HAIS Advanced Whole Air Sampler (AWAS)

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The trace gases that we have routinely measured from whole air samples in tropospheric and stratospheric platforms are listed in Table 1. The list of compounds includes trace gases with sources from industrial midlatitude emissions, from biomass burning, and from the marine boundary layer. The use of a broad suite of tracers with different sources and lifetimes provides powerful diagnostic information on air mass history and chemical processing that currently is only available from measurements from whole air samples. Previous deployments of the whole air sampler have shown that the sampling and analytical procedures employed by our group are capable of accessing the wide range of mixing ratios at sufficient precision to be used for tracer studies. Thus, routine measurement of species, such as methyl iodide, at $<= 0.1 \times 10^{-12}$ mole fraction, or NMHC at levels of a few $\times 10^{-12}$ mole fraction are possible.

In addition to the tracer aspects of the whole air sampler measurements, we measure a full suite of halocarbon species that provide information on the role of short-lived halocarbons in the UT/LS region, on halogen budgets in the UT/LS region, and on continuing increasing temporal trends of HFCs (such as 134a), HCFCs (such as HCFC 141b), PFCs (such as C_2F_6), as well as declining levels of some of the major CFCs and halogenated solvents. The measurements of those species that are changing rapidly in the troposphere also give direct indications of the age and origin of air entering the stratosphere across the tropopause. Thus, several estimates of air transport rates and age will be available from the measurement of species measured with AWAS (and PANTHER), plus the measurement of CO_2 and SF_6 by others during START08.

Physical Description and operation of the HAIS AWAS.

The HAIS AWAS can deploy up to 60 canisters per flight. These samples are collected in 5 canister modules, with 12 canisters/module. Each canister is approximately 1.1 liters volume and the interior surfaces are electropolished stainless steel. The samples are pressurized to approximately 3 atmospheres using 2 – two stage metal bellows compressors. Sample collection rate is a function of altitude, and the details of this relationship will be determined during test flights prior to START08. Estimated sample integration times are expected to be less than 30 – 40 seconds at maximum flight altitude.

Sample collection is controlled by a computer, with manual override options available. This allows unattended operation at a pre-programmed rate, and also on-demand sampling for to collect samples under targeted conditions.

