

# ARM

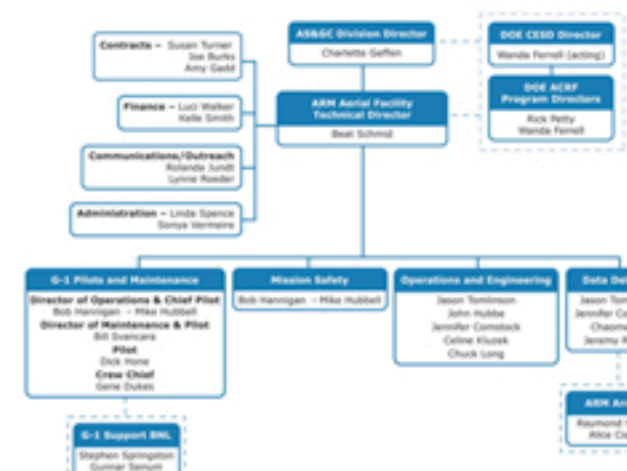
## Aerial Facility

Jason Tomlinson<sup>1</sup>, John Hubbe<sup>1</sup>, Jennifer Comstock<sup>1</sup>, Beat Schmid<sup>1</sup>, Stephen Springston<sup>2</sup> and Gunnar Senum<sup>2</sup>

### Abstract

The ARM Aerial Facility (AAF) provides airborne measurements to answer science questions proposed by the ASR Science Team and the external research community. The AAF operates a Gulfstream-1 (G-1) turboprop aircraft and has access to a multitude of research aircraft operated by other agencies. The G-1 is currently undergoing a number of improvements that will increase the flight time, increase the available research power, enable the aircraft to carry a total of 8 external probes, enable it to carry radiometers, and update the onboard data system. The AAF is in the process of acquiring 17 state-of-the-art cloud probes, aerosol instruments, and gas phase instruments through Recovery Act funding.

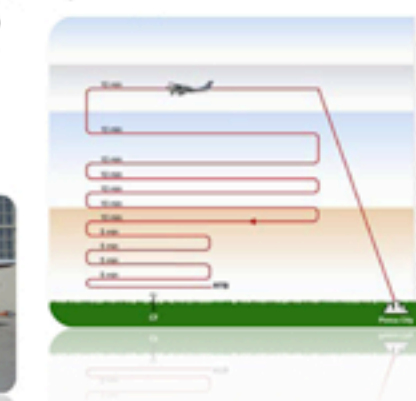
### Organizational Chart



### AAF Routine Flight Operations

#### ARM Airborne Carbon Measurement Experiment (ACME)

- Routine flights over the SGP site using a Cessna 206
- Measurements of carbon cycle gases and ozone



### AAF Funded Proposals

2007	2008	2009	2010	2010	2011	2012
Southern Great Plains Site	North Slope of Alaska Site	Southern Great Plains Site	Southern Great Plains Site	Sacramento, CA	Maturation and Hardening of Airborne Instrumentation	Ganges Valley India
The Cloud and Land Surface Interaction Campaign (CLASIC) <a href="http://campaign.arm.gov/clasic/">http://campaign.arm.gov/clasic/</a>	The Indirect and Semi-Direct Aerosol Campaign (ISDAC) <a href="http://campaign.arm.gov/isdac/">http://campaign.arm.gov/isdac/</a>	Routine AAF Clouds with Low Optical Water Depths (CLOWD) Optical Radiative Observations (RACORO) <a href="http://campaign.arm.gov/racoro/">http://campaign.arm.gov/racoro/</a>	Small Particles in Cirrus (SPARTICUS) <a href="http://campaign.arm.gov/sparticus/">http://campaign.arm.gov/sparticus/</a>	Carbonaceous Aerosol and Radiative Effects Study (CARES) <a href="http://campaign.arm.gov/cares/">http://campaign.arm.gov/cares/</a>	Integrating and test flying instruments purchased with Recovery Act funding aboard the G-1	Ganges Valley Aerosol Experiment (GVAX) Coordinated with AMF deployment

### AAF G-1



#### Aircraft Technical Information

- Length:** 63.75 feet (19.44 m)
- Wingspan:** 78.33 feet (23.88 m)
- Height:** 23.33 feet (7.11 m)
- Cabin space:** 165 square feet
- External probes (PMS cans, etc.):** 8
- Maximum gross weight:** 36,000 pounds (16,330 kg)
- Endurance with maximum fuel:** 6 hours
- Crew capacity:** 2 pilots, 1-4 scientists
- Cabin payload:** 4,200 pounds
- Research Power:** 500A @ 28 VDC (incl. 10 KVA @ 110 VAC, 60 Hz, 1-phase).



