

ARM

CLIMATE RESEARCH FACILITY

Update on AAF and the G-1



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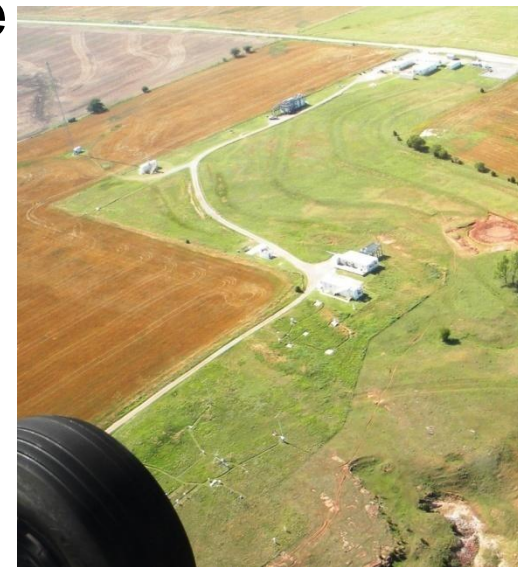


U.S. DEPARTMENT OF
ENERGY

Office of
Science

ARM Aerial Facility Campaigns

- CLASIC (Miller), SGP, June 2007
- ISDAC (Ghan/McFarquhar) NSA, April 2008
- RACORO (Vogelmann) ,SGP, Jan – June 2009
- SPARTICUS (Mace), SGP, Jan – June 2010
- ARM Airborne Carbon Measurement Experiment (Biraud) SGP, - Dec 2011
- CARES (Zaveri), Sacramento, CA; June 2010.
- So far worked with 13 different aircraft:



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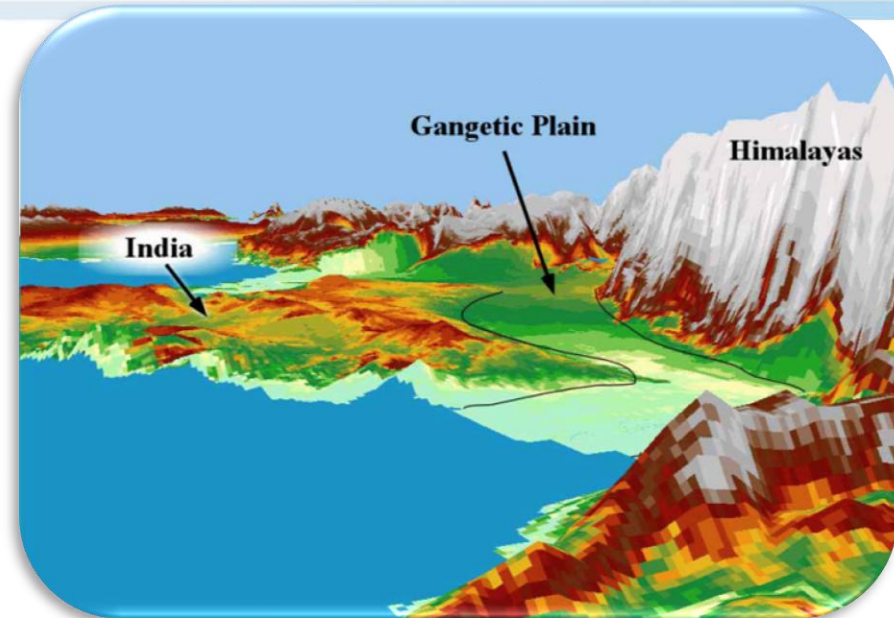
ER-2, Lear 25, P-3 (2), B-200, CV-580, J-31, G-1, Twin Otters (3), C206, Bell 206

Instrument Maturation– FY11

- **Airborne Open Polar/Imaging Nephelometer for Ice Particles in Cirrus Clouds** - J. Vanderlei Martins
- **Aircraft Integration and Flight Testing of 4STAR** - Connor Flynn
- **Further Development of the HOLODEC 2 (Holographic Detector for Clouds 2) Instrument** - Raymond Shaw
- **Parameterization of Extinction Coefficient in Ice and Mixed-Phase Arctic Clouds During ISDAC** - Alexei Korolev
- **The Maturation and Hardening of a Stabilized Radiometer Platform** - Anthony Bucholtz

