



# **ARM Climate Research Facility**

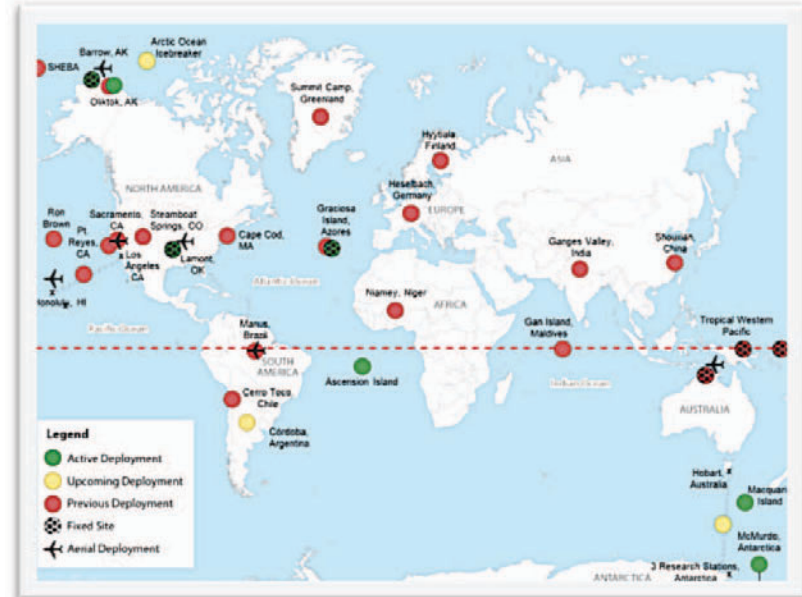
**Jim Mather**  
**ARM Technical Director**

**GEWEX Data and Assessments Panel**  
**Annual Meeting**  
**Washington, DC**  
**November 30, 2016**

# ARM Mission: Providing Atmospheric Observations in Diverse Climate Regimes

The ARM Climate Research Facility, a DOE scientific user facility, provides the climate research community with strategically located in situ and remote sensing observatories designed **to improve the understanding and representation, in climate and earth system models**, of clouds and aerosols as well as their interactions and coupling with the Earth's surface.

?



Southern Great Plains



North Slope of Alaska



Eastern North Atlantic

# Current Mobile Facility Deployments



## Layered Atlantic Smoke Interactions with Clouds (LASIC)

Ascension Island in the Southeast Atlantic (8S, 14W) experiences high frequency of marine stratocumulus coupled with biomass plumes from the African continent providing a laboratory to study aerosol-cloud interactions.

## ARM West Antarctic Radiation Experiment (AWARE)

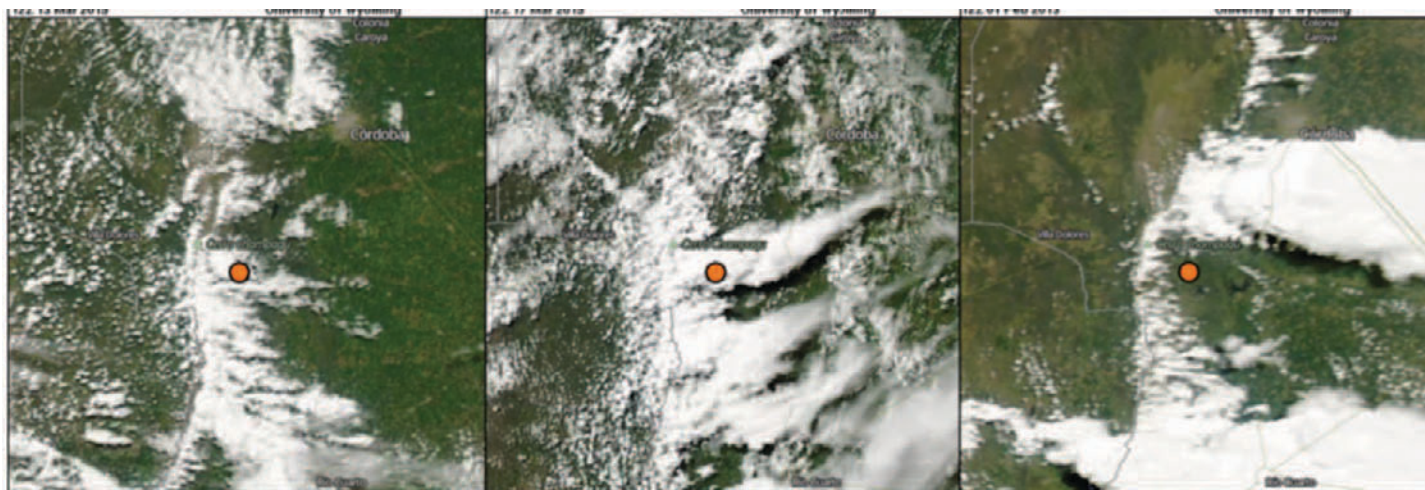
Observations at McMurdo & the West Antarctic Ice Sheet to study clouds & their impact on the surface energy balance.





