ARM

CLIMATE RESEARCH FACILITY

ARM Climate Research Facility

Jim Mather
ARM Technical Director

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

U.S. DEPARTMENT OF ENERGY | Office of Science

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

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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 content 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.

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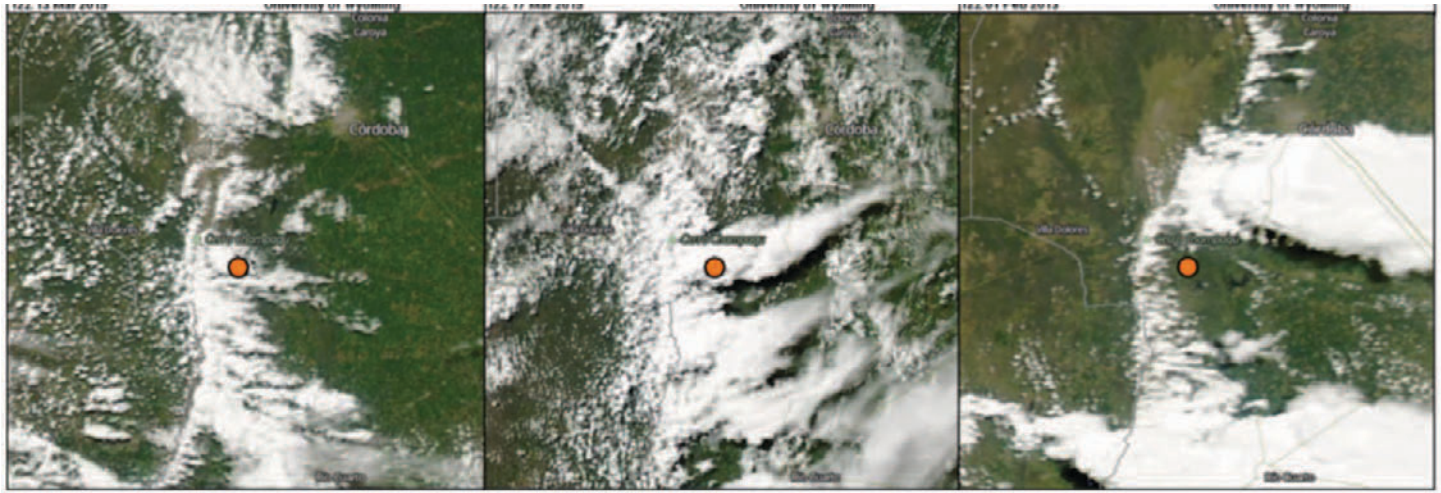
Upcoming Deployments/Campaigns

- 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



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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:

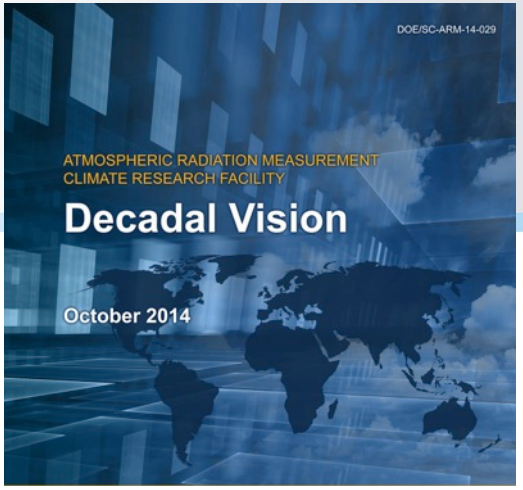
- Gulfstream G-1 aircraft; assessing succession
- *DataHawk* small unmanned aerial systems (UAS)
- *Arctic Shark* mid-size UAS (2017)
- Tethered balloon systems (TBS; managed by Sandia)

