Overview of the US DOE Atmospheric Radiation Measurement (ARM) Climate Research Facility (ARCF)

Douglas Sisterson

ACRF Operations Manager

Argonne National Laboratory

May 22-24, 2006

ARM Climate Research Facility

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Objectives
ARM Mission Summary

1990: The Atmospheric Radiation Measurement (ARM) Program was established by the Office of Biological and Environmental Research (BER), Office of Science, US Department of Energy, to improve climate modeling.

ARM Infrastructure: Development of ground-based remote sensing facilities with continuous data acquisition and archival.

ARM Science: Data analysis, physical modeling, and parameterization development and testing.

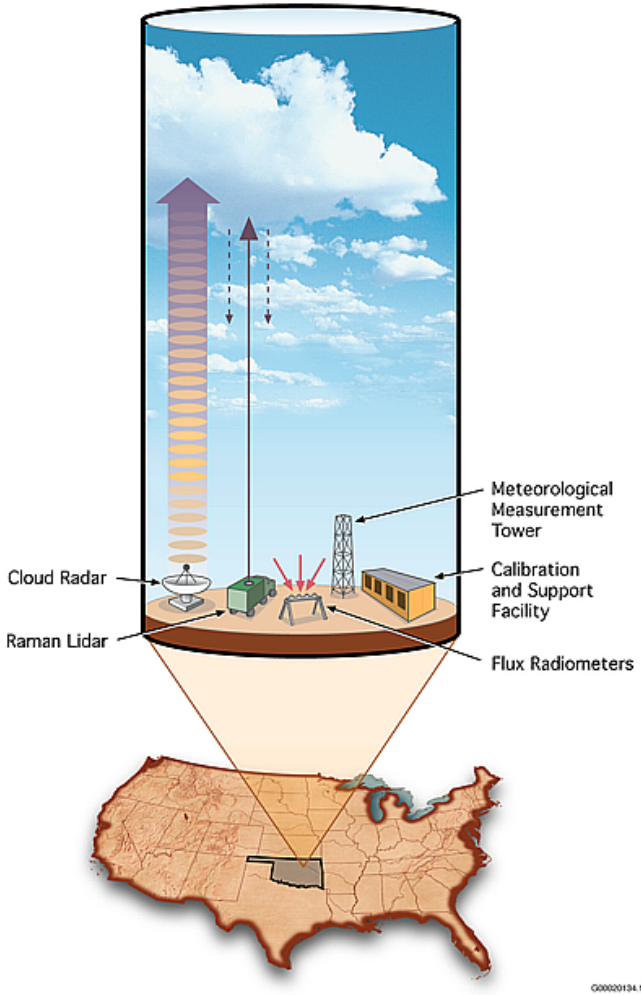
ARM Goal (Ackerman 2005)

Atmospheric Radiation Measurement Program

Goal

Improve the treatment of cloud and radiation physics in global climate models in order to improve the climate simulation capabilities of these models

ARM Atmospheric Radiation Measurement



Knowing the state of the overlying atmosphere is critical

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Objectives
ACRF Mission Summary

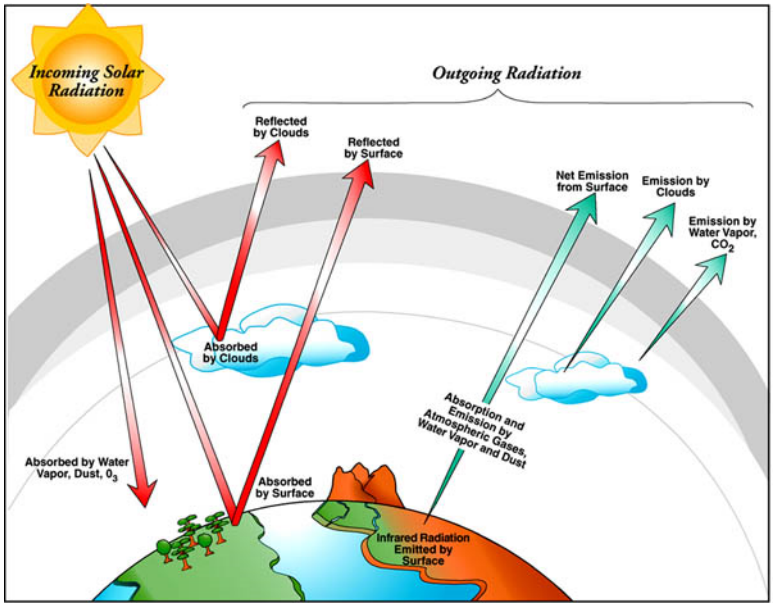
2003: The ARM fixed sites and Infrastructure were designated national user facility and a mobile site capability was added. The ARM Infrastructure was renamed the ARM Climate Research Facility (ACRF).

- 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

Objectives
Primary ACRF Goals

- Provide the infrastructure at both fixed and mobile sites to meet the ACRF mission and ARM scientific goals
- Contribute to the Interagency Working Group on the Earth Observing Systems



ARM Science Objective

Improve global climate models by developing and testing improved representation of cloud and radiative processes