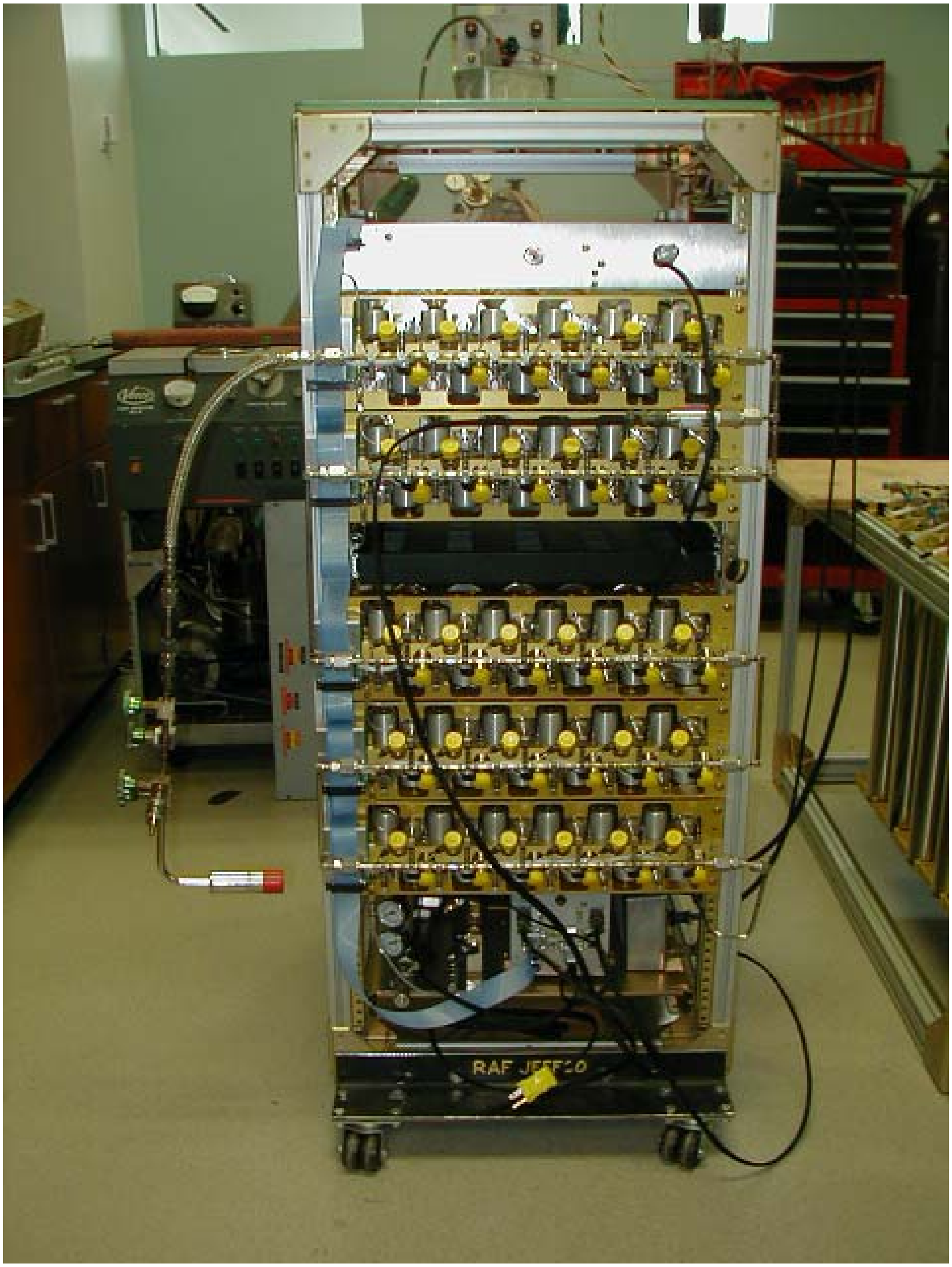

Figure 1. HAIS Advanced Whole Air Sampler (AWAS) during laboratory tests. Bottom rack holds pump, electronics, and pneumatics for sample valves.

Table 1. **Selected compounds to be measured from the HAIS AWAS during START08, approximate atmospheric lifetimes (yrs), and predominant source (N=natural; A=anthropogenic).**

	Yrs	Source
Chlorofluorocarbons		
CFC-11 (CCl_3F)	50	A
CFC-12 (CCl_2F_2)	102	A
CFC-113 (CCl_2FCClF_2)	85	A
CFC-114 ($CClF_2CClF_2$)	300	A
CFC-115 (CF_2ClCF_3)	1700	A
Halons		
CFC-12b1 (Halon 1211,CF_2ClBr)	20	A
CFC-13b1 (Halon 1301, CF_3Br)	65	A
CFC-114b2 (Halon 2402, $C_2F_4Br_2$)	20	A
Hydrochlorofluorocarbons/ Hydrofluorocarbons		
HCFC-22 (CHF_2Cl)	13	A
HCFC-141b (CH_3CFCl_2)	9.4	A
HCFC-142b (CH_3CF_2Cl)	19.5	A
HFC-134a ($C_2H_2F_4$)	14	A
HFC-152a ($F_2HC\text{-}CH_3$)	1.5	A
HCFC-124 (C_2HF_4Cl)	5.9	A
HCFC-21 ($CHFCl_2$)	2	A
Others (TBD)		
Solvents		
Carbon Tetrachloride (CCl_4)	40	A
Methyl Chloroform(CH_3CCl_3)	4.8	A
Tetrachloroethylene (C_2Cl_4)	0.3	A
Methylene Chloride (CH_2Cl_2)	0.3	A
Chloroform ($CHCl_3$)	0.4	A
Trichloroethylene(C_2HCl_3)	0.02	A
1,2 Dichloroethane ($C_2H_4Cl_2$)	0.25	A

	Yrs	Source
Organic Nitrates		
Methyl nitrate(CH_3ONO_2)	0.08	A/N
Ethyl nitrate($C_2H_5ONO_2$)	0.04	A/N
Propyl nitrates($C_3H_7ONO_2$)	0.03	A/N
Butyl nitrates ($C_4H_9ONO_2$)	0.02	A
Non-Methane Hydrocarbons		
Ethane (C_2H_6)	0.2	A
Ethyne (C_2H_4)	0.06	A
Propane(C_3H_8)	0.04	A
Isobutane(C_4H_{10})	0.02	A
n-Butane (C_4H_{10})	0.02	A
Isopentane (C_5H_{12})	0.01	A
n-Pentane (C_5H_{12})	0.01	A
Isoprene (C_5H_{10})	hrs	N
Benzene (C_6H_6)	0.04	A
Toluene (C_7H_8)	0.01	A
Methyl Halides and related		
Methyl Bromide(CH_3Br)	0.8	A/N
Methyl Chloride (CH_3Cl)	1.5	N
Methyl Iodide (CH_3I)	0.01	N
Methylene Bromide(CH_2Br_2)	0.4	N
CHxBryClz	0.1	N
Bromoform ($CHBr_3$)	0.1	N
Other		
Methane (CH_4)	9	A/N
Carbon Monoxide (CO)	0.4	A/N
Nitrous Oxide (N_2O)	115	N
Carbonyl Sulfide (COS)	30	N/A
Dimethyl Sulfide (C_2H_6S)	<.01	N