

Table 1. Instrumentation Aboard the University of Washington's Convair-580 Aircraft for FIRE-ACE/SHEBA

(a) Navigational and Flight Characteristics			
Parameter	Instrument Type	Manufacturer	Range (and error)
Latitude and longitude, ground speed	Global positioning system	Bendix/King KLN900	Global
True airspeed	Variable capacitance	Rosemount Model 831 BA	0 to 250 m s ⁻¹ (<0.2%)
Heading	Gyrocompass	King KCS-55A	0 to 360° (± 1°)
Pressure altitude	Variable capacitance	Rosemount Model 830 BA	150 to 1100 mb (<0.2%)
Pitch, roll, and azimuth	Differential GPS	Trimble TANS/Vector	0 to 360° (±0.15°)
Pitch and roll	CAR Gyro	--	±20°
(b) General Meteorological			
Parameter	Instrument Type	Manufacturer	Range (and error)
Total air temperature	Platinum wire resistance	Rosemount Model 102CY2CG and 414 L Bridge	-60 to 40°C (<0.1°C)
Static air temperature	Reverse-flow thermometer	In-house	-60 to 40°C (<0.5°C)
Dew point	Cooled-mirror dew point	Cambridge System Model TH73-244	-40 to 40°C (<1°C)
Absolute humidity	IR optical hygrometer	Ophir Corp. Model IR-2000	0 to 10 g m ⁻³ (~5%)
Air turbulence	RMS pressure variation	Meteorology Research Inc. Model 1120	0 to 10 cm ^{2/3} s ⁻¹ (<10%)
Horizontal winds	GPS	Bendix/King KLN900	Global
UV hemispheric irradiance (upward and downward)	Diffuser, filter photo-cell (0.295 to 0.390 μm)	Eppley Lab. Inc. Model 14042	0 to 70 W m ⁻² (±3 W m ⁻²)
VIS-NIR hemispheric irradiance (upward and downward)	Eppley thermopile (0.3 to 3 μm)	Eppley Lab. Inc. Model PSP	0 to 1400 W m ⁻² (±10 W m ⁻²)
Surface radiative temperature*	IR radiometer 1.5° FOV (8 to 14 μm)	Omega Engineering 053701	-50° to 1000°C ±0.8% or reading
Video image	Forward-looking camera and time code	Sony Hi8 camera	SVHS tape
(c) Aerosol			
Parameter	Instrument Type	Manufacturer	Range (and error)
Number concentration of particles	Condensation particle counter	TSI Model 3760	10 ⁻² to 10 ⁴ cm ⁻³ (>0.02 μm to ~0.3 μm)
Size spectrum of particles	Forward light-scattering	Particle Measuring Systems Model FSSP-300	0.3 to 20 μm (31 channels)

(Cont.)

* Malfunctioned during most of study

TABLE 1 (continued)

(c) Aerosol (continued)			
Parameter	Instrument Type	Manufacturer	Range (and error)
Size spectrum of particles	35 to 120° light-scattering	Particle Measuring Systems Model PCASP-100X	0.10 to 3.0 μm (15 channels)
Size spectrum of particles	90° light-scattering	Particle Measuring Systems Model LAS-200	0.5 to 11 μm (15 channels)
Size spectrum of particles	Forward light-scattering	Particle Measuring Systems Model FSSP-100	2 to 47 μm (15 channels)
Size spectrum of particles	Differential Mobility Particle Sizing Spectrometer (DMPS)	TSI, modified in-house	0.01 to 0.6 μm (21 channels)
Light-scattering coefficient	Integrating 3-wavelength nephelometer with backscatter shutter	MS Electron	$1.0 \times 10^{-7} \text{ m}^{-1}$ to $1.0 \times 10^{-3} \text{ m}^{-1}$ for 550 and 700 nm channels, $2.0 \times 10^{-7} \text{ m}^{-1}$ to $1.0 \times 10^{-3} \text{ m}^{-1}$ for 450 nm channel
Light-scattering coefficient (for bag-house)	Integrating nephelometer	Radiance Research	$1.0 \times 10^{-6} \text{ m}^{-1}$ to $2.0 \times 10^{-4} \text{ m}^{-1}$ or $1.0 \times 10^{-6} \text{ m}^{-1}$ to $1.0 \times 10^{-3} \text{ m}^{-1}$
Light absorption and graphitic carbon	Particle soot/absorption photometer	Radiance Research	Absorption coefficient: 10^{-7} to 10^{-2} m^{-1} ; Carbon: $0.1 \mu\text{m m}^{-3}$ to 10 mg m^{-3} ($\pm 5\%$)
Graphitic and/or Organic Carbon	Quartz filters thermal optical technique*	Lawrence Berkeley Lab. (T. Novakov)	4 to 160 $\mu\text{m m}^{-3}$ ($\pm 1.6 \mu\text{g m}^{-3}$) for 1 m^3 sample
Humidification factor for aerosol light-scattering	Scanning humidigraph	In house (designed and built for UW by Mark Rood)	b_{sp} (RH) for 30% RH 85%
(d) Cloud Physics			
Parameter	Instrument Type	Manufacturer	Range (and error)
Cloud and precipitation particle images	Digital holographic camera	SPEC, Inc. Model CPI-230	5 μm to 3 mm
Size spectrum cloud particles	Forward light-scattering	Particle Measuring Systems FSSP-100	2 to 47 μm (15 channels)
Size spectrum of cloud and precipitation particles	Diode occultation	Particle Measuring Systems OAP-200X (1D-C)	20 to 310 μm (15 channels)
Images of precipitation particles	Diode imaging	Particle Measuring Systems OAP-2D-C	Resolution 25 μm
Liquid water content	Hot wire resistance	Johnson-Williams	0 to 2 or 0 to 6 g m^{-3}
Liquid water content	Hot wire resistance	King/PMS [†]	0 to 5 g m^{-3}
Liquid water content; particle surface area; effective droplet radius	Optical sensor	Gerber Scientific Inc. PVM-100X	0.001-10 g m^{-3} ; 5-10,000 $\text{cm}^2 \text{ m}^{-3}$; 2-70 μm