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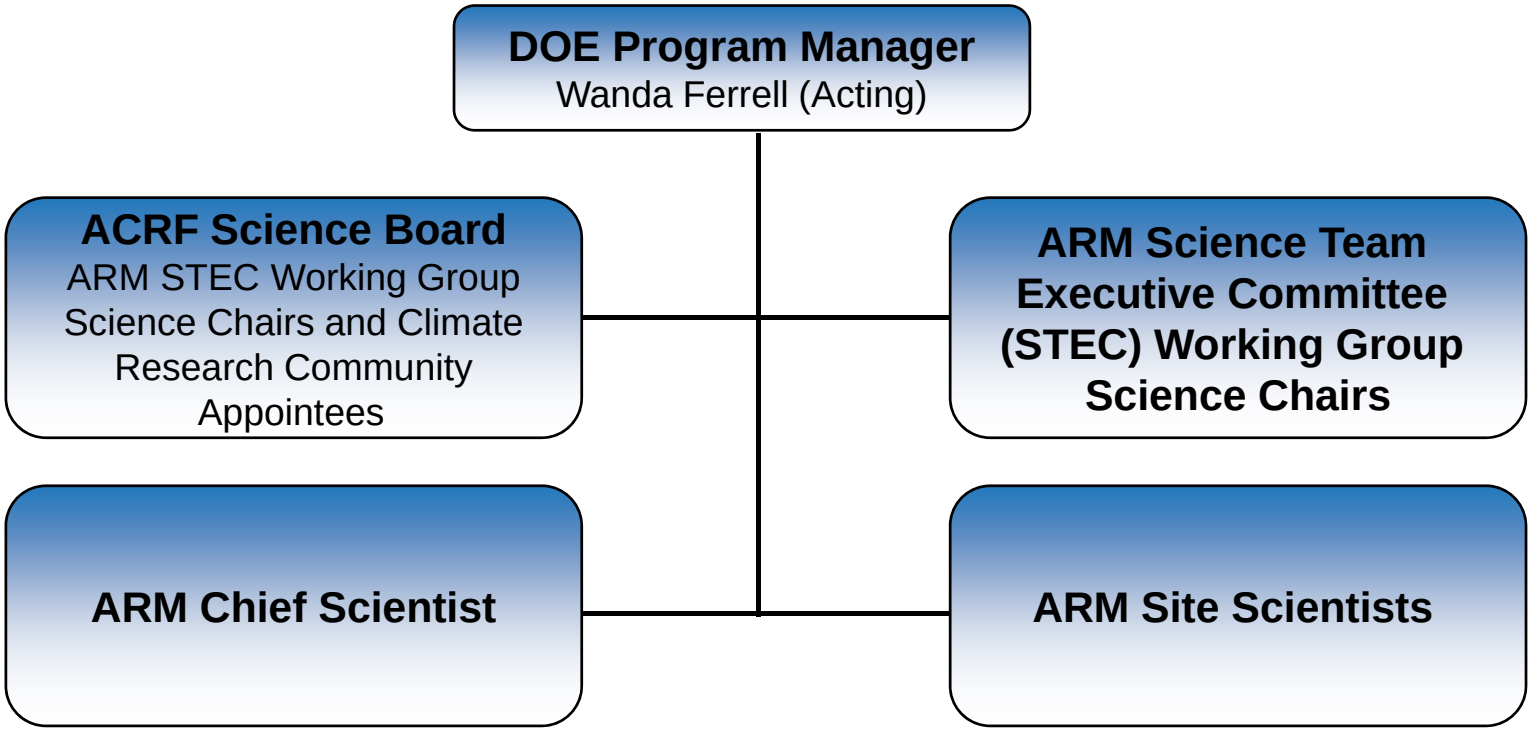
Organization
ARM Science Management



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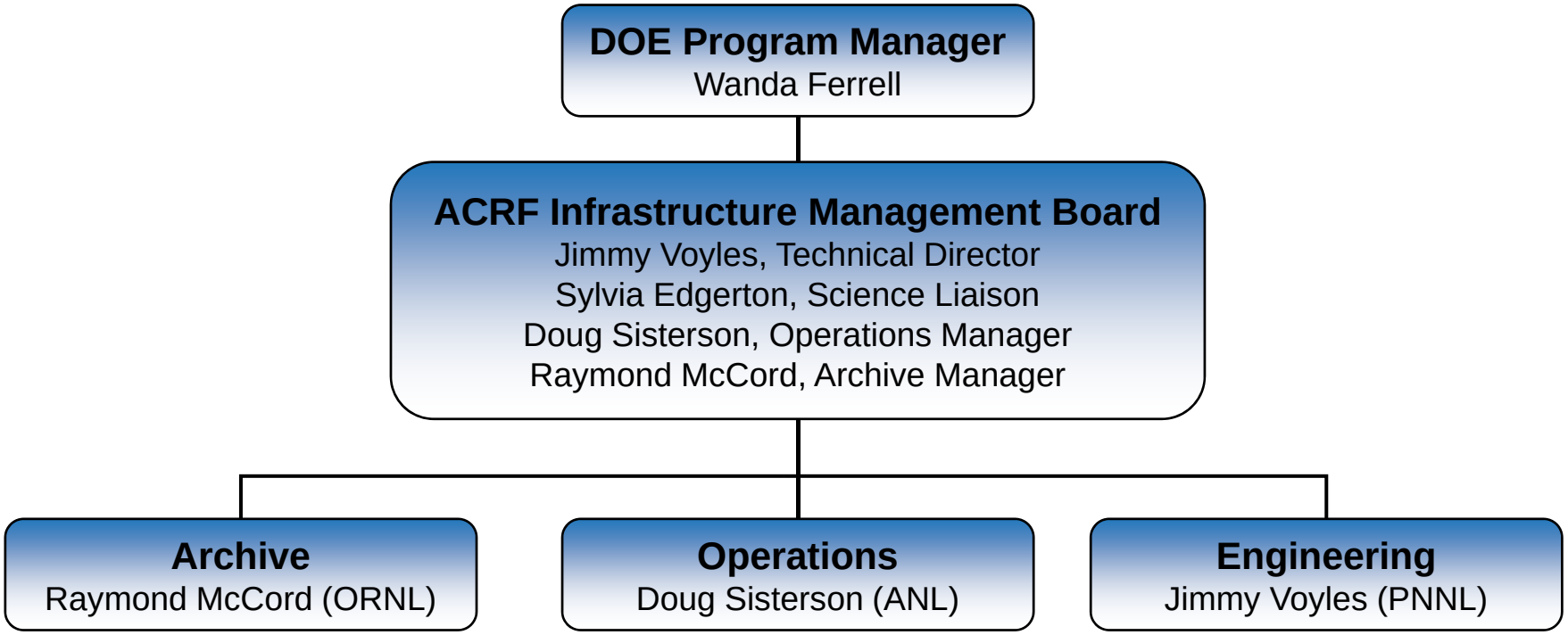
Organization
ACRF Infrastructure Management