# Upcoming Deployments/Campaigns

- Aerosol and Cloud Experiments in the Eastern North Atlantic (ACE-ENA) – June 2017, January 2018
- Measurements of Aerosols, Radiation and Clouds over the Southern Ocean (MARCUS) – September 2017
- Clouds, Aerosol, and Complex Terrain Interactions (CACTI) – September 2018
- Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAIC) - September 2019



# Aerial Measurements



The G-1 is deploying this summer to the Azores in 2017/18.

**ARM Aerial Facility (AAF) provides extensive in situ measurements using a broad array of platforms:**

- Gulfstream G-1 aircraft; assessing succession
- *DataHawk* small unmanned aerial systems (UAS)
- *Arctic Shark* mid-size UAS (2017)
- Tethered balloon systems (TBS; managed by Sandia)



CLIM.

Datahawk UAS



Arctic Shark



Tethered Balloon

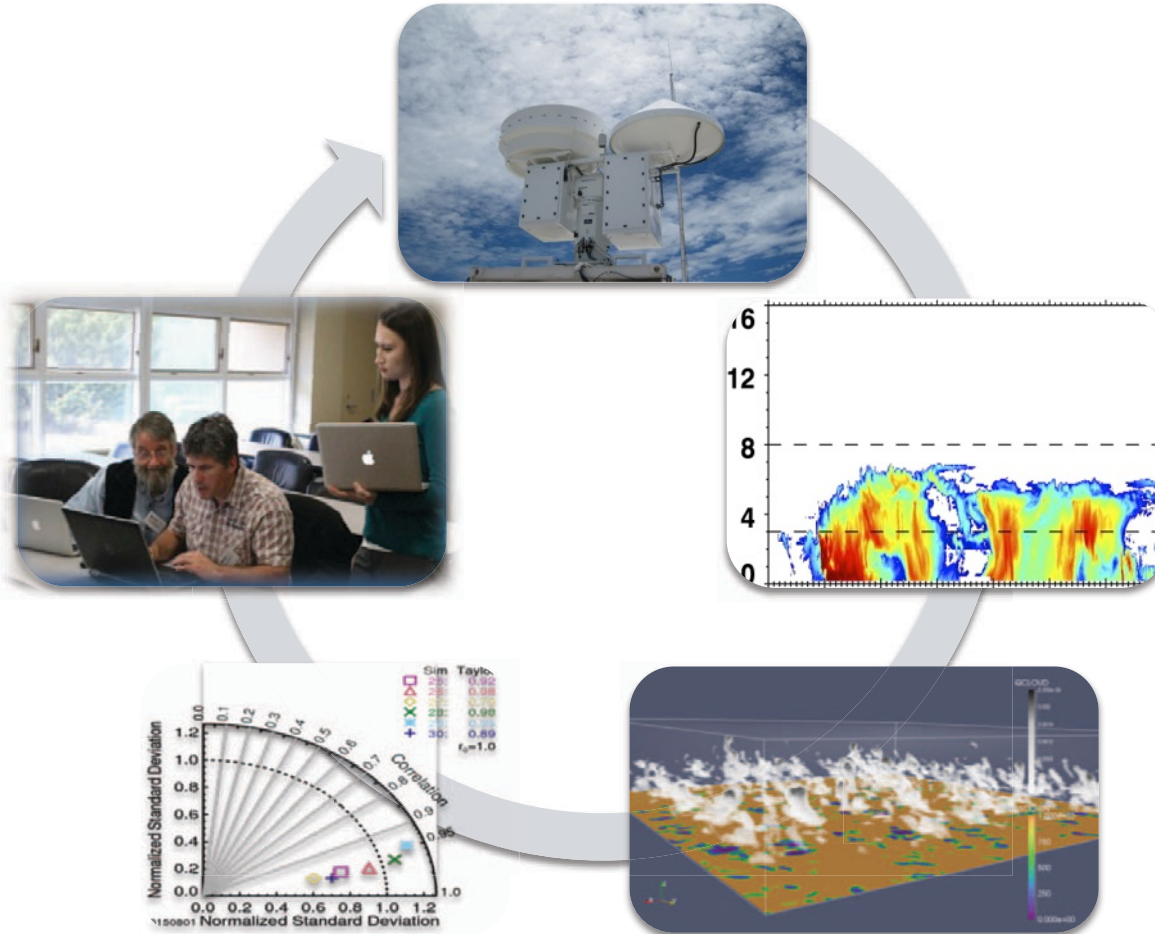


# Integrating Observations and Models



Decadal vision outlines strategy to address next-generation science questions.

