Revision Date: November 30, 2012

HIPPO Combined Discrete Flask and GC Sample GHG, Halocarbon, and Hydrocarbon Data (R_20121129)

Summary:

This data set contains the results of analyses of discrete samples from the on-board in situ PANTHER or UCATS GC instruments and the analyses of flask samples collected by the AWAS, NWAS, or MEDUSA whole air flask samplers for all Missions, 1 through 5, of the HIAPER Pole-to-Pole Observations (HIPPO) study of carbon cycle and greenhouse gases. The Missions took place from January of 2009 to September 2011.

This data set contains the results of analyses of discrete samples from the on-board in situ PANTHER or UCATS GC instruments and the analyses of flask samples collected by the AWAS, NWAS, or MEDUSA whole air flask samplers. The file contents and structure are suited for comparative analyses of the fast-sample GC and whole air sample results.

Each row of the data file contains the results for all of measurements of a discrete sample performed on one of several instruments.

The column titled 'INSTRUMENT' indicates which instrument / laboratory made a particular discrete measurement: *1 =AWAS/U.Miami, 2 = NWAS/NOAA+CU, 3 = PantherMSD/NOAA, 4 = MEDUSA/Scripps, 5 = UCATS GC/NOAA, and 6 = PantherECD/NOAA.*

When the same species was measured by more than one instrument (e.g., CFC_11), the results from all instruments are included in the same column (i.e., CFC_11). However, when only one instrument measured a given species (e.g., HCFC_21) the results are reported in in a column labeled to also indicated the source instrument (e.g., HCFC_21_AW).

Selected continuous parameters are also included in the data file. One-second merged data were aggregated, by averaging, over the precise sampling interval of each of the discrete samples. In the case of MEDUSA an exponential weighting function was applied for more accurate averaging.

In summary, the resulting data file's structure has discrete sample measurement values from a given instrument on each row while averaged one-second values occur on every row. Note that the time interval between discrete samples is not equal / continuous.

The first series of columns are the discrete sample results followed by the high-rate averaged parameters.

Data Notes:

The CO2.X, CO.X, and APO.X derived parameters only exist at 10-second resolution. For merging with the discrete sample results, the closest 10-second values were used.

Adjustments to measurements from AWAS flasks were made for differences in calibration scales between NOAA and U. Miami analyses for species that were measured by both laboratories. Species measured by both labs are reported in a single column. Compounds measured only at U. Miami were not adjusted. The U.Miami's PI is developing documentation about how these adjustments were made.

Adjustments to the MEDUSA CO_2 values were made for differences in calibration scales between the NOAA laboratory and Scripps Laboratory .

When the same species were measured by two or more instruments, comparable results are reported in a single column under a common name.

Scripps and NOAA isotope measurements are currently in separate columns but may be merged in the future.

Use: scientific analysis of the fast-sample GC and whole air samples

Summary of 10-Second Data Completeness by Mission

A supplementary file is provided with this product that summarizes the completeness of the reported data values. The completeness entries are the number of non-missing observations for each species in the main data file for each mission and in total. The number of observation given for species "jd" is the maximum number of possible non-missing observations per mission. The data are provided in one space-delimited format ASCII file.

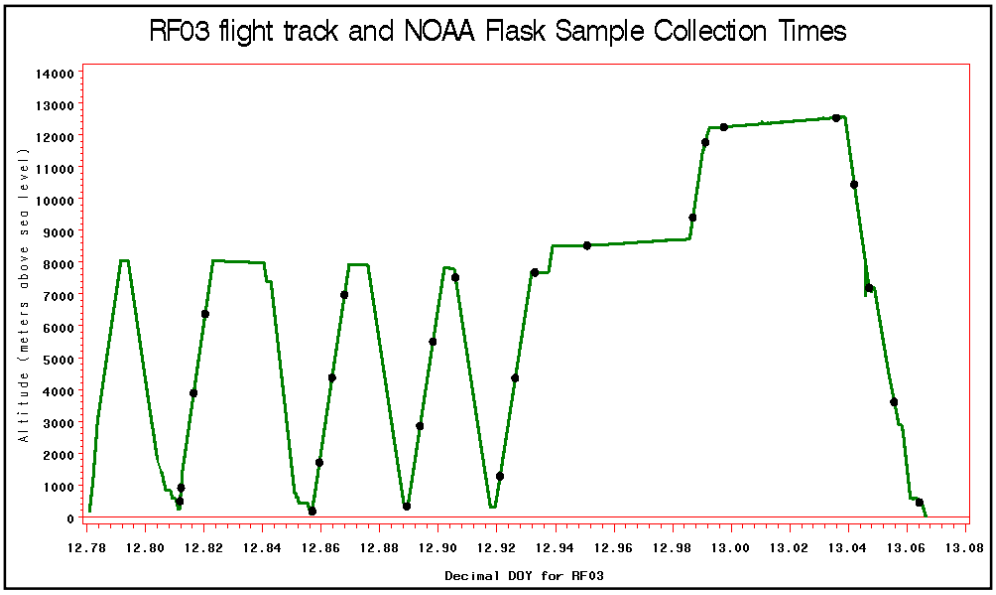

Figure 1. Example of flask sample collection times.

Data Set Citation:

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Cite this data set as follows:

Wofsy, S. C., B. C. Daube, R. Jimenez, E. Kort, J. V. Pittman, S. Park, R. Commane, B. Xiang, G. Santoni, D. Jacob, J. Fisher, C. Pickett-Heaps, H. Wang, K. Wecht, Q.-Q. Wang, B. B. Stephens, S. Shertz, A.S. Watt, P. Romashkin, T. Campos, J. Haggerty, W. A. Cooper, D. Rogers, S. Beaton, R. Hendershot, J. W. Elkins, D. W. Fahey, R. S. Gao, F. Moore, S. A. Montzka, J. P. Schwarz, A. E. Perring, D. Hurst, B. R. Miller, C. Sweeney, S. Oltmans, D. Nance, E. Hintsa, G. Dutton, L. A. Watts, J. R. Spackman, K. H. Rosenlof, E. A. Ray, B. Hall, M. A. Zondlo, M. Diao, R. Keeling, J. Bent, E. L. Atlas, R. Lueb, M. J. Mahoney. 2012. **HIPPO Combined Discrete Flask and GC Sample GHG, Halo-, Hydrocarbon Data (R_20121129).** Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/CDIAC/hippo_012 (Release 20121129)
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***** Users are encouraged to include the Data File Name(s) with the citation to document the data file and version used for reproducibility. Please append: "[File name(s):** list file name(s) or reference another included table or source that lists the files**]"**

Data Set Contents:

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Data files with version control information:

Data Product	File Name w/Version	Date Published	Date Superseded	Change Description
Flask and GC data	HIPPO_discrete_continuous_merge_20121129.tbl	20121129		First archived version
	DISCRETE_meta_summary.tbl	20121129		First archived version

User's Guide Contents:

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HIPPO Project

The HIAPER Pole-to-Pole Observations (HIPPO) study is investigating the Carbon Cycle and greenhouse gases throughout various altitudes of the western hemisphere through the annual cycle. HIPPO is supported by the National Science Foundation (NSF) and its operations are managed by the Earth Observing Laboratory (EOL) of the National Center for Atmospheric Research (NCAR). Its base of operations is EOL's Research Aviation Facility (RAF) at the Rocky Mountain Metropolitan Airport (RMMA) in Jefferson County, Colorado. The main goal of this study is to determine the global distribution of carbon dioxide and other trace atmospheric gases by sampling at various altitudes and latitudes in the Pacific Basin.

