Interagency Coordinating Committee for Airborne Geosciences Research and Applications

DOE Collaborative Efforts

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ARM Aerial Facility

Consortium for Ocean Leadership

October 17, 2012

ARM CLIMATE RESEARCH FACILITY

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

ARM-UAV conducted 12 major field campaigns 1993-2006

Field Campaigns :

- Fall 1993, Edwards AFB, CA
- Spring 1994, Northern OK
- Fall 1995, Northern OK
- Spring 1996, Northern OK
- Fall 1996, Northern OK
- Fall 1997, Northern OK
- Spring 1999, PMRF Kauai, HI
- Summer 1999, Monterey, CA
- Winter 2000, Northern OK
- Fall 2002, Northern OK
- Fall 2004, North Slope, AK
- Winter 2006, Darwin, Australia

GA-ASI "GNAT 750"
(F93, S94)

Grob "Egrett"
(F95, S96)

GA-ASI "Altus I" (F96, F97)

GA-ASI "Altus II"
(Su99)

Twin Otter
(F93, S94, F95, S96, F96,
F97, Sp99, Su99, W00)

Proteus(F04, W06)

More Recent AAF Collaborative Efforts

CLASIC/CHAPS - 2007
CIRPAS Twin Otter, NASA P3, NASA ER2, NASA J-31, Twin Otter International, Duke University Helicopter Observation Platform, Cessna 206, NASA B-200 and DOE G-1

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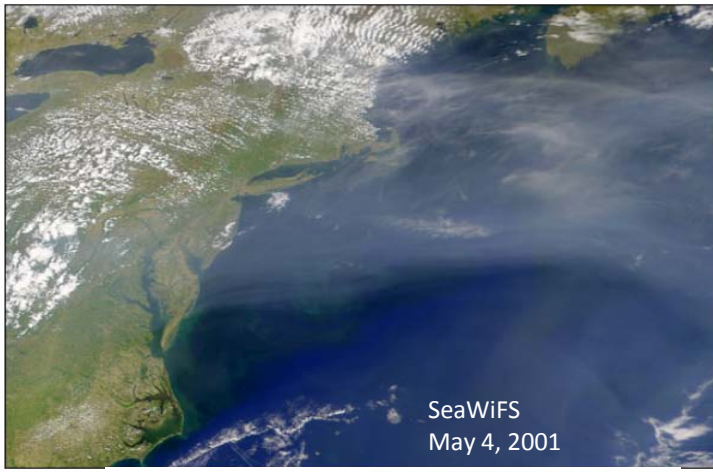
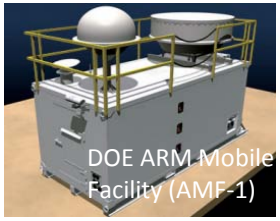
Two-Column Aerosol Project (TCAP)

- Cloud Condensation Nuclei (CCN) studies
  - Does size or composition matter
- Local and Columnar radiation closure study
  - AOD will be measured with a range of different instruments
- Cloud-aerosol interactions
  - Long time series with detailed information about particles
- High resolution modeling
- Climate modeling
  - How well does a climate model represent horizontal and vertical variability of anthropogenic aerosols and their impact on scattering and absorption?
  - What are the important factors?

