. Hannun, J.M. St.Clair, and G.M. Wolfe. 2019. ATom: L2 Measurements of In Situ Airborne Formaldehyde (ISAF). ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1730>

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1. Dataset Overview

This dataset provides the atmospheric volume mixing ratio of formaldehyde measured during airborne campaigns conducted by NASA's Atmospheric Tomography (ATom) mission. ATom deploys 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. The NASA In Situ Airborne Formaldehyde (ISAF) instrument, based at the Goddard Space Flight Center, measures formaldehyde on high-altitude NASA aircraft. The instrument uses laser-induced fluorescence (LIF) to obtain the high detection sensitivity needed to detect formaldehyde in the upper troposphere and lower stratosphere where abundances are 10 parts per trillion. LIF also enables a fast time response needed to measure the abundance of formaldehyde in the finely structured outflow of convective storms. These measurements of formaldehyde will be used elucidate mechanisms of convective transport and quantify the effects of boundary layer pollutants on the ozone photochemistry and cloud microphysics of the upper atmosphere.

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: one second

Data File Information

This dataset includes 41 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 *ISAF-H2CO_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.

Table 2. Variables in the data files. Missing data are indicated by -9999.

Name	Units	Description
Start.UTC	seconds	Start time of measurement in seconds since UTC midnight on the flight date.
CH2O	parts per trillion by volume (pptv)	Volume mixing ratio of formaldehyde

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

Calibration uncertainty is +/-10 percent. Offset uncertainty is +/- 10 pptv. Ozone interference correction adds an upper uncertainty estimate of (correction factor) * O3(in ppb) pptv, when correction factor is given in Special Comments.

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.

In Situ Airborne Formaldehyde (ISAF) instrument

The NASA GSFC In Situ Airborne Formaldehyde (ISAF) instrument measures formaldehyde on high altitude NASA aircraft. The instrument uses laser induced fluorescence (LIF) to obtain the high detection sensitivity needed to detect formaldehyde in the upper troposphere and lower stratosphere where abundances are 10 parts per trillion. LIF also enables a fast time response needed to measure the abundance of formaldehyde in the finely structured outflow of convective storms. These measurements of formaldehyde will be used elucidate mechanisms of convective transport and quantify the effects of boundary layer pollutants on the ozone photochemistry and cloud microphysics of the upper atmosphere.

All data are provided in parts per trillion by volume (pptv). Time is aligned to DLH H2O_ppmv via cross-correlation and inspection. When noted in Special Comments, observations are corrected for an apparent ozone-generated artifact. The correction is the mean of the slopes generated for fits of HCHO vs. NOyO3 O3_CL and inherently assumes that O3 and HCHO in the lowermost stratosphere should not correlate.

6. Data Access

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

[ATom: L2 Measurements of In Situ Airborne Formaldehyde \(ISAF\)](#)

Contact for Data Center Access Information:

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



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