Figure 2. NSF/NCAR G-V aircraft at various locations during Mission 1.

Data and Documentation Access:

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Get Data:

Integrated-product data access at CDIAC: (http://hippo.ornl.gov/dataaccess)

EOL HIPPO Data Archive and Web Site: Download imagery, publications, supporting documentation, and component data: (www.eol.ucar.edu/projects/hippo)

Links to Companion Files and Supplemental Information:

HIPPO Instrument Description Document:
(ftp://cdiac.ornl.gov/pub/HIPPO/HIPPO_all_docs/HIPPO_Instrument_Descriptions_20121116.doc)

Data Dictionary:
(ftp://cdiac.ornl.gov/pub/HIPPO/HIPPO_all_docs/HIPPO_data_dictionary.xls)

EOL HIPPO Data Quality Reports: (www.eol.ucar.edu/projects/hippo)

- Mission Data Quality Reports
- Investigator provided "Readme Files"

HIPPO Data Policy -- Sharing, Access, and Use Recommendations:
(ftp://cdiac.ornl.gov/pub/HIPPO/HIPPO_all_docs/HIPPO_Full_Data_Policy.pdf)

UCAR HIPPO Project Web Site: http://hippo.ucar.edu/

HIPPO Flight Tracks in Google Earth: **Download *.kmz files for Google Earth**

HIPPO Data Fair Use

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Before you use HIPPO data, please first familiarize yourself with the HIPPO Data Fair Use agreement below. Your cooperation is appreciated.

The HIPPO data provided on this public archive are freely available and were furnished by HIPPO researchers who encourage their use. Data users are encouraged to consider the following recommendations for fair, appropriate, and optimal use of data products.

HIPPO Scientist Interactions:

- Please kindly inform the HIPPO scientist(s) associated with each data product about the new data analysis activity near the beginning of the effort, and of any publication plans as the effort nears completion.
- Consult with the respective HIPPO scientist(s) concerning your data analysis plans to assure that the latest data product is being used and that it is being used appropriately.
- HIPPO science team members are listed at http://hippo.ucar.edu/team. Alternatively, initiate contact with Dr. Steven C. Wofsy (swofsy@seas.harvard.edu), Lead Principal Investigator.

Acknowledgments:

- Please acknowledge (1) the use of HIPPO data products with a citation as provided in the data archive documentation, and (2) website information downloads as a bibliographic web citation.
- Acknowledge the agency or organization (e.g., NSF and NOAA) that supported the collection of the original HIPPO data when publishing new analyses and results using HIPPO data products.
- Please submit a HIPPO publication reference or reprint at http://www.eol.ucar.edu/projects/hippo/publications/publication_refs.html of your independent work so that all publications resulting from HIPPO data products may be tracked, recorded, and referenced.

Read the complete HIPPO Data Policy: Sharing, Access, and Use Recommendations
(ftp://cdiac.ornl.gov/pub/HIPPO/HIPPO_all_docs/HIPPO_Full_Data_Policy.pdf)

Data Description:

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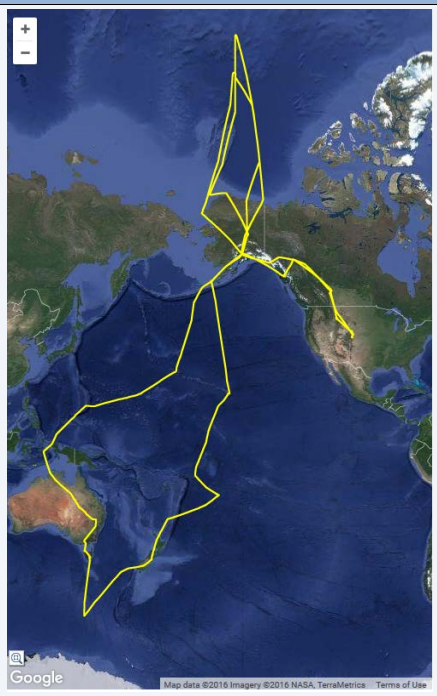
Temporal and Spatial (horizontal) Coverage of Research Flights

These tables describe at a general level the mission-by-mission research flights

Mission	Flight Path Notes	Flight Path
HIPPO-1	Northern polar flight #1 reached 80º N.	
Sampling Dates	Southbound Pacific flights followed the typical central flight path.	
January 8 to January 30, 2009	Southern ocean flight reached 67º S, 175º W	
Vertical Profiles Flown	The northbound flights followed an Eastern Pacific Route over Central and Southern North America.	
138	HIPPO-1 was only mission to not return to the Arctic a second time.	

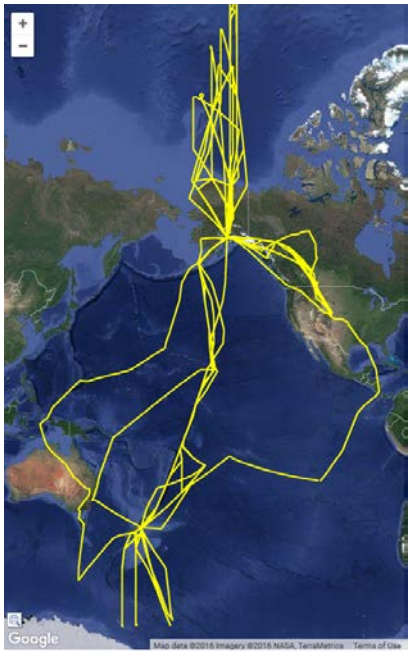
Mission	Flight Path Notes	Flight Path
HIPPO-2	Northern polar flight #1 reached 80º N.	
Sampling Dates	Both southbound and northbound Pacific flights followed a central flight path.	
October 31 to November 22, 2009	Southern ocean flight reached 66º S, 174º W	
Vertical Profiles Flown	Northern polar flight #2 reached 83º N.	
148		

Mission	Flight Path Notes	Flight Path
HIPPO-3	Northern polar flight #1 reached 84.75º N. Both southbound and northbound Pacific flights followed a central flight path. • Southbound RF04 reached 41,000 feet over the equator allowing insight into the atmospheric cross section near the Intertropical Convergence Zone (ITCZ). • Northbound RF09 was coordinated to track with the NASA Global Hawk (50,000 feet higher) and both intercepted the track of the NASA Aura satellite, which carries the Microwave Limb Sounder (MLS). Southern ocean flight reached 66.8º S, 170º E. Northern polar flight #2 reached 85º N. • Polar flight RF10 flew three 500 feet altitude by 5 minute legs crossing extensive networks of fractures in ice	
Sampling Dates March 24 to April 16, 2010		
Vertical Profiles Flown 136		

