



ARM Climate Research Facility

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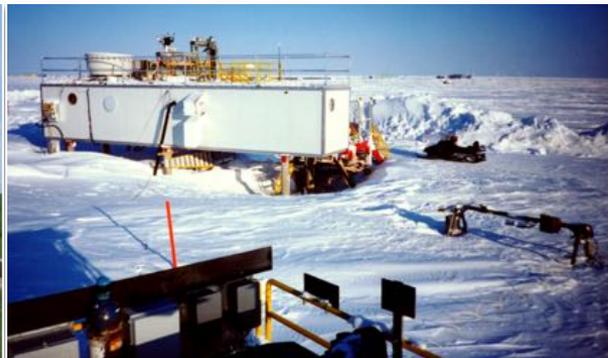
Lower Atmospheric Observing Facilities Workshop,
Boulder, CO, June 18, 2012

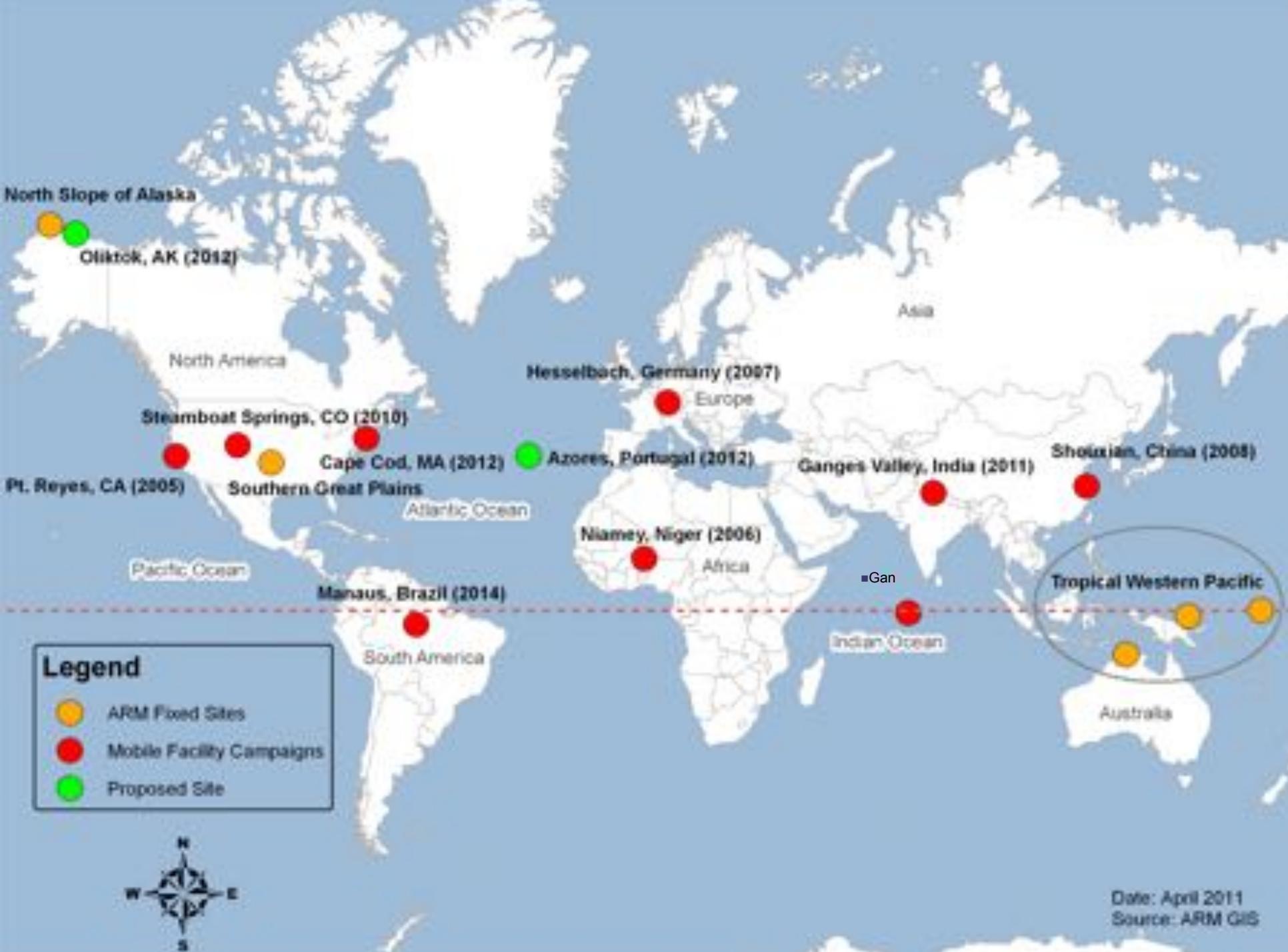
ARM Climate Research Facility

- **The Atmospheric Radiation Measurement (ARM) Climate Research Facility is a DOE Office of Science user facility available to academic, DOE national lab, and international research community**
- **ARM provides unique, continuous, long-term measurements for innovative research to address two largest uncertainties in climate models: the role of clouds and aerosols in climate change**

ARM Climate Research Facility

- **Atmospheric Radiation Measurement (ARM) Climate Research Facility provides remote sensed and in situ measurements of cloud, aerosol, precipitation and radiation in key climatic locales**
 - fixed locations, mobile facilities, and aerial facility
- **Long-term climate data are critical for improving model representations of interactions among aerosols, clouds, precipitation, and radiation.**