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ACRF Site Locations

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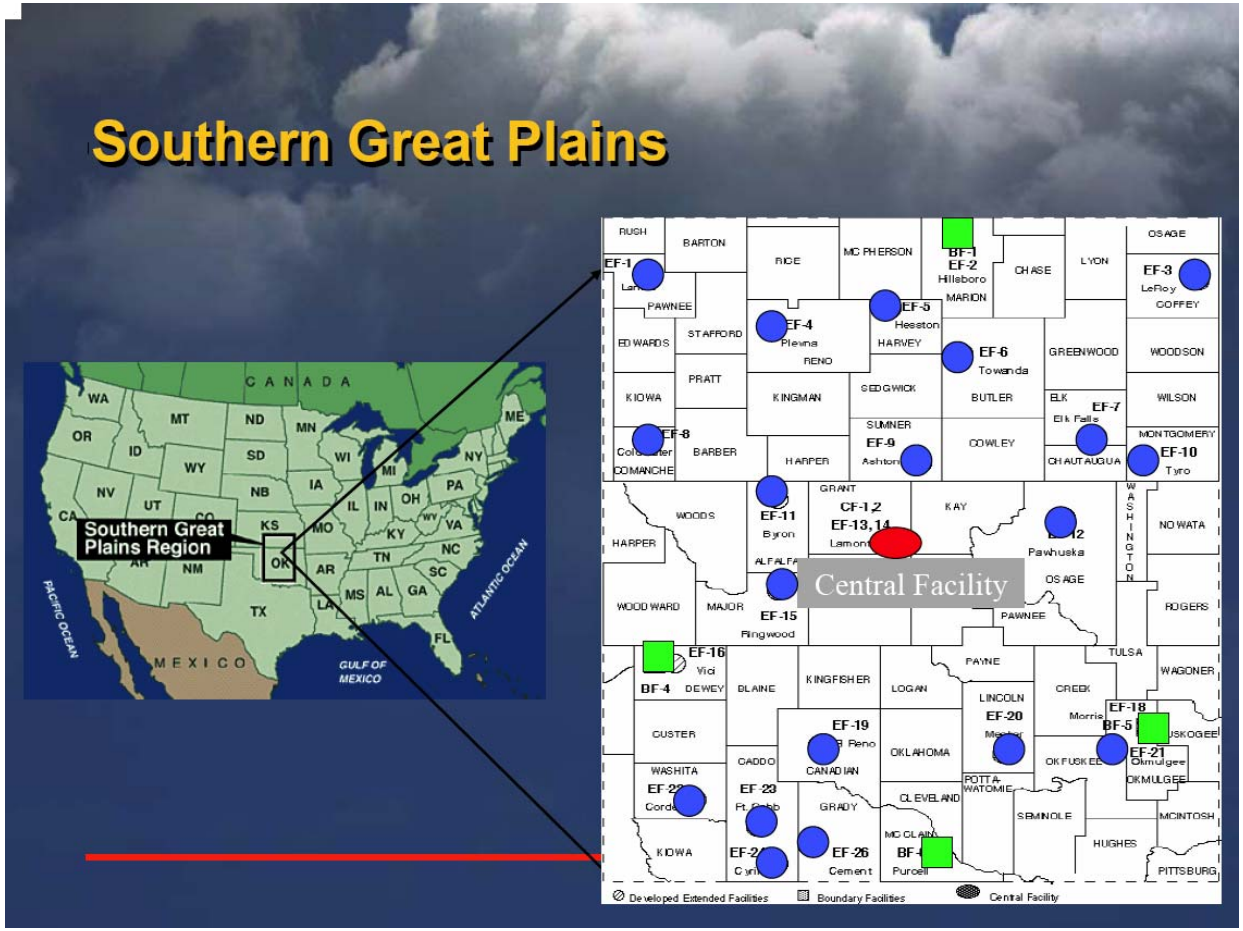
ACRF Site Locations
Southern Great Plains



Central Facility (1992)

ACRF Site Locations
Southern Great Plains

Central Facility (1992)

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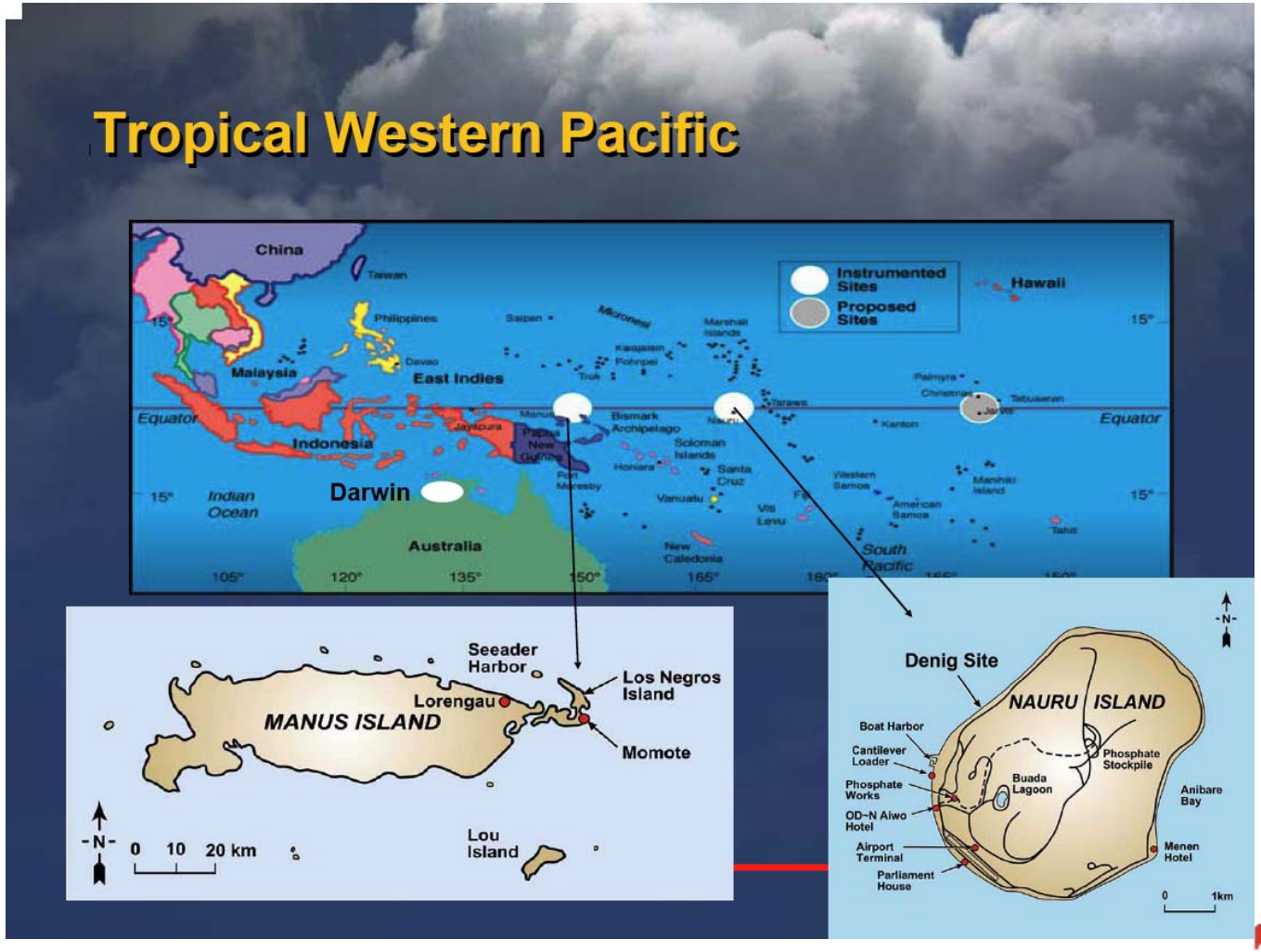
ACRF Site Locations
Tropical Western Pacific



