ARM

CLIMATE RESEARCH FACILITY

Aerial Facility

Jason Tomlinson

Pacific Northwest National Laboratory

ICCAGRA Meeting

May 10, 2011

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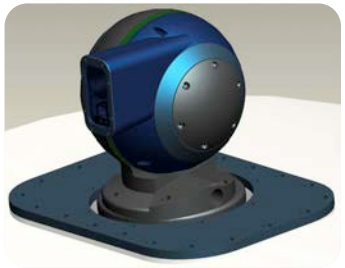
ARM Aerial Facility

- The AAF operation is multi faceted

Virtual hangar.
AAF has worked with 13 different aircraft



Instrument Operation and Development

G-1

We find the aircraft that suits the needs of the scientist!

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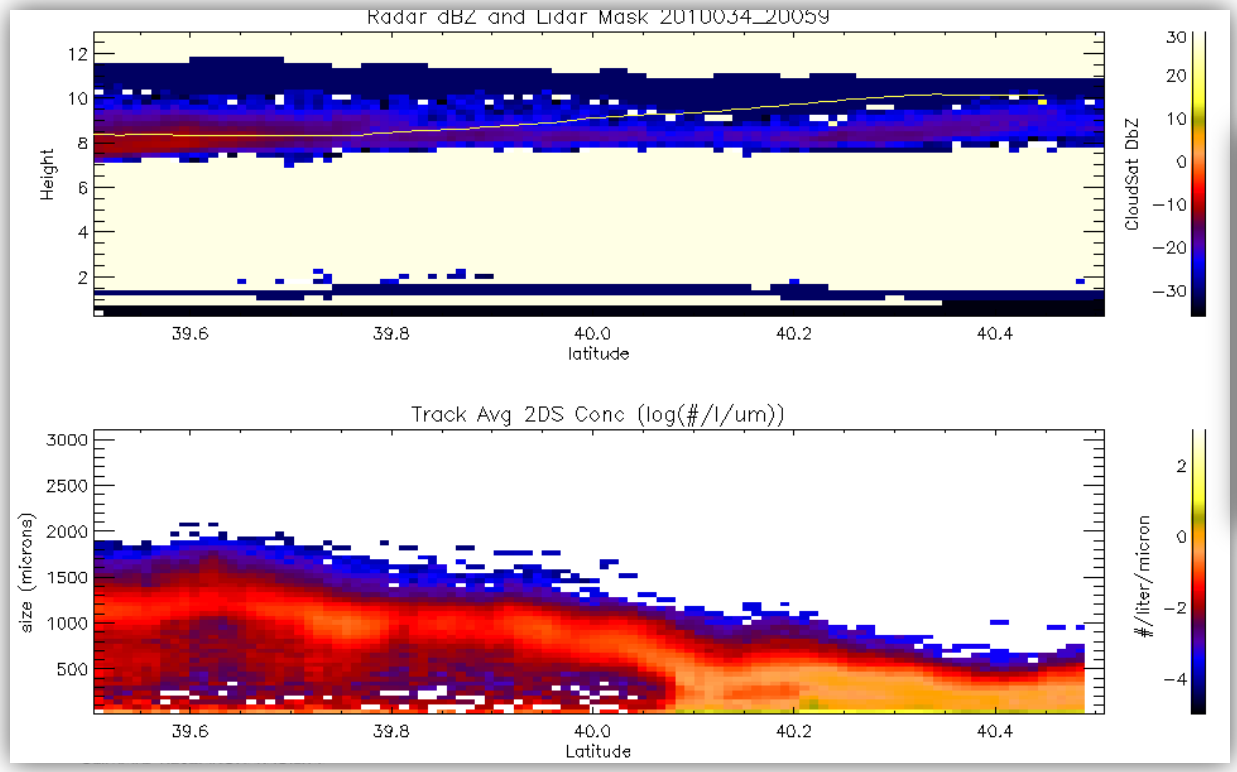
SPARTICUS – January to June 2010

