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U.S. Department
of Energy



THE UNIVERSITY OF
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Office of
Science

U.S. DEPARTMENT OF ENERGY

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managed by The University of Chicago

The ARM Climate Research Facility

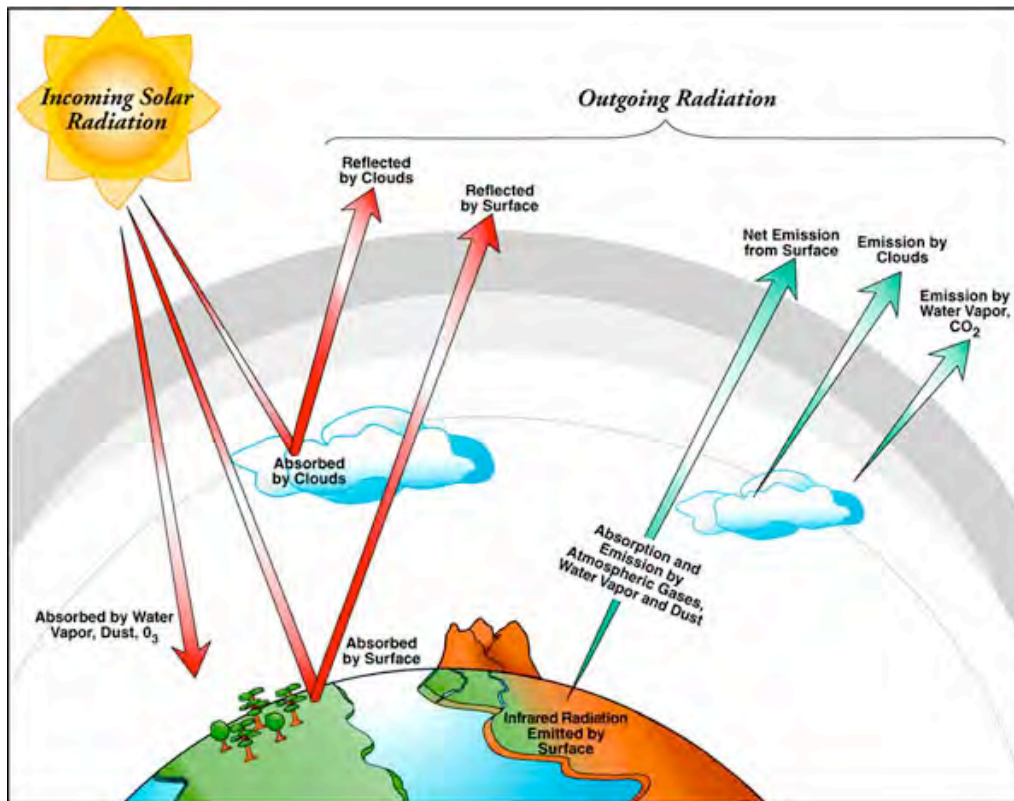
Douglas Sisterson

*ARM Climate Research Facility
Operations Manager
March 15, 2007*

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

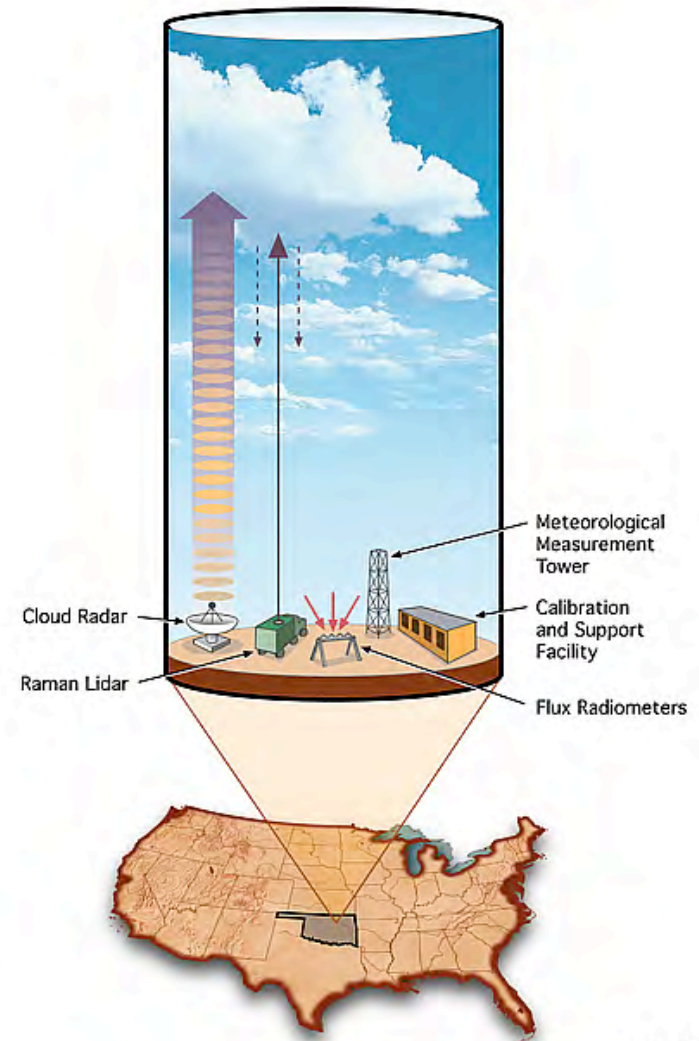


ARM Science Objective

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



00000134.1

ARM Climate Research Facility: A DOE BER National User Facility (www.arm.gov)

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.