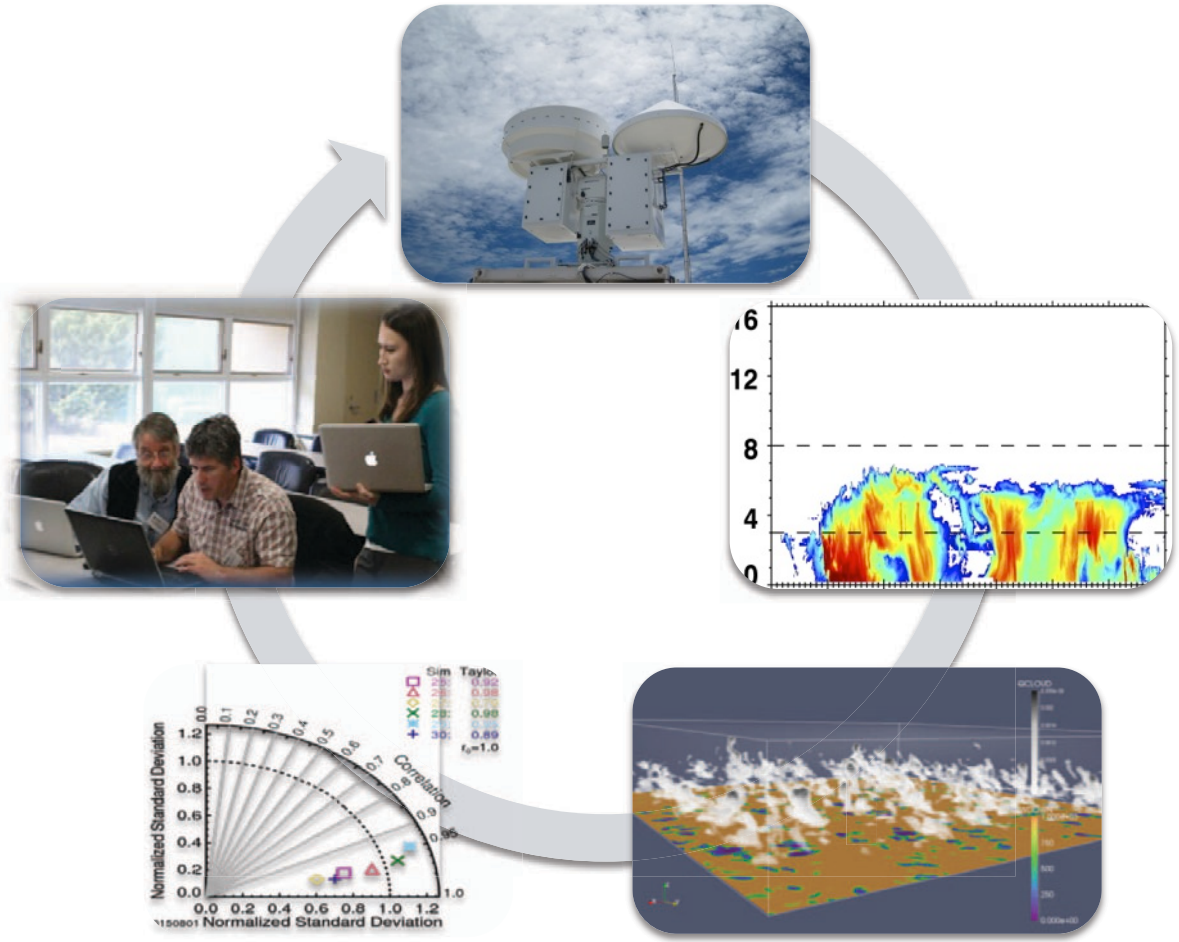
Datahawk UAS

Arctic Shark

Tethered Balloon

Integrating Observations and Models





Comprehensive strategy to integrate ARM observations and model simulations.

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

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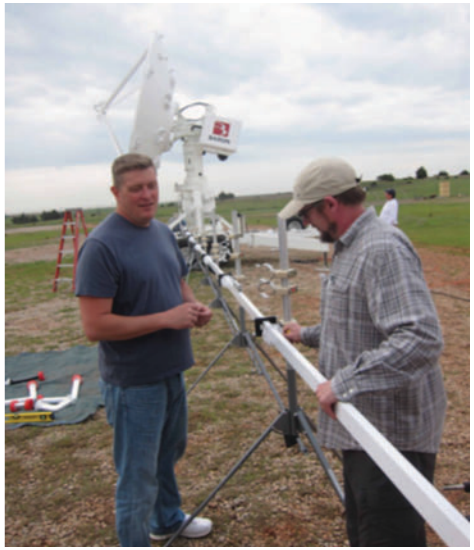
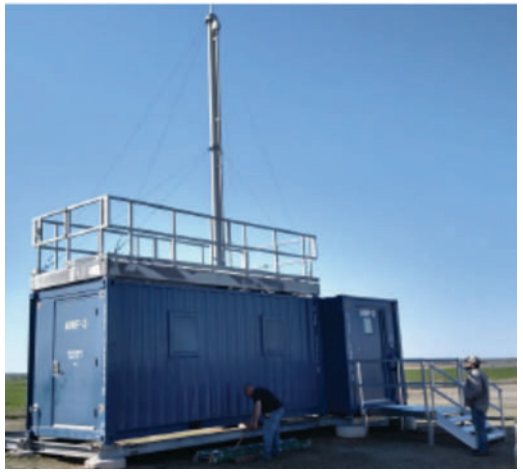
https://www.arm.gov/publications/programdocs/doe-sc-arm-14-029.pdf