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ACRF Site Locations
Tropical Western Pacific

Darwin
(2003)

Manus
(1996)

Nauru (1998)

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ACRF Site Locations
North Slope of Alaska

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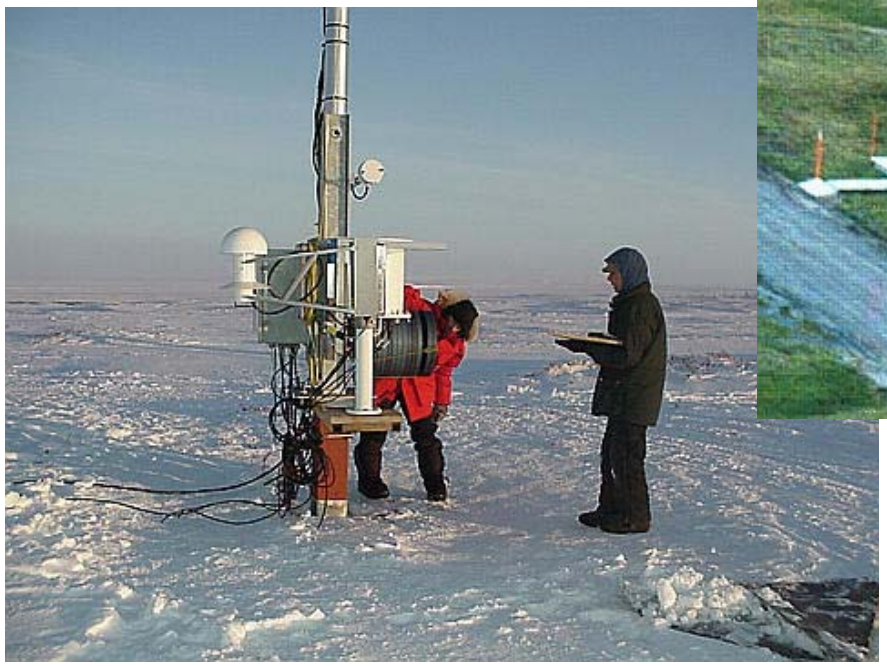
ACRF Site Locations
North Slope of Alaska

Barrow (1997)



Atqasuk (1999)

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ACRF Site Locations
ARM Mobile Facility

ARM Mobile Facility
Beta Test at PNNL
January 2005

1st deployment:
Point Reyes, California
March through September 2005

Currently:
Niger, Africa
2006

Next:
Black Forest, Germany 2007

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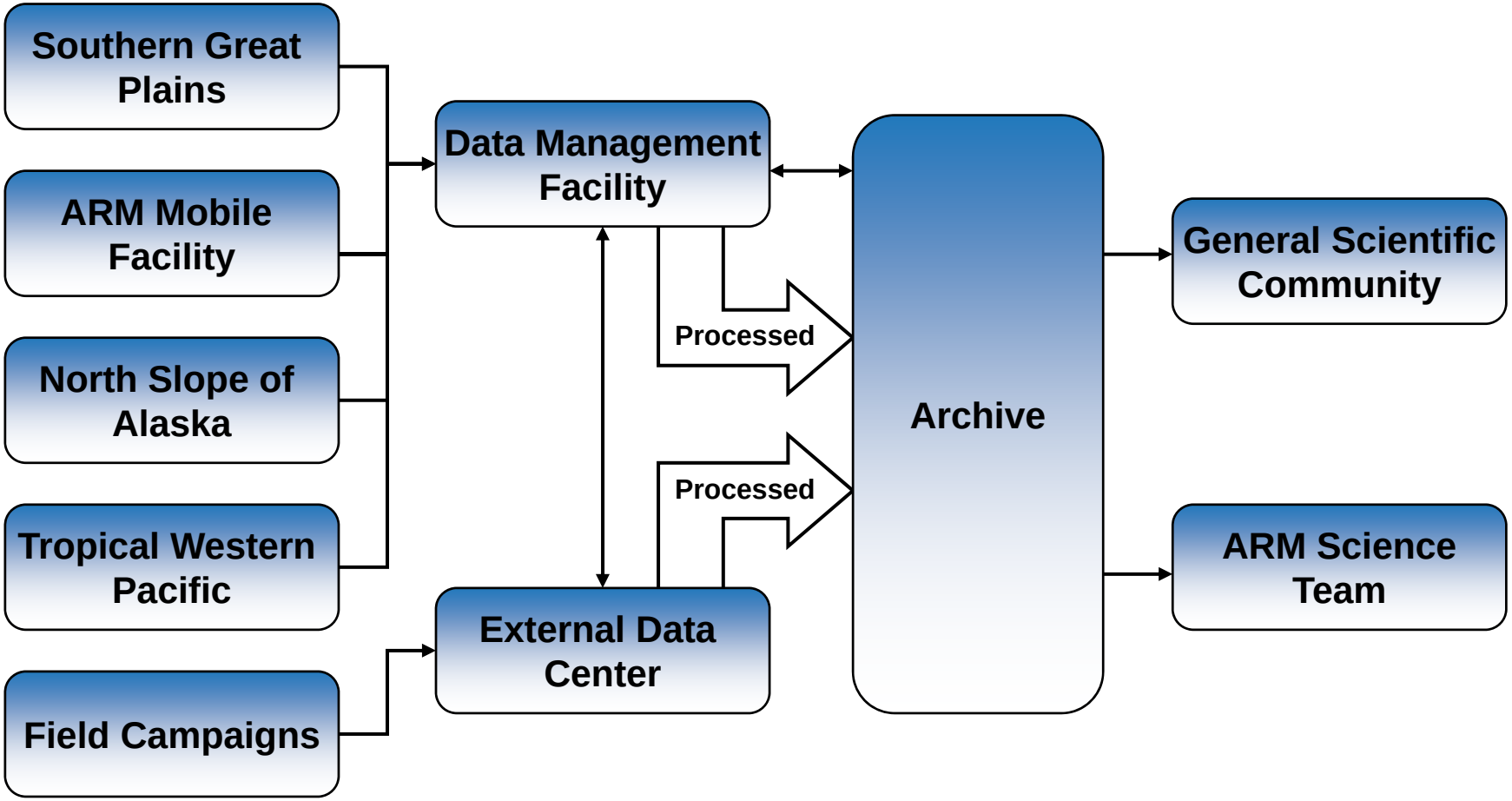
ACRF Data Flow