Mission	Flight Path Notes	Flight Path
HIPPO-4	Northern polar flight #1 reached 84º N. Southbound Pacific flights followed the typical central flight path. • In the Southern Pacific, a Chilean volcanic ash cloud caused a schedule change. Flights were delayed to allow ash-free air masses to move in to permit safe sampling. High latitude air masses were also pushed south, which limited GV access to Polar air. Southern ocean flight reached 58º S, 145º E. The northbound flights followed a Western Pacific route but the earthquake and tsunami in Japan necessitated a less westerly return than was planned. Northern polar flight #2 reached 82º N. • Polar flight RF11 flew over Point Hope, AK and traversed open ocean, scattered ice, flooded ice, and ice with melt ponds with a low altitude transect ranging from 500 to 5,000 feet. Solid ice was not reach by turnaround at 82N.	
Sampling Dates June 14 to July 11, 2011		
Vertical Profiles Flown 175		

Mission	Flight Path Notes	Flight Path
HIPPO-5	Northern polar flight #1 reached 82º N.	
Sampling Dates	Both southbound and northbound Pacific flights followed a central flight path.	
August 9 to September 8, 2011	Southern ocean flight reached 67º S, 164º E. • Flight RF09 reached the ice edge; one profile crossed the edge and another profile was over solid ice.	
Vertical Profiles Flown	Northern polar flight #2 reached 87º N.	
190		

Bounding Box for All Research Flights:



Flight paths for all five Missions

Longitude	Longitude	Northernmost Latitude	Southernmost Latitude
128.2 E	**-84.0 W**	**87.04313 N**	**-67.15801 S**

Spatial Coverage (vertical) of Research Flights

The 10-second merged data are highly time resolved due to the component 1-second in situ reporting frequency and vertically-resolved as well because of GV flight plans that performed 787 vertical ascents /descents from the ocean/ice surface/land surface to as high as the tropopause. It was planned to have two maximum altitude ascents per flight to the tropopause/lower stratosphere, one in the first half and one in the second half of a research flight. In between, several vertical profiles from below the planetary boundary layer (PBL) to the mid-troposphere (1,000-28,000 feet) were flown.

- Profiles were flown approximately every 2.2º of latitude with 4.4º between consecutive near-surface or high-altitude samples.
- Rate of climb and descent was 1,500 ft/ minute (457 m/minute).
- During these profiles, the GV averaged a ground speed of about 175 m/sec or 10 km/min.

Typical Flight Plan

Ideally a flight would take off and go to FL430 (43,000 ft or 13,100 m) over the first 15 minutes, then descend belowFL290 (29,000 ft or 8,850 m) and proceed in a sawtooth pattern between FL270 (27,000 ft or 8250 m) and FL10 (1,000 ft or 300 m) with a 1,500 ft (457 m)/minute climb/descent rate, then climb to FL450 (45,000 ft or 13,700 m) near the end of the flight for about 15 minutes, then descend, and proceed to the airport.

Most of a flight was conducted below the international Reduced Vertical Separation Minimum (RVSM) usually 29,000 ft or 8,850 m, in order to allow the G-V to descend and climb constantly to collect data at different altitudes throughout the troposphere. All flights plans were subject to modifications depending upon local atmospheric conditions and approval by air traffic control.

On average, consecutive profile samples in the midtroposphere are separated by 2.2º of latitude, with 4.4º between consecutive near-surface or high-altitude samples. Most profiles extended from approximately 300 to 8,500 m altitude, constrained by air traffic, but significant profiling extended above approximately 14 km.

Flight Patterns

These two images provide a good visualization of the typical HIPPO flight pattern, which is designed to sample the global distribution of carbon dioxide and other trace atmospheric gases at various altitudes and latitudes in the Pacific Basin.

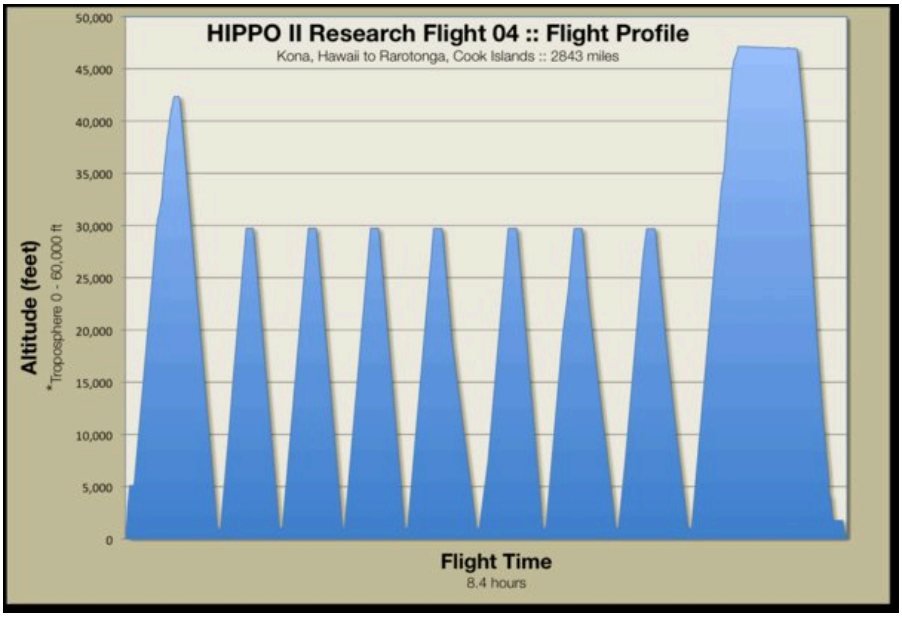


Figure 2. Example of NSF/NCAR G-V aircraft flight pattern. Eighteen profiles are shown in the image; the ascending and descending flight paths of each peak are a separate profile.

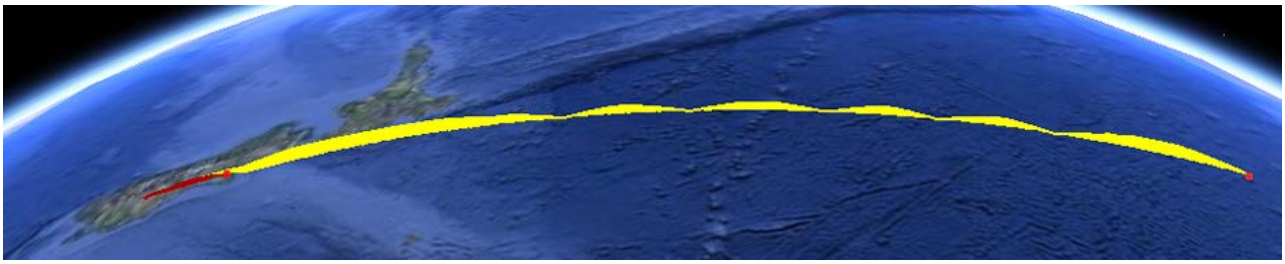


Figure 3. Example of NSF/NCAR G-V aircraft flight pattern. The x-axis in this figure is space and is a more realistic representation of the vertical aspect of a flight than in Figure 2.