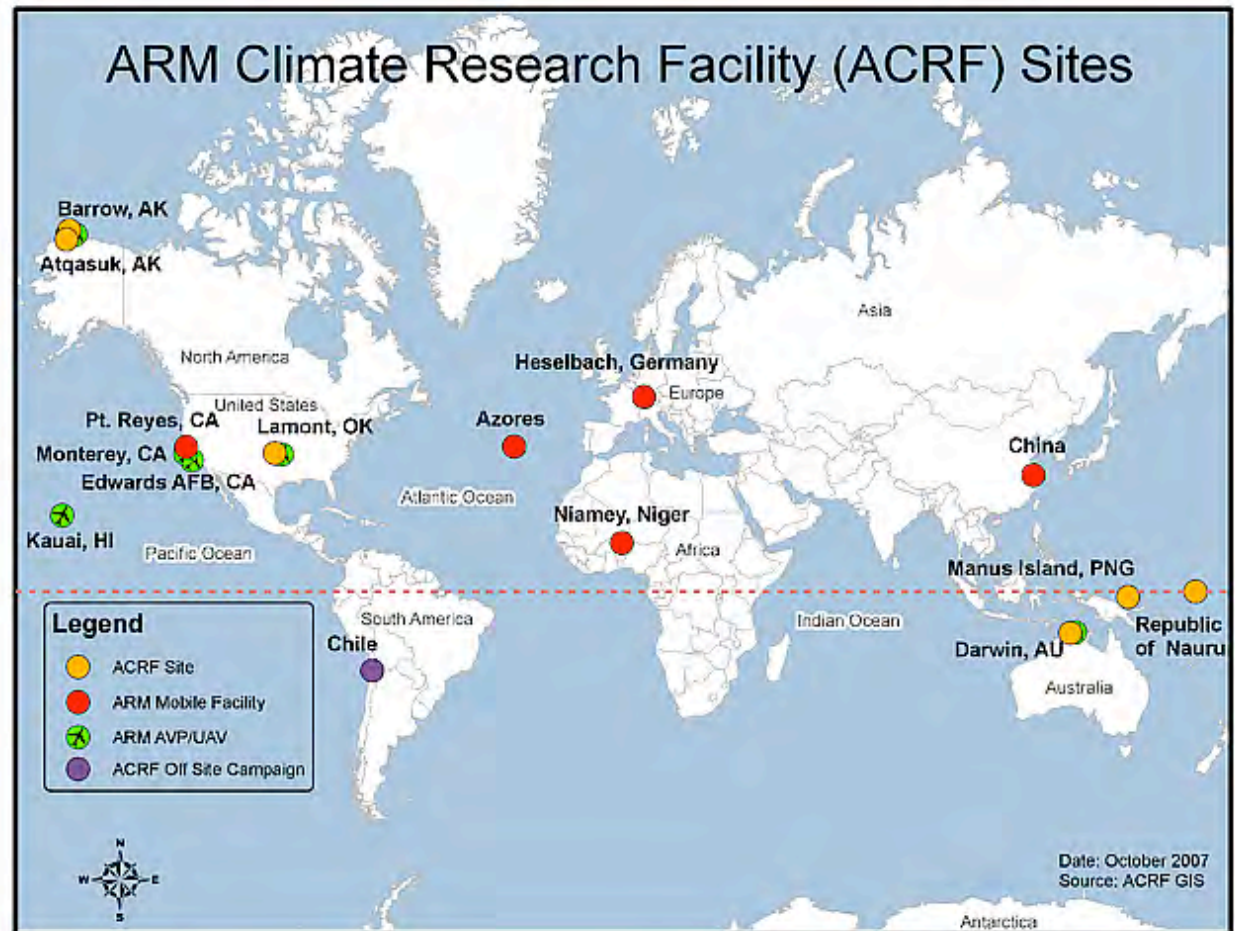
ARM Climate Research Facility Capabilities and Deployment Locations

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

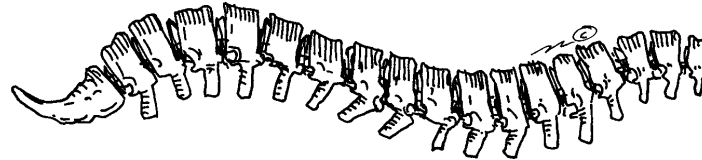


Not Your Typical User Facility!

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.



ACRF: Not Your Typical User Facility!

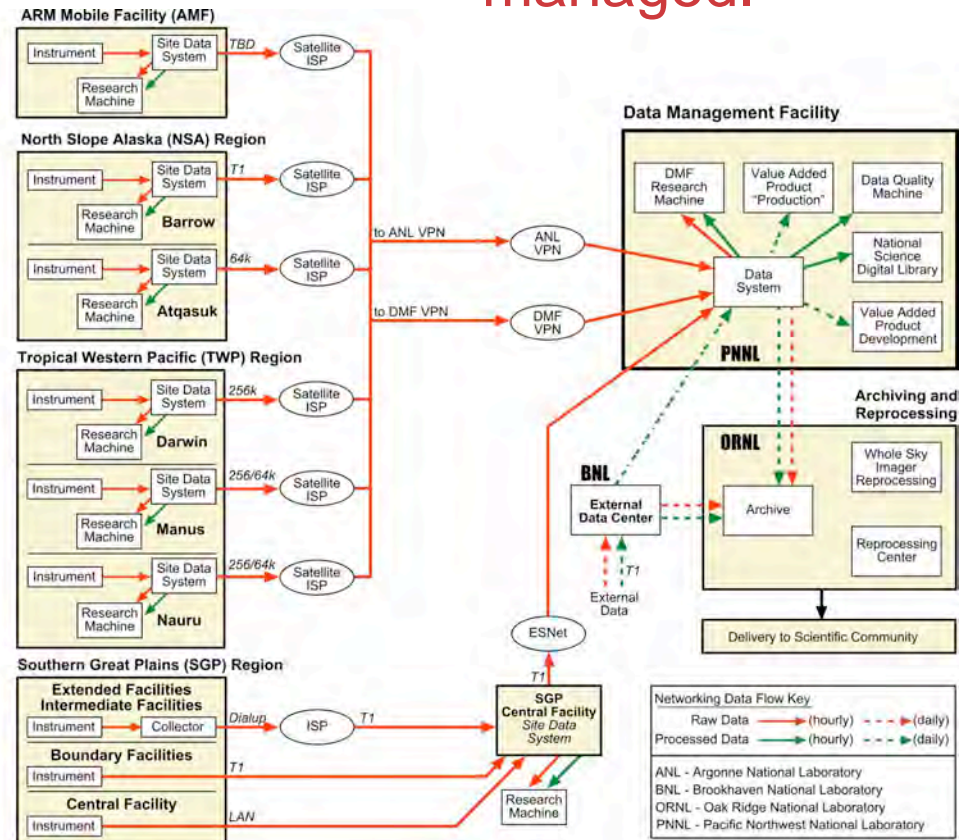
Multi-facilities,
multi-laboratory
managed.

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.