FY 12 GVAX - Ganges Valley Aerosol Experiment

- Study the radiative impact of aerosols in the Indo-Gangetic Plain (Kotamarthi)
- Ground based:
 - ARM Mobile Facility
 - MAOS
 - Aerosol Super Site
- G-1 Aircraft:
 - provide vertical and horizontal context
 - aerosols and their precursors, clouds and solar radiation
 - 8 weeks starting Jan 15, 2012
- Additional Indian Assets



AAF Campaigns FY 12 -14

- Two Column Aerosol Project (Berkowitz), Cape Cod, MA (with AMF and MAOS)
 - G-1 in Summer 2012
 - G-1 in Winter 2012
- FY13, open slot to be competed with next ACRF call
- Amazon Basin (Martin), Brazil (with AMF and MAOS)
 - G-1 Jan/March 2014
 - G-1 Aug/Oct 2014

G-1 (BMI owned, ARM base funded, PNNL based and managed, for the science community)



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: 8 hours

Endurance with typical payload/fuel: 5- 6
hours

Crew capacity: 2 pilots, 3-5 scientists

Cabin payload: 4,200 pounds

Research Power: 700A @ 28 VDC (incl. 85A
@ 115 VAC, 60 Hz)

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New AAF Instruments - Recovery Act

Instrument	Source	Measurement
Atmospheric and Aircraft State		
Multi Element Water Content System - WCM-2000	SEA	Liquid water content, total water content, and ice water content
Cloud Spectrometer and Impactor (CSI)	DMT	Total condensed atmospheric water content
Aircraft Integrated Meteorological Measurement System (AIMMS-20)	Aventech, Inc.	5-port air motion sensing: true air, speed, altitude, angle-of-attack, side-slip, temperature, and relative humidity
Cloud Properties		
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 Stereo Probe (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

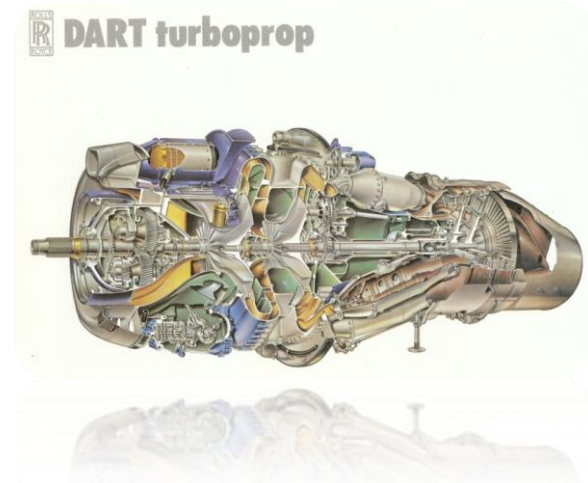
New AAF Instruments - Recovery Act

Instrument	Source	Measurement
Aerosol Properties		
Scanning Mobility Particle Sizer	BNL Build	Size distribution 0.015 to 0.450 μm
Ultra-High Sensitivity Aerosol Spectrometer (UHSAS)	DMT	Size distribution 0.055 to 1 μm
Dual Column Cloud Condensation Nuclei Counter	DMT	Concentration of CCN at 2 specified
Single Particle Soot Photometer (SP2)	DMT	Soot spectrometry
Photo-Acoustic Soot Spectrometer, 3 wavelength (PASS-3)	DMT	Light absorption and scattering
Humidigraph	PNNL Build	f(RH)
Particle in Liquid System (PILS)	BNL Build	Particle ionic composition
Counterflow Virtual Impactor (CVI)	Brechtel/PNNL	Sampling of cloud droplets
Gas Phase Measurements		
Cavity Ring Down (CRD)	Picarro	Concentration of CO ₂ , CH ₄ , and H ₂ O
Trace Gas System	BNL Build	Concentration of SO ₂ , CO, O ₃ , NO, NO ₂ , and NO _y