Temporal Resolution of Merged Observations

Data Center Note: To provide a more complete description of the temporal resolution of measurements, we will be developing a table that lists for each instrument or sampling device, the native sampling duration, the reporting or integration interval, and the inter-sample interval.

Data File Description

A note about North American training and research flights:

For Mission 2-5, results of measurements collected during instrument check training flights and research flights conducted over North America are included in the data file. For Missions 2, 3, and 4, the training flights have "flt" values of -1 and 0. For Mission 5, research flights have "flt" values of 1 and 2. Users may want to exclude those from their HIPPO data analyses. The next flight in the series, the first HIPPO flight, originated at NCAR's Earth Observing Laboratory, Research Aviation Facility (RAF), located at the Rocky Mountain Metropolitan Airport (KBJC), Broomfield, CO and proceeded to Anchorage, AK.

Note that the first research flight for Mission 1 originated in Billings, MT, and has a"flt" value of 2.

This table provides an overview of sources of data in the Combined Discrete Flask and GC Sample product.

Instrument	Instrument code	Instrument detail	Institution	Investigators	Method
	NA-V	Various	Various	Various	Not applicable
	NA	Not applicable	Harvard	Wofsy	Not applicable
	GV-TIME	GV time sychronized to GPS	NCAR	Romashkin	To be determined
	AWAS	Advanced Whole Air Sampler	U. Miami	Atlas	Not applicable
1	AWAS-MS	Advanced Whole Air Sampler-MS	U. Miami	Atlas	GC/MS (Gas chromatograph/mass spectrometer)
2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2	NOAA-GMD	Montzka, Miller	GC/MS (Gas chromatograph/mass spectrometer)
6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment	NOAA-GMD	Moore, Elkins	GC/ECD (Gas chromatograph/ electron capture detector)
3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment	NOAA-GMD	Moore, Elkins	GC/MS (Gas chromatograph/ mass spectrometer)
1	AWAS-FID	Advanced Whole Air Sampler-FID	U. Miami	Atlas	GC/FID (gas chromatograph/flame ionization detector), or occasionally GC/MS (Gas chromatograph/mass spectrometer)
2	NWAS-MAGICC	NOAA Whole Air Sampler - Measurement of Atmospheric Gases that Influence Climate Change	NOAA-GMD	Tans, Miller	GC/NDIR/Resonance Fluorescence/UV Absorption Spectroscopy
5	UCATS-UGC	Unmanned Aircraft Systems (UAS) Chromatograph for Atmospheric Trace Species	NOAA-GMD	Hurst, Hintsa	GC/ECD (Gas chromatograph/ electron capture detector)
1	AWAS-ECD	Advanced Whole Air Sampler-ECD	U. Miami	Atlas	GC/ECD (gas chromatograph/electron capture detector)
1	AWAS-RGD	Advanced Whole Air Sampler	U. Miami	Atlas	GC/RCD (gas chromatograph/reduction gas detector)
4	MEDUSA-IR	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)	Scripps, NOAA	Stephens, Keeling, Bent	Infrared absorption
	NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry	NOAA-GMD	Vaughn, White	Mass spectrometry
	AO2-QCLS-OMS	Various	Multiple	Various	Various

Instrument	Instrument code	Instrument detail	Institution	Investigators	Method
	MEDUSA-SM				
	MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)	Scripps, NOAA	Stephens, Keeling, Bent	Sector-magnet mass spectrometry
	GV-GP	GV gust probe	NCAR	Romashkin	Radome differential pressure
	GV-AV	GV Avionics	NCAR	Romashkin	Thermal sensor?
	GV-CMS	GV cooled-mirror sensor	NCAR	Romashkin	Condensation?
	GV-LWCS	GV PMS liquid water content sensor (King probe)	NCAR	Romashkin	Heat loss from water vaporization
	GV-NOGPS	GV Novatel Omnistar-enabled GPS (Reference)	NCAR	Romashkin	GPS (Global Positioning System)
	GV-GUST	GV 5-hole radome gust probe	NCAR	Romashkin	Differential pressure?
	GV-MULTIPLE	Multiple GV instruments	NCAR	Romashkin	Various
	NACA	National Advisory Committee for Aeronautics method	NCAR	Romashkin	National Advisory Committee for Aeronautics method
	SP2-PRES	Single particle soot photometer	NOAA-CSD	Fahey, Gao, Spackman, Schwarz, Perring	Pressure sensor
	GV-HIRS	GV Honeywell YG1854 Laseref SM Inertial Reference System 1	NCAR	Romashkin	IRS (Inertial Reference System) and GPS (Global Positioning System)
	GV-PS	GV Paroscientific Model 1000, using fuselage holes	NCAR	Romashkin	Pressure transducer
	GV-CDPT	GV calibrated differential pressure transducer	NCAR	Romashkin	Pressure sensors
	GV-SENSOR	GV aircraft sensor	NCAR	Romashkin	To be determined
	GV-RICE	GV Rosemount Model 871FA icing rate detector	NCAR	Romashkin	To be determined
	GV-MENSOR	GV Mensor 6100 sensor	NCAR	Romashkin	Pressure sensor
	GV-UCATS	GV and UCATS instruments	NCAR	Romashkin	Various
	GV-1DOAP	One Dimensional Optical Array Probe	NCAR	Romashkin	Laser beam, diode array
	GV-2DOAP	Two Dimensional Optical Array Probe	NCAR	Romashkin	Laser beam, diode array
	GV-2D-C	2D-C Probe	NCAR	Romashkin	Laser beam, diode array
	GV-CDP	Cloud droplet probe on GV	NCAR	Romashkin	Diode laser - forward scattered light
	UHSAS	Ultra-high sensitivity aerosol spectrometer	NCAR	Cooper	Aerosol spectrometer
	AO2-IR	NCAR Airborne Oxygen Instrument	NCAR	Stephens, Bent	Vacuum-ultraviolet absorption and Infrared absorption
	AO2-VUV	NCAR Airborne Oxygen Instrument	NCAR	Stephens, Bent	Vacuum-ultraviolet absorption
	AO2-M	NCAR Airborne Oxygen Instrument	NCAR	Stephens, Bent	Multiple
	QCLS-IR	Quantum Cascade Laser System (NCAR system built by Harvard/Aerodyne)	Harvard	Daube, Jimenez, Kort	Infrared absorption
	QCLS-NDIR	Quantum Cascade Laser System (NCAR system built by Harvard/Aerodyne)	Harvard	Daube, Jimenez, Kort	Nondispersive infrared analyzer
	OMS	Harvard Licor 6251 NDIR CO2 sensor, heritage NASA "Observations of the Middle Stratosphere"	Harvard	Daube, Pittman, Kort, Jimenez	Non-dispersed infrared absorption