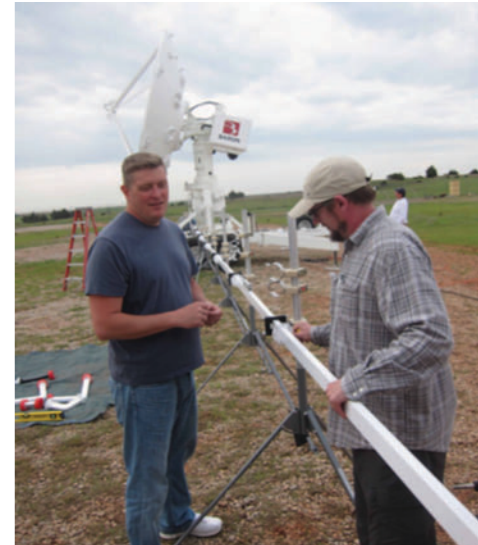
- Optimize measurement facilities to better support high-resolution modeling
- Implement high-resolution modeling at ARM sites
- Develop diagnostic data products to bridge observations and models



Comprehensive strategy to integrate ARM observations and model simulations.

# Other Measurement Developments

- X-band radar about to go-online in Azores
- Deploying new solid precipitation sensors at Oliktok and Barrow
- Developing photogrammetry measurements at the SGP
- 3- $\lambda$  lidar technique for aerosol profiling tested using observations from SGP (Raman + HSRL; CHARMS)
- Reviewing/improving complex instrument ops
  - Six months into intensive radar plan
  - Reviewing aerosol measurement strategy
  - Reviewing segregation of core and episodic measurements



# Data Product Activities

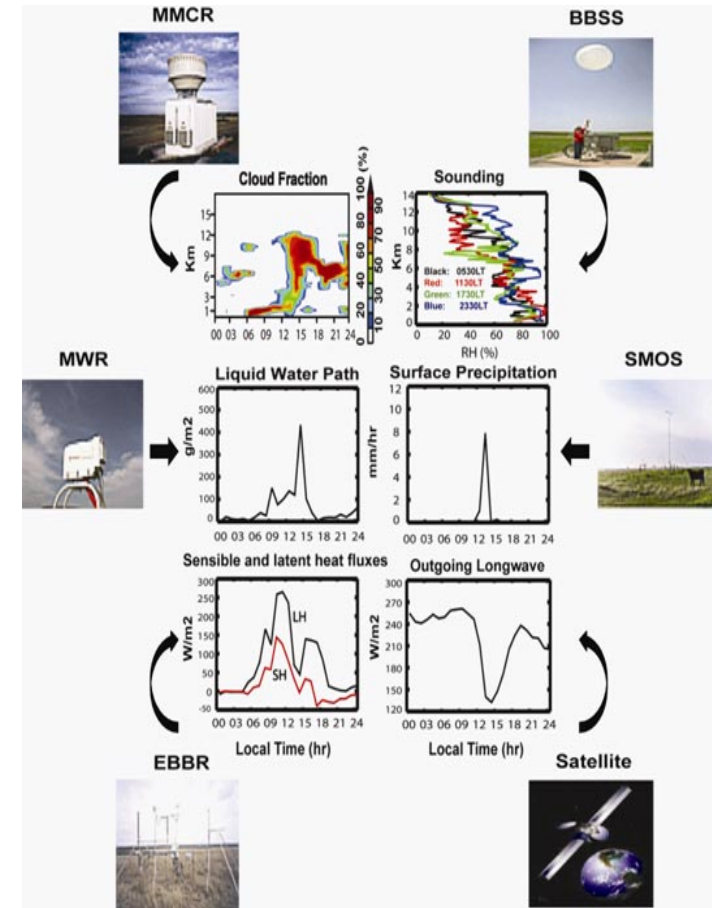
- Best estimate cloud retrieval + associated framework
- Scanning radar products including quasi-vertical profiles of polarimetric variables
- Radar – higher-order radar spectral moments
- Drivers (e.g. moisture tendencies) and diagnostics (e.g. liquid water path) for the model-observation framework