Recent Updates to G-1 Aircraft

■ Rolls Royce DART1860 Engines

- Noticeably quieter
- More power (~10%)
- Greater fuel efficiency (~20%)
- Higher operating ceiling (25kft)




Battelle
The Business of Innovation

■ Power distribution and inverter upgrade

- Higher capacity generators
- Higher capacity inverters
- 40% increase in available payload power

Battelle
The Business of Innovation

Enhanced Sampling Capability on G-1

- Wing Pylons (FAA Approved) 
- New Aerosol Inlet
- New CVI Inlet
- New tip designs to reduce shattering artifacts for all of our cloud probes



Enhanced Radiometry on G-1

4STAR

Battelle
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- Completed first test flights Sep 2010
- To be used in TCAP



Non-moving Radiometer Package (for India)

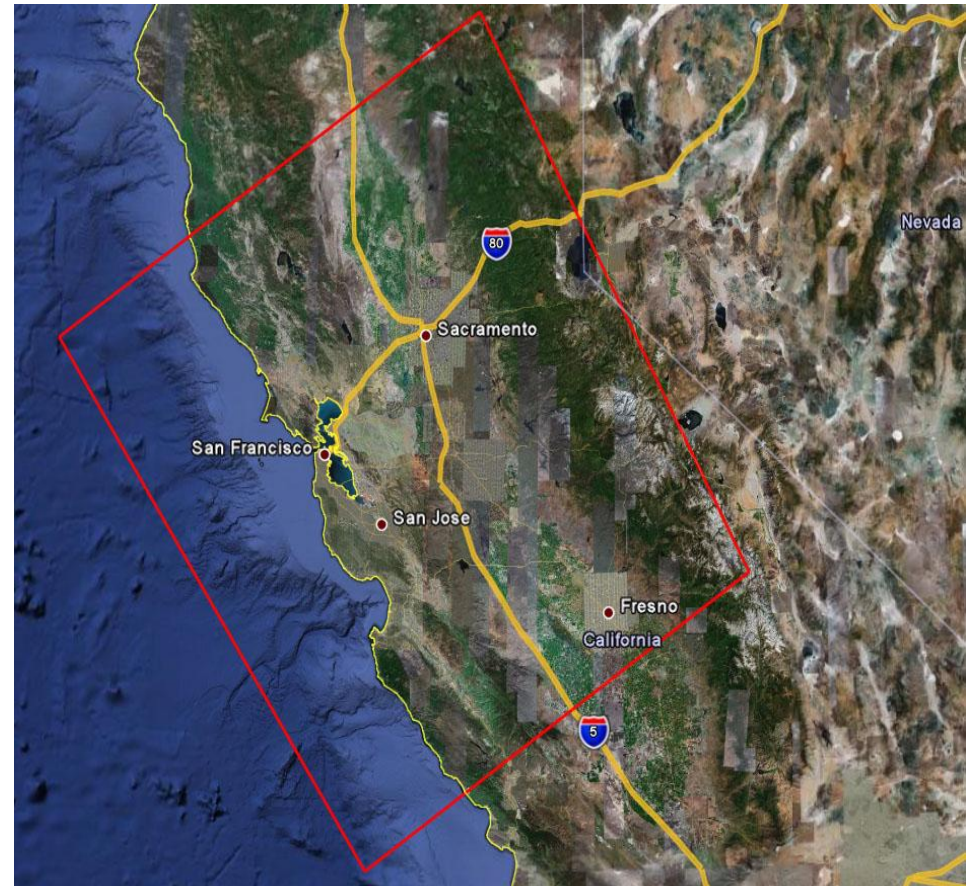
- MFR, SW, 5-wavelengths
 - SPN-1 shaded, SW broadband, diffuse and global
 - SPN-1 unshaded, SW broadband, global
-
- MFR, SW, 5-wavelengths
 - SPN-1 unshaded SW global, broadband
 - IR (Heitronics) IR broadband

Long C.N. et al. (2010). A Method of Correcting for Tilt from Horizontal in Downwelling Shortwave Irradiance Measurements on Moving Platforms. *The Open Atmospheric Science Journal*, 4, 78-87.