ACRF Block Diagram



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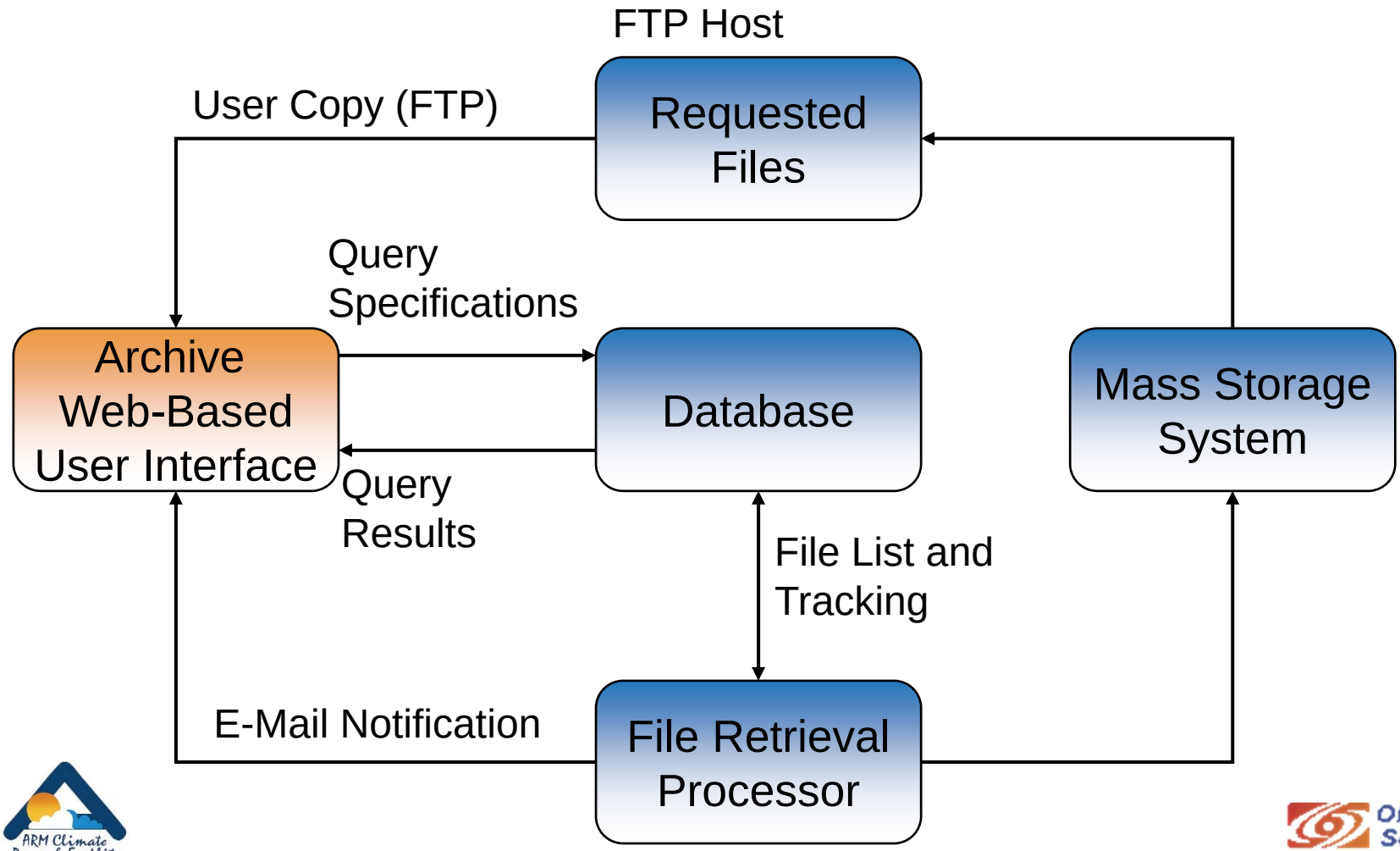
ACRF Archive Overview
Data Request and Retrieval Processing



