The ARM Climate Research Facility

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ASR Science Team Meeting
Overview of the US DOE Atmospheric Radiation Measurement (ARM) Climate Research Facility

A national user facility for the Office of Science, Office of Biological and Environmental Research

ARM Science Objective

Improve global climate models by developing and testing improved representation of cloud and radiative processes
Objectives: ACRF National User Facility Mission Summary

- Provide the national and international scientific community with the infrastructure needed for scientific research on global change

- Global change research includes the study of alterations to climate, land productivity, oceans, water cycle, atmospheric chemistry, and ecological systems
Since 1990, the U.S. Department of Energy Atmospheric Radiation Measurement (ARM) Climate Research Facility, supported by the DOE Office of Science, unites the expertise of nine national laboratories:

Argonne
Lawrence Livermore
Oak Ridge
Brookhaven
Los Alamos
Pacific Northwest
Lawrence Berkeley
National Renewable Energy
Sandia

This partnership supports the DOE mission to provide for the energy security of the nation. This mission includes climate impacts of current and future energy production and developing solutions based on a sound energy strategy.

In 2004, Facility was designated a DOE BER national user facility.
ARM Climate Research Facility Capabilities and Deployment Locations

5 Fixed Sites in three vastly different climatic regions

2 mobile facilities that can be deployed worldwide

Aircraft platforms for in-situ observations

Off-site deployment capabilities that do not require a full complement of ARM instrumentation
Not Your Typical User Facility!

The ARM Climate Research Facility uses remote sensing instrumentation to make atmospheric (weather) observation and:

- supports the long-term operation of over 1,100 instrument systems in climatically important regions of the world;

- collects over 2,400 data streams per day, representing about 25 GB/day; and

- Provides the quality data and its associated metadata to anyone through the ARM Archive for free.

At the heart of the Facility, there are the 35 instrument scientists that know the capability and limitations of the ARM instruments.
None of the ACRF facilities are located at a national Laboratory.

The ACRF is a facility without walls: the great outdoors is our experimental environment.

The ACRF provides the infrastructure to enable experiments to be conducted virtually.

The Internet is our dataflow pipeline, connecting instrument data streams to users.

There are considerable logistical challenges; yet the ACRF operations safely and efficiently and within budget.
ACRF Illustration and Statistics

UNIQUE SCIENTIFIC USERS 1,186 (December 31, 2009)

Monthly input: ~5 Terabytes
Pulled by Users: ~5 Terabytes
Stored in library: 200 Terabytes

Facility

- External Sources and Collaborators
- Fixed and Mobile Research Sites

Data Products

Data Library

Product

- Data Files and Accompanying Documentation
- ASR Science Team
- Research Community
- Education and Public Outreach
ARM Climate Research Facility: Provides Its Climate Observations to Anyone for Free

The ARM Climate Research Facility provides the world’s most comprehensive 24/7 observational capabilities for obtaining atmospheric data specifically for climate change research.

The ARM Climate Research Facility sites provide information on cloud formation processes and aerosols and their influence on clouds in the atmosphere.
ACRF Fixed Site Locations
Southern Great Plains
ACRF Fixed Site Locations
Southern Great Plains

Southern Great Plains Central Facility

Central Facility (1992)
ACRF Fixed Site Locations
Tropical Western Pacific

Tropical Western Pacific

[Map showing locations in the Tropical Western Pacific]

Argonne NATIONAL LABORATORY
ACRF Site Locations
Tropical Western Pacific

Manus (1996)
Nauru (1998)
ACRF Fixed Site Locations
North Slope of Alaska
ACRF Fixed Site Locations
North Slope of Alaska

ARM Mobile Facility (AMF1) Components
To collect data from cloud aerosol interactions and to improve understanding of cloud organization that is often associated with patches of drizzle.
AMF Niger 2006
Radiative Divergence using ARM, GERB, and AMMA Stations (RADAGAST) field campaign.

To provide the first well-sampled, direct estimates of the divergence of solar and thermal radiation across the atmosphere.
To improve the representation of convective clouds in models and to develop strategies for determining cloud climatology in complex terrain.
AMF China 2008

Application of the ARM Mobile Facility (AMF) to Study the Aerosol Indirect Effects in China

Multiple Deployments

AAF-Linze, AAF-Xianghe, AUX-Taihu Lake, AMF-Shouxian
AMF Azores (Portugal) 2009-2010

Clouds, Aerosol, and Precipitation in the Marine Boundary Layer (CAP-MBL)

Surrounded by the Atlantic Ocean, Graciosa Island is ideal for sampling ocean stratocumulus clouds.
The ACRF is developing AMF2 for more modular deployments

Rapid setup time!

Minimal footprint

Instrument stabilization platforms for ship deployments

Modular, distributed systems
The ACRF is developing a second AMF for with smaller footprint and rapid deployment

Storm Peak, Colorado

October 2010: Steamboat Springs
The ACRF also has an Aerial Vehicle Facility: Aircraft Platforms Leased for In-Situ Measurements for Field Campaigns

Piloted Aircraft

Unpiloted Aircraft
The New Capabilities at the ARM Climate Research Facility will Substantially Improve Climate Observations

The American Recovery and Reinvestment Act of 2009 provided $60M to the facility for instrumentation that will be fully operational by the end of 2011. This enhanced instrumentation suite will provide unparalleled research capabilities.

