Whole Air Sampler (WAS)

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The Whole Air Sampler (WAS) collects samples from airborne platforms for detailed analysis of a wide range of trace gases. The compounds that are typically measured from the WAS includes trace gases with sources from industrial midlatitude emissions, from biomass burning, and from the marine boundary layer, with certain compounds (e.g. organic nitrates) that have a unique source in the equatorial surface ocean. 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 x 10^{-12} mole fraction, or NMHC at levels of a few x 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 tropical 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. The table below shows a selected list of compounds that are typically analyzed from the whole air sampler.

Physical Description and operation of the WAS. The UM sampler (formerly NCAR) has flown in an automated version a number of airborne platforms. In the automated configuration, metal valves on the sample canisters are turned with external motors. Open and close commands to collect samples are sent from a small processor that is programmed with sample pressure, time, and frequency information. Pilot override can initiate sample collection on command, or can modify the sample frequency. The configuration to be used in SEAC4RS incorporates a 4-stage metal bellows pump, 32 1.5 liter canisters, and control electronics. These components will be mounted in the belly pod of the ER-2 (Figure 1).

Figure 1. Picture of ER-2 aircraft noting location of the Whole Air Sampler (WAS) in the belly pod of the aircraft. ***Inset:*** Canisters used in the WAS being prepared for flight. Actual configuration in the pod is 2 canisters wide.

Table 1. Compounds typically analyzed from whole air samples, with approximate atmospheric lifetimes (yrs), and predominant source (N=natural; A=anthropogenic).

	Yrs	Source		Yrs	Source
Chlorofluorocarbons			**Organic Nitrates**		
CFC-11 (CCl_3F)	50	A	Methyl nitrate(CH_3ONO_2)	0.08	A/N
CFC-12 (CCl_2F_2)	102	A	Ethyl nitrate($C_2H_5ONO_2$)	0.04	A/N
CFC-113 (CCl_2FCClF_2)	85	A	Propyl nitrates($C_3H_7ONO_2$)	0.03	A/N
CFC-114 ($CClF_2CClF_2$)	300	A	Butyl nitrates ($C_4H_9ONO_2$)	0.02	A
CFC-115 (CF_2ClCF_3)	1700	A	Pentyl nitrates ($C_5H_{11}ONO_2$)	0.02	A
Halons			**Non-Methane Hydrocarbons**		
CFC-12b1 (Halon 1211,CF_2ClBr)	20	A	Ethane (C_2H_6)	0.2	A
CFC-13b1 (Halon 1301, CF_3Br)	65	A	Ethyne (C_2H_4)	0.06	A
CFC-114b2 (Halon 2402, $C_2F_4Br_2$)	20	A	Propane(C_3H_8)	0.04	A
HCFCs/HFCs			Isobutane(C_4H_{10})	0.02	A
HCFC-22 (CHF_2Cl)	13	A	n-Butane (C_4H_{10})	0.02	A
HCFC-141b (CH_3CFCl_2)	9.4	A	Isopentane (C_5H_{12})	0.01	A
HCFC-142b (CH_3CF_2Cl)	19.5	A	n-Pentane (C_5H_{12})	0.01	A
HFC-134a ($C_2H_2F_4$)	14	A	Isoprene (C_5H_{10})	hrs	N
HFC-152a ($C_2H_4F_2$)	1.5	A	Benzene (C_6H_6)	0.04	A
Solvents			Toluene (C_7H_8)	0.01	A
Carbon Tetrachloride (CCl_4)	40	A	C2-Benzenes (C_8H_{10})	<.01	A
Methyl Chloroform(CH_3CCl_3)	4.8	A	a-Pinene ($C_{10}H_{20}$)	hrs	N
Tetrachloroethylene (C_2Cl_4)	0.3	A	**Other**		
Methylene Chloride (CH_2Cl_2)	0.3	A	Methane (CH_4)	9	A/N
Chloroform ($CHCl_3$)	0.4	A	Carbon Monoxide (CO)	0.4	A/N
Trichloroethylene(C_2HCl_3)	0.02	A	Nitrous Oxide (N_2O)	115	N
Methyl Halides and related			Carbonyl Sulfide (COS)	30	N/A
Methyl Bromide(CH_3Br)	0.8	A/N	Dimethyl Sulfide (C_2H_6S)	<.01	N
Methyl Chloride (CH_3Cl)	1.5	N	Methyl Acetate (CH_3COOCH_3)	0.1	N/A
Methyl Iodide (CH_3I)	0.01	N	Methacrolein (C_4H_6O)	hrs	N
Methylene Bromide(CH_2Br_2)	0.4	N	Methylvinylketone (C_4H_6O)	hrs	N
CHxBryClz	0.1	N			
Bromoform ($CHBr_3$)	0.1	N			