

# **Whole Air Sampling (WAS) from the DC-8 Aircraft during SEAC<sup>4</sup>RS, 2012**

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## **General Description**

The UC-Irvine research group proposes to collect whole air samples aboard the NASA DC-8 aircraft during the 2012 campaign of the Southeast Asia Composition, Cloud, Climate Coupling Regional Study (SEAC<sup>4</sup>RS) field mission. More than 70 trace gases will be identified and quantified at our Irvine laboratory, including C<sub>2</sub>-C<sub>10</sub> NMHCs, C<sub>1</sub>-C<sub>2</sub> halocarbons, C<sub>1</sub>-C<sub>5</sub> 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, for example PEM-Tropics B (*Blake et al.*, 2001, 2003a; *Colman et al.*, 2001; *Simpson et al.*, 2001), TRACE-P (*Blake et al.*, 2003b, 2003c, 2004; *Simpson et al.*, 2003a, 2003b), INTEX-A and B (*Blake et al.*, 2008; *Barletta et al.*, 2009), and ARCTAS (*Simpson et al.*, 2010, 2011).

As in previous missions, we are also prepared to provide back-up capability for the *in situ* CO and CH<sub>4</sub> measurements when the principal *in situ* CH<sub>4</sub> 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 to collect an integrated air sample every 4-5 minutes 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 onboard the aircraft will be coordinated with other experiments and any intercomparison activities, so as to optimize sample overlap with other groups.

## **Sampling Equipment**

Our onboard sampling equipment includes seven foam-embedded sets of 24 linked, 2-L stainless steel sampling canisters (see 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 SEAC<sup>4</sup>RS.

Compound	Formula	Lifetime	LOD (pptv)	Precision (%)	Accuracy (%)
<b>Hydrocarbons</b>					
Ethane	C <sub>2</sub> H <sub>6</sub>	47 d	3	1	5
Ethene	C <sub>2</sub> H <sub>4</sub>	1.4 d	3	3	5
Ethyne	C <sub>2</sub> H <sub>2</sub>	12-17 d	3	3	5
Propane	C <sub>3</sub> H <sub>8</sub>	11 d	3	2	5
Propene	C <sub>3</sub> H <sub>6</sub>	11 hr	3	3	5
Propyne	C <sub>3</sub> H <sub>4</sub>	2 d	5	30	20
<i>n</i> -Butane	C <sub>4</sub> H <sub>10</sub>	4.9 d	3	3	5
<i>i</i> -Butane	C <sub>4</sub> H <sub>10</sub>	5.5 d	3	3	5
1-Butene	C <sub>4</sub> H <sub>8</sub>	8.8 hr	3	3	5
<i>i</i> -Butene	C <sub>4</sub> H <sub>8</sub>	5.4 hr	3	3	5
<i>cis</i> -2-Butene	C <sub>4</sub> H <sub>8</sub>	4.9 hr	3	3	5
<i>trans</i> -2-Butene	C <sub>4</sub> H <sub>8</sub>	4.3 hr	3	3	5
1,3-Butadiene	C <sub>4</sub> H <sub>6</sub>	4.2 hr	3	3	5
<i>n</i> -Pentane	C <sub>5</sub> H <sub>12</sub>	5 d	3	3	5
<i>i</i> -Pentane	C <sub>5</sub> H <sub>12</sub>	5 d	3	3	5
Isoprene	C <sub>5</sub> H <sub>8</sub>	2.8 hr	3	3	5
2-Methylpentane	C <sub>6</sub> H <sub>14</sub>	2-3 d	3	3	5
3-Methylpentane	C <sub>6</sub> H <sub>14</sub>	2-3 d	3	3	5
Benzene	C <sub>6</sub> H <sub>6</sub>	9.5 d	3	3	5
Toluene	C <sub>7</sub> H <sub>8</sub>	2.1 d	3	3	5
<i>m</i> + <i>p</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	12-19 hr	3	3	5
<i>o</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	20 hr	3	3	5
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	1.7 d	3	3	5
2-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	23 hr	3	3	5
3-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	15 hr	3	3	5
4-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	24 hr	3	3	5
1,2,3-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	8.5 hr	3	3	5
1,2,4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	8.5 hr	3	3	5
1,3,5-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	4.9 hr	3	3	5
$\alpha$ -Pinene	C <sub>10</sub> H <sub>16</sub>	5.3 hr	3	3	5
$\beta$ -Pinene	C <sub>10</sub> H <sub>16</sub>	3.7 hr	3	3	5
<b>Alkyl Nitrates</b>					
Methyl nitrate	CH <sub>3</sub> ONO <sub>2</sub>	1 mo	0.02	5	10
Ethyl nitrate	C <sub>2</sub> H <sub>5</sub> ONO <sub>2</sub>	2-4 wk	0.02	5	10
1-Propyl nitrate	C <sub>3</sub> H <sub>7</sub> ONO <sub>2</sub>	1-2 wk	0.02	5	10
2-Propyl nitrate	C <sub>3</sub> H <sub>7</sub> ONO <sub>2</sub>	1-3 wk	0.02	5	10
2-Butyl nitrate	C <sub>4</sub> H <sub>9</sub> ONO <sub>2</sub>	1-2 wk	0.02	5	10
2-Pentyl nitrate	C <sub>5</sub> H <sub>11</sub> ONO <sub>2</sub>	4-5 d	0.02	5	10
3-Pentyl nitrate	C <sub>5</sub> H <sub>11</sub> ONO <sub>2</sub>	4-5 d	0.02	5	10

