Whole Air Sampling (WAS) from the DC-8 Aircraft during ARCTAS, 2008

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General Description

The UC-Irvine research group proposes to collect whole air samples aboard the DC-8 aircraft during both the spring and summer 2008 campaigns of the ARCTAS field mission. More than 60 trace gases will be identified and quantified at our Irvine laboratory – including C_2-C_{10} NMHCs, C_1-C_2 halocarbons, C_1-C_5 alkyl nitrates, and selected sulfur compounds (Table 1). This will be achieved using our established technique of airborne whole air sampling followed by laboratory analysis using gas chromatography (GC) with flame ionization detection (FID), electron capture detection (ECD), and mass spectrometric detection (MSD). Our experimental procedures will build on those that have been successfully employed for numerous prior NASA field missions, most recently PEM-Tropics B [*Blake et al*., 2001, 2003c; *Colman et al*., 2001; *Simpson et al*., 2001], TRACE-P [*Blake et al*., 2003b, 2003d; *Simpson et al*., 2003a, 2003b], and INTEX-A and B [*Blake et al*., 2007, in press].

The $^{13}C/^{12}C$ and ^{14}C content of CO_2 will also be determined, separately, in selected air samples using AMS. These measurements, which will be made by Stan Tyler (as described in *Tyler et al*. [1999]) in his UC-Irvine laboratory, can be readily obtained using the air that remains in selected canisters after we have finished our analysis of NMHCs.

As in previous missions, we are also prepared to provide back-up capability for the *in situ* CO and CH_4 measurements when the principal *in situ* CH_4 or CO measurements have gone off-line.

Sampling Frequency.

We propose to collect up to 168 air samples per flight, which (depending on the duration of the flight) allows us a 4-5-minute sampling during horizontal flight legs, and every 1-2 minutes during ascents and descents. The time taken to fill each sampling canister can be adjusted, but is usually about 1 minute. Sample collection on board the aircraft will be coordinated with other experiments and any intercomparison activities, so as to optimize sample overlap with other groups.

Sampling Equipment.

Our on-board sampling equipment includes seven foam-embedded sets of 24 linked, 2-L stainless steel samplings canisters (see photo in Figure 1), plus a metal bellows pump. We use a window-mounted ¼" forward-facing inlet and an aft-facing outlet.

Table 1. Compounds to be measured and archived by UC-Irvine during ARCTAS.

Compound	Formula	Lifetime	LOD (pptv)	Precision (%)	Accuracy (%)
Hydrocarbons					
Ethane	C_2H_6	2-3 mo	3	0.5	5
Ethene	C_2H_4	1-2 d	3	0.7	5
Ethyne	C_2H_2	12-17 d	3	0.5	5
Propane	C_3H_8	10-15 d	3	0.7	5
Propene	C_3H_6	8-12 hr	3	16	5
Propyne	C_3H_4	2 d	3	2	5
n-Butane	C_4H_{10}	4-6 d	3	0.6	5
i-Butane	C_4H_{10}	5-7 d	3	1	5
1-Butene	C_4H_8	9 hr	3	2	5
cis-2-Butene	C_4H_8	5 hr	3	2	5
trans-2-Butene	C_4H_8	5 hr	3	2	5
1,3-Butadiene	C_4H_6	5 hr	3	2	5
n-Pentane	C_5H_{12}	5 d	3	2	5
i-Pentane	C_5H_{12}	5 d	3	2	5
Isoprene	C_5H_8	1-2 hr	3	2	5
2-Methylpentane	C_6H_{14}	2-3 d	3	2	5

3-Methylpentane	C_6H_{14}	2-3 d	3	2	5
Benzene	C_6H_6	9-13 d	3	2	5
Toluene	C_7H_8	2-3 d	3	3	5
m-Xylene	C_8H_{10}	1 d	3	5	5
o-Xylene	C_8H_{10}	1-2 d	3	5	5
p-Xylene	C_8H_{10}	1-2 d	3	5	5
Ethylbenzene	C_8H_{10}	2 d	3	5	5
m-Ethyltoluene	C_9H_{12}	17 hr	3	5	5
o-Ethyltoluene	C_9H_{12}	1 d	3	5	5
p-Ethyltoluene	C_9H_{12}	1 d	3	5	5
1,2,4-Trimethylbenzene	C_9H_{12}	10 hr	3	5	5
1,3,5-Trimethylbenzene	C_9H_{12}	5 hr	3	5	5
α-Pinene	$C_{10}H_{16}$	6 hr	3	5	5
β-Pinene	$C_{10}H_{16}$	4 hr	3	5	5
Alkyl Nitrates					
Methyl nitrate	CH_3ONO_2	1 mo	0.02	2	10
Ethyl nitrate	$C_2H_5ONO_2$	2-4 wk	0.02	1	10
1-Propyl nitrate	$C_3H_7ONO_2$	1-2 wk	0.02	1	10
2-Propyl nitrate	$C_3H_7ONO_2$	1-3 wk	0.02	2	10
2-Butyl nitrate	$C_4H_9ONO_2$	1-2 wk	0.02	1	10
2-Pentyl nitrate	$C_5H_{11}ONO_2$	4-5 d	0.02	2	10
3-Pentyl nitrate	$C_5H_{11}ONO_2$	4-5 d	0.02	2	10

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Table 1 continued. Compounds to be measured and archived by UC-Irvine during ARCTAS.