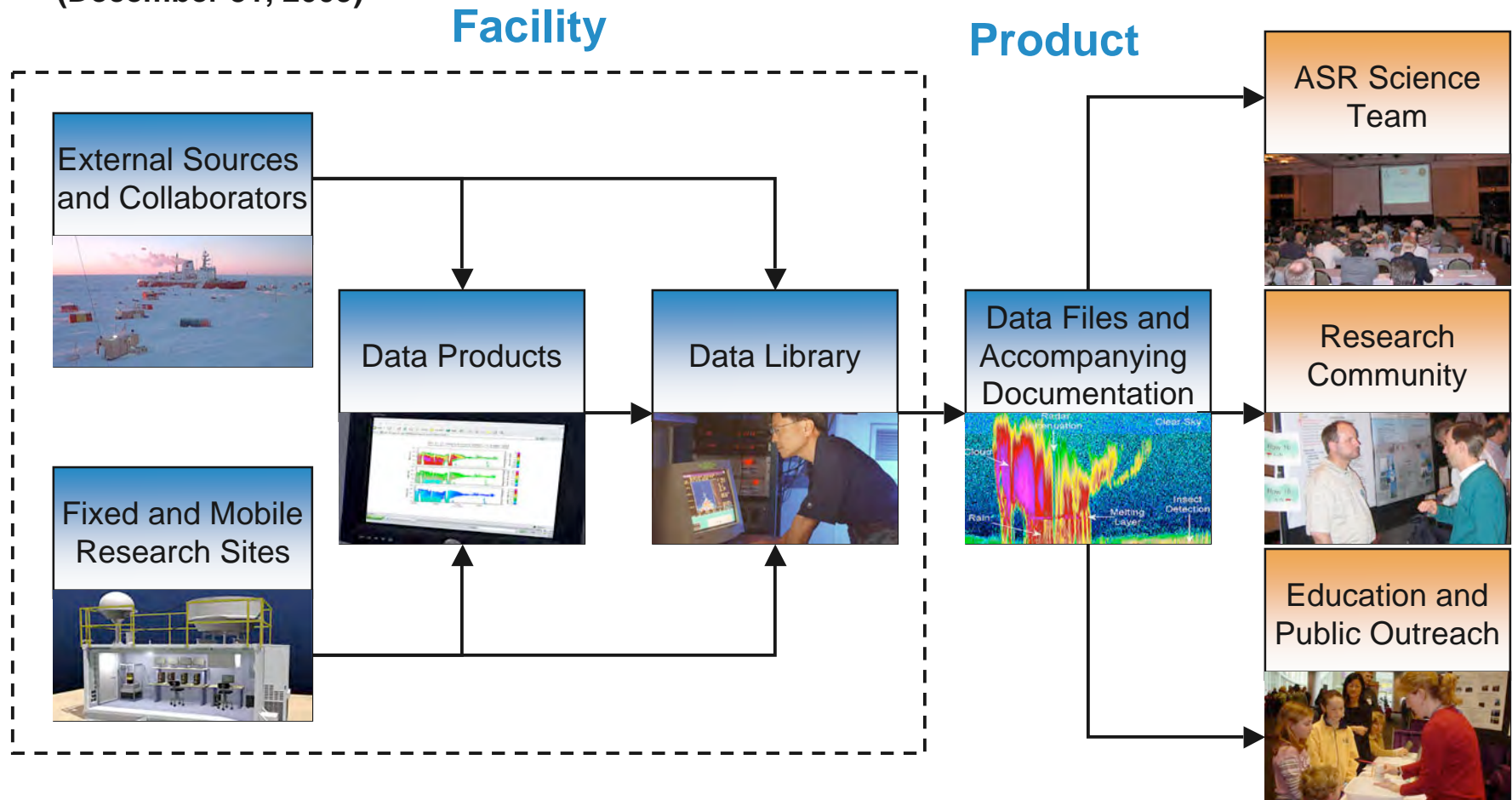


There are considerable logistical challenges; yet the ACRF operations safely and efficiently and within budget.

ACRF Illustration and Statistics

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

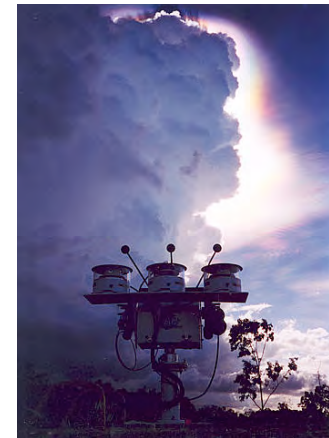
Monthly input: ~5 Terabytes
Pulled by Users: ~5 Terabytes
Stored in library: 200 Terabytes



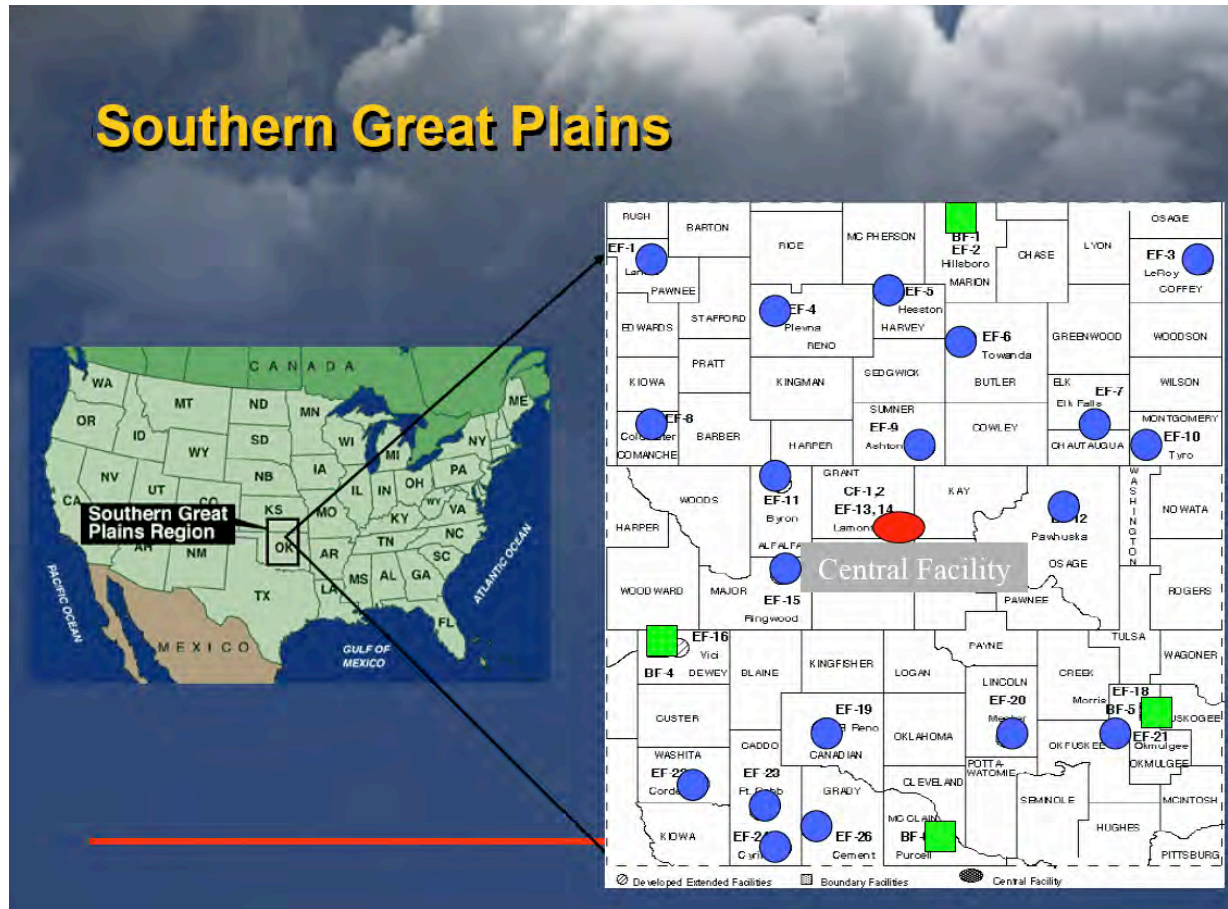
ARM Climate Research Facility: Provides Its Climate Observations to Anyone for Free