# ARM Best Estimate (ARMBE)

Hourly Averages of Core Parameters  
Currently Available at SGP, NSA, TWP, ENA

- **ARMBE-ATM**
  - P, T, RH, U Profiles
  - Surface sensible and latent heat fluxes
  - Surface precipitation
- **ARMBE-CLDRAD**
  - Cloud fraction profiles (Radar/lidar)
  - Integrated cloud fraction
  - Liq. Water Path/Precipitable Water
  - Surface radiative fluxes
- **ARMBE-LAND (SGP only)**
  - Soil temperature and moisture



Xie et al. 2010, BAMS

# ARM Web Site

- Updated site to be released in December
- Reorganized to support reconfiguration
- Better support for collecting feedback and sharing current activities
- Virtual tours for SGP, NSA, and ENA
- Other improvements in process including:
  - Search
  - Instrument pages



# Data Discovery Tool

# DATA DISCOVERY

SEARCH RESULTS

[HOME](#)
[DATA SEARCH](#)
[DATASTREAM SEARCH](#)
ARM DATA ARCHIVE // HELP // FEEDBACK

SEARCH

Search Text:

Start Date: End Date:

(Start Date) (End Date)

[Expand All] [Close All] Clear » Apply »

CATEGORIES 2

- ☐ Cloud Properties 64
- ☐ Atmospheric State 18
- ☒ DATA PRODUCTS 23
- ☒ SUBCATEGORIES 4
- ☒ MEASUREMENTS 8
- ☒ SITES 1
- ☒ FACILITIES 1
- ☒ SOURCES TYPES 2
- ☒ SOURCE 4
- ☒ DATASTREAMS 23

Home / Data Discovery

## Search Results

To search for and request data, select a category, measurement, site, or source. Use the Start Date and End Date below to limit the data results timeline. Use the checkboxes below to add a data product to the Data Cart.

✕ Remove All
✕ Search: arsl
✕ Sites: North Slope Alaska (Permanent)

☒ ROUTINE DATA
 ☒ PI / CAMPAIGN DATA

DATA UNRELIABLE
 DATA QUESTIONABLE
 DATA MISSING
 DATA NOTE
 LIMITED ACCESS

1998-03-24
  2014-02-06
 Applies to this timeline view only.
 Sort by: Priority

Showing 1-20 of 82 measurements Page Size: 20

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>arsl1cloth c1 @ nsa C1 // ARSL: multiple outputs from first Clothiaux algorithms on Vaisala or Belfort ceilometers, Micropulse lidar, and M...</b>																
<input type="checkbox"/>	★ 1 <b>Cloud base height</b> // CloudBase, Best estimate															
<input type="checkbox"/>	<b>Cloud base height</b> // Cloud Mask Occurrence, MPL Campbell et al. algorithm															
<input type="checkbox"/>	<b>Vertical velocity</b> // MMCR Mean Doppler Velocity															
<input type="checkbox"/>	<b>Radar reflectivity</b> // MMCR Reflectivity															
<input type="checkbox"/>	<b>Radar reflectivity</b> // MMCR Reflectivity, Best estimate, Hydrometer															
<input type="checkbox"/>	<b>Radar reflectivity</b> // MMCR Reflectivity, clutter removed															
<b>arslkazr1kollas c1 @ nsa C1 // KAZRARSL: multiple outputs from first Kollias algorithm</b>																
<input type="checkbox"/>	<b>Cloud base height</b> // Cloud base best estimate, based on ceilometer and micropulse lidar															
<input type="checkbox"/>	<b>Radar reflectivity</b> // Reflectivity															



# Data Discovery Tool

**ARM** CLIMATE RESEARCH FACILITY

## DATA DISCOVERY

SEARCH RESULTS

ARM DATA ARCHIVE // HELP // FEEDBACK

HOME DATA SEARCH

SEARCH

Search Text: Search for...