**Table 1 continued.** Compounds to be measured and archived by UC-Irvine during SEAC<sup>4</sup>RS.

Compound	Formula	Lifetime	LOD (pptv)	Precision (%)	Accuracy (%)
<b>Halocarbons</b>					
CFC-11	CFCl <sub>3</sub>	45 yr	10	1	3
CFC-12	CF <sub>2</sub> Cl <sub>2</sub>	100 yr	10	1	3
CFC-113	CCl <sub>2</sub> FCClF <sub>2</sub>	85 yr	5	1	3
CFC-114	CClF <sub>2</sub> CClF <sub>2</sub>	300 yr	1	1	10
Methyl chloroform	CH <sub>3</sub> CCl <sub>3</sub>	5.0 yr	0.1	1	5
Carbon tetrachloride	CCl <sub>4</sub>	26 yr	1	1	5
Halon-1211	CBrClF <sub>2</sub>	16 yr	0.1	1	5
Halon-2402	CBrF <sub>2</sub> CBrF <sub>2</sub>	20 yr	0.01	1	5
HCFC-22	CHF <sub>2</sub> Cl	12 yr	2	2	5
HCF-134a	CH <sub>2</sub> FCF <sub>3</sub>	14 yr	1	3	10
HCFC-141b	CH <sub>3</sub> CCl <sub>2</sub> F	9.3 yr	0.5	3	10
HCFC-142b	CH <sub>2</sub> CClF <sub>2</sub>	18 yr	0.5	3	10
Methyl bromide	CH <sub>3</sub> Br	0.7 yr	0.5	5	10
Methyl chloride	CH <sub>3</sub> Cl	1.0 yr	50	5	10
Methyl iodide	CH <sub>3</sub> I	4 d	0.005	5	20
Dibromomethane	CH <sub>2</sub> Br <sub>2</sub>	3-4 mo	0.01	5	20
Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	3-5 mo	1	5	10
Chloroform	CHCl <sub>3</sub>	3-5 mo	0.1	5	10
Trichloroethylene	C <sub>2</sub> HCl <sub>3</sub>	5 d	0.01	5	10
Tetrachloroethylene	C <sub>2</sub> Cl <sub>4</sub>	2-3 mo	0.01	5	10
1,2-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1-2 mo	0.1	5	10
Bromoform	CHBr <sub>3</sub>	11 mo	0.01	10	20
Bromodichloromethane	CHBrCl <sub>2</sub>	2-3 mo	0.01	10	50
Dibromochloromethane	CHBr <sub>2</sub> Cl	2-3 mo	0.01	10	20
Bromochloromethane	CH <sub>2</sub> BrCl	5 mo	0.01	10	20
<b>Sulfur Compounds</b>					
Carbonyl sulfide	OCS	2.5 yr	10	2	10
Dimethyl sulfide	CH <sub>3</sub> SCH <sub>3</sub>	1-2 d	1	10	20
Dimethyl disulfide	CH <sub>3</sub> SSCH <sub>3</sub>	1 hr	10	2	10
Carbon disulfide	CS <sub>2</sub>	2-3 d	10	2	10

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**Figure 1.** A UC-Irvine foam-embedded set of 24 linked, 2-L stainless steel samplings canisters installed on the NASA DC-8 aircraft during the TC<sup>4</sup> mission. Photo by Nicola Blake.