ATom: In Situ Tropical Aerosol Properties and Comparable Global Model Outputs

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Dataset Version: 1

Summary

This dataset provides (1) the results of in situ aerosol particle property measurements collected over remote tropical areas of both Pacific and Atlantic Oceans during the NASA airborne Atmospheric Tomography (ATom) campaigns for ATom-1 and ATom-2 and (2) modeled outputs of comparable aerosol properties, atmospheric chemistry and meteorology at 70 m resolution from four chemical-transport models matched to the location and time of the aircraft measurements.

The in-situ aircraft measurements of vertical profiles of aerosol particle size distributions were collected during ATom 1 and ATom 2 missions, comprised of four sets of contiguous flights over both Pacific and Atlantic Ocean basins from 81 N to 65 S, from July 29, 2016 to February 21, 2017. The flights focused on the remote marine atmosphere, constantly profiling between about 0.18 and 11-13 km altitude to resolve the vertical structure of the atmosphere. Results provide a global-scale survey of new particle formation (NPF) occurrence in the tropics.

The four chemical-transport models were: GEOS-Chem, with aerosol microphysics from either TOMAS or APM; CESM with aerosol microphysics from CARMA; and CAM5 with aerosol microphysics from APM. The atmospheric conditions for the model runs were approximated by calculating back-trajectories along the ATom flight paths and deriving cloud fractions from satellite sources. Both of these model input products are provided. The four model results were used for comparison to the airborne collected data.

There are 136 data files with this dataset. This includes 13 ATom-1 and ATom-2 airborne in situ measurement data files in .txt format, four back-trajectory files in NetCDF (.nc4) format (two each for ATom-1 and ATom-2), four cloud fraction files in .txt format (two each for ATom-1 and ATom-2), and 115 model output files in .txt format.

Figure 1. The NASA DC-8 aircraft used for the ATom missions.

Citation

Williamson, C.J., A. Kupc, K.R. Bilsback, T.P. Bui, P.C. Jost, M. Dollner, K.D. Froyd, A.L. Hodshire, J.L. Jimenez, J.K. Kodros, G. Luo, D.M. Murphy, B.A. Nault, E. Ray, B. Weinzierl, F. Yu, P. Yu, J.R. Pierce, and C.A. Brock. 2019. ATom: In Situ Tropical Aerosol Properties and Comparable Global Model Outputs. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1684

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1. Dataset Overview

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The four chemical-transport models were: GEOS-Chem, with aerosol microphysics from either TOMAS or APM; CESM with aerosol microphysics from CARMA; and CAM5 with aerosol microphysics from APM. The atmospheric conditions for the model runs were approximated by calculating back-trajectories along the ATom flight paths and deriving cloud fractions from satellite sources. Both of these model input products are provided. The four model results were used for comparison to the airborne collected data.

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 Dataset:

Wofsy et al. 2018. ATom: Merged Atmospheric Chemistry, Trace Gases, and Aerosols. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1581

Related Publication:

Williamson, C.J., A. Kupc, D. Axisa, K.R. Bilsback, T. Bui, P. Campuzano-Jost, M. Dollner, K.D. Froyd, A.L. Hodshire, J.L. Jimenez, J.K. Kodros, G. Luo, D.M. Murphy, B.A. Nault, E.A. Ray, B. Weinzierl, J.C. Wilson, F. Yu, P. Yu, J.R. Pierce, and C.A. Brock. A Large Source of Cloud Condensation Nuclei from New Particle Formation in the Tropics. 2019, in review.

Acknowledgement:

This research was funded with NASA grant NNX13AK20G.

2. Data Characteristics

Spatial Coverage: Global, sampling primarily over the remote oceans

Spatial Resolution: 70 m

Temporal Coverage: 2016-07-29 to 2017-02-21

Temporal Resolution: one minute

Study Area: (all latitudes and longitudes given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
ATom-1 and 2 flights	-180	180	80.52	-65.33

Data File Information

There are 136 data files with this dataset. This includes 13 ATom-1 and ATom-2 airborne in situ measurement data files in .txt format, four back-trajectory files in NetCDF (.nc4) format (two each for ATom-1 and ATom-2), four cloud fraction files in .txt format (two each for ATom-1 and ATom-2), and 115 model output files in .txt format.

User Note: "std" in units denotes that results are reported at standard temperature and pressure of 0 degrees C and 1013 hPa.

Data File Descriptions and Variables

For details about data collection, processing, and model runs, please see Williamson et al. (2019) for details.