Instrument	Instrument code	Instrument detail	Institution	Investigators	Method
	GV-AEROLASER	GV AeroLaser VUV CO sensor	NCAR	Campos	VUV fluorescence
	UV-PHOT-N	UV ozone photometer (NOAA)	NOAA-CSD	Fahey, Gao, Spackman	Ultraviolet absorption
	SP2	Single particle soot photometer	NOAA-CSD	Fahey, Gao, Spackman, Schwarz, Perring	LII (Laser-induced incandescence)
	UCATS-UWV	Unmanned Aircraft Systems (UAS) Chromatograph for Atmospheric Trace Species	NOAA-GMD	Hurst, Hintsa	Tunable diode laser
	UCATS-PHOT	2B (modified) UV ozone photometer (UCATS)	NOAA-GMD	Hurst, Hintsa	Photometer
	GV-VCSEL	GV near-infrared vertical cavity surface emitting laser (VCSEL) hygrometer	Princeton	Zondlo	Laser hygrometer

Data Dictionary:

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These data are considered at **Quality Level 2**. Level 2 indicates a complete, externally consistent data product that has undergone interpretative and diagnostic analysis by HIPPO researchers. Sampling, data collection and instrument calibration issues are identified in the daily mission summary reports, daily technician's reports and the Project Managers' Data Quality Reports, and have been addressed to the extent possible as indicated in the metadata.

Note that the **data files are space delimited and use "NA" as the missing value code**. NA is typically used in data products processed by "R".

When the same species was measured by more than one instrument (e.g., CFC_11), the results from all instruments are included in the same column (i.e., CFC_11 -- column 11). Note that there are three entries in the data dictionary for CFC_11, one for each instrument that measured it. The entries vary in the Instrument, Instrument Code, and Instrument Detail columns.

The first series of columns, 11 - 87, are the discrete sample results followed by the high-rate averaged parameters in columns 88-143.

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
1	INSTRUMENT	Indicates source of data In discrete_continuous_merge file: 1=AWAS; 2=NWAS; 3=PANTHER-MSD; 4=MEDUSA; 5=UCATS; 6=PANTHER-ECD.	None	None		NA-V	Various
2	jd	Decimal day number for HIPPO project, sequential, starting with January 1, 2009	d	day		NA	Not applicable
3	Year	Year	y	year		NA	Not applicable
4	H.no	HIPPO mission number (1 through 5)	None	None		NA	Not applicable
5	flt	Flight sequence number within the mission	None	None		NA	Not applicable
6	DOY	Day of the year	d	day		NA	Not applicable
7	UTC	Elapsed flight time, seconds, since 0000 UTC on day flight started	s	second		GV-TIME	GV time sychronized to GPS
8	UT_MID	Representative sample time, seconds, since 0000 UTC on day flight started	s	second		NA-V	Various
9	UT_START	AWAS sample start time, seconds, since 0000 UTC on day flight started	s	second		AWAS	Advanced Whole Air Sampler
10	UT_STOP	AWAS sample closure time, seconds, since 0000 UTC on day flight started	s	second		AWAS	Advanced Whole Air Sampler
11	CFC_11	CFC-11 (CCl3F)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
11	CFC_11	CFC-11 (CCl3F)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
11	CFC_11	CFC-11 (CCl3F)	pptv	part per trillion dry air mole fraction	6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment
12	CFC_12	CFC-12 (CCl2F2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
12	CFC_12	CFC-12 (CCl2F2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
12	CFC_12	CFC-12 (CCl2F2)	pptv	part per trillion dry air mole fraction	6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
13	CFC_13	CFC-13 (CClF3)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
14	CFC_113	CFC-113 (CCl2FCClF2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
14	CFC_113	CFC-113 (CCl2FCClF2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
14	CFC_113	CFC-113 (CCl2FCClF2)	pptv	part per trillion dry air mole fraction	6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment
15	CFC_115	CFC-115 (CF2ClCF3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
15	CFC_115	CFC-115 (CF2ClCF3)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
16	HCFC_21_AW	HCFC-21 (CHCl2F)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
17	HCFC_22	HCFC-22 (CHF2Cl)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
17	HCFC_22	HCFC-22 (CHF2Cl)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
17	HCFC_22	HCFC-22 (CHF2Cl)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
18	HCFC_141b	HCFC-141b (CH3CFCl2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
18	HCFC_141b	HCFC-141b (CH3CFCl2)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
19	HCFC_142b	HCFC-142b (CH3CF2Cl)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
19	HCFC_142b	HCFC-142b (CH3CF2Cl)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
19	HCFC_142b	HCFC-142b (CH3CF2Cl)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
20	HCFC_123_AW	HCFC-123 (C2HCl2F3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
21	HCFC_124_AW	HCFC-124 (C2HClF4)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
22	HFC_125	HFC-125 (C2HF5)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
22	HFC_125	HFC-125 (C2HF5)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
23	HFC_23	HFC-23 (CHF3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
23	HFC_23	HFC-23 (CHF3)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
24	HFC_134a	HFC-134a (C2H2F4)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
24	HFC_134a	HFC-134a (C2H2F4)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
24	HFC_134a	HFC-134a (C2H2F4)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
25	HFC_143a	HFC-143a (C2H3F3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
25	HFC_143a	HFC-143a (C2H3F3)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
26	HFC_152a	HFC-152a (C2H4F2) (1,1-difluoroethane)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
26	HFC_152a	HFC-152a (C2H4F2) (1,1-difluoroethane)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
27	Halon_1301	CFC-13b1 (Halon 1301, CF3Br)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
27	Halon_1301	CFC-13b1 (Halon 1301, CF3Br)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
28	Halon_1211	CFC-12b1 (Halon 1211, CF2ClBr)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
28	Halon_1211	CFC-12b1 (Halon 1211,CF2ClBr)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
28	Halon_1211	CFC-12b1 (Halon 1211, CF2ClBr)	pptv	part per trillion dry air mole fraction	6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment
29	Halon_2402	CFC-114b2 (Halon 2402, C2F4Br2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
29	Halon_2402	CFC-114b2 (Halon 2402, C2F4Br2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
30	OCS	Carbonyl sulfide (COS)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
30	OCS	Carbonyl Sulfide (COS)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
30	OCS	Carbonyl sulfide (COS)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
31	CH3Cl	Methyl chloride (CH3Cl)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
31	CH3Cl	Methyl chloride (CH3Cl)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
31	CH3Cl	Methyl chloride (CH3Cl)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
32	CH3Br	Methyl bromide(CH3Br)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
32	CH3Br	Methyl bromide(CH3Br)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
32	CH3Br	Methyl bromide (CH3Br)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
33	CH3I	Methyl iodide (CH3I)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
33	CH3I	Methyl iodide (CH3I)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
33	CH3I	Methyl iodide (CH3I)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
34	CHCl3	Chloroform (CHCl3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
34	CHCl3	Chloroform (CHCl3)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
35	CH2Cl2	Methylene chloride (CH2Cl2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
35	CH2Cl2	Methylene chloride (CH2Cl2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
36	CH2ClCH2Cl_AW	1,2-Dichloroethane (C2H4Cl2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
37	CH3CCl3_AW	Methyl chloroform(CH3CCl3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
38	C2HCl3_AW	Trichloroethylene(C2HCl3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
39	CCl4	Carbon tetrachloride (CCl4)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
39	CCl4	Carbon tetrachloride (CCl4)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
40	C2Cl4	Tetrachloroethylene (C2Cl4)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
40	C2Cl4	Tetrachloroethylene (C2Cl4)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
41	MeONO2_AW	Methyl nitrate(CH3ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
42	EthONO2_AW	Ethyl nitrate(C2H5ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
43	i_PropONO2_AW	Propyl nitrates(C3H7ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
44	n_PropONO2_AW	Propyl nitrates(C3H7ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
45	X2_ButylONO2_AW	Butyl nitrates (C4H9ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
46	X3_C5ONO2_AW	Pentyl nitrates (C5H11ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
47	X2_C5ONO2_AW	Pentyl nitrates (C5H11ONO2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
48	C2H5Br_AW	Ethyl bromide (C2H5Br)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
49	CH2Br2	Methylene bromide(CH2Br2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
49	CH2Br2	Methylene bromide(CH2Br2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
50	CHClBr2_AW	Dibromochloromethane (CHBr2Cl)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
51	CHBr3	Bromoform (CHBr3)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
51	CHBr3	Bromoform (CHBr3)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
52	Ethane_AW	Ethane (C2H6)	pptv	part per trillion dry air mole fraction	1	AWAS-FID	Advanced Whole Air Sampler-FID
53	Ethene_AW	Ethene (C2H4)	pptv	part per trillion dry air mole fraction	1	AWAS-FID	Advanced Whole Air Sampler-FID
54	Ethyne	Ethyne (C2H2)	pptv	part per trillion dry air mole fraction	1	AWAS-FID	Advanced Whole Air Sampler-FID
54	Ethyne	Ethyne (C2H2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
55	Propane	Propane (C3H8)	pptv	part per trillion dry air mole fraction	1	AWAS-FID	Advanced Whole Air Sampler-FID
55	Propane	Propane (C3H8)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
56	Isobutane_AW	Isobutane (C4H10)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
57	n_butane	n-Butane (C4H10)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
57	n_butane	n-Butane (C4H10)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
58	Isopentane	Isopentane (C5H12)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
58	Isopentane	Isopentane (C5H12)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
59	n_pentane	n-Pentane (C5H12)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
59	n_pentane	n-Pentane (C5H12)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
60	n_hexane_AW	n-Hexane (C6H14)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
61	Isoprene_AW	Isoprene (C5H10)? Different formula?	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
62	Benzene	Benzene (C6H6)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
62	Benzene	Benzene (C6H6)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
63	Toluene_AW	Toluene (C7H8)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
64	Ethyl_benzene_AW	C2-Benzenes (C8H10)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
65	m_p_Xylene_AW	m+p-Xylene (C8H10)?	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
66	o_Xylene_AW	o-Xylene (C8H10)?	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
67	Methyl_Acetate_AW	Methyl acetate (C3H6O2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
68	C2H6S_AW	Dimethyl sulfide (C2H6S)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
69	Methyl_t_butylether_AW	Methyl-t-butyl ether	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
70	SF6	Sulfur hexafluoride (SF6)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
70	SF6	Sulfur hexafluoride (SF6)	ppt	part per trillion dry air mole fraction	2	NWAS-MAGICC	NOAA Whole Air Sampler - Measurement of Atmospheric Gases that Influence Climate Change
70	SF6	Sulfur hexafluoride (SF6)	pptv	part per trillion dry air mole fraction	5	UCATS-UGC	Unmanned Aircraft Systems (UAS) Chromatograph for Atmospheric Trace Species
70	SF6	Sulfur hexafluoride (SF6)	pptv	part per trillion dry air mole fraction	6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment
71	PFC116_AW	PFC-116 (C2F6)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
72	PFC_c_318_AW	PFC-318 (C4F8) (perfluorocyclobutane)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS
73	CS2	Carbon disulphide (CS2)	ppt	part per trillion dry air mole fraction	2	NWAS-M2	NOAA Whole Air Sampler - Montzka Mass Spectrometer #2
73	CS2	Carbon disulphide (CS2)	pptv	part per trillion dry air mole fraction	3	PANTHER-MSD	PAN and other Trace Hydrohalocarbon ExpeRiment
74	HFC_32_AW	Difluoroethane (CH2F2)	pptv	part per trillion dry air mole fraction	1	AWAS-MS	Advanced Whole Air Sampler-MS