- Routine aircraft in situ measurements in cirrus over DOE ARM Southern Great Plains Site - Total Hours: 200 hr (190 research / 10 test flight) over 47 Flight Days (1-3 flights per day)
  - 21 CALIPSO/CloudSat and 3 TERRA Flights



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AAF Instrumentation

- **Instrument Maturation– FY11**
  - **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
  - **Aircraft Integration and Flight Testing of 4STAR -** Connor Flynn
- **AAF Instrument Testing– FY11**
  - AAF procured 18 new instruments under the 2009 Recovery Act
  - Will be spending the rest of the fiscal year test flying the new instrumentation

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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 150 to 19,200 µm

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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_2O
Trace Gas System	BNL Build	Concentration of SO_2, CO, O_3, NO, NO_2, and NO_y

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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: **500A @ 28 VDC (incl. 77A @ 115 VAC, 60 Hz)**

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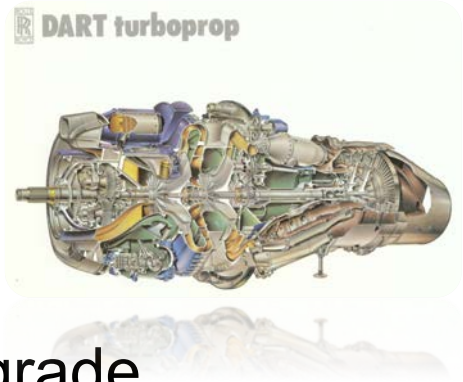
Updates to G-1 Aircraft

- 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 and more reliable inverters
  - 40% increase in available payload power

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The Business of Innovation

- Wing Tip Fuel Tanks planned this year

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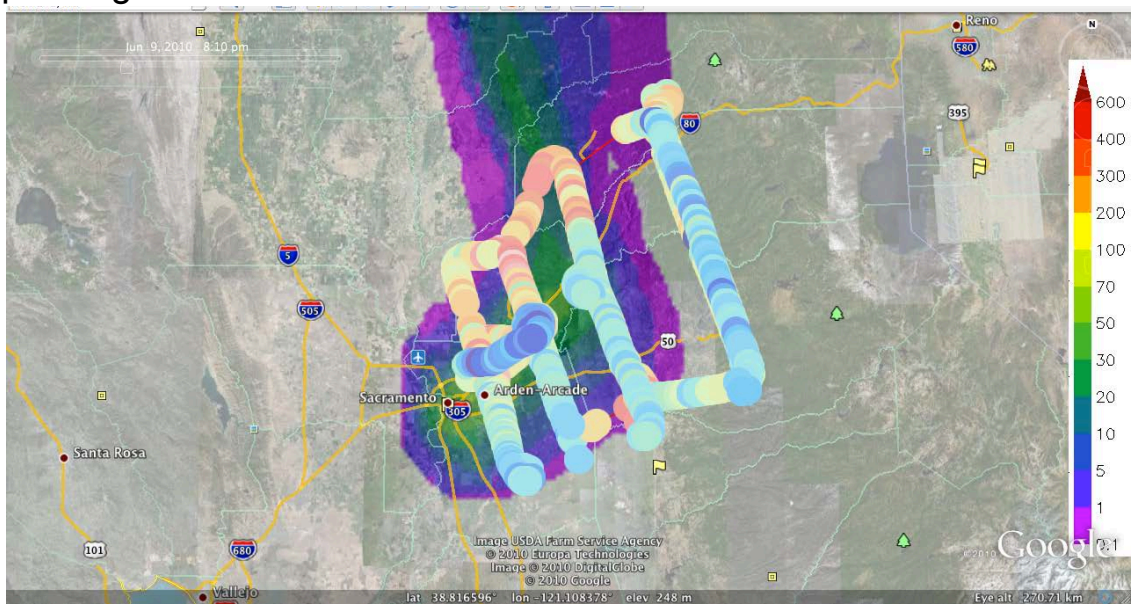
G1 Resources