 - 24/7 data collection
 - Near real time data availability





Legend

- ARM Fixed Sites
- Mobile Facility Campaigns
- Proposed Site



Date: April 2011
Source: ARM GIS

Two New ARM Sites in 2013



Azores

The **Azores** are an island group in the **Eastern North Atlantic (ENA)** ocean in a region characterized by marine stratocumulus. Marine stratocumulus have a strong influence on climate yet are poorly represented in global climate models.



Oliktok Point

The **Oliktok Point** site is located approximately 300 km Southeast of the existing ARM site in Barrow and provides an opportunity to link coastal conditions from the standard ARM measurement suite with near-coast conditions using an **Unmanned Aerial System (UAS)**.

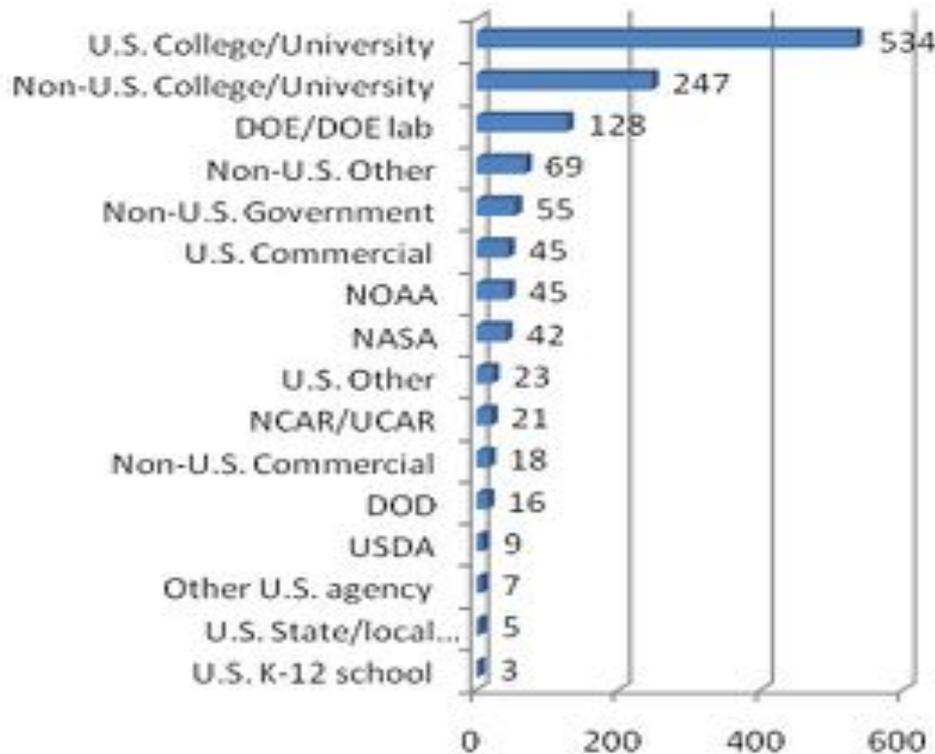
- Sites scheduled to come on line by September 2013
- The facility at Oliktok Point is a mobile facility deployed for an extended term
- Instruments at these sites match those found at other sites including many of the enhancements added through the Recovery Act and plans to add Unmanned Aerial component at Oliktok