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
75	CH4_flask	Methane (CH4)	ppbv	part per billion dry air mole fraction	1	AWAS-FID	Advanced Whole Air Sampler-FID
75	CH4_flask	Methane (CH4)	ppb	part per billion dry air mole fraction	2	NWAS-MAGICC	NOAA Whole Air Sampler - Measurement of Atmospheric Gases that Influence Climate Change
76	N2O_flask	Nitrous oxide (N2O)	ppbv	part per billion dry air mole fraction	1	AWAS-ECD	Advanced Whole Air Sampler-ECD
76	N2O_flask	Nitrous oxide (N2O)	ppb	part per billion dry air mole fraction	2	NWAS-MAGICC	NOAA Whole Air Sampler - Measurement of Atmospheric Gases that Influence Climate Change
77	CO_flask	Carbon monoxide (CO)	ppbv	part per billion dry air mole fraction	1	AWAS-RGD	Advanced Whole Air Sampler
77	CO_flask	Carbon monoxide (CO)	ppb	part per billion dry air mole fraction	2	NWAS-MAGICC	NOAA Whole Air Sampler - Measurement of Atmospheric Gases that Influence Climate Change
78	H2	Hydrogen (H2)	ppbv	part per billion dry air mole fraction	5	UCATS-UGC	Unmanned Aircraft Systems (UAS) Chromatograph for Atmospheric Trace Species
78	H2	Hydrogen (H2)	ppbv	part per billion dry air mole fraction	6	PANTHER-ECD	PAN and other Trace Hydrohalocarbon ExpeRiment
79	CO2_flask	Carbon dioxide (CO2)	ppm	part per million dry air mole fraction	2	NWAS-MAGICC	NOAA Whole Air Sampler - Measurement of Atmospheric Gases that Influence Climate Change
79	CO2_flask	Carbon dioxide (CO2)	ppm	part per million dry air mole fraction	4	MEDUSA-IR	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
80	CO2isoC13_SIL	delta 13C in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil		NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry
80	CO2isoC13_SIL	delta 13C in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil	2	NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry
81	CO2isoO18_SIL	delta 18O in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil		NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry
81	CO2isoO18_SIL	delta 18O in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil	2	NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry
82	CH4isoC13_SIL	delta 13C in methane (CH4). See Data Dictionary's More Information worksheet.	per mil	per mil		NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry
82	CH4isoC13_SIL	delta 13C in methane (CH4). See Data Dictionary's More Information worksheet.	per mil	per mil	2	NWAS-SIL	NOAA Whole Air Sampler - INSTAAR Stable Isotope Lab Mass spectrometry
83	APO_MED	Apparent potential oxygen (APO) based on best available data, weighted by MEDUSA averaging kernel. See Data Dictionary's More Information worksheet.	per meg	per meg		AO2-QCLS-OMS	Various
83	APO_MED	Apparent potential oxygen (APO) based on best available data, weighted by MEDUSA averaging kernel. See Data Dictionary's More Information worksheet.	per meg	per meg	4	AO2-QCLS-OMS	Various
84	O2N2_MED	Oxygen/nitrogen ratio (O2/N2) per meg	per meg	per meg (see reference)		MEDUSA-SM	
84	O2N2_MED	Oxygen/nitrogen ratio (O2/N2) per meg	per meg	per meg (see reference)	4	MEDUSA-SM	