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-λ 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





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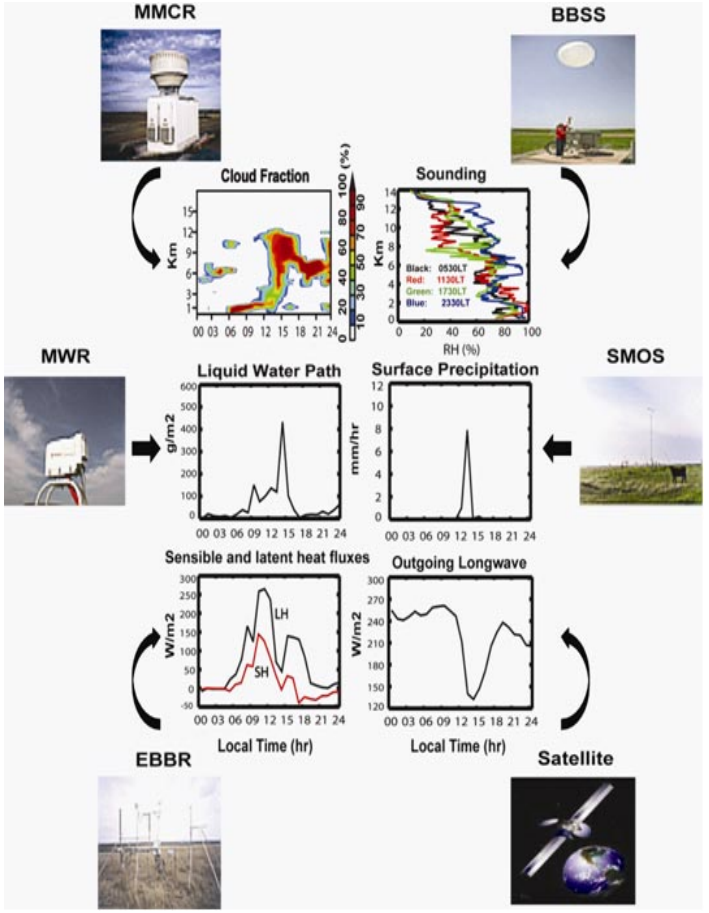
Data Product Activities

- 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

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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

