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## ATom: Measurements from Meteorological Measurement System (MMS), 2016-2018

### Get Data

Documentation Revision Date: 2021-09-23

Dataset Version: 1

### Summary

This dataset contains measurements from the Meteorological Measurement System (MMS) instrument from the four ATom campaigns. MMS is a state-of-the-art instrument for measuring accurate, high resolution in situ airborne state parameters (pressure, temperature, turbulence index, and the 3-dimensional wind vector). These key measurements enable our understanding of atmospheric dynamics, chemistry, and microphysical processes. The MMS is used to investigate atmospheric mesoscale (gravity and mountain lee waves) and microscale (turbulence) phenomena. An accurate characterization of the turbulence phenomenon is important for the understanding of dynamic processes in the atmosphere, such as the behavior of buoyant plumes within cirrus clouds, diffusions of chemical species within wake vortices generated by jet aircraft, and microphysical processes in breaking gravity waves. Accurate temperature and pressure data are needed to evaluate chemical reaction rates as well as to determine accurate mixing ratios. Accurate wind field data establish a detailed relationship with the various constituents and the measured wind also verifies numerical models used to evaluate air mass origin.

There are 56 data files in ICARTT (\*.ict) format included in this dataset.

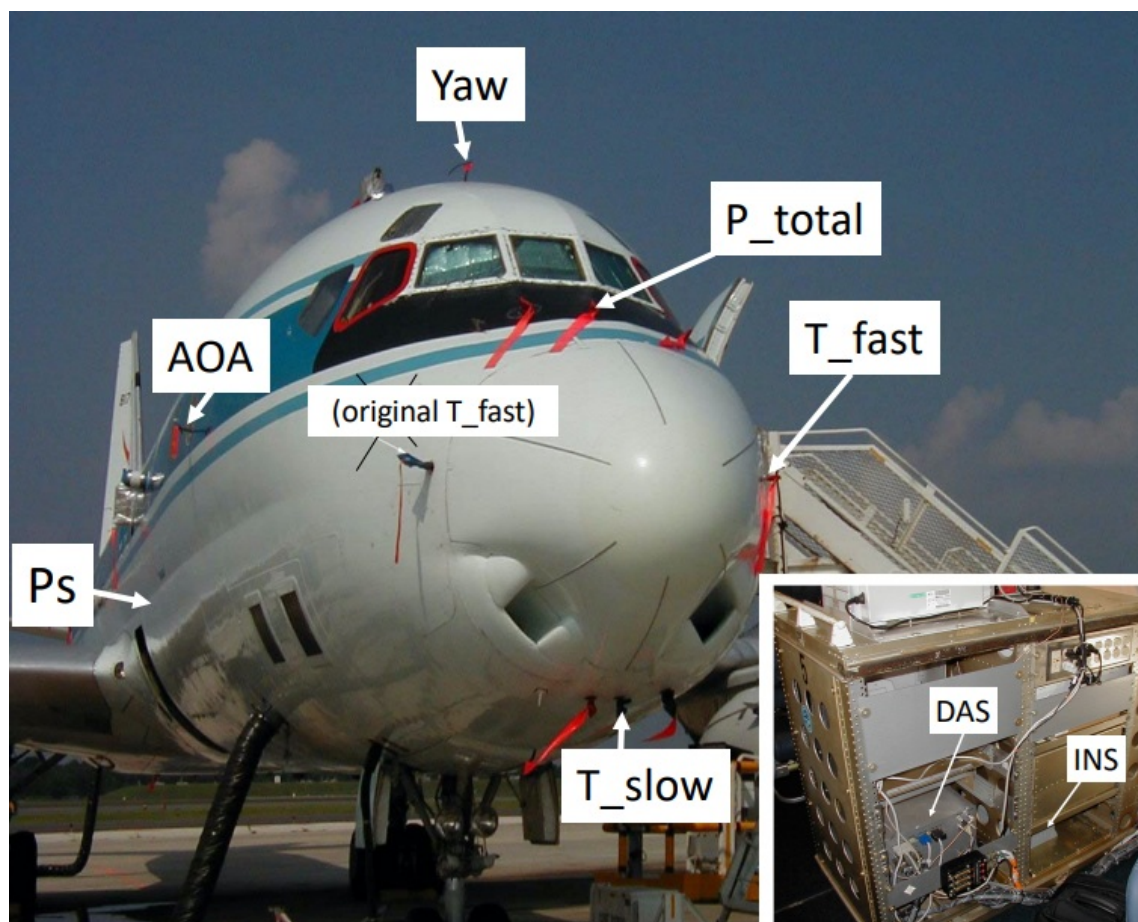


Figure 1. MMS instrumentation on the DC-8 aircraft during the fourth field campaign in the NASA Convection and Moisture Experiment (CAMEX) series. The MMS Air Motion Sensor System consists of sensors that measure airflow angles such as angle of attack (AOA) and yaw angle, total and static pressure ( $P_{total}$ ,  $P_s$ ), and slow and fast temperature responses ( $T_{fast}$ ,  $T_{slow}$ ). The fast temperature probe location has been modified recently. The inset picture shows the rear rack with the Data Acquisition System (DAS) and Inertial Navigation System (INS).