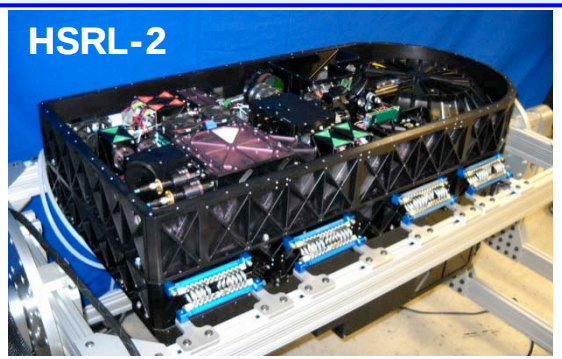


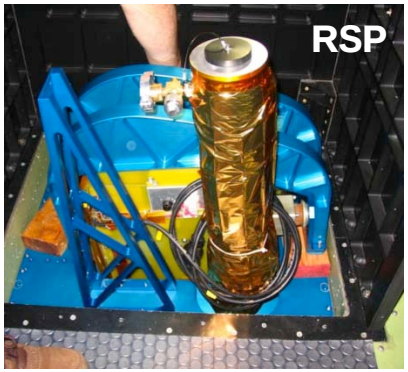


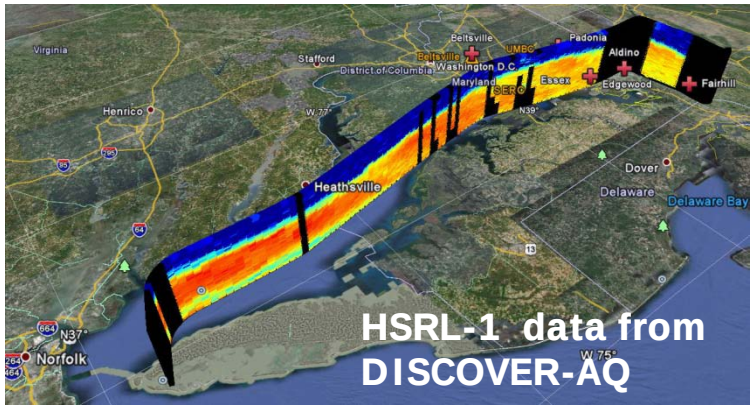
- Airborne (DOE G-1, NASA LaRC King Air)
- Surface (DOE AMF-1, MAOS)
- July 7-29, 2012
- Cape Cod, MA

NASA LaRC King Air Deployment for TCAP

- King Air deployed under DOE contract for TCAP
- Instruments
  - LaRC High Spectral Resolution Lidar (HSRL-2)
    - HSRL at 355 nm (interferometric technique) and 532 nm (iodine technique)
    - Backscatter lidar at 1064 nm
    - Depolarization at 355, 532, and 1064 nm
  - GISS Research Scanning Polarimeter (RSP)
    - Scanning multiwavelength polarimeter
    - Precursor to APS
    - Column measurements of aerosol and cloud optical and microphysical properties
- Objectives (DOE)
  - Provide vertical context to G-1 in situ measurements
  - Allows for determination of aerosol type and comparisons of aerosol optical thickness
  - Remotely measures curtains of aerosol properties
- Objectives (NASA)
  - Demonstrate technology and potential remote sensing strategy for ACE
  - Validate multiwavelength lidar "$3\beta+2\alpha$" aerosol retrievals
  - Investigate combined lidar+polarimeter retrievals of aerosols and clouds