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



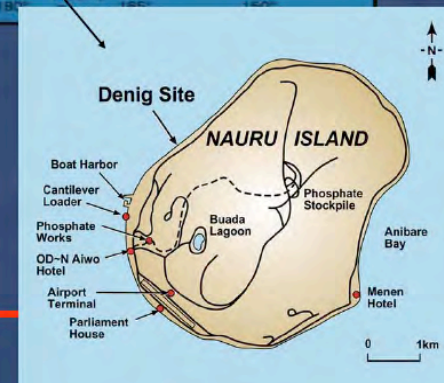
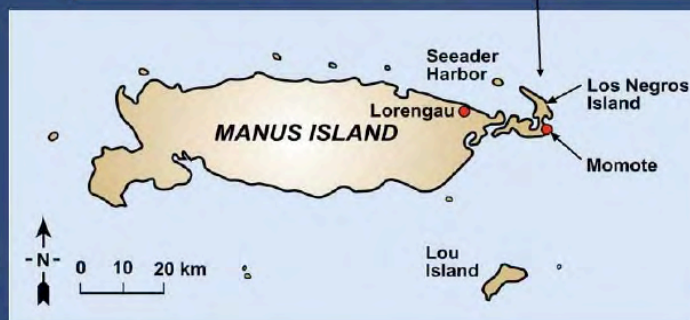
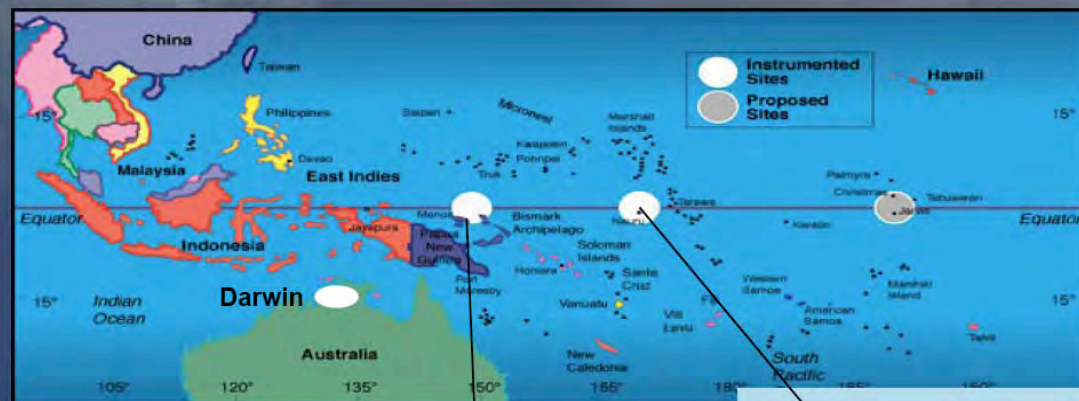
ACRF Fixed Site Locations Southern Great Plains



Central Facility (1992)

ACRF Fixed Site Locations Tropical Western Pacific

Tropical Western Pacific



ACRF Site Locations Tropical Western Pacific



Darwin
(2003)



Manus
(1996)

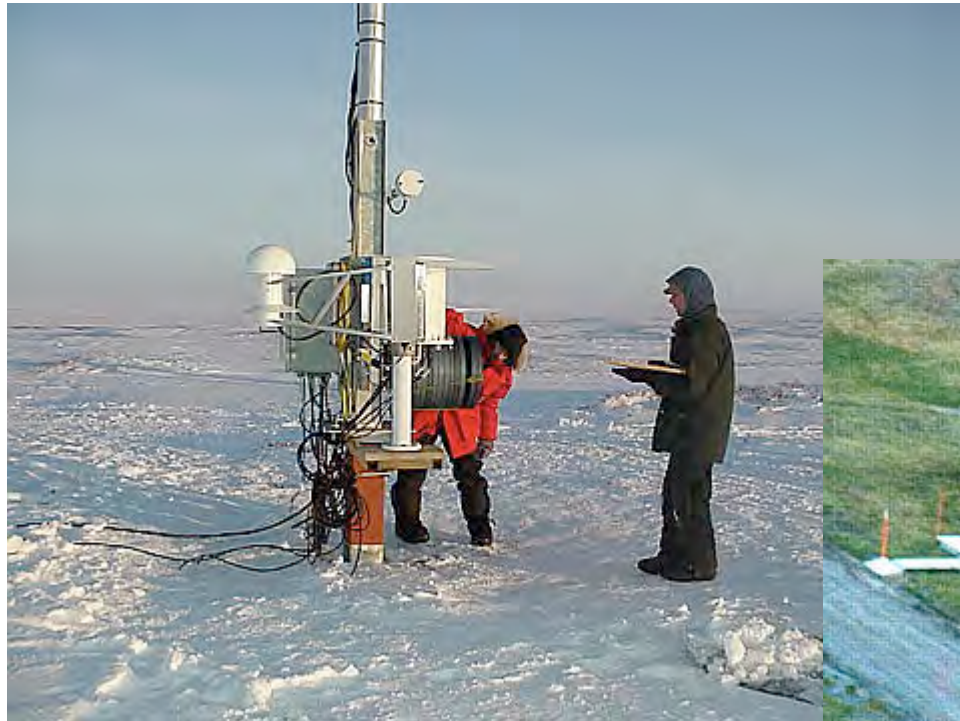


Nauru (1998)