Compound	Formula	Lifetime	LOD (pptv)	Precision (%)	Accuracy (%)
Halocarbons					
CFC-11	$CFCl_3$	45 yr	1	0.8	2
CFC-12	CF_2Cl_2	100 yr	10	0.7	2
CFC-113	CCl_2FCClF_2	85 yr	1	1.2	2
CFC-114	$CClF_2CClF_2$	300 yr	1	1.9	5
Methyl chloroform	CH_3CCl_3	4.9 yr	1	1.0	5
Carbon tetrachloride	CCl_4	35 yr	0.1	0.7	5
Halon-1211	$CBrClF_2$	11 yr	0.05	1.1	5
Halon-2402	$CBrF_2CBrF_2$	<20 yr	0.05	2.5	5
HCFC-22	CHF_2Cl	11.8 yr	1	2.0	5
HCF-134a	CH_2FCF_3	13.6 yr	1	5.2	10-20
HCFC-141b	CH_3CCl_2F	9.2 yr	1	4.2	10-20
HCFC-142b	CH_2CClF_2	18.5 yr	1	3.6	10-20
Methyl bromide	CH_3Br	9-10 mo	0.1	1.7	5
Methyl chloride	CH_3Cl	1.3 yr	5	1.5	5
Methyl iodide	CH_3I	4 d	0.01	1.1	10
Methylene bromide	CH_2Br_2	3-4 mo	0.05	1.6	10-20
Methylene chloride	CH_2Cl_2	3-5 mo	1	4.5	10
Chloroform	$CHCl_3$	3-5 mo	0.1	1.1	5
Trichloroethene	C_2HCl_3		0.05	1.5	5
Tetrachloroethene	C_2Cl_4	2-3 mo	0.05	1.2	10
1,2-Dichloroethane	$C_2H_4Cl_2$	1-2 mo	0.05	5.0	20
Bromodichloromethane	$CHBrCl_2$	2-3 mo	0.01	2.0	10-20
Dibromochloromethane	$CHBr_2Cl$	2-3 mo	0.01	9.3	20
Bromochloromethane	CH_2BrCl	5 mo	0.01	7.4	20
Sulfur Compounds					
Carbonyl sulfide	OCS	16 yr	10	2	10
Dimethyl sulfide	CH_3SCH_3	1-2 d	10	2	10
Dimethyl disulfide	CH_3SSCH_3	1 hr	10	2	10
Carbon disulfide	CS_2	2-3 d	10	2	10

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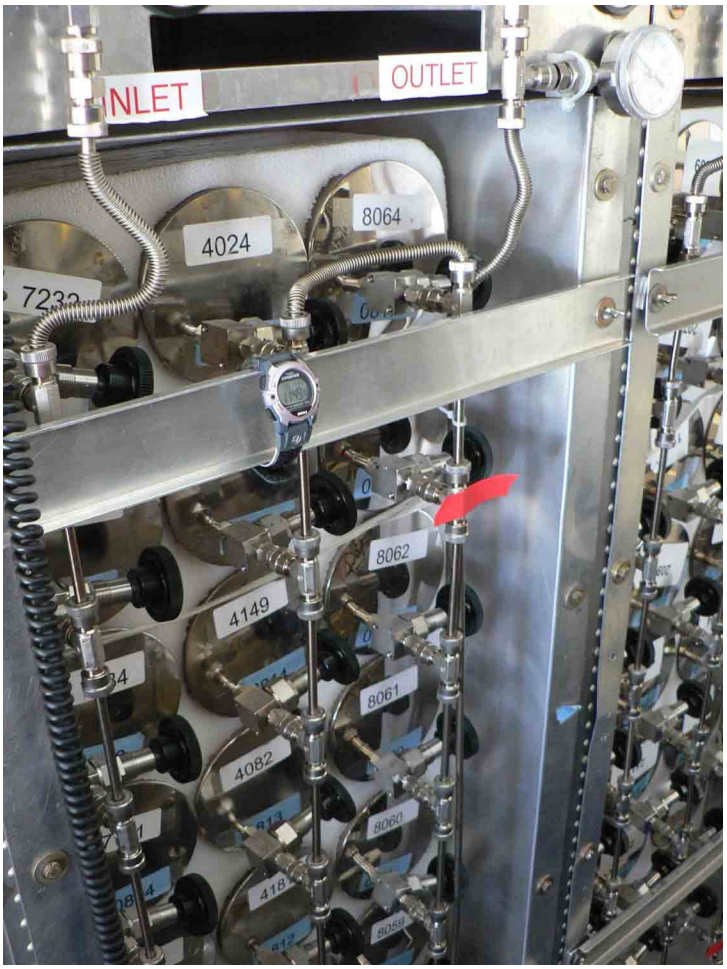

Figure 1. Photo of a UCI foam-embedded set of 24 linked, 2-L stainless steel samplings canisters installed on the NASA DC-8 during TC[4]. Photo by Nicola J. Blake.