Configuration of the G-1 aircraft's cabin with instrumentation for the 2010 CARES field campaign

### AAF G-1 Upgrades

- Zenith looking port for radiometers
- Antenna
- Rolls Royce DART1860 Engines - More power (2.5%), greater fuel efficiency (10-12%), and higher operating ceiling
- Power distribution and inverter upgrade
- Data System – fanless brick computers, aircraft LAN upgrade, new KVM, SEA M300, and Labview based data acquisition
- Isokinetic Inlet (Brechtel Manufacturing, Inc.)



### AAF G-1 Deployments



### AAF Instrumentation

Instrument	Manufacturer	Measurement	Instrument	Manufacturer	Measurement
<b>Atmospheric and Aircraft State</b>			<b>Gas-Phase Instruments</b>		
Hygrometer - 0118	Rosemount	Temperature	Proton Transfer Reaction Mass Spectrometer (PTR-MS)	Ionicon Analytik	Concentration of volatile organic compounds
Tunable Diode Laser (TDL) Hygrometer	General Eastern	Dew-Point temperature	43 S Pulsed Fluorescence (fast response)	TEI	Concentration of SO <sub>2</sub>
Hygrometer - 1011C	MayCom	Absolute humidity	49 UV Absorption	TEI	Concentration of O <sub>3</sub>
Hygrometer - CR2	Buck	Dew-Point temperature	Mercury UV	BNL Build	Concentration of CO
SO <sub>2</sub> Probe	Rosemount	Absolute pressure	3 Channel NO/NO <sub>2</sub> /NO <sub>y</sub>	TEI	Concentration of NO/NO <sub>2</sub> /NO <sub>y</sub>
3000 GPS and DSH GPS	Rosemount	Absolute pressure	A2C	TEI	Concentration of CO <sub>2</sub>
Trendline Advanced Navigation System (TANS) Vector GPS	Trendline	Position and velocity	Mass Spectrometer	TAGA	Concentration of trace gases
C-INSIGHT III	System Donner	Aircraft altitude	Mass Spectrometer	API-365	Concentration of trace gases
Radiar Altimeter	Tetra	Journal Navigation System/GPS	3 Channel Radiance System	GC/EC	Concentration of H <sub>2</sub> O, RH <sub>2</sub> O
<b>Cloud Properties</b>			<b>Radiation</b>		
King Liquid Water Content	King	Liquid water content	UV Radiometer	Epply	UV irradiance
Particle Volume Monitor-100A (PVM-100A)	Gerber	Liquid water content	Pyranometer	PI-5	Surface/Sky IR temperature
Neovisor Probe	Sky Tech Research	Liquid water content	Pyranometer	Epply	Shortwave irradiance
Forward Scattering Spectrometer Probe (FSSP)	DMT	Size distribution 0.5 to 47.0 µm	Pyranometer	Epply	Longwave irradiance
Cloud Aerosol Precipitation Spectrometer (CAPS)	DMT	Particle images and size distribution 25 - 1500 µm	F-channel MultiFilter Radiometer (MFR)	Yankee	Short-wave spectral irradiance
Cloud Particle Imager (CPI) Version 2	SPEC	Liquid water content	IR thermometer - Model K11585	Helionics	IR temperature
Cloud Integrating Nephelometer (CIN)	Gerber	Optical extinction coefficient	IR thermometer - Model K11581	Helionics	IR temperature
<b>Aerosol Properties</b>			<b>Gas Phase Measurements</b>		
Passive Cavity Aerosol Spectrometer-100X (PCASP)	PHS	Size distribution 0.1 to 3 µm	Cavity Ring Down (CRD)	Picarro	Concentration of CO <sub>2</sub> , CH <sub>4</sub> , and H <sub>2</sub> O
Wavelength Integrating Nephelometer - Model 3563	TSS	Light scattering	Trace Gas System	BNL Build	Concentration of SO <sub>2</sub> , CO, O <sub>3</sub> , NO, NO <sub>2</sub> , and NO <sub>x</sub>
Particle Soot Absorption Photometer (PSAP)	Radiance	Light absorption			
Condensation Particle Counter (CPC) - Model 3010	TSS	Total aerosol concentration (>0.007 µm)			
Condensation Particle Counter (CPC) - Model 3025A	TSS	Total aerosol concentration (>0.003 µm)			
Particle in Liquid System (PILS)	BNL Build	Particle ionic composition			
Aerosol Time of Flight Mass Spectrometer (ATOFMS)	Aerodyne	Particle organic composition			
Tandem Scanning Electrical Mobility System (TSEMS)	BNL Build	Submicron size distribution			
Single Particle Soot Photometer (SP2)	DMT	Soot spectrometry			
Fast Integrated Mobility Spectrometer (FIMS)	BNL Build	Concentration of single particle chemical composition			
Time Resolved Aerosol Collector (TRAC)	PNL Build				