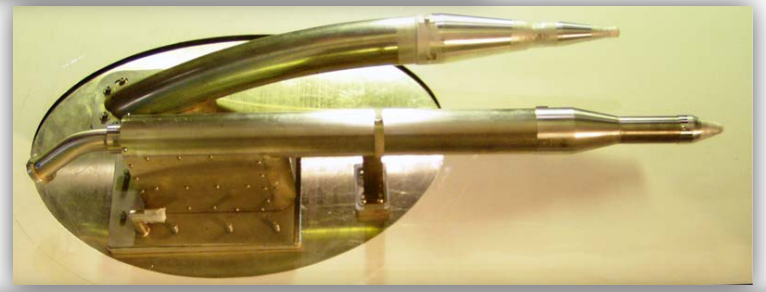
- RTMM - 5 variables right now are being sent down along with telemetry info
  - Will be pushing IWG1 both on the downlink and onboard data stream



- NTP uses IRIG-B. Everybody syncs before takeoff
- UltraVNC

Enhanced Sampling Capability on G-1

- Wing Pylons (FAA Approved)
  - Operated 8+ cloud probes during the CALWATER project
- New Aerosol Inlet
- New Counter-flow Virtual Impactor Inlet
- New tip designs to reduce shattering artifacts for all of our cloud probes



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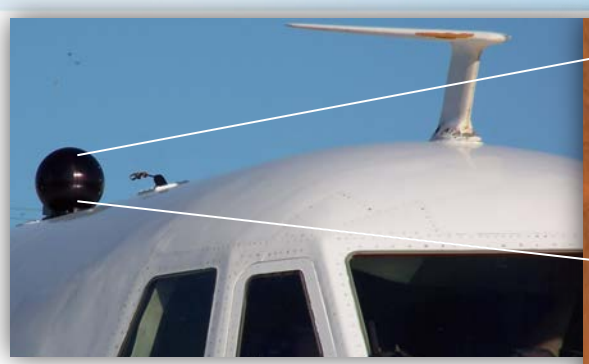
Enhanced Radiometry on G-1

- 4STAR
  - Completed two test flights
    - Sep 2010 and April 2011
  - To be used in Twin Column Aerosol Project (TCAP)
    - Direct Solar Beam and Sky-Scanning: Aerosol OD, Size Distribution, Absorption, Extinction, Cloud OD, H2O, O3

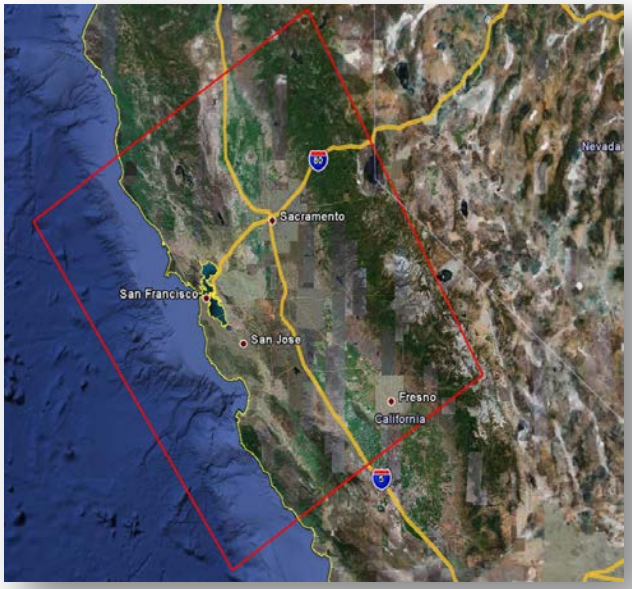


- Non-moving Radiometer Package (for TCAP)
  - MFR, SW, 415, 500, 615, 673, 870 ,940, and 1625 nm (albedo) spectral channels
  - SPN-1 unshaded SW global, broadband

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.