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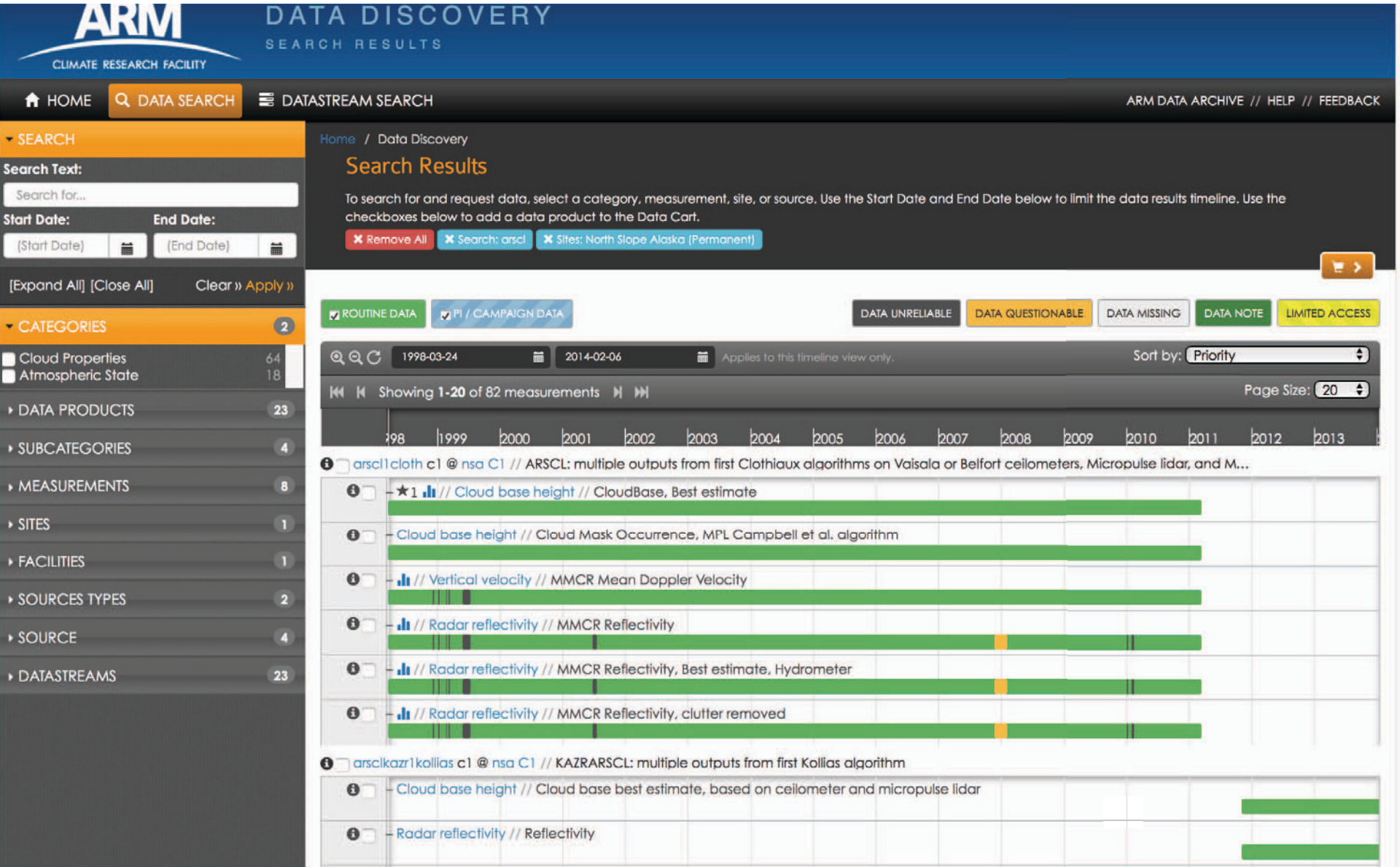
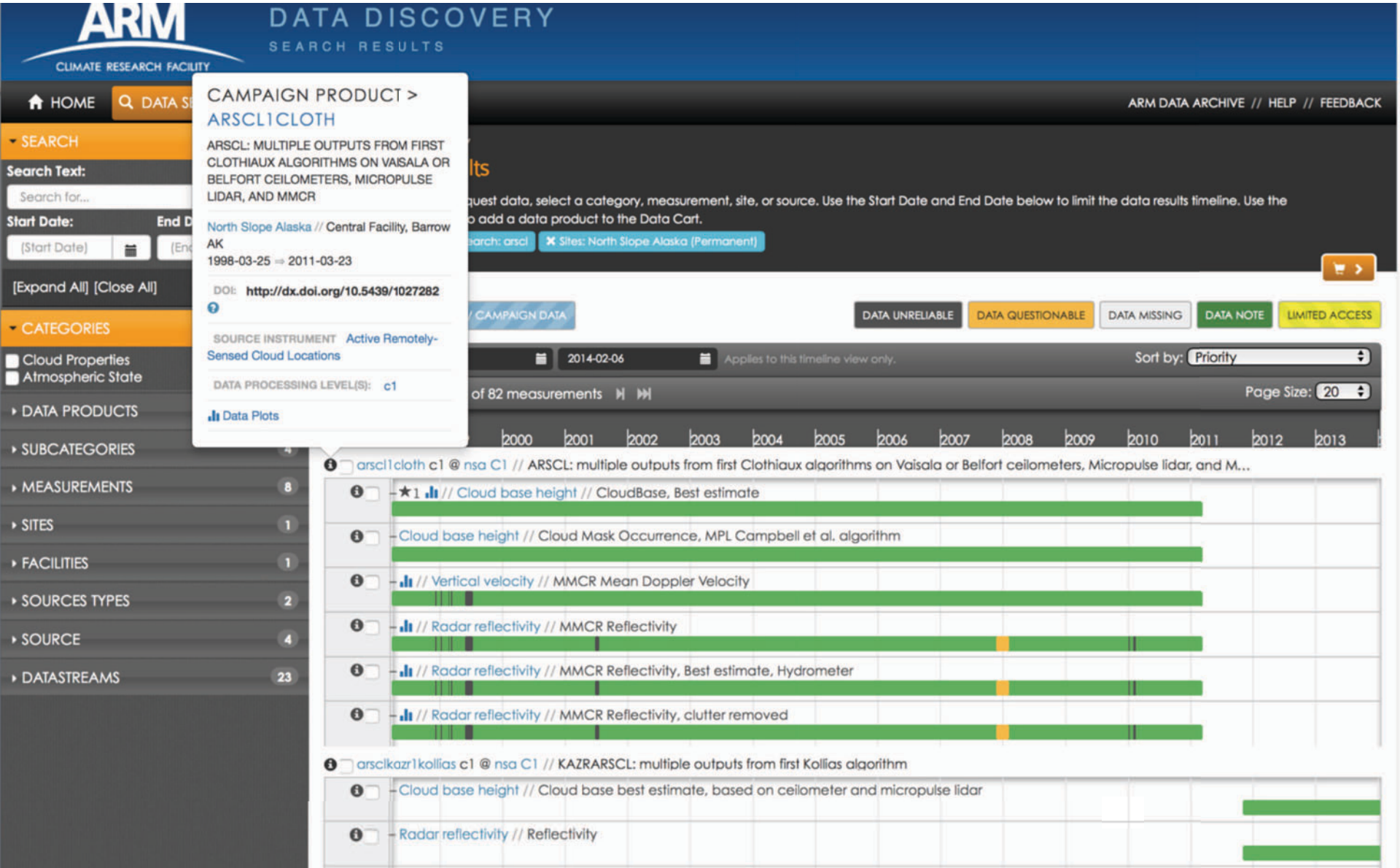
Data Discovery Tool