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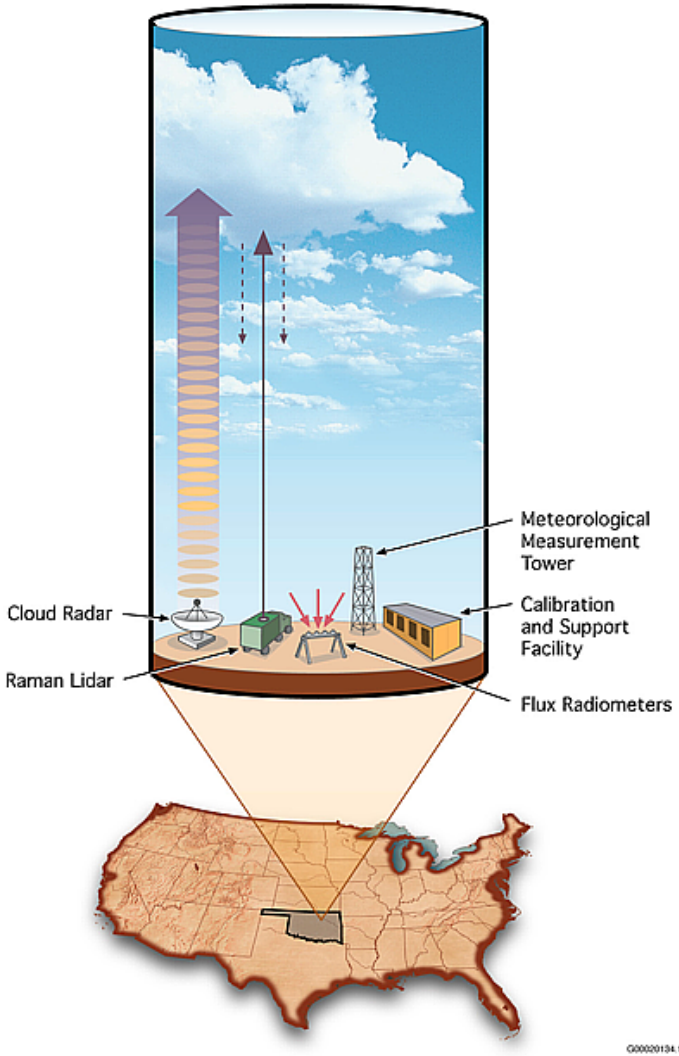
ACRF Measurements

Atmospheric State

upper air state

- Advective tendency
- Atmospheric moisture
- Atmospheric pressure
- Atmospheric temperature
- Atmospheric turbulence
- Cloud ice water
- Cloud liquid water
- Convection
- Geopotential height
- Horizontal wind
- Liquid water path
- Microwave radiation
- Precipitable water
- Radiative heating rate
- Vertical velocity
- Virtual temperature



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ACRF Measurements

ACRF Instruments

Atmospheric Profiling

- Atmospherically Emitted Radiance Interferometer (AERI)
- Balloon-Borne Sounding System (BBSS)
- Microwave Radiometer (MWR)
- Microwave Radiometer Profiler (MWRP)
- Mini Sound Detection and Ranging (SODAR)
- Radar Wind Profiler / Radio Acoustic Sounding System (RWP)
- Raman Lidar (RL)

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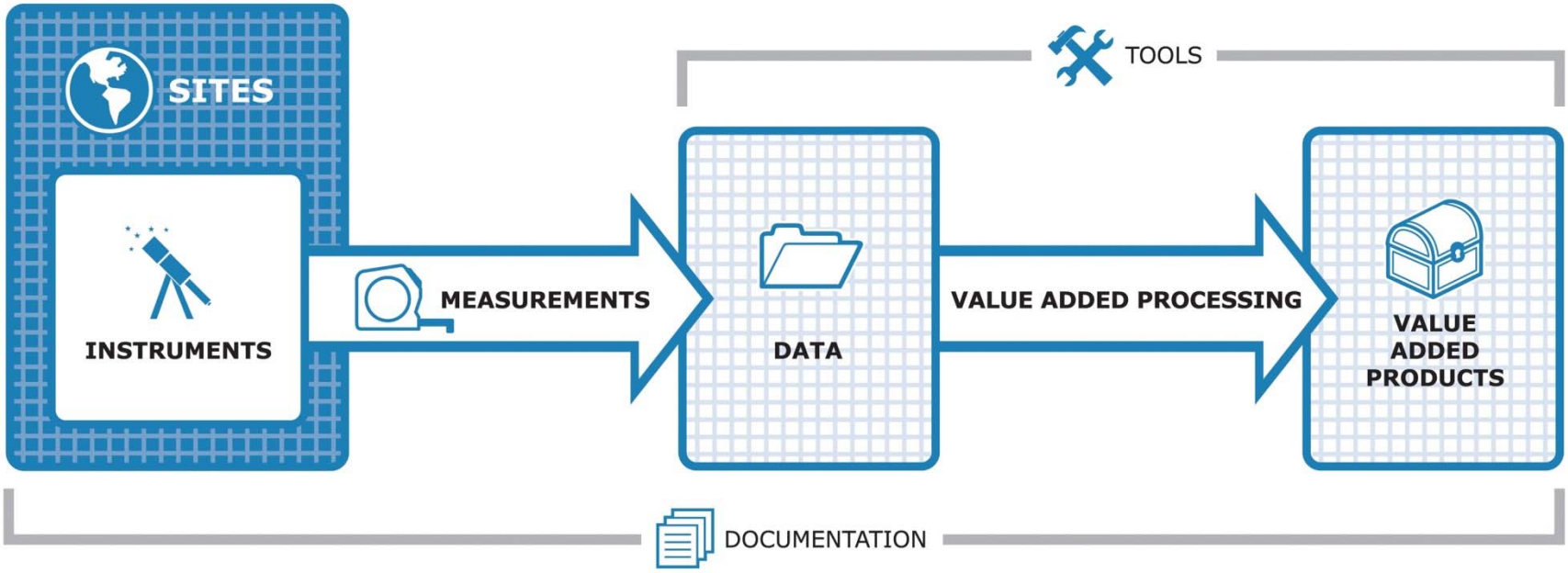
ACRF Measurements

Value Added Products!



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ACRF Measurements

Value-Added Products (VAPS)

Despite extensive instrumentation deployed at the ARM sites, there will always be quantities of interest that are either impractical or impossible to measure directly or routinely.

Therefore, a data set can be “engineered” from individual instrument measurement outputs.