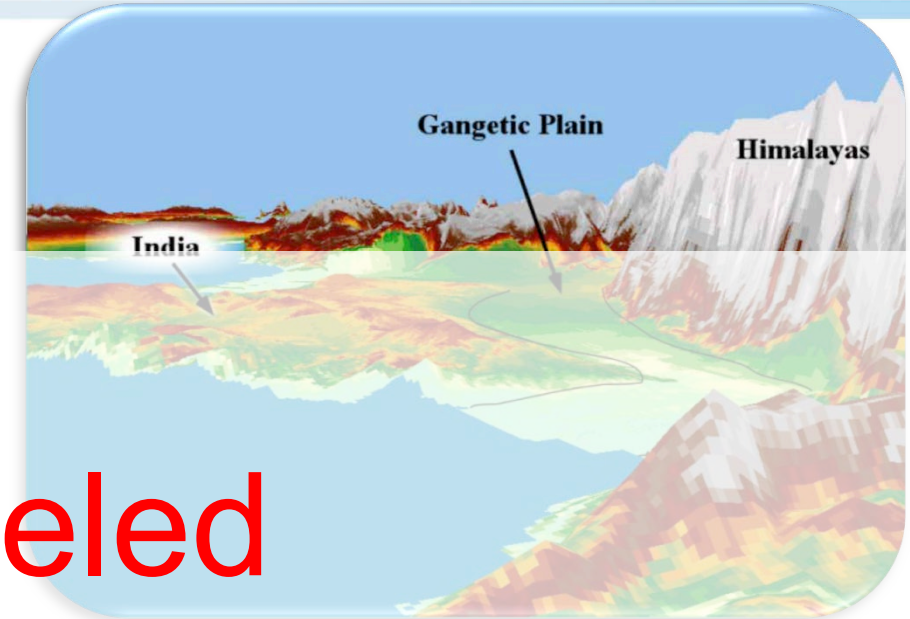
CalWater

- Investigated the effects of anthropogenic emissions on winter precipitation in the California Central Valley and Sierra Nevada mountain range
  - PI: K. Prather, UCSD
- 81 hours (incl. transit and test)
  - 28 flights, 70 hours on station
  - Feb 1 to March 7, 2011
- Atmospheric state, LWC/TWC, cloud microphysics, aerosols, and gases
  - First project for the 2D-S, HVPS-3, CSI, AIMMS-20, WCM, and CVI.

