TOGA and AWAS Instrument Descriptions

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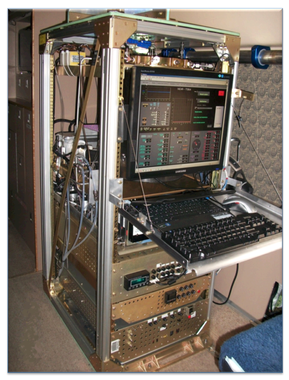
The CONvective TRansport of Active Species in the Tropics (CONTRAST) field campaign, was conducted using the NSF/NCAR GV research aircraft (HIAPER) to investigate the role of convective transport in TTL chemistry and the vertical distribution of the short-lived species in the western Pacific region.

The flights were based in Guam (13.48°N, 144.8°E) and occurred during January-February 2014. These dates were designed to coordinate with flights of the Global Hawk (GH) as part of the NASA Airborne Tropical TRopopause Experiment (ATTREX) program and of the BAe-146 as part of the NERC Coordinated Airborne Studies in the Tropics (CAST) program. Combined measurements from the three aircraft spanned the surface to the lowermost stratosphere, providing an unprecedented opportunity to assess the role of convection on atmospheric composition in the tropical western Pacific.

The Trace Organic Gas Analyzer (TOGA) and the Advanced Whole Air Sampler (AWAS) provided critical measurements of a wide range of organic compounds that are required to adequately characterize different air masses and different photochemical regimes. ATTREX and CAST payloads also included whole air samplers, which allowed much broader spatial and temporal whole air sampling and provided a unique opportunity for instrument intercomparisons (see the Intercomparison Poster).

HAIS Trace Organic Gas Analyzer (TOGA)

- Fast online GC/MS VOC measurement
- Up to 70 different VOCs measured
- High sensitivity: detection limits of NMHCs & OVOCs to ppt, many halocarbons to sub-ppt
- 35-sec integrated measurements every 2 min
- 14.5 cc sample volume up to 40Kft; pressure dependent lower volume above 40Kft
- Altitude: surface - 50,000 feet



TOGA installed on GV

TOGA inlet on GV

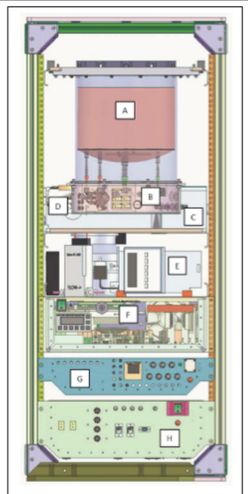
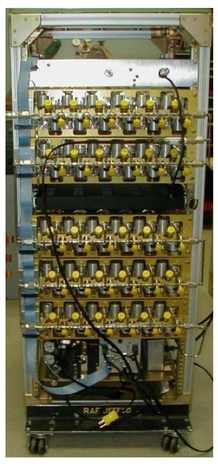


Figure 1. Diagram of the HIAPER/TOGA showing the major instrument components: (A) LN_2 dewar, (B) Heated space holding cryogenic enrichment traps and switching valves, (C) Mass spectrometer vacuum chamber, (D) Gas chromatograph, (E) Mass spectrometer, (F) Electronics box, (G) Zero air generator/dilution system, (H) Power box and UPS.

HAIS Advanced Whole Air Sampler (AWAS)

- 60 total sample canisters: 5 modules with 12 canisters/module
- Each canister is ~ 1.1 liters and the interior surface is electropolished stainless steel
- 4 stage metal bellows pump
- Each sample pressurized to ~40 psi
- Sample fill time dependent on altitude. Range is 5 sec. in the boundary layer to 50+ sec at 49Kft
- A broad suite of trace gases are measured in each sample in the laboratory using multiple GC systems
- High sensitivity: detection limits of ppt to sub-ppt
- Altitude: surface - 50,000 feet

Modules ready for installation.



HAIS Advanced Whole Air Sampler (AWAS) during laboratory tests. Bottom rack holds pump, electronics, and pneumatics for sample valves.