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ACRF Measurements

ARM VAP Products

- AERINF - AERI, Noise Filtered
- AERIPROF - AERI Profiles of Water Vapor and Temperature
- ARSCL - Active Remotely-Sensed Cloud Locations
- BAEBBR - Best estimate fluxes from EBBR measurements and bulk aerodynamics calculations
- BEFLUX - Best-Estimate Radiative Flux
- DIFFCOR1DUTT - Correction of Diffuse Shortwave Measurements
- LBL - Line-By-Line Radiative Transfer Model
- LSSONDE - Microwave Radiometer-Scaled Sonde Profiles
- MWRAVG - MicroWave Radiometer Averages in 1- and 5-minute increments
- OD1BARNMICH - Barnard-Michalsky MFRSR-NIMFR optical depth
- QME - Quality Measurement Experiment for AERI; Quality Measurement Experiment for MWR
- RLPROF - Raman LIDAR vertical profiles
- RWPTEMP - RWP-based virtual temperature profile
- SFCCLDGRID - Surface Cloud Grid
- TOACESS - Top of Atmosphere
- TWRMR - Tower Water-Vapor Mixing Ratio

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LSSONDE Value Added Product

Description: BBSS: derived, relative humidity scaled with MWR

A detailed data analysis indicated an error between the observed radiance from the AERI and that calculated by the Line-by-Line Radiative Transfer Model (LBLRTM).

The difference is primarily due to errors in specifying the atmospheric state: the water vapor profile has a pronounced influence on the radiance residuals, introducing both a bias and increasing the variability.

BBSS: Balloon Borne Sounding System
MWR: Microwave Radiometer
AERI: Atmospherically Emitted Radiance Interferometer

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LSSONDE Value Added Product

The radiosonde's water vapor calibration has been observed to fluctuate between radiosonde calibration lots (called batches), as well as within each calibration batch.

To reduce the variability and bias, the moisture profiles from each radiosonde are scaled such that its total precipitable water vapor matches that retrieved from the microwave radiometer (MWR).

For more details, see http://science.arm.gov/vaps/lssonde.stm.

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ACRF Measurements

Raw instrument output are archived as well as the processed data and available to users.

For ARM, knowing the state of the atmosphere in sufficient detail is more important than a single measurement. VAPs are archived, as well as the individual instrument data.

Keeping track of the pedigree of the VAP as well as the individual instruments allow long-term analysis of the data to be possible.

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Radiosonde and ground-based remotely sensed PWV data from the 2004 North Slope of Alaska Arctic Winter Radiometric Experiment: Implications for the US Arctic Climate Record

V. Mattioli, E. R. Westwater, D. Cimini, J. S. Liljegren, B. M. Lesht, S. I. Gutman, and F. J. Schmidlin

- Radiosondes launched during the NSA-WVIOP04 experiment (Vaisala RS90, NWS-VIZ, Snow White)
- Radiosonde quality control
- Analyses of temperature and relative humidity measurements: **Significant biases in T and RH and implications for US Arctic Climate Record**

Comparison of PWV from MWRP, GPS, MWR, and RAOB's

- PWV day-night differences
- A powerful tool: 22.235 GHz Tb observations

Submitted to JAOT,10-14-05

ARM/ACRF Infomercial

Dr. Ed R. Westwater (ARM Science Team Member)
Cooperative Institute for Research in Environmental Sciences
University of Colorado/NOAA ESRL Physical Science Division
Microwave Systems Development Branch
325 Broadway MS R/PSD4
Boulder, CO 80305-3328 USA
PH: 303-497-6527 FAX: 303-497-3577
E-mail: Ed.R.Westwater@noaa.gov
Web: http://www.etl.noaa.gov/~ewestwater

Dr. Barry M. Lesht (ACRF BBSS Mentor)
ASTNS Directorate
MS 203
Argonne National Laboratory
9700 S. Cass Ave.
Argonne, IL 60439
Office: 630-252-4208
FAX: 630-252-2959
bmlesht@anl.gov

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What Has ARM Learned?

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What Has ARM Learned?

Dr. Thomas P. Ackerman (Past ARM Chief Scientist)
Battelle Fellow
Professor, University of Washington
Pacific Northwest National Laboratory
P.O. Box 999 / K9-34
Richland, WA 99352

Office: 509-372-6032
FAX: 509-372-6153
ackerman@pnl.gov

Dr. Warren Wiscombe (Current ARM Chief Scientist)
NASA Goddard Space Flight Center
Brookhaven National Laboratory
Environmental Sciences Department
Mail Stop 490D
Upton, NY 11973

Office: 631-344-4260
FAX: 631-344-2060
wwiscombe@bnl.gov

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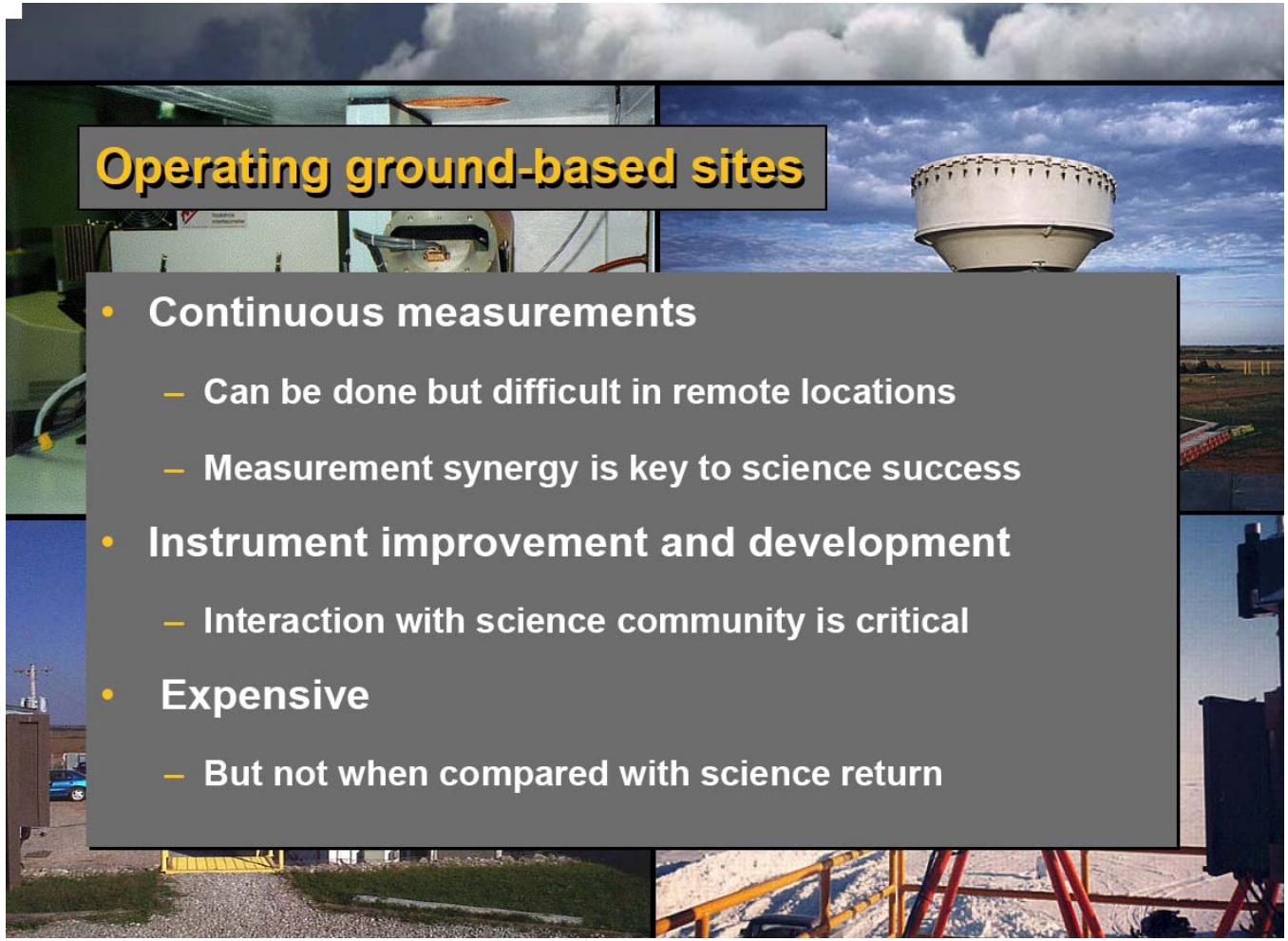
What Has ARM Learned? (Ackerman 2005)