(Cont.)

* Guest filters (measurements invalid)

[†] Malfunctioned during most of study

TABLE 1 (continued)

(d) Cloud Physics (continued)			
Parameter	Instrument Type	Manufacturer	Range (and error)
Optical scattering/extinction coefficients at 630 nm, asymmetry parameter, and back-to-forward scattering ratio for cloud and precipitation drops and ice particles	g-meter	Gerber Scientific, Inc.	Particles to 10-2000 μm . Rate 5-100 Hz. Asymmetry parameter (g) to 1-2% accuracy. Optical extinction coefficient to 5-10%.
(e) Chemistry[†]			
Parameter	Instrument Type	Manufacturer	Range (and error)
Particulate species $\text{SO}_4^{=}$, NO_3^- , Cl^- , Na^+ , K^+ , NH_4^+ , Ca^{++} , Mg^{++}	Teflon filters and ion exchange chromatography	Gelman Dionix	0.1 to 50 $\mu\text{g m}^{-3}$ (for 500 liter air sample)
SO_2	Pulsed fluorescence	Teco 43S (modified in-house)	0.1 to 200 ppb
O_3	Chemi-luminescence (C_2H_4)	Monitor Labs Model 8410 A	0 to 5 ppmv (<7 ppb)
CO	Infrared correlation spectrometer	Teco Model 141	0 to 50 ppmv (~0.1 ppmv)
CO_2	Infrared correlation spectrometer	LI-COR Li-6262	0 to 300 ppmv (0.2 ppmv at 350 ppmv)
NO/ NO_x	Chemi-luminescence (O_3)	Modified Monitor Labs Model 8840	0 to 5 ppmv (~1 ppb)
(f) Remote Sensing			
Parameter	Instrument Type	Manufacturer	Range (and error)
Absorption and scattering of solar radiation by clouds; BRDF and albedo of surfaces	Thirteen wavelength scanning radiometer	NASA-Goddard/ University of Washington	13 discrete wavelengths between 470 and 2300 nm
Solar Spectral irradiance or radiance; Spectral transmission and reflectance*	Up and down looking hemispherical signal collectors	NASA Ames Solar Spectral Flux Radiometer (SSFR) (P. Pilewskie)	300-2500 nm (5-10 nm resolution). FOV 1 mrad. 1 Hz spectral sampling rate.
Weather radar	Pilot's radar (=3 cm)	Bendix/King (now Allied Signal)	160 nm

(Cont.)

* Guest instrument

[†] Due to problems with a newly constructed inlet tube, the gas measurements (SO_2 , O_3 , CO, CO_2 and NO/ NO_x) were not reliable.

TABLE 1 (continued)

(g) Data Processing and Display			
Parameter	Instrument Type	Manufacturer	Range (and error)
In-flight data processing and recording	Microcomputer	In-house, based on Motorola MVME-133A technology	
Recording (analog voice transcription)	Cassette recorder	---	
In-flight data processing and display	Laptop PC	NEC Versa 5060X	
Digital printout	Impact printer	Epson MX-80	