List of Compounds Measured by AWAS and TOGA During CONTRAST

For the full list of measurement capabilities contact Elliot Atlas for AWAS and Eric Apel for TOGA

	Lifetime	Source	AWAS	TOGA
Oxygenates				
Formaldehyde (CH2O)	1 day	A/N/B		✔
Acetaldehyde	1 day	A/N/B		✔
Propanal	1 day	A/B		✔
Butanal	0.5 day	A/B		✔
Acrolein	1 day	A/B		✔
Methacrolein	0.5 day	N		✔
Methyl Vinyl Ketone	1 day	N		✔
Methyl Butenol	0.5 day	N		✔
Methanol	~20 days	A/N/B		✔
Ethanol	~4 days	A/N/B		✔
Acetone	~15 days	A/N/B		✔
Butanone	3 days	N/A/B		✔
Methyl t-Butyl Ether	3 days	A		✔
Methyl Halides and related				
Methyl Bromide(CH3Br)	0.8 yrs	A/N/B	✔	✔
Methyl Chloride (CH3Cl)	1.5 yrs	N/B	✔	✔
Methyl Iodide (CH3I)	~4 days	N	✔	✔
Methylene Bromide(CH2Br2)	145 days	N	✔	✔
Bromoform (CHBr3)	~22 days	N	✔	✔
CHxBryClz	50-165 days	N	✔	✔
Chloroiodomethane	hrs	N		✔
Diiodomethane	mins	N		✔
Solvents				
Carbon Tetrachloride (CCl4)	40 yrs	A	✔	✔
Methyl Chloroform(CH3CCl3)	4.8 yrs	A	✔	
Tetrachloroethylene (C2Cl4)	0.3 yrs	A	✔	✔
Methylene Chloride (CH2Cl2)	0.3 yrs	A	✔	✔
Chloroform (CHCl3)	0.4 yrs	A	✔	✔
Trichloroethylene (C2HCl3)	~7 days	A	✔	
1,2 Dichloroethane (C2H4Cl2)	0.25 yrs	A	✔	
Chlorobenzene	~20 days	A	✔	✔
Other				
Methane (CH4)	9 yrs	A/N	✔	
Dimethyl Sulfide (C2H6S)	< 4 days	N	✔	✔
Carbonyl Sulfide (COS)	30 yrs	N/A/B	✔	
Hydrogen Cyanide (HCN)	1 yr	B		✔
Acetonitrile (CH3CN)	2 yrs	B		✔
Chlorofluorocarbons				
CFC-11 (CCl3F)	50 yrs	A	✔	✔
CFC-12 (CCl2F2)	102 yrs	A	✔	
CFC-113 (CCl2FCClF2)	85 yrs	A	✔	
CFC-114 (CClF2CClF2)	300 yrs	A	✔	✔

	Lifetime	Source	AWAS	TOGA
Organic Nitrates				
Methyl nitrate(CH3ONO2)	~30 days	A/N	✔	✔
Ethyl nitrate(C2H5ONO2)	~15 days	A/N	✔	✔
Propyl nitrates(C3H7ONO2)	~11 days	A/N	✔	✔
Butyl nitrates (C4H9ONO2)	~7 days	A	✔	
Non-Methane Hydrocarbons				
Ethane (C2H6)	~73 days	A	✔	
Ethene (ethylene; C2H4)	~2 days	A/N	✔	
Ethyne (acetylene; C2H2)	~22 days	A/B	✔	
Propane(C3H8)	~15 days	A	✔	✔
Isobutane(C4H10)	~ 7 days	A	✔	✔
n-Butane (C4H10)	~ 7 days	A	✔	✔
Butene	hrs	A		✔
Isobutene	hrs	A		✔
Isopentane (C5H12)	~4 days	A	✔	✔
n-Pentane (C5H12)	~4 days	A	✔	✔
n-Hexane	~3 days	A		✔
n-Heptane	~3 days	A		✔
Isoprene (C5H10)	hrs	N	✔	✔
Benzene (C6H6)	~15 days	A/B	✔	✔
Toluene (C7H8)	~3 days	A	✔	✔
Xylene	~36 days	A		✔
Trimethylbenzene	hrs	A		✔
Ethyl Benzene	~2.2 days	A		✔
a-Pinene	hrs	N		✔
b-Pinene	hrs	N		✔
Limonene	hrs	N		✔
Camphene	hrs	N		✔
Myrcene	hrs	N		✔
Halons				
CFC-12b1 (Halon 1211,CF2ClBr)	20 yrs	A	✔	
CFC-13b1 (Halon 1301, CF3Br)	65 yrs	A	✔	
CFC-114b2 (Halon 2402, C2F4Br2)	20 yrs	A	✔	
Hydrochlorofluorocarbons/ Hydrofluorocarbons				
HCFC-22 (CHF2Cl)	13 yrs	A	✔	
HCFC-141b (CH3CFCl2)	9.4 yrs	A	✔	
HCFC-142b (CH3CF2Cl)	19.5 yrs	A	✔	
HFC-134a (C2H2F4)	14 yrs	A	✔	
HFC-152a (F2HC-CH3)	1.5 yrs	A	✔	
HCFC-124 (C2HF4Cl)	5.9 yrs	A	✔	
HCFC-21 (CHFCl2)	2 yrs	A	✔	

Sources
A= antropogenic/industrial
N= natural/marine
B=Biomass burning

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