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What Has ARM Learned? (Ackerman 2005)

Data acquisition and archiving

- Science success depends on a good archive
- Good => reliable, easy to use, responsive
- Best metric is user satisfaction
- Second best metric is data outflow

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What Has ARM Learned? (Ackerman 2005)

Data analysis

- Data must be calibrated and quality-controlled
- Continuous data
  - Multiple instruments
  - Multiple sites
  - Multiple seasons and years
- Scientists will find more things to do with the data than you ever imagined

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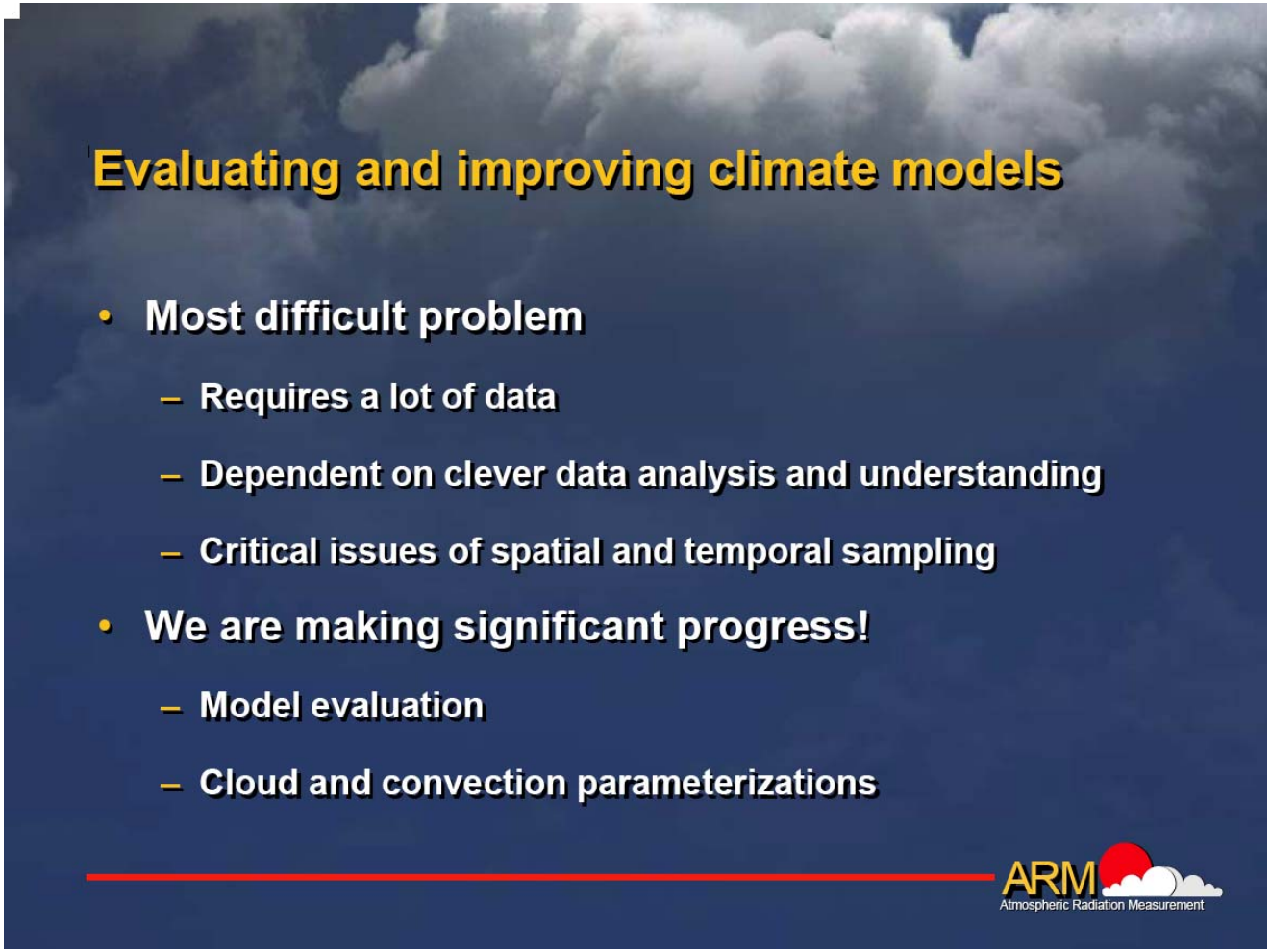
What Has ARM Learned? (Ackerman 2005)



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