Calwater



- Investigating the effects of anthropogenic emissions on winter precipitation in the California Central Valley and Sierra Nevada mountain range
- 80 flight hours on the G-1 (incl. transit and test)
 - Feb 1 to March 7, 2011 (incl. transit days)
- Measurements
 - Atmospheric state, LWC/TWC, cloud microphysics, aerosols, and gases



Calwater G-1 Instrument Proposal

Instrument	Measurement	PI
Platform Pos/Vel/Attitude		
Trimble DSM	position/velocity @ ~10Hz	PNNL
Trimble TANS 10Hz	pitch/roll/azimuth	PNNL
C-MIGITS	inertial GPS	PNNL
Atmospheric State		
Rosemount 102 probe	temperature	PNNL
Rosemount 1201F1	static pressure	PNNL
Rosemount 1221F2 (3x)	differential pressure (dynamic, alpha, beta)	PNNL
GE-1011B chilled-mirror hygrometer	dew-point temperature	PNNL
AIMMS-20	wind and turbulence	PNNL
Liquid and Total Water Content		
Gerber PVM-100	liquid water content	PNNL/CIRPAS
CAPS-hotwire	liquid water content	PNNL/CIRPAS
DMT Cloud Spectrometer and Impactor (CSI)	total water content	PNNL
SEA total water WCM-2000	liquid water content, total water content	PNNL/CIRPAS
Cloud Microphysics		
HVPS-3	cloud droplets size distribution (400-50,000 μm)	PNNL
2DS	cloud droplets size distribution (10 – 3,000 μm)	PNNL
CIP (part of CAPS)	cloud droplet size distribution (25-1500 μm)	PNNL/CIRPAS
CDP (part of CSI)	large aerosol and cloud droplets (2-50 μm)	PNNL/CIRPAS
CAS (part of CAPS)	large aerosol and cloud droplets (0.5-50 μm)	PNNL/CIRPAS
Aerosol		
UCPC TSI 3025	total particle concentration (> 3 nm)	PNNL
CPC TSI 3010	total particle concentration (> 10 nm)	PNNL
PCASP	aerosol size distribution (100-3000 nm)	PNNL/CIRPAS
UHSAS-A	aerosol size distribution (55-1000 nm)	PNNL
DMT Cloud Condensation Nuclei (CCN) counter (dual SS)	CCN concentration	PNNL/CIRPAS
ATOF-MS	single-particle mass spectrometer	UCSD-Prather
Radiance Particle/Soot Absorption Photometer (PSAP)	aerosol absorption	PNNL
Nephelometer (TSI 3563)	aerosol scattering	PNNL
CFDC	ice nuclei concentration	CSU-DeMott

Calwater G-1 Instrument Proposal

Instrument	Measurement	PI
Sample Collection		
isokinetic inlet	sample stream of dry aerosol, sizes < 2.5um	PNNL
pumps for aerosol flow	maintains flow through aerosol inlet and internal plumbing.	PNNL
Counter-flow Virtual Impactor (CVI)	sample stream of cloud-droplet residuals	PNNL
Cloud Water Collector	collects cloud water	PNNL
Gases		
Thermo Electron 48C	Carbon Monoxide	PNNL
Thermo Electron 49	Ozone	PNNL
Other		
Weather radar	cockpit display of precipitation returns	PNNL
SEA Data System	Central Data System	PNNL
Iridium Satellite Modem	Limited data link to ground station	PNNL
Radar Altimeter	Altitude above surface	PNNL
TCAS	Traffic Collision and Avoidance System	PNNL
TAWS	Terrain Awareness and Warning System	PNNL
nose video camera	forward video images out wind screen	PNNL