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
85	ArN2_MED	delta (Ar/N2). See Data Dictionary's More Information worksheet.	per meg	per meg		MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)
85	ArN2_MED	delta (Ar/N2). See Data Dictionary's More Information worksheet.	per meg	per meg	4	MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)
86	13CO2_MED	delta 13C in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil		MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)
86	13CO2_MED	delta 13C in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil	4	MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)
87	18CO2_MED	delta18O in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil		MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)
87	18CO2_MED	delta18O in CO2. See Data Dictionary's More Information worksheet.	per mil	per mil	4	MEDUSA-MS	Multiple Enclosure Device for Unfractionated Sampling of Air (MEDUSA)
88	AKRD	Aircraft attack angle	deg	degree		GV-GP	GV gust probe
89	SSRD	Aircraft sideslip angle	deg	degree		GV-GP	GV gust probe
90	ATX	Temperature of the ambient air outside the aircraft	deg C	degree Celsius		GV-AV	GV Avionics
91	DPXC	Dew point temperature of the ambient air outside the aircraft	deg C			GV-CMS	GV cooled-mirror sensor
92	PLWCC	Water (H2O), liquid content	g/m3	gram per cubic meter		GV-LWCS	GV PMS liquid water content sensor (King probe)
93	GGALT	Geometric altitude above mean sea level, datum WGS84	m asl	meter (above sea level)		GV-NOGPS	GV Novatel Omnistar-enabled GPS (Reference)
94	GGLAT	Latitude from GPS, datum WGS84	decimal degree	decimal degree		GV-NOGPS	GV Novatel Omnistar-enabled GPS (Reference)
95	GGLON	Longitude from GPS, datum WGS84	decimal degree	decimal degree		GV-NOGPS	GV Novatel Omnistar-enabled GPS (Reference)

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
96	GGSPD	Ground speed	m/s	meter per second		GV-NOGPS	GV Novatel Omnistar-enabled GPS (Reference)
97	GGTRK	Ground track (direction)	degree			GV-NOGPS	GV Novatel Omnistar-enabled GPS (Reference)
98	UIC	Wind vector, East component, GPS-corrected	m/s	meter per second		GV-GUST	GV 5-hole radome gust probe
99	VIC	Wind vector, North component, GPS-corrected	m/s	meter per second		GV-GUST	GV 5-hole radome gust probe
100	WIC	Vertical wind speed	m/s	meter per second		GV-MULTIPLE	Multiple GV instruments
101	MR	H2O mixing ratio	g/kg	gram per kilogram		GV-CMS	GV cooled-mirror sensor
102	PALT	Pressure altitude	m	meter		NACA	National Advisory Committee for Aeronautics method
103	PALTF	Pressure altitude	ft	foot		NACA	National Advisory Committee for Aeronautics method
104	PCAB_SP2	Cabin pressure	torr	torr		SP2-PRES	Single particle soot photometer
105	PITCH	Aircraft pitch attitude angle	degree	degree		GV-HIRS	GV Honeywell YG1854 Laseref SM Inertial Reference System 1
106	PSXC	Reference static pressure: research static pressure corrected for airflow effects	hPa	hectopascal		GV-PS	GV Paroscientific Model 1000, using fuselage holes
107	QCXC	Dynamic pressure, corrected, reference	hPa	hectopascal		GV-CDPT	GV calibrated differential pressure transducer
108	RHUM	Relative humidity	%	percent		GV-SENSOR	GV aircraft sensor
109	RICE	Raw icing rate indicator	icing rate index	Icing rate index		GV-RICE	GV Rosemount Model 871FA icing rate detector
110	ROLL	Roll angle	degree	degree		GV-HIRS	GV Honeywell YG1854 Laseref SM Inertial Reference System 1
111	TASX	Airspeed, true	m/s	meter per second		GV-MENSOR	GV Mensor 6100 sensor
112	TCAB	Cabin temperature at aerosol rack	deg C	degree Celsius		GV-SENSOR	GV aircraft sensor

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
113	THETA	Potential temperature	K	kelvin		GV-MULTIPLE	Multiple GV instruments
114	THETAE	Equivalent potential temperature	K	kelvin		GV-UCATS	GV and UCATS instruments
115	THETAV	Virtual potential temperature	K	kelvin		GV-UCATS	GV and UCATS instruments
116	TTX	Total temperature (static and RAM), reference	m/s	meter per second		GV-SENSOR	GV aircraft sensor
117	UXC	Wind vector, longitudinal component, GPS-corrected	m/s	meter per second		GV-GUST	GV 5-hole radome gust probe
118	XMACH2	Mach number squared	None	None		GV-SENSOR	GV aircraft sensor
119	CONC1DC_LWO	Cloud water droplet (40-600 um) concentration	number/L	number per liter		GV-1DOAP	One Dimensional Optical Array Probe
120	CONC2C_LWO	Cloud water droplet (25-800 um) concentration	number/L	number per liter		GV-2DOAP	Two Dimensional Optical Array Probe
121	DBAR1DC_LWO	Mean water droplet particle diameter?	um	micrometer		GV-2D-C	2D-C Probe
122	CONCD_LWI	Cloud water droplet (2-50 um) concentration	number/cm3	number per cubic centimeter		GV-CDP	Cloud droplet probe on GV
123	DBARD_LWI	Mean water droplet particle diameter?	um	micrometer		GV-CDP	Cloud droplet probe on GV
124	CONCU_RWI	Particle number density	number per cm3	number per cubic centimeter		UHSAS	Ultra-high sensitivity aerosol spectrometer
125	CONCU100_RWI	Concentration of particles 0.1 micrometer and larger	number/cm3	number per cubic centimeter		UHSAS	Ultra-high sensitivity aerosol spectrometer
126	CONCU500_RWI	Concentration of particles 0.5 micrometer and larger	number/cm3	number per cubic centimeter		UHSAS	Ultra-high sensitivity aerosol spectrometer
127	CO2_AO2	Carbon dioxide (CO2) ppm	ppm	part per million dry air mole fraction		AO2-IR	NCAR Airborne Oxygen Instrument
128	O2_AO2	Oxygen (O2) per meg	per meg	per meg (see reference)		AO2-VUV	NCAR Airborne Oxygen Instrument
129	APO_AO2	Atmospheric potential oxygen (APO). See Data Dictionary's More Information worksheet.	per meg	per meg		AO2-M	NCAR Airborne Oxygen Instrument