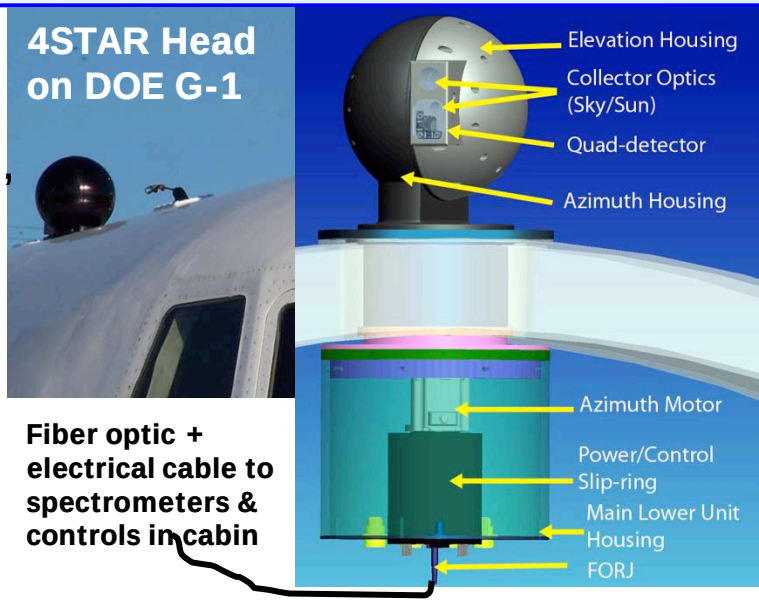


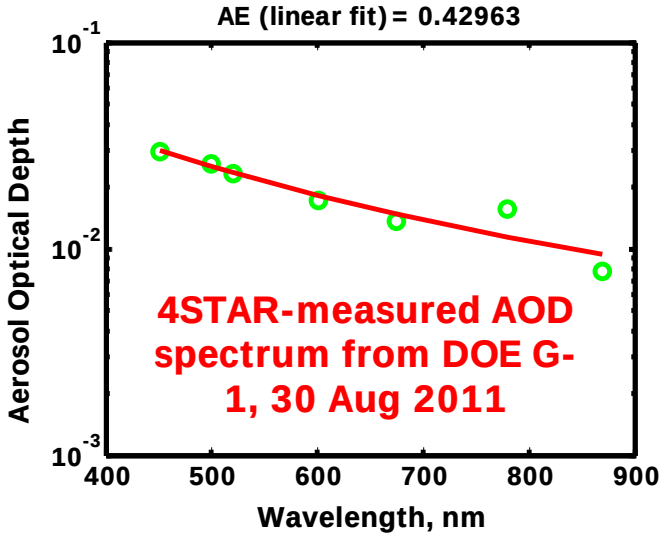




4STAR Deployment in TCAP

- 4STAR (Spectrometers for Sky-Scanning, Sun-Tracking Atmospheric Research) is a collaborative development by NASA Ames, Battelle PNW (PNNL), and NASA Goddard
- Instrument Features/Goals
  - AATS-like sun tracking
    - Aerosol Optical Depth (AOD) at 13 wavelengths
    - H_2O vapor column
    - Horizontally and vertically resolved
  - AERONET-like direct beam+ sky scanning
    - AOD
    - Size distributions (mode-resolved)
    - Single-scattering albedo (SSA)
    - Asymmetry parameter
    - Sphericity
    - Cloud OD from zenith-viewing mode
  - Hyperspectrally resolved (>1,000 channels) calibrated radiances
    - Better gas retrievals, hence better aerosol products
- TCAP Science Objectives for 4STAR
  - Local Radiation Closure Study (slab AOD from 4STAR compared to estimates from A/C in situ)
  - Columnar Radiation Closure Study (A/C AOD & column SSA compared to values from ARM Mobile Facility (AMF) radiometer





Future AAF Schedule

	G1 Available
	G1 Not Available (Deployment)
	G1 Not Available (Transition)

AAF G-1 Availability	CY2012												CY2013												CY2014												CY2015											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

- Twin Column Aerosol Project
  - PI: Carl Berkowitz/Larry Berg (PNNL)
  - Cape Cod, MA
- GoAmazon2014
  - PI: Scott Martin (MIT)
  - Manaus, Brazil
  - IOP1: Feb 15 - Mar 26 , 2014
  - IOP2: Sep 01 - Oct 10, 2014

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Future Collaborative Efforts

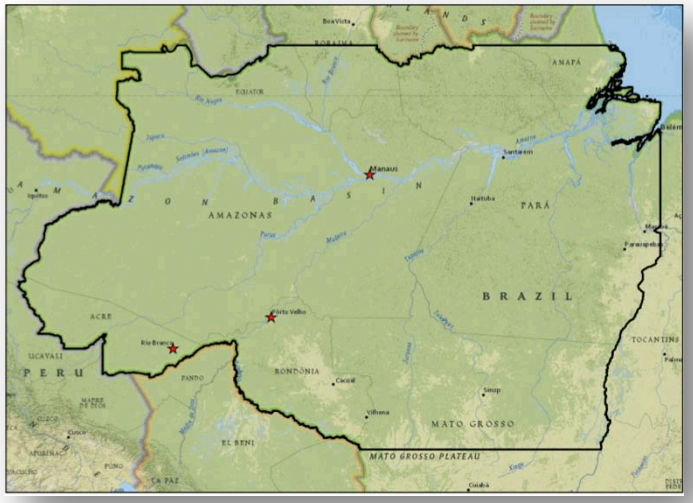
Go Amazon 2014

Domestic

- NSF may be entertaining proposals for ground site instrumentation

International

- National Institute for Space Research (INPE) - Embraer EMB-110B1
- DLR is considering bringing the HALO