ATom 1 and ATom 2 in-situ aircraft measurements

In-situ aircraft measurements of vertical profiles of aerosol size distributions were collected to evaluate new particle formation (NPF) occurrence in the tropics. Measurements were collected during airborne campaigns conducted by NASA's ATom 1 and ATom 2 missions.

File names:

- **AMS_flt208.txt**
- **AMS_flt104.txt**
- **AMS_flt108.txt**

This file provides organic and sulfate particle mass measured by the aerosol mass spectrometer (AMS) (50-500 nm) and Particle

Analysis by Laser Mass Spectrometry (PALMS) (150-500 nm), and ambient *RH* for the tropical convective region (TCR) with data affected by biomass burning and dust plumes removed (AMS excludes ATom-2 Pacific where overall mass was too low to measure sulfate and organic components). Both composition measurements have limitations in this regime (the AMS is close to detection limit, and PALMS cannot measure particles <150 nm).

Table 1. Variables in the data files.

The variables are the same for all three files. The column order varies in all three files. Blank rows at the beginning of a data file are due to ground-time.

Variable	**Units**	**Description**
GALT_MMS	m	Altitude
HROrg_CE	1. g std. m^{-3}	Organic Aerosol Mass from AMS
HRSO4_CE	1. g std. m^{-3}	Sulfate Aerosol Mass from AMS
LAT_MMS		Latitude
LON_MMS		Longitude
PALMS_BB		Fraction of particles classified as biomass burning
PALMS_Dust		Fraction of particles classified as dust
RHw	%	Relative humidity over water
StaticP	hPa	Pressure

File names:

- **ATom1PALMSlt500nm.txt**
- **ATom2PALMSlt500nm.txt**

Table 2. Variables in the data files.

Variable	**Units**	**Description**
PALMS_SulfMAMS	1. g std. m^{-3}	Sulfate Aerosol Mass from PALMS for particles < 500nm
PALMS_OrgMAMS	1. g std. m^{-3}	Organic Aerosol Mass from PALMS for particles < 500nm
ATomDateTime	UTC	Date and time

File names:

- **ATom1_final_dndlogd.txt**
- **ATom2_final_dndlogd.txt**

These two files contain the variable **Final_dndlogd:** the number concentration in each size bin divided by the difference in the log of the diameter covered by the size bin, std. cm^{-3}. Corresponding times are in ATom1_SDparams.txt or ATom2_SDparams.txt, diameters are in ATom_diameters.txt

File name:

- **ATom_diameters.txt**

Table 3. Variables in the data files.

Variable	Units	Description
final_dlogd	Nm	Log of each bin width
final_diam_image_nm	Nm	Lowest diameter of each size bin
final_diam_nm	Nm	Central diameter of each size bin

File names:

- **ATom1_final_dvdlogd.txt**
- **ATom2_final_dvdlogd.txt**

These two files contain the variable **Final_dvdlogd**: the volume in each size bin divided by the difference in the log of the diameter covered by the size bin. Corresponding times are in ATom1_SDparams.txt or ATom2_SDparams.txt, diameters are in ATom_diameters.txt.

File names:

- **ATom1_SDparams.txt**
- **ATom2_SDparams.txt**

Corresponding time to files ATom1_final_dndlogd.txt and ATom2_final_dndlogd.txt, and ATom1_final_dvdlogd.txt and ATom2_final_dvdlogd.txt

Table 4. Variables in the data files.

Variable	Units	Description
G_ALT	m	Altitude
G_LAT		Latitude
PW	hPa	Pressure
TW	K	Temperature
RHw_pct	%	Relative humidity over water
Time_UTC	UTC	Date and time
g_long_360		Longitude

ATom 1 and ATom 2 calculated back-trajectories for model input

There are two files for ATom-1 and two files for ATom-2 (**X** in the file names). These files provide 10-day back-trajectories calculated with the Bowman trajectory model and NCEP GFS meteorology. Trajectories were initialized each minute along the ATom flight tracks.

These files are in Net CDF (.nc4) format.

Data files:

- **ATomX_Atl_tropical_30day_back_trajectories.nc4**
- **ATomX_Pac_tropical_30day_back_trajectories.nc4**
- **ATomX_Atl_tropical_30day_back_trajectories.nc4**
- **ATomX_Pac_tropical_30day_back_trajectories.nc4**

Table 5. Variables in the data files.