Column	Column name	Expanded description	Unit	Unit long name	Instrument	Instrument code	Instrument detail
130	CH4_QCLS	Methane (CH4)	ppbv	part per billion dry air mole fraction		QCLS-IR	Quantum Cascade Laser System (NCAR system built by Harvard/Aerodyne)
131	N2O_QCLS	Nitrous oxide (N2O)	ppbv	part per billion dry air mole fraction		QCLS-IR	Quantum Cascade Laser System (NCAR system built by Harvard/Aerodyne)
132	CO_QCLS	Carbon monoxide (CO)	ppbv	part per billion dry air mole fraction		QCLS-NDIR	Quantum Cascade Laser System (NCAR system built by Harvard/Aerodyne)
133	CO2_OMS	Carbon dioxide (CO2)	ppmv	part per million dry air mole fraction		OMS	Harvard Licor 6251 NDIR CO2 sensor, heritage NASA "Observations of the Middle Stratosphere"
134	CO2_QCLS	Carbon dioxide (CO2)	ppmv	part per million dry air mole fraction		QCLS-NDIR	Quantum Cascade Laser System (NCAR system built by Harvard/Aerodyne)
135	CO_RAF	Carbon monoxide (CO)	ppbv	part per billion dry air mole fraction		GV-AEROLASER	GV AeroLaser VUV CO sensor

Example Data Records

Note that **data files are space delimited and use "NA" as the missing value code**. NA is typically used in data products processed by "R".

```
INSTRUMENT jd Year H.no flt DOY UTC UT_MID UT_START UT_STOP CFC_11 CFC_12 CFC_13 CFC_113 CFC_115
HCFC_21_AW HCFC_22 HCFC_141b HCFC_142b HCFC_123_AW HCFC_124_AW HFC_125 HFC_23 HFC_134a HFC_143a
HFC_152a Halon_1301 Halon_1211 Halon_2402 OCS CH3Cl CH3Br CH3I CHCl3 CH2Cl2 CH2ClCH2Cl_AW CH3CCl3_AW
C2HCl3_AW CCl4 C2Cl4 MeONO2_AW EthONO2_AW i_PropONO2_AW n_PropONO2_AW X2_ButylONO2_AW
X3_C5ONO2_AW X2_C5ONO2_AW C2H5Br_AW CH2Br2 CHClBr2_AW CHBr3 Ethane_AW Ethene_AW Ethyne Propane
Isobutane_AW n_butane Isopentane n_pentane n_hexane_AW Isoprene_AW Benzene Toluene_AW Ethyl_benzene_AW
m_p_Xylene_AW o_Xylene_AW Methyl_Acetate_AW C2H6S_AW Methyl_t_butylether_AW SF6 PFC116_AW PFC_c_318_AW
CS2 HFC_32_AW CH4_flask N2O_flask CO_flask H2 CO2_flask CO2isoC13_SIL CO2isoO18_SIL CH4isoC13_SIL APO_MED
O2N2_MED ArN2_MED 13CO2_MED 18CO2_MED AKRD SSRD ATX DPXC PLWCC GGALT GGLAT GGLON GGSPD GGTRK
UIC VIC WIC MR PALT PALTF PCAB_SP2 PITCH PSXC QCXC RHUM RICE ROLL TASX TCAB THETA THETAE THETAV TTX
```

```
UXC XMACH2 CONC1DC_LWO CONC2C_LWO DBAR1DC_LWO CONCD_LWI DBARD_LWI CONCU_RWI CONCU100_RWI
CONCU500_RWI CO2_AO2 O2_AO2 APO_AO2 CH4_QCLS N2O_QCLS CO_QCLS CO2_OMS CO2_QCLS CO_RAF O3_ppb
BC_ng_kg BC_ng_m3 H2O_UWV O3_UO3 H2Oppmv_vxl n.prof Dist

6 9.85231481481481 2009 1 2 9 73640 NA NA NA 245.36 532.09 NA 76.59 NA NA NA NA NA NA NA NA NA NA NA NA NA 4.4
NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
NA NA NA NA NA NA NA 6.88 NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA 3.885404 -0.120249 -12.537338 -
19.258698 -0.00617 3096.075928 45.906315 -108.777977 136.786453 309.5 9.301398 -7.893493 NA 0.99502 3055.421143
10024.347656 698.014771 6.736154 696.158447 109.105583 53.440121 0.768275 0.372714 149.241074 0.656739 289.105438
292.28363 289.280487 -1.21033 -12.312244 0.212376 NA NA NA 0 NA 872.15033 353.715515 0 389.228 -496.99 -290.61 NA NA
NA 389.11 NA 128.5 42 0.48 0.444545454545455 2614 39 2530 1 20.8609891201727
...
5 982.863888888889 2011 5 14 252 74640 NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA
NA NA NA NA NA 7.43 NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA NA 1.65646 -0.109634 -19.200031 -
26.786245 0 6766.848145 40.569157 -105.55426 212.009476 157 -8.657322 -1.131515 -1.638038 0.966225 6458.68457
21189.910156 NA 0.015254 442.881866 154.489853 51.09864 1.193145 0.328429 213.589462 20.312731 320.485779
323.988678 320.673798 3.561974 -2.652649 0.446287 0 NA 0 0 0 78.318871 59.438431 0 388.882 -481.93 -277.89 1836.6
326.12 83.63 388.13 388.13 NA 57 NA NA 1394.34 70.2 NA 198 64339.915660277

Line breaks added to improve readability.
```

Supplementary Data File

Summary of 10-Second Data Completeness by Mission

A supplementary file is provided with this product that summarizes the completeness of the reported data values. The completeness entries are the number of non-missing observations for each species in the main data file for each mission and in total. . The number of observation given for species "jd" is the maximum number of possible non-missing observations per mission. The data are provided in one space-delimited format ASCII file.

Example Data Records

DISCRETE_meta_summary.tbl

```
species total_nonmissing H1 H2 H3 H4 H5
INSTRUMENT 32589 6547 6269 1811 9175 8787
jd 32589 6547 6269 1811 9175 8787
Year 32589 6547 6269 1811 9175 8787
H.no 32589 6547 6269 1811 9175 8787
flt 32589 6547 6269 1811 9175 8787
DOY 32589 6547 6269 1811 9175 8787
UTC 32589 6547 6269 1811 9175 8787
…
O3_ppb 32346 6505 6253 1795 9054 8739
BC_ng_kg 26215 5746 5529 1451 6220 7269
BC_ng_m3 26124 5736 5467 1432 6220 7269
H2O_UWV 32487 6546 6184 1810 9163 8784
O3_UO3 29149 6004 5782 0 9089 8274
H2Oppmv_vxl 26556 4386 3452 1372 9010 8336
n.prof 29719 5993 5664 1224 8458 8380
Dist 30900 6276 5919 1478 8791 8436
```

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Data Center Information:

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This data set is available through the Oak Ridge National Laboratory (ORNL) Carbon Dioxide Information Analysis Center (CDIAC).

Data Archive:

Web Site: http://hippo.ornl.gov/

Contact for Data Center Access Information:

E-mail: CDIAC
Telephone: +1 (865) 241-4846