### Citation

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## 1. Dataset Overview

This dataset contains measurements from the Meteorological Measurement System (MMS) instrument from the four ATom campaigns. MMS is a state-of-the-art instrument for measuring accurate, high resolution in situ airborne state parameters (pressure, temperature, turbulence index, and the 3-dimensional wind vector). These key measurements enable our understanding of atmospheric dynamics, chemistry, and microphysical processes. The MMS is used to investigate atmospheric mesoscale (gravity and mountain lee waves) and microscale (turbulence) phenomena. An accurate characterization of the turbulence phenomenon is important for the understanding of dynamic processes in the atmosphere, such as the behavior of buoyant plumes within cirrus clouds, diffusions of chemical species within wake vortices generated by jet aircraft, and microphysical processes in breaking gravity waves. Accurate temperature and pressure data are needed to evaluate chemical reaction rates as well as to determine accurate mixing ratios. Accurate wind field data establish a detailed relationship with the various constituents and the measured wind also verifies numerical models used to evaluate air mass origin.

### 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 Datasets

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 the four ATom campaigns, including aircraft location and navigation data, merged to several different 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 ATom campaigns provided in KML and CSV format.

Yang, M.M., and J.R. Bennett. 2021. ATom: Flight Dynamics and Environmental Parameters of the NASA DC-8 Aircraft. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1909>

- Flight dynamics and environmental parameters collected from an assortment of instruments across the four ATom campaigns that can be used to understand the interior and exterior conditions and positioning of the DC-8 aircraft at 1-second resolution.

## 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

**Temporal Resolution:** 1 second

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

### Data File Information

There are 56 data files in ICARTT (\*.ict) format included in this dataset. Data files conform to the [ICARTT File Format Standards V1.1](#).

The files are named MMS-1HZ\_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. Files contain measurements from the Meteorological Measurement System (MMS) instrument.

### Data File Details

Missing data are represented by -9999.

Table 1. Variables in the data files named MMS-1HZ\_DC8\_YYYYMMDD\_R#.ict.

Name	Units	Description
TIME.UTC	Seconds	Seconds since 0000 UTC
P	hPa	Static pressure
T	K	Static temperature
TAS	m/s	True air speed
U	m/s	E-W horizontal wind speed

V	m/s	N-S horizontal wind speed
W	m/s	Vertical wind speed
TEDR	kW/kg	Log10 of turbulent dissipation rate
REYN	Reynolds #/m	Log10 of Reynolds Number per Length
G_LAT	Decimal degrees	GPS latitude
G_LONG	Decimal degrees	GPS longitude
G_ALT	m	GPS altitude
POT	K	Potential temperature
ROLL	Degrees	Roll angle (+ right wing down)
HDG	Degrees	Heading angle
PITCH	Degrees	Pitch angle
YAW	Degrees	Yaw angle
AOA	Degrees	Angle of attack

### 3. Application and Derivation

ATom builds the scientific foundation for mitigation of short-lived climate forcers, in particular, methane (CH<sub>4</sub>), tropospheric ozone (O<sub>3</sub>), and Black Carbon aerosols (BC).

#### ATom Science Questions

##### Tier 1

- What are chemical processes that control the short-lived climate forcing agents CH<sub>4</sub>, O<sub>3</sub>, 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 is 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.

#### Meteorological Measurement System

The Meteorological Measurement System (MMS) is a state-of-the-art instrument for measuring accurate, high resolution in situ airborne state parameters (pressure, temperature, turbulence index, and the 3-dimensional wind vector). These key measurements enable our understanding of atmospheric dynamics, chemistry, and microphysical processes. The MMS is used to investigate atmospheric mesoscale (gravity and mountain lee waves) and microscale (turbulence) phenomena. An accurate characterization of the turbulence phenomenon is important for the understanding of dynamic processes in the atmosphere, such as the behavior of buoyant plumes within cirrus clouds, diffusions of chemical species within wake vortices generated by jet aircraft, and microphysical processes in breaking gravity waves. Accurate temperature and pressure data are needed to evaluate chemical reaction rates as well as to determine accurate mixing ratios. Accurate wind field data establish a detailed relationship with the various constituents and the measured wind also verifies numerical models used to evaluate air mass origin. Since the MMS provides quality information on atmospheric state variables, MMS data have been extensively used by many investigators to process and interpret the in situ experiments aboard the same aircraft.

Additional information can be found on the [ESPO's MMS Instrument Page](#).

### 6. Data Access

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

[ATom: Measurements from Meteorological Measurement System \(MMS\), 2016-2018](#)

Contact for Data Center Access Information:

- E-mail: [uso@daac.ornl.gov](mailto:uso@daac.ornl.gov)
- Telephone: +1 (865) 241-3952

## 7. References



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