Start Date: End Date: (Start Date) (End Date)

[Expand All] [Close All]

CATEGORIES

- Cloud Properties
- Atmospheric State
- DATA PRODUCTS
- SUBCATEGORIES
- MEASUREMENTS
- SITES
- FACILITIES
- SOURCES TYPES
- SOURCE
- DATASTREAMS

CAMPAIGN PRODUCT > **ARSCL1CLOTH**

ARSCL: MULTIPLE OUTPUTS FROM FIRST CLOTHIAUX ALGORITHMS ON VAISALA OR BELFORT CEILOMETERS, MICROPULSE LIDAR, AND MMCR

North Slope Alaska // Central Facility, Barrow AK  
1998-03-25 ⇒ 2011-03-23

DOI: <http://dx.doi.org/10.5439/1027282>

SOURCE INSTRUMENT Active Remotely-Sensed Cloud Locations

DATA PROCESSING LEVEL(S): c1

Data Plots

DATA UNRELIABLE DATA QUESTIONABLE DATA MISSING DATA NOTE LIMITED ACCESS

2014-02-06 Applies to this timeline view only. Sort by: Priority

of 82 measurements

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

arscl1cloth c1 @ nsa C1 // ARSCL: multiple outputs from first Clothiaux algorithms on Vaisala or Belfort ceilometers, Micropulse lidar, and M...

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# Summary

- Continuous observations available at Oliktok and Azores
- AMF deployments
  - Current: Antarctica and Ascension Island
  - Upcoming: Southern Ocean, Argentina (deep convection), Arctic (marine)
- Implementing UAS operations at Oliktok (and elsewhere)
- Implementing joint observation/high-resolution modeling system
- Push to optimize operation of/and data processing for complex instruments (esp. scanning radars and aerosol systems)
- ARM Best Estimate family of products is more autonomous and configurable
- Updates to ARM website and Data Discovery interface

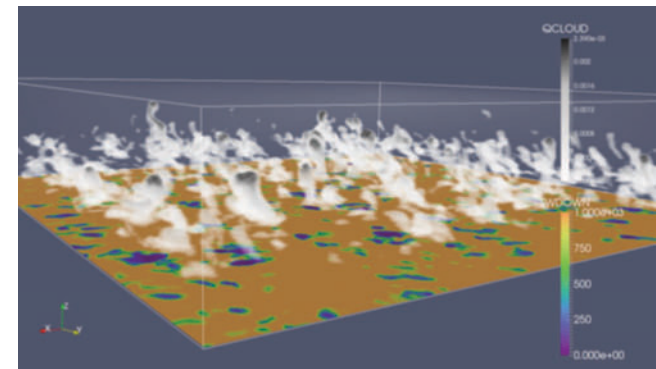
# Development of a Framework for Routine Modeling over ARM Sites

Development of framework for routine high-resolution ( $\sim 100$  m) model simulations over the Southern Great Plains site is being led by Bill Gustafson at PNNL.

These simulations will:

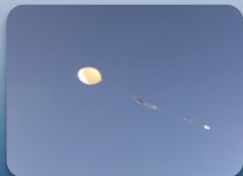
- Provide the basis for an integrated observation-simulation description of the atmosphere for improved process-study analysis
- Enable the larger modeling community to more readily run their own models over ARM sites

In process of expanding computing capabilities to support model simulations and complex data processing.





# Comprehensive Measurements of Climate-Relevant Parameters



Background Atmospheric State:  
Temperature, humidity, wind, precipitation



Surface Energy Balance:  
Radiation, latent, and sensible heat fluxes



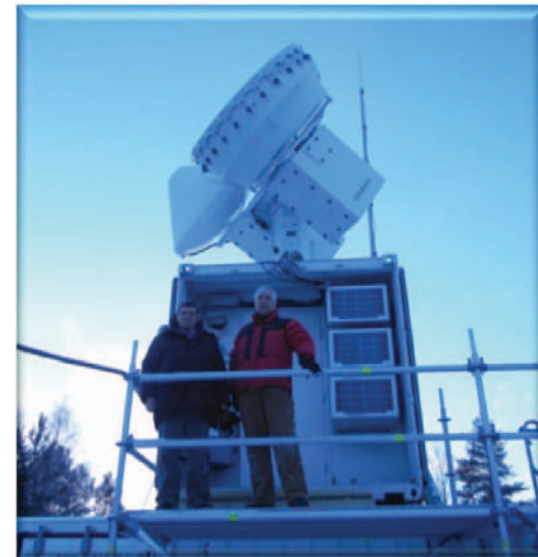
Aerosol and Hydrometeor Profiles:  
Remote sensing of aerosol, cloud, and precipitation optical and microphysical properties



Near-Surface Aerosol Properties:  
In situ optical, microphysical, and chemical aerosol properties and trace gases



Upper-Air Parameters:  
Aerial measurements of background state, aerosol, trace gas, cloud properties



Scanning Cloud Radar



In situ probes on the G1