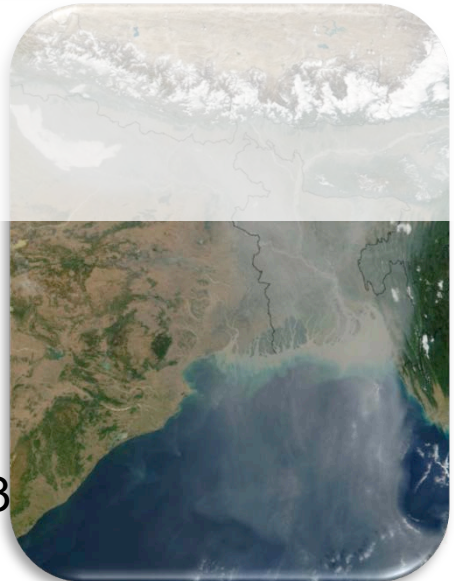


FY 12 GVAX - Ganges Valley Aerosol Experiment

- 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



Canceled



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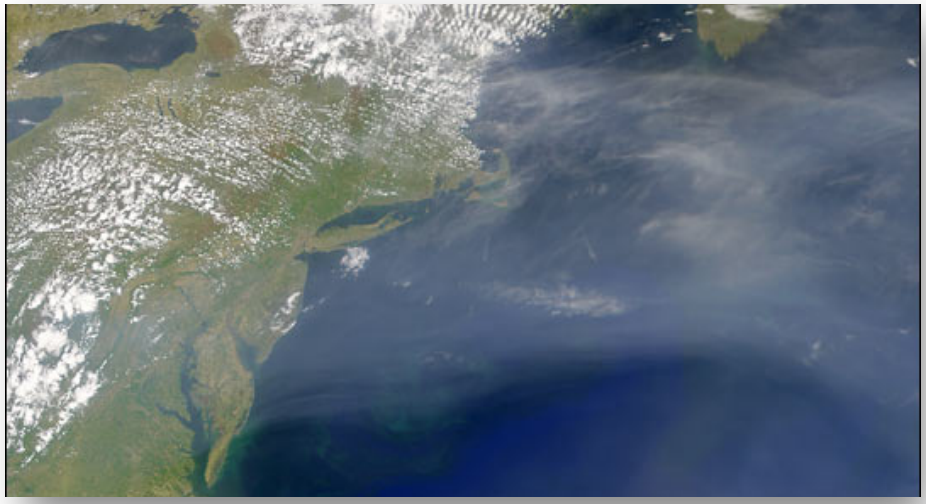
FY12 TCAP – Twin Column Aerosol Project

- PI: Carl Berkowitz (PNNL)
- Location: Cape Cod, MA
  - Barnstable Municipal Airport in Hyannis, MA.
- Mission Dates
  - IOP1: 3 weeks in July , 2012
  - IOP2: 3 weeks in February, 2013
- Payload
  - Aerosols, clouds, radiation and gases
  - Hopeful for the NASA B-200 (HSRL)



AAF Campaigns FY 13 -14

- FY13 will be announced this Fall
- FY14 Amazon Basin
  - PI: Scott Martin (MIT)
  - Two Deployments for the G1
    - G-1Jan/March 2014
    - G-1 Aug/Oct 2014
  - AMF and MAOS

More Information

ARM

http://www.arm.gov

Jason Tomlinson
Pacific Northwest National Laboratory
AAF Operations Lead
P.O. Box 999, K9-24
Richland, WA 99352
(509) 375-2715
jason.tomlinson@pnl.gov

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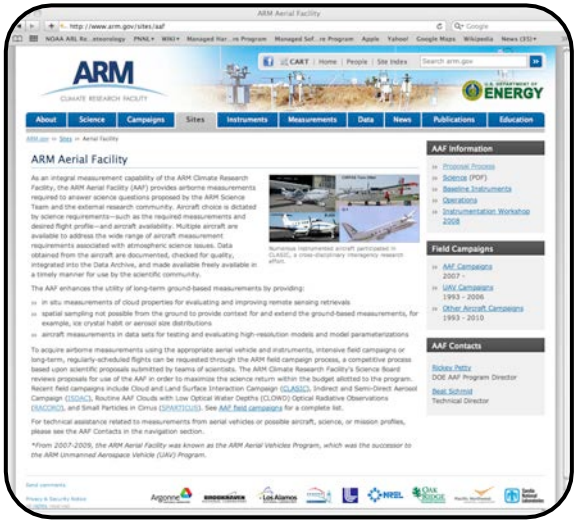

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G-1 TCAP Payload
(High Level Summary)

- Aircraft and Atmospheric State Parameters
- Trace Gases
  - H_2O (column and in-situ)
  - CO (in situ)
  - O_3 (column)
- Aerosol Properties
  - Total Concentration
  - Size Distribution (55 nm – 50 μm)
  - Cloud Condensation Nuclei Concentration
  - Hygroscopicity
  - Optical Properties (absorption, scattering, extinction, AOD)
  - Size resolved and single particle physico-chemical composition
- Cloud Properties
  - Liquid water, total water, ice water
  - Size Distribution (0.5 μm to 1.5 mm)
- Radiation
  - Upwelling hemispheric, spectral
  - Upwelling hemispheric, broadband
  - Direct beam irradiance and diffuse radiance angularly resolved