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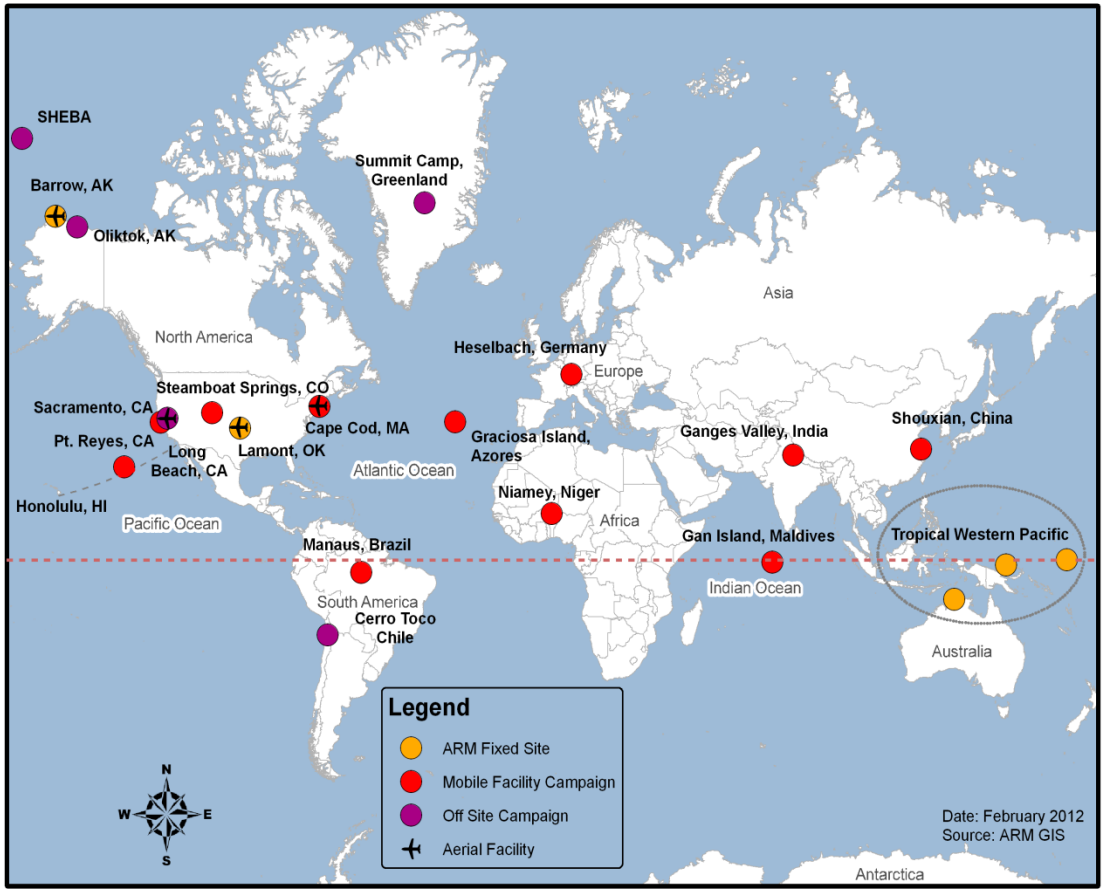
Summary of AAF Field Campaigns

AAF Campaign	Date	Ops Area	AAF Aircraft	Concurrent Campaign(s)	Coordinated Flights
IAP	2000-2006 2006-2007	Central OK	DOE Cessna 172 DOE Cessna 206	DOE CHAPS DOE CLASIC	CIRPAS Twin Otter
ACME	2008 - ongoing	Central OK	DOE Cessna 206	NASA CO	NASA Learjet
CLASIC	Jun-07	Central OK	NASA ER-2 NASA P-3 CIRPAS Twin Otter International Twin Otter Sky Research J-31 Dukes Bell 206 DOE Cessna 206	DOE CHAPS	DOE G-1 NASA B-200
ISDAC	Apr-08	Barrow, AK	NRC Canada CV-580 NASA B-200	NASA ARCTAS NOAA ARCPAC	
RACORO	Jan-June 2009	Central OK	CIRPAS Twin Otter NASA B-200		NASA B-200
SPARTICUS	Jan-July 2010	Central OK	SPEC Learjet		
CARES	Jun-10	Central CA	DOE G-1 NASA B-200	NOAA CALNEX	NOAA Twin Otter NOAA P-3
CALWATER	Jan/Feb 2011	Central CA	DOE G-1		
TCAP	July 2012 & February 2013	Cape Cod, MA	DOE G-1 NASA B-200		NASA B-200

Backup Slides

ARM's Global Reach



ARM's History with UAVs

- Demonstrated how measurements from UAVs contributed to the understanding of cloud and radiative processes.
- Data collected used in the study of radiative transfer processes through clouds, evaluation of cloud parameterizations, & development of cloud remote sensing methods.
- Total of 8 campaigns / 140h science flights/ 3 UAV platforms (**GNAT -750, Altus, and Altus II**).
- Stephens, G. L., Ellingson, R.G., et. al.; BAMS, Vol. 81, No. 12, December 2000.

ARM Aerial Facility (AAF)

- AAF provides airborne measurements required to answer science questions proposed by the ARM Science Team and the external research community.
- Aircraft choice is dictated by science requirements—such as the required measurements and desired flight profile—and aircraft availability.

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: 9.5 hours

Endurance with typical payload/fuel: 4-5 hrs

Crew capacity: 7 max**,** 2 pilots + 3-5 scientists

Cabin payload: 4,200 pounds

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

ARM Mobile Facility (AMF)

Measurement capabilities

- 95-GHz W-Band ARM Cloud Radar
- Balloon-Borne Sounding System
- Doppler Lidar, Micropulse Lidar, and Laser Ceilometer
- Microwave Radiometer Profiler
- Sky Radiation System
- Ground Radiation System
- Radar Wind Profiler
- Aerosol Observing System
- Surface Meteorology Station
- Eddy Correlation System
- W- and Ka-Band Scanning ARM Cloud Radar (AMF1)
- X-and Ka-Band Scanning ARM Cloud Radar (AMF2)

Shouxian, China (2008)