The majority of instrumentation in the tables above and to the left indicate the G-1 aircraft has been primarily focused on meteorological, aerosol, and gas-phase measurements. However with the AAF merger and funds from the Recovery Act, the capabilities of the aircraft in measuring cloud properties have been improved. By FY11, AAF will have one of the more state of the art suite of instruments for any atmospheric research aircraft within the United States of America.

### New AAF Instruments Acquired Through Recovery Act Funding

Instrument	Manufacturer	Measurement
<b>Atmospheric and Aircraft State</b>		
Multi Element Water Content System - WCH-2000	SEA	Liquid water content, total water content, and ice water content
Cloud Spectrometer and Impactor (CSI)	DMT	Total condensed atmospheric water content
<b>Integrated</b>		
Fast - Forward Scattering Spectrometer Probe (F-FSSP)	SPEC	Size distribution 2.0 to 47.0 µm
Cloud Droplet Probe (CDP)	DMT	Size distribution 2 to 50 µm
Fast-CDP (F-CDP)	SPEC	Size distribution 2 to 50 µm
2 Dimensional Soot Photometer (2D-S)	SPEC	Size distribution 10 to 3,000 µm
High Volume Precipitation Spectrometer version 3 (HVPS-3)	SPEC	Size distribution 400 to 50,000 µm
Cloud Particle Imager (CPI) Version 2	SPEC	Images of cloud droplets and ice
<b>Aerosol Properties</b>		
Ultra-High Sensitivity Aerosol Spectrometer (UHSAS)	DMT	Size distribution 0.055 to 1 µm
Scanning Mobility Particle Sizer	BNL Build	Size distribution 0.015 to 0.450 µm
Dual Column Cloud Condensation Nuclei Counter (Dual-CCNC)	DMT	Concentration of CCN at a specified supersaturation
Single Particle Soot Photometer (SP2)	DMT	Soot spectrometry
Photo-Acoustic Soot Spectrometer, 3 wavelength (PASS-3)	DMT	Light absorption and scattering
Humidigraph (HMS-3)	PNL Build	(RH)
Particle in Liquid System (PILS)	BNL Build	Particle ionic composition
Counterflow Virtual Impactor (CVI)	Revolutions/BNL Build	Sampling of cloud droplets
<b>Gas Phase Measurements</b>		
Cavity Ring Down (CRD)	Picarro	Concentration of CO <sub>2</sub> , CH <sub>4</sub> , and H <sub>2</sub> O
Trace Gas System	BNL Build	Concentration of SO <sub>2</sub> , CO, O <sub>3</sub> , NO, NO <sub>2</sub> , and NO <sub>x</sub>

### AAF Campaign Resources

AAF uses the ARM Wiki to share information and to foster collaboration amongst PIs



AAF will be providing merged data sets for ISDAC, RACORO, and all future field campaigns

AAF campaign journal keeps a running online record of campaign activities



Real Time Flight Monitoring in Google Earth



Flight Playback in Google Earth