The variables are the same for all files where **X** is **1 or 2** and **YYY** is **atl** for Atlantic or **pac** for Pacific.

Variable	Units	Description
ATomX_flight_track_lat_YYY		Latitude on flight track
ATomX_flight_track_lon_YYY		Longitude on flight track
ATomX_flight_track_pres_YYY	hPa	Pressure

ATomX_traj_lat_YYY		Latitude of back- trajectory
ATomX_traj_lon_YYY		Longitude of back-trajectory
ATomX_traj_pres_YYY	hPa	Pressure
ATomX_traj_rh_YYY	%	Relative humidity of back-trajectory

ATom 1 and ATom 2 derived cloud fractions for model input

File names:

- **ATom1PacificCloudFraction.txt**
- **ATom1AtlanticCloudFraction.txt**
- **ATom2PacificCloudFraction.txt**
- **ATom2AtlanticCloudFraction.txt**

These data files provide the latitude and percent cloud fraction during the ATom-1 and -2 flights. The cloud fractions were based on satellite derived clouds within 5 degrees longitude of the flight tracks averaged within 5-degree latitude bins (from NASA Langley Cloud and Radiation Research. Satellite imagery and cloud products page www.cloudsway2.larc.nasa.gov).

Model Output Files

Output data from four global chemical-transport models for comparison to the airborne collected ATom data. The locations and times of the model outputs were matched to the aircraft measurements.

Files are grouped by model name:

1. GEOS-Chem-TOMAS
2. CESM-CARMA
3. CAM5-APM and
4. GEOS-Chem-APM

1) GEOS-Chem-TOMAS (GCT): GEOS-Chem chemical transport model, with aerosol microphysics from either TOMAS or APM.

Data files:

- **GCT_Aug16_N3.txt**
- **GCT_Feb17_N3.txt**

These two files contain the variable **N3mat_lonT_180**: the number concentration of particles >3 nm in bins corresponding to latitude longitude in **GCT_latlonmap.txt** described below.

Data file:

- **GCT_latlonmap.txt**

This file contains two variables: **Lat1i and Lon1i:** the **latitude** and **longitude** of the grid box edge.

Data files:

- **GCT_ATom1_SF_OC.txt**
- **GCT_ATom2_SF_OC.txt**

Table 6. Variables in the data files.

Variable	**Units**	**Description**
OCIL1-15	kg std. m^{-3}	Mass of hydrophilic organic carbon aerosol in relevant size bin
OCOB1-15	kg std. m^{-3}	Mass of hydrophobic organic carbon aerosol in relevant size bin
SF1-15	kg std. m^{-3}	Mass of sulfate aerosol in relevant size bin

Data files:

- **GCT_ATom1_SD.txt**
- **GCT_ATom2_SD.txt**

The variable in the data files is **NK1**; the number concentration of aerosol in relevant size bin, std. cm.

Data files:

- **GCT_ATom1_params.txt**
- **GCT_ATom2_params.txt**

Table 7. Variables in the data files.

Variable	Units	Description
HHMM	HHMM	Hour and minute since 00:00
LAT	hPa	Latitude
LON	K	Longitude
PRESS	year-month-day	Pressure
Temp__K_	hPa	Temperature
YYYMMDD	K	Date

Data files:

- **GCT_ATom1_DUST_EC.txt**
- **GCT_ATom2_DUST_EC.txt**

GCT modeled mass of dust and elemental carbon aerosol.

Table 8. Variables in the data files.

Variable	Units	Description
DUST1	kg std. M	Mass of dust aerosol in relevant size bin, kg std. M
ECIL1	kg std. M	Mass of hydrophilic elemental carbon aerosol in relevant size bin, kg std. M
ECOB1	kg std. M	Mass of hydrophobic elemental carbon aerosol in relevant size bin, kg std. M

Data file:

- **GCT_diameters.txt**

Table 9. Variables in the data file.

Variable	Units	Description
Dp_microns	1. m	Central diameter of each size bin
Dpk_microns	1. m	Lowest diameter of each size bin
dlogDp		Log of each bin width
Dp_nm	nm	Central diameter of each size bin

2) CESM-CARMA: CESM model files with aerosol microphysics from CARMA.

Data files:

- **CARMAnoBB_ATom1.txt**
- **CARMAnoBB_ATom2.txt**

The location and time of the model outputs were matched to the aircraft measurements. For analyses where biomass burning (BB) and dust plumes were filtered from the ATom data, they were likewise filtered from the model outputs. A separate model run was completed with biomass burning switched off, and times when the total mass of dust aerosol exceeding 5 x 10^{-13} kg m^3 (STP) were removed.