ACRF Fixed Site Locations North Slope of Alaska



ACRF Fixed Site Locations North Slope of Alaska



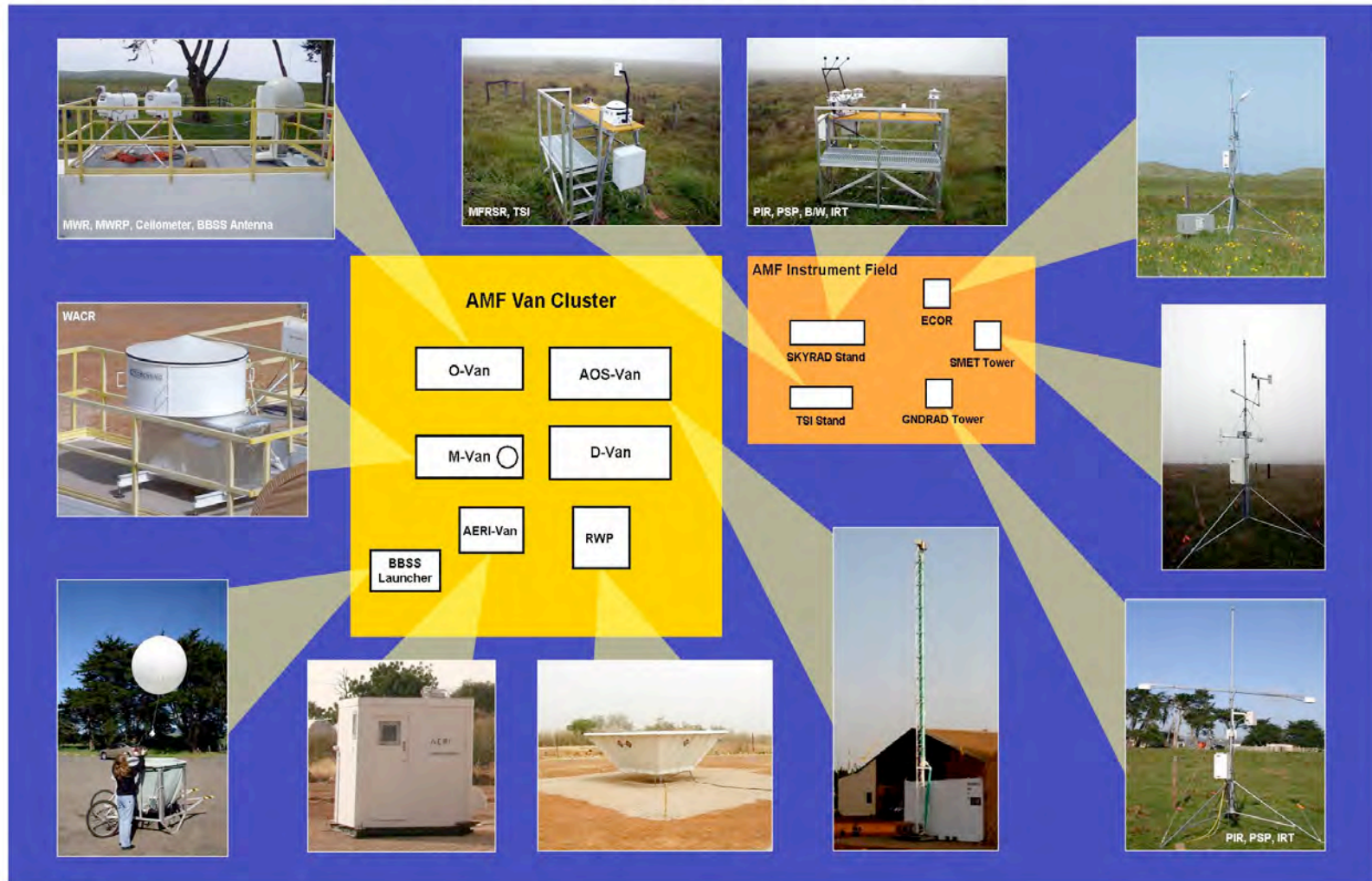
Atkasuk (1999)



Barrow (1997)

ARM Mobile Facility (AMF1) Components

ARM Mobile Facility Typical Deployment



Revised April 2009
TWF/AMF Management Office



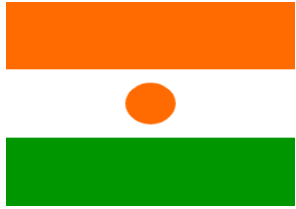
AMF California 2005

Marine Stratus,
Radiation, Aerosol,
and Drizzle
(MASRAD) Project



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.



AMF Germany 2007

Convective and Orographically Induced Precipitation Study (COPS)

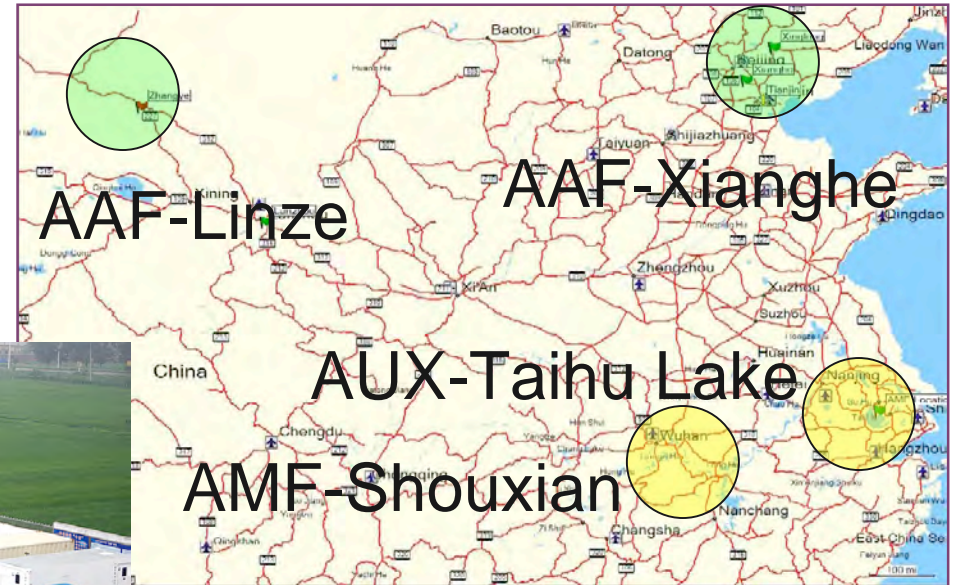


To improve the representation of convective clouds in models and to develop strategies for determining cloud climatology in complex terrain.