These new measurements will greatly expand the set of scientific questions in climate change research that can be supported and reduce the uncertainty of the roles of clouds and aerosols in climate models.
Scanning Radars

- WSR-88D (S)
  - CPOL
  - 3*XPOL
  - W, Ka SCR

- Mobile Facilities
  - AMF1: W, Ka SCR
  - AMF2: X, Ka SCR

- CPOL
  - X, Ka SCR

- WF100 (C)
  - CPOL
  - X, Ka SCR
**Engineering and Operations Management Processes and Procedures**

- **Monitor**
  - Identify Anomalies

- **Identify Anomalies**

- **Review History**
  - Identify Trends

- **Diagnose**
  - Identify Problem

- **Analyze**
  - Identify Root Cause

- **Assign**
  - Assign Priority and Staff

- **Approve**
  - Approve Resources

- **Prescribe**
  - Develop a Solution

- **Re-Design**
  - Develop Modification

- **Correct**
  - Implement Solution

- **Revise**
  - Implement Modification

- **Log**
  - Record History

- **Document**
  - Record Baseline Change

**Data Quality Problem Report/Problem Identification Form**

**Engineering Change Request**

**Baseline Change Request**

**Corrective Action Report**
Engineering and Operations Management Processes and Procedures

Operations Status System:

- Time-stamped events of the status of all our instrument systems
  - By site
  - By systems
  - By components
  - By events
- Inventory database
- Includes the Calibration data base
Data Quality

Data must be available, usable, and accessible

- Users must be able to readily tell whether the data have been examined, how they were reviewed, and whether there are known problems

- This information is communicated via quality information and ancillary data quality reports and databases
Data Quality Office: Inspection, Assessment, Reporting

Data Quality Office

Inspect ➔ Assess ➔ Report

- Data Quality HandS Flag Results
- Weekly Assessments
- Data Quality Problem Reports
- Data Quality HandS Diagnostic Plots
- NCVweb Interactive Plots
- Weekly Synopses
- Data Quality Reports
Inspection

Data Quality Office

Inspect ➔ Assess ➔ Report

Weekly Assessments

Data Quality Problem Reports

Data Quality Reports

Inspect

Assess

Report

ARM DQO Diagnostic Plots
Assessment

Data Quality Office

Inspect → Assess → Report

Data Quality HandS Flag Results

Diagnostic Plots

Weekly Assessments

Weekly Synopses

Data Quality Reports

Problem Reports

Data Quality Office

Argonne NATIONAL LABORATORY
Reporting

Data Quality Office

Inspect ➔ Assess ➔ Report

Data Quality HandS Flag Results

Data Quality HandS Diagnostic Plots

Argonne National Laboratory
Reporting Mechanisms

- Data Quality Report (DQR)
  - Report to data user on a problem found and solved (or not)
  - Attached to data files when ordered from the Archive
  - Retroactively distributed from the Archive by email to previous data requestors
Overview

One of the goals of the ARM Program is to provide data streams of reasonable quality for scientific research. Traditionally, data quality issues have been addressed within ARM at several levels, including by instrument mentors, site scientists, value-added product scientists, and Science Team members at large. Maintaining data quality for a program of the size and complexity of ARM is a significant challenge — our efforts toward this end have matured and evolved over the life of the program.

The ARM Program Data Quality (DQ) Office, established in July 2000, conducts a data quality program to ensure the quality of the data collected by ARM field instrumentation. The DQ Office has the responsibility for ensuring that quality assurance results are communicated to 1) data users so that they may make informed decisions when using the data, and 2) ARM’s site operators and engineers to facilitate optimal instrument performance and minimize the amount of unacceptable data collected.

On this page you will find links to our Data Quality Health and Status (DQ HandS) tool that allows us to inspect and assess ARM data on a near real-time basis and our interactive data plotting tool, NCVweb. Also provided are links to the ARM Report Search Tool, and an archive of weekly Data Quality Assessment Reports.

Questions and comments about the Data Quality Office, or specific ARM datastreams can be directed to Randy Peppler, Ken Kellogg, Karen Sonntag, or Sean Moore.
Reporting Mechanisms

Data Quality Problem Report (DQPR)
- Internal mechanism to alert instrument mentors, site operators, and site scientists of a data quality (i.e., instrument performance) problem
- Captures discussion and sequence of actions performed to resolve the problem
- Spawns data quality report to data user
Reporting Mechanisms

Data Quality Report (DQR) – cont.
- Dynamically viewed during data selection in the ARM data browser
- Accessed by links in the thumbnail browser
- Searched by keywords and full text

Flags
- Contained in data files for most instruments
ARM Climate Research Facility:
A DOE/BER National User Facility for
Climate Observations for Climate Research

WWW.ARM.GOV

THANK YOU!