Table 10. Variables in the data files

Variable	**Units**	**Description**
Alt	m	Altitude
dust_kgsm3	kg std. m^{-3}	Mass of dust particles
lat		Latitude
lon		Longitude
Temperature	K	Temperature
press	hPa	Pressure
N0 to N031		Number concentration of particles in corresponding size bin in CARMAdiameters.txt.
POA_noBB		Primary organic aerosol mass-without biomass burning
sulfate_kgsm3		Sulfate aerosol mass
total_kgsm3		Total aerosol mass
UTCtime		Time and date- UTC
X_date		Date
X_time		Time

Data file:

- **CARMAcomposition.txt**

Table 11. Variables in the data file

Variable	**Units**	**Description**
dateW	YYYYMMDD	Date
timeW		Seconds since 00:00
lat		Latitude
lon		Longitude
alt_m	m	Altitude
POA_carbon_mass_kg_sm3	kg std. m^{-3}	Primary organic aerosol mass

SOA_carbon_mass_kg_sm3	kg std. m^{-3}	Secondary organic aerosol mass
Sulfate_mass_kg_sm3	kg std. m^{-3}	Sulfate aerosol mass
dust_mass_kg_sm3	kg std. m^{-3}	Dust aerosol mass
N_all	std. cm^{-3}	Total aerosol number concentration

Data files:

- **CARMA_ATOM1.txt**
- **CARMA_ATOM2.txt**

Table 12. Variables in the data files

Variable	**Units**	**Description**
Alt	m	Altitude
lat		Latitude
lon		Longitude
Temperature	K	Temperature
press	hPa	Pressure
N0 to N031		Number concentration of particles in corresponding size bin in CARMAdiameters.txt (global concentrations for the latitude and longitude bins given)
UTCtime		Time and date- UTC
X_date		Date
X_time		Time

Data file:

- **CARMAdiameters.txt**

Table 13. Variables in the data file

Variable	**Units**	**Description**
diam_nm	Nm	Geometric mean diameter of the bin
diam_nm_image	Nm	Lower limit of the bin
dlogD_nm	Nm	Change in logarithm of the diameter over each bin

Data files:

- **CESM_N4_ATom1.txt**
- **CESM_N4_ATom2.txt**

These files provide the number concentration of particles >4 nm, in bins corresponding to lat and lon in **CESM_latlonmap.txt** in monthly average for August16 (ATom1) and February17 (ATom2).

Data file:

- **CESM_latlonmap.txt**

This file contains the variables Lat and Lon_180 for latitude and longitude, corresponding to the number concentration of particles >4 nm above.

3) CAM5-APM: CAM5 model files with aerosol microphysics from APM.

Data files:

- **CAM5Feb17_N3.txt**
- **CAM5Aug16_N3.txt**

These files contain the variable **ATOMX_NtotT_180** where X is ATom-1 or 2: the number concentration of particles >3 nm in bins modeled for August 2016 and February 2017corresponding to latitude longitude in **CAM5_latlonmap.txt** described below.

Data file:

- **CAM5_latlonmap.txt**

Table 14. Variables in the data file

Variable	**Units**	**Description**
CAM5_lat		Latitude for bin center
CAM5_lat_im		Latitude for bin edge
CAM5_lon		Longitude for bin center 0 - 360
CAM5_lon_im		Longitude for bin edge 0 - 360
CAM5_lon_180		Longitude for bin center -180 - 180

Data file:

- **APM_diameters.txt**

Table 15. Variables in the data file

Variable	Units	Description
DryDiam_nm	nm	Central diameter of each size bin
DryDiamK_nm	nm	Lower and upper diameter of each size bin

4) GEOS-Chem-APM: GEOS-Chem model files with aerosol microphysics from APM

File names:

- **GC_APMFeb17_N3.txt**
- **GC_APMAug16_N3.txt**

These files contain the variable **ATOMX_NtotT_180** where X is ATom-1 or 2: the number concentration of particles >3 nm in bins modeled for August 2016 and February 2017 corresponding to latitude longitude in **GC_APM_latlonmap.txt** described below.