AMF China 2008

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



Multiple Deployments



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.

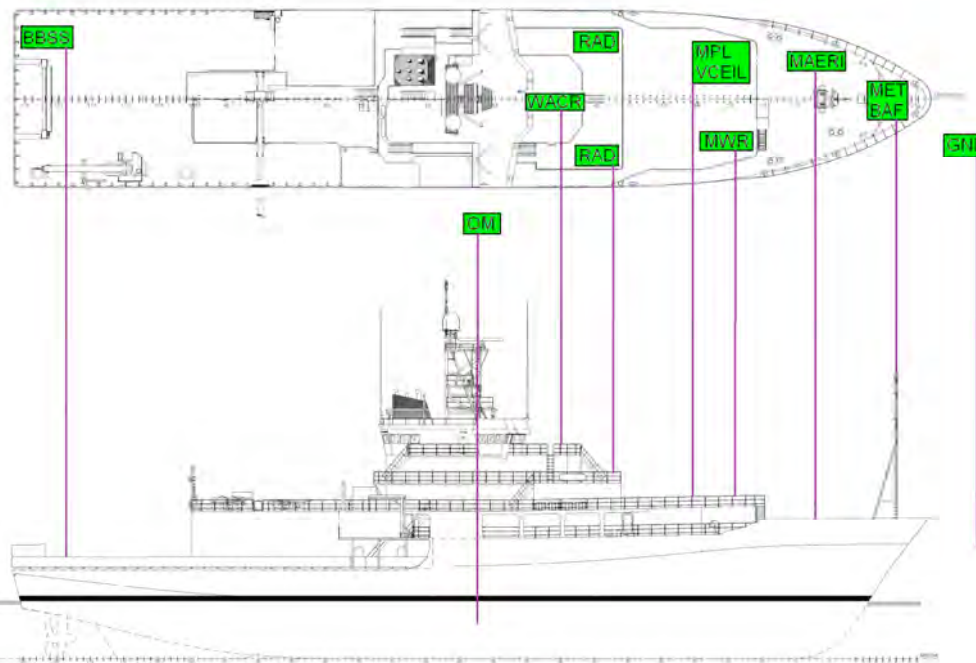


The ACRF is developing AMF2 for more modular deployments

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

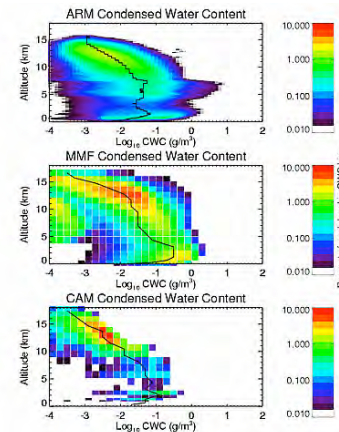


Unpiloted Aircraft

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



XPOL
W, Ka SCR

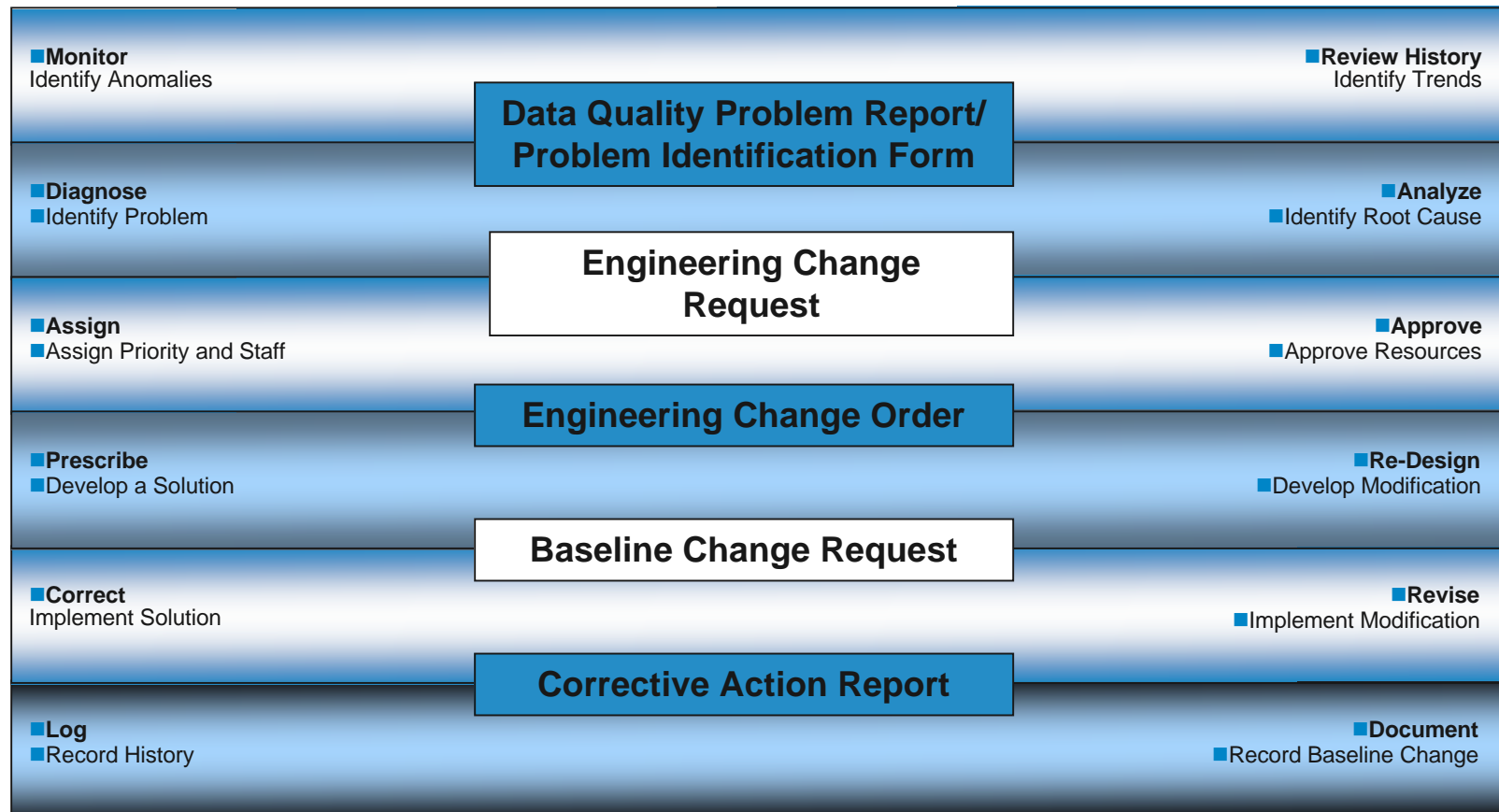
WSR-88D (S)
CPOL
3*XPOL
W, Ka SCR

CPOL
X, Ka SCR

CPOL
X, Ka SCR
WF100 (C)