ARM Climate Research Facility— significant accomplishments

- **Improved the representation of radiation in climate models**
Scientists using ARM data developed an improved radiative transfer code that has been incorporated in the major U.S. and international climate models.
- **Improved water vapor measurements**
ARM scientists reduced measurement uncertainties of water vapor (the greenhouse gas with largest impact) from greater than 25% to less than 3%.
- **Develop a model diagnostic tool**
ARM and Climate Modeling Program jointly developed a diagnostic tool for evaluating general circulation models (GCMs) using weather prediction techniques.
- **Data used by international modeling groups**
ARM data are being used for development and diagnostics by modelers in Australia, the UK, France, Japan, Germany, and Canada

Facility Data Archive Users

Number of Active Users by Institution Type
FY08 - FY10



- 400+ institutions worldwide
- 178 total colleges/universities
 - 92 US colleges/universities
 - 85 non-US colleges/universities
- 65 countries

Submitting a Proposal

How Do I Propose a Campaign?

First, review the guidelines for submitting proposals. See details at <http://www.arm.gov/campaigns>

Next, submit a pre-proposal; a short summary of the proposed campaign. Due date is February 1. Should identify science goals and how the ARM facility will help meet those goals.

Wait for a response from the Infrastructure Management Board (IMB). A full proposal may be requested. Proposals are due on May 1.

Full proposals are reviewed by the ARM Science Board, a panel comprised of ASR leadership and independent scientists. The science board meets in August to discuss reviews.

Decision is made circa October.

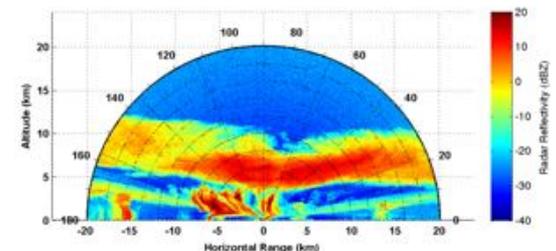
Measurements and Instruments

Baseline Capabilities

- Cloud profiles: millimeter radar and lidar
- T/RH/Wind profiles: radiosondes
- Column water: microwave radiometer
- Column aerosol: solar spectral radiometer
- In situ aerosol optical and cloud nucleation properties
- Surface radiation budget
- Surface meteorology

New Measurements as of 2011

- 3-dimensional measurements of cloud scale dynamics, microphysics, and precipitation
- Enhanced measurements atmospheric aerosol absorption, scattering, composition and chemistry
- Improved measurements of humidity and vertical motion
- Expanded in-house capabilities for airborne measurements



Lidars

Micropulse Lidar (MPL): Deployed at all sites, 532 nm lidar, dual-polarization, range to tropopause+

Vaisala CL31 Ceilometer: Deployed at all sites, provides cloud base to 7 km

Doppler Lidar: Deployed at the Southern Great Plains, Darwin, AMF1, 1.5 micron scanning lidar, used primarily to observe vertical motion in the boundary layer

Raman Lidar: Deployed at the Southern Great Plains and Darwin, a UV lidar with elastic backscattering as well as nitrogen and water vapor Raman scattering detection.

High Spectral Resolution Lidar: Deployed at Barrow and the AMF2, 532 nm locked to an Iodine line, provides profiles of optical thickness and extinction



mm/cm-Wavelength Radars

- X-Band Precipitation ●
- C-Band Precipitation ●
- Ka-X Band Cloud ●
- Ka-W Band Cloud ●
- Ka-band Zenith Upgrades ●

- SGP ● ● ● ●
- NSA ● ● ●
- TWP-Darwin ● ●
- TWP-Manus ● ● ●
- AMF2 ●
- AMF1 ●



Radars represent the largest portion of the Recovery Act investment. ARM will soon operate 25 radars (not counting profilers) ranging from 5 GHz to 94 GHz. It is the most complex and one of the largest radar networks in the world.