Data Discovery Tool



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

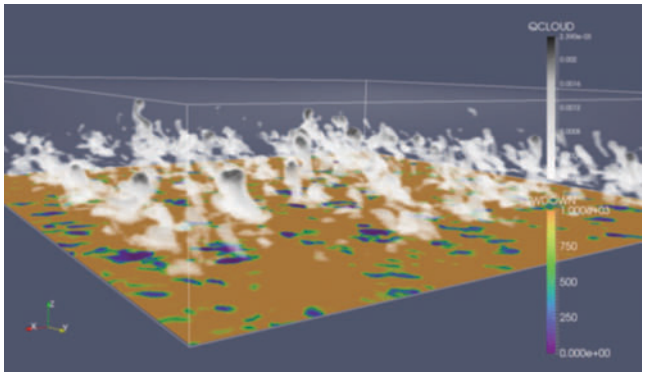
Development of a Framework for Routine Modeling over ARM Sites

Development of framework for routine high-resolution (~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.



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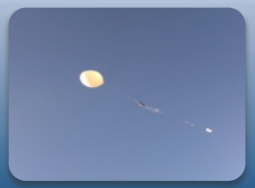
Comprehensive Measurements of Climate-Relevant Parameters



Background Atmospheric State:

Temperature, humidity, wind, precipitation

Surface Energy Balance:

Radiation, latent, and sensible heat fluxes

Aerosol and Hydrometeor Profiles:

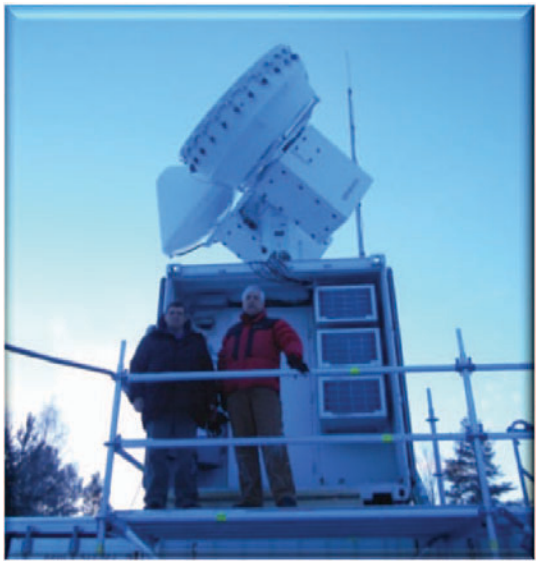
Remote sensing of aerosol, cloud, and precipitation optical and microphysical properties

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