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

Engineering and Operations Management Processes and Procedures



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

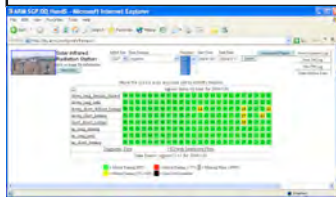
- Users must be able to readily tell whether the data have been examined, how they were reviewed, and whether there are known problems
- This information is communicated via quality information and ancillary data quality reports and databases

Data Quality Office: Inspection, Assessment, Reporting


Data Quality Office

Inspect → Assess → Report

Data Quality
HandS Flag
Results



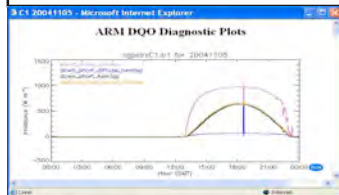
Weekly
Assessments



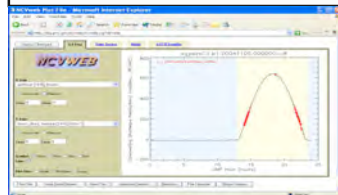
Data Quality
Problem
Reports



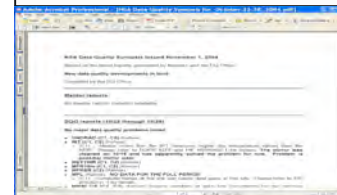
Data Quality
HandS
Diagnostic Plots



NCVweb
Interactive Plots



Weekly
Synopsis



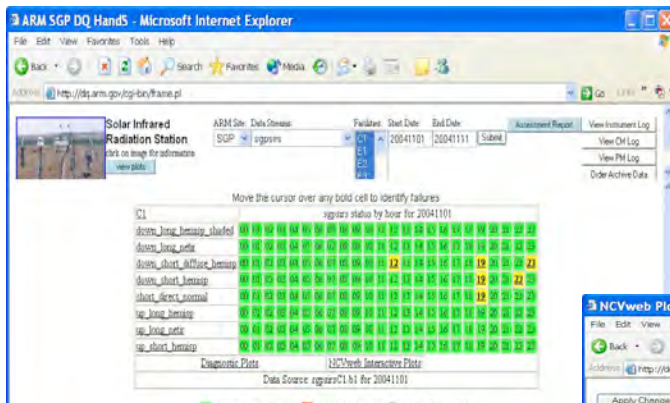
Data Quality
Reports



Inspection

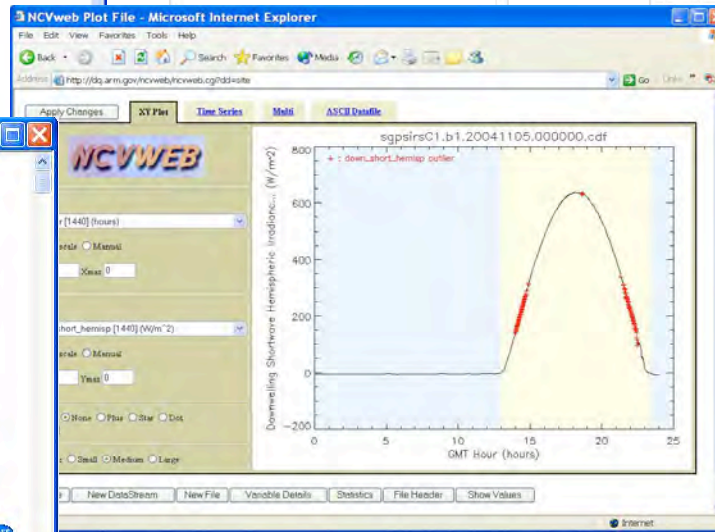
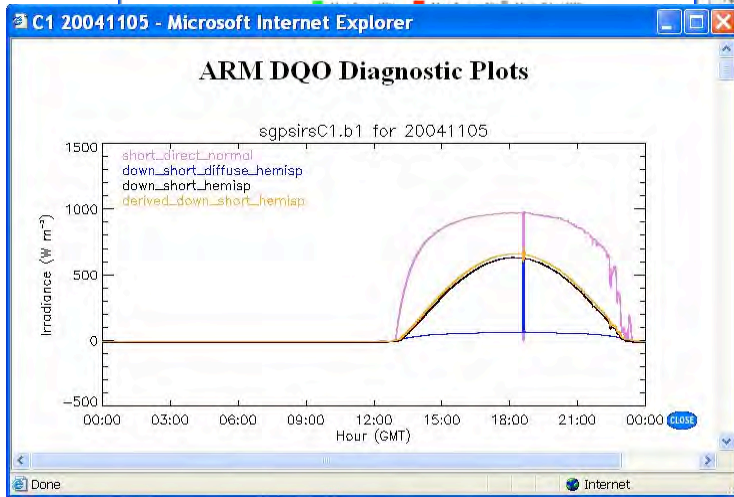
Data Quality Office

Inspect → Assess → Report



Weekly Assessments

Data Quality Problem Reports



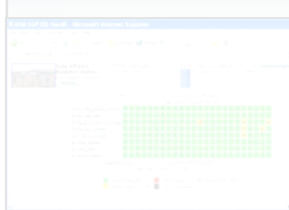
Data Quality Reports

Assessment

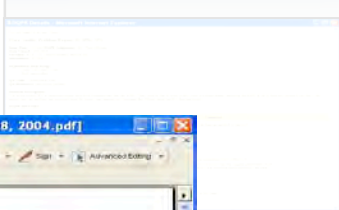
Data Quality Office



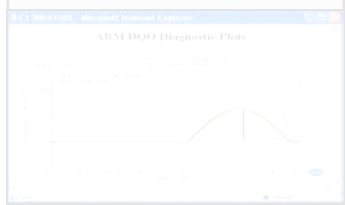
Data Quality HandS Flag Results



Data Quality Problem Reports



Data Quality HandS Diagnostic Plots



Interactive Plots



Adobe Acrobat Professional - [fig8.pdf]

Subject: TWP VCEIL Data Quality Assessment Report for 20041025-20041103.
To: rpeppler@ou.edu.