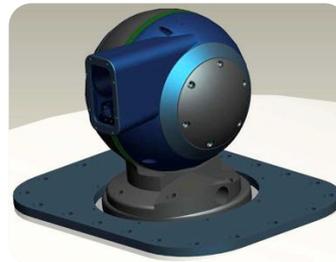


ARM Aerial Facility

The AAF operation is multi faceted



Virtual hangar



**Instrument
Operation and
Development**



G-1

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

Components of the ARM Aerial Facility



Virtual Hangar + Instrumentation + G-1

- CLASIC, Oklahoma; 6/2007
- ISDAC, Alaska; 4/2008
- RACORO, Oklahoma; 1–6/2009
- SPARTICUS, Oklahoma; 1–6/2010
- ARM Airborne Carbon Measurement Experiment, Oklahoma, 2008 - 2013
- So far worked with 13 aircraft:
 - ER-2, Lear 25, P-3 (2), B-200, CV-580, J-31, G-1, Twin Otters (3), C206, Bell 206

- Legacy
- Recovery Act
- PI's
- Maturation Program

- PNNL since 1989
- ARM since 2010
- CARES, Sacramento, 6/2010
- CALWATER, Sacramento, 2-3/2011

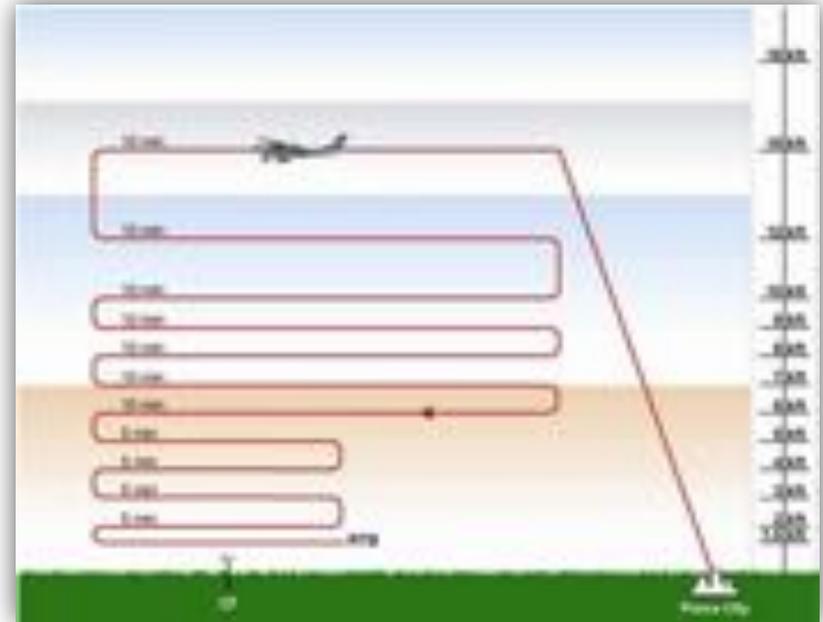
Planned

- Cape Cod 7/2012 & 2/2013
- Brazil 2x in 2014

ARM-ACME (2008-2013)

ARM Airborne Carbon Measurement Experiment (ACME)

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



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 hours

Crew capacity: 2 pilots, 3-5 scientists

Cabin payload: 4,200 pounds

Research Power: 600A @ 28 VDC (incl. 100A
@ 115 VAC, 60 Hz)

Enhanced Sampling Capability on G-1



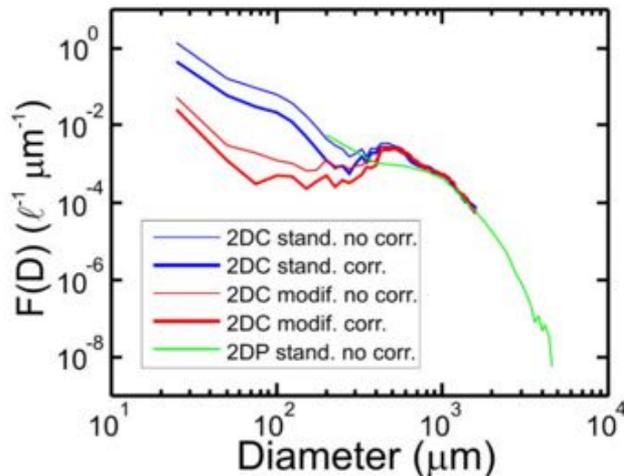
▶ New Aerosol and CVI Inlets



▶ Wing Pylons (FAA Approved)



- New tip designs to reduce shattering artifacts for all of our cloud probes (Korolev design)



Future AAF Schedule



- 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