Data file:

- **GC_APM_latlonmap.txt**

Table 16. Variables in the data file

Variable	**Units**	**Description**
GEOS_lat		Latitude for bin center
GEOS_lat_im		Latitude for bin edge
GEOS_lon		Longitude for bin center 0 - 360
GEOS_lon_im		Longitude for bin edge 0 - 360
GEOS_lon_180		Longitude for bin center -180 - 180

CAM5-APM and GEOS-Chem-APM model outputs of (1) particle number concentrations and (2) atmospheric chemistry and meteorology data for Atom1 and Atom2 campaigns.

Outputs from both models are provided for the selected Atom1 and Atom2 flights. There are 44 data files for each campaign.

Data files for ATom-1 or ATom-2 flights:

File names:

Atom(1 or 2)**XXXX**size**YYYYMMDD**.txt

“size” = Number concentration of aerosol particles in relevant size bin.

Model ouput where **XXXX** is **CAM5** or **GEOS** and **YYYYMMDD** is the **YEARMONTHDAY** for ATom-1 or ATom-2 flights.

Example file names:

- Atom1CAM5size20160729.txt
- Atom1GEOSsize20160729.txt
- Atom2GEOSsize20170218.txt

The files provide the date and time (month, day, hour, minute, second), latitude, longitude, and pressure (hPa) for each of the particle bins 1-40. Bin sizes are found in **APM_diameters.txt.**

Table 17. Variables in the data files

Variable	**Units**	**Description**
Month	M	Month
Day	dd	Day
Hour	hh	Hour
Minute	mm	Minute
second	ss	Second
latitude	Decimal degrees	Latitude
longitude	Decimal degrees	Longitude
pressure(hPa)	hPa	Presure
bin01-40	std. cm^{-3}	Number concentration of aerosol particles in relevant size bin. See **APM_diameters.txt.**

File names:

Atom(1 or 2)**XXXX**output**YYYYMMDD**.txt "output" = Atmospheric chemistry and meteorology data.

Model output data where **XXXX** is **CAM5** or **GEOS** and **YYYMMDD** is the **YEARMONTHDAY** for ATom-1 or ATom-2 flights. 2016 dates for Atom1 and 2017 dates for Atom2.

Example file names:

- Atom1CAM5output20160729.txt
- Atom1GEOSoutput20160729.txt
- Atom2GEOSoutput20170205.txt

The files provide the date and time (month, day, hour, minute, second), latitude, longitude, and atmospheric chemistry and meteorology data for the same locations as in the "size" files above.

Table 18. Variables in the data files

Variable	**Units**	**Description**
month	M	Month
day	dd	Day
hour	hh	Hour
minute	hh	Minute
second	hh	Second
latitude	Decimal degrees	Latitude
longitude	Decimal degrees	Longitude
pressure(hPa)	hPa	Pressure
T(K)	K	Temperature
RH(%)	Percent	Relative humidity
SO2(ppt)	ppt	Sulfur dioxide
SO4(ug/m3)	ug/m3	Sulfate
NIT(ug/m3)	ug/m3	Nitroaniline
NH4(ug/m3)	ug/m3	Ammonium
CN(#/cm3,STP)	#/cm3,STP	Cyanide

3. Application and Derivation

These global-scale measurements are needed to understand the scale and impact of NPF in the upper troposphere. Satellites cannot detect particles with diameters < 100 nm, and previous in-situ observations have been regional scale (Williamson et al., 2019, in review).

4. Quality Assessment

A sensitivity analysis was performed. Results showed that errors in nucleation rate or mechanisms are unlikely to cause the model underprediction of particle concentrations since substantial scaling of nucleation rates did not produce a substantial change in the particle size distribution and resulting number of CCN. This is due to a feedback whereby increasing nucleation rates slows growth rates and increases coagulation rates, thus dampening the sensitivity of CCN to changes in nucleation. Uncertainty in the amount of inorganic condensable material is also shown to have little effect on the result number of CCN.

Missing organics could also explain the underprediction. None of the models in this study include organic-mediated nucleation (Williamson et al., 2019, in review).

5. Data Acquisition, Materials, and Methods

Below is a brief synopsis of the ATom in situ data collection methods and modeling tasks. Please see Williamson et al., 2019 for details.

ATom flights

In-situ aircraft measurements of vertical profiles of aerosol size distributions were used to present a global-scale survey of new particle formation (NPF) occurrence in the tropics. Measurements were collected during airborne campaigns conducted by NASA's ATom 1 and ATom 2 missions, comprised of four sets of contiguous flights over both Pacific and Atlantic Ocean basins from 81 °N to 65 °S, from July 29, 2016 to February 21, 2017. The flights focused on the remote marine atmosphere, constantly profiling between about 0.18 and 11-13 km altitude to resolve the vertical structure of the atmosphere. Aerosol measurements were made with a suite of fast-response instruments on board a NASA DC-8 aircraft.

ATom Aerosol measurements

Aerosol dry size distributions were measured from 2.7 nm - 4.8-µm diameter at 1-Hz time resolution. Inside the DC-8, a Nucleation Mode Aerosol Size Spectrometer (NMASS), a custom-built battery of five condensation particle counters provided five channels between 2.7 and 60- nm diameter on ATom 1. Two NMASSes were operated on ATom 2, providing 10 distinct channels over the same size-range.

A commercial optical particle counter (OPC), the Ultra-High Sensitivity Aerosol Spectrometer (UHSAS, Droplet Measurement Technologies) specifically adapted to operate over rapidly changing pressures, measured from 60-500 nm. A second commercial OPC, Laser Aerosol Spectrometer (LAS, Thermo-Systems Engineering Co.) extended this distribution to 4.8 µm. Dry (<40% *RH*) size distributions were measured at 1 Hz time resolution.

Figure 2. The aerosol microphysical properties (AMP) instrument package. Five instruments, two nucleation-mode aerosol size spectrometers (NMASS; Williamson et al., 2018), two ultra-high sensitivity aerosol spectrometers (UHSAS; Kupc et al., 2018), and a laser aerosol spectrometer (LAS) comprise the AMP package.

Identifying new particle formation (NPF)

To identify recent NPF, times were identified when the concentration in the smallest size channel of an NMASS (d_{50} = 2.7 nm) was significantly larger than that in the next-largest channel (d_{50} = 6.9 nm).

Sink Calculations

For each point in flight the condensation kernel for a sulfuric acid molecule with particles of each diameter in the size distribution, at the ambient temperature and pressure, is calculated using the Fuchs expression for coagulation rate coefficient, substituting a sulfuric acid molecule for one of the particles to get a condensation sink instead of a coagulation sink.

Back-trajectories

Ten-day back trajectories were calculated with the Bowman trajectory model (Bowman, 1993) and NCEP GFS meteorology.

Particle composition

The Particle Analysis by Laser Mass Spectrometry (PALMS) instrument measured the size and chemical composition of individual aerosol particles with diameters from 150 - 4000 nm. Mass spectral signatures differentiate each particle into a compositional class such as biomass burning, mineral dust, sea salt, sulfate/organic/nitrate mixtures, and others. For analysis of organic and sulfate mass, the PALMS size range was restricted to particles less than or equal to 500 nm (PALMS cannot measure particles <150 nm).

A highly customized high-resolution time of flight aerosol mass spectrometer (HR-ToF-AMS, Aerodyne Research Inc.) measured non-refractory submicron (50-500 nm physical diameter at 50 % counting efficiency, extending to 20 and 700 nm with counting efficiency decreasing to 0) aerosol mass composition at 1-Hz resolution. Particles were sampled in-situ through a dedicated inlet (HIMIL) and aerodynamic lens into a vacuum chamber, flash vaporized at 600 °C and analyzed by electron impact time-of-flight mass spectrometry. Overall instrument sensitivity was calibrated every flight day, and sulfate relative ionization efficiencies and instrument particle transmission at regular intervals during the missions. A limitation is that the AMS is close to detection limit.

Model comparison descriptions

Four chemical-transport models were used to compare with the ATom data: GEOS-Chem, with aerosol microphysics from either TOMAS or APM; CAM5 with aerosol microphysics from APM (Luo and Yu, Manuscript in preparation); and CESM with aerosol microphysics from

CARMA. The location and time of the model outputs were matched to the aircraft measurements.

For analyses where biomass burning and dust plumes were filtered from the ATom data, they were likewise filtered from the model outputs using the following methods. For CESM-CARMA, a separate model run was completed with biomass burning switched off, and times when the total mass of dust aerosol exceeding 5 x 10^{-13} kg m^3 (STP) were removed. For CAM5-APM and GEOS-Chem-APM, times where the number fraction of dust or black carbon particles exceeded 10% and 40% were removed. For GEOS-Chem-TOMAS times where the number fraction of dust and elemental carbon submicron particles exceeded 0.5% were removed.

6. Data Access

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

ATom: In Situ Tropical Aerosol Properties and Comparable Global Model Outputs

Contact for Data Center Access Information:

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

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