Data evaluated based on visual inspection of DQ Health and Status tables found at the [DQHandS](#) website. These reports are produced by the ARM Data Quality Office at the University of Oklahoma.

Questions can be sent to Kenneth Kehoe (kkehoe@ou.edu) or Randy Peppler (rpeppler@ou.edu)

*** new developments are highlighted in bold ***

TWP VCEIL Data Quality Assessment Report for 20041025 - 20041103

C1 (Central Facility, Manus I, PNG): No obvious problems with data quality.
No data available during the following
10/25/2004 2:00 GMT through 19:26 05:00 GMT
10/27/2004 0200 - 0600 GMT
10/28/2004 0530 - 2100 GMT
10/29/2004 2030 - 10:30 1200 GMT
10/31/2004 0400 - 0500 GMT
11/01/2004 0500 - 0600 GMT

C2 (Central Facility, Nauru Island): No obvious problems with data quality.
C3 (Central Facility, Darwin, North Aust): No obvious problems with data quality.

To view this assessment and related DQPRs, please refer to the [DQA View](#) web page.

Adobe Acrobat Professional - [NSA Data Quality Synopsis for October 22-28, 2004.pdf]

NSA Data Quality Synopsis Issued November 1, 2004

Based on the latest reports generated by Mentors and the DQ Office

New data quality developments in bold

Compiled by the DQ Office

Mentor reports:
No mentor reports currently available.

DQO reports (10/22 through 10/28)

No major data quality problems noted:

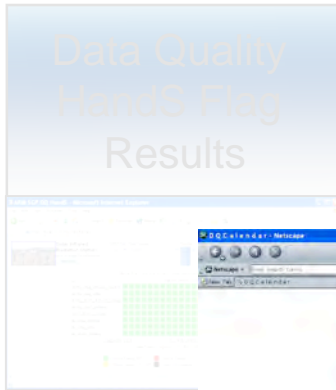
- **GNDRAD (C1, C2)** (Kehoe)
- **IRT (C1, C2)** (Kehoe)
 - (C1) - Mentor notes that the IRT measures higher sky temperature values than the AERI. Please refer to DQPR #278 and PIF #P040602.1 for details. **The mirror was cleaned on 10/15 and has apparently solved the problem for now. Problem is possibly mirror wear.**
- **METWR (C1, C2)** (Kehoe)
- **MFR10m (C1, C2)** (Kehoe)
- **MFRSR (C2)** (Kehoe)
- **MPL (Kehoe): NO DATA FOR THE FULL PERIOD**
 - (C1) - Computer hangs at the site can cause data gaps at this site. Please refer to PIF #P040331.1 for details
 - **MWR10m (C1, C2)** (Kehoe): Several variables at each site consistently fail the minimum

Reporting

Data Quality Office



Data Quality
HandS Flag
Results



Data Quality
HandS
Diagnostic Plots



DQPR Details - Microsoft Internet Explorer

You are logged in as user: Guest

Data Quality Problem Report (DQPR): 191

Issue Data: 1/22/04 DQPR Originator: DM - Victor Morze
Date Created: 2/19/2004
Location: NSA - CI - Central Facility, Barrow AK
Instrument: SKYRAD

DQPR Date Range:
Start: 12/11/2003 12:00
End: unspecified

QA Code: Questionable Data
QA Reason: Instrument problem

Problem Description:
The downwelling IRT is measuring higher skyload temperatures than the AERI. This could be due to either a dirty lens or a failed heater, warming the AERI in oil. It does not appear to be due to the sun since the problem has persisted since the sensor was changed on Christmas day. Please check the IRT lens and heater.

DQPR HISTORY:

Who	Comment
Victor Morze	This problem may be related to that reported in DQPR 159 but the lens should still be checked.
Jeffrey Zarew	MAINTENANCE PERFORMED Check lens, test dirty, replace sensor, oil not switched. Maintenance Date: 01/09/2004

GetID - Microsoft Internet Explorer

DQR ID: D040127.2
DQR SUBMITTER: Barry Lesht
DATE SUBMITTED: 01-27-2004
DQR SUBJECT: SGP/SOMDE/CI - Bad RH Data
SUGGESTIONS: Near zero RH values are incorrect and the other RH values obtained during the first part of the sounding are suspect. Because the problem is related to the heating circuit, we cannot recover the RH data when both RH sensors are heated.

QUALITY COLOR: Red - Incorrect
PRB REVIEWED: Y

DQR DESCRIPTION:
The RH values during the first half of this sounding oscillate between reasonable values and near-zero values. The oscillation is irregular and seems to be related to failure of the RH sensor heating process.

DQR DATASTREAM(S):
sgpsondeumpn01.bl
dp
rh

START DATE/TIME: 01/16/2004 20:15 GMT END DATE/TIME: 01/16/2004 21:51 GMT

LINK(S):
none

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



Data Quality Program

PEOPLE | SITE INDEX | HOME
SEARCH

- ABOUT ARM
- ABOUT ACRF
- SCIENCE
- SITES
- INSTRUMENTS
- MEASUREMENTS
- DATA**
- PUBLICATIONS
- EDUCATION
- FORMS

- Datastreams by Alpha
- Datastreams by Category
- PI Data Products
- Related Data Sets
- Value-Added Products

Overview

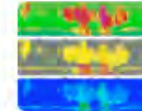
One of the goals of the ARM Program is to provide data streams of reasonable quality for scientific research. Traditionally, data quality issues have been addressed within ARM at several levels, including by instrument mentors, site scientists, value-added product scientists, and Science Team members 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 Kehoe](#), [Karen Sonntag](#), or [Sean Moore](#).

DQ Hands



- [QC Metrics and Plots](#)
- [Plot Browser](#)
- [DQ wiki](#)

NCVweb



- [Interactive Data Plotting](#)

DQ Reports



- [Search All Reports](#)
- [DQ Assessment Reports](#)
- [Report Findings](#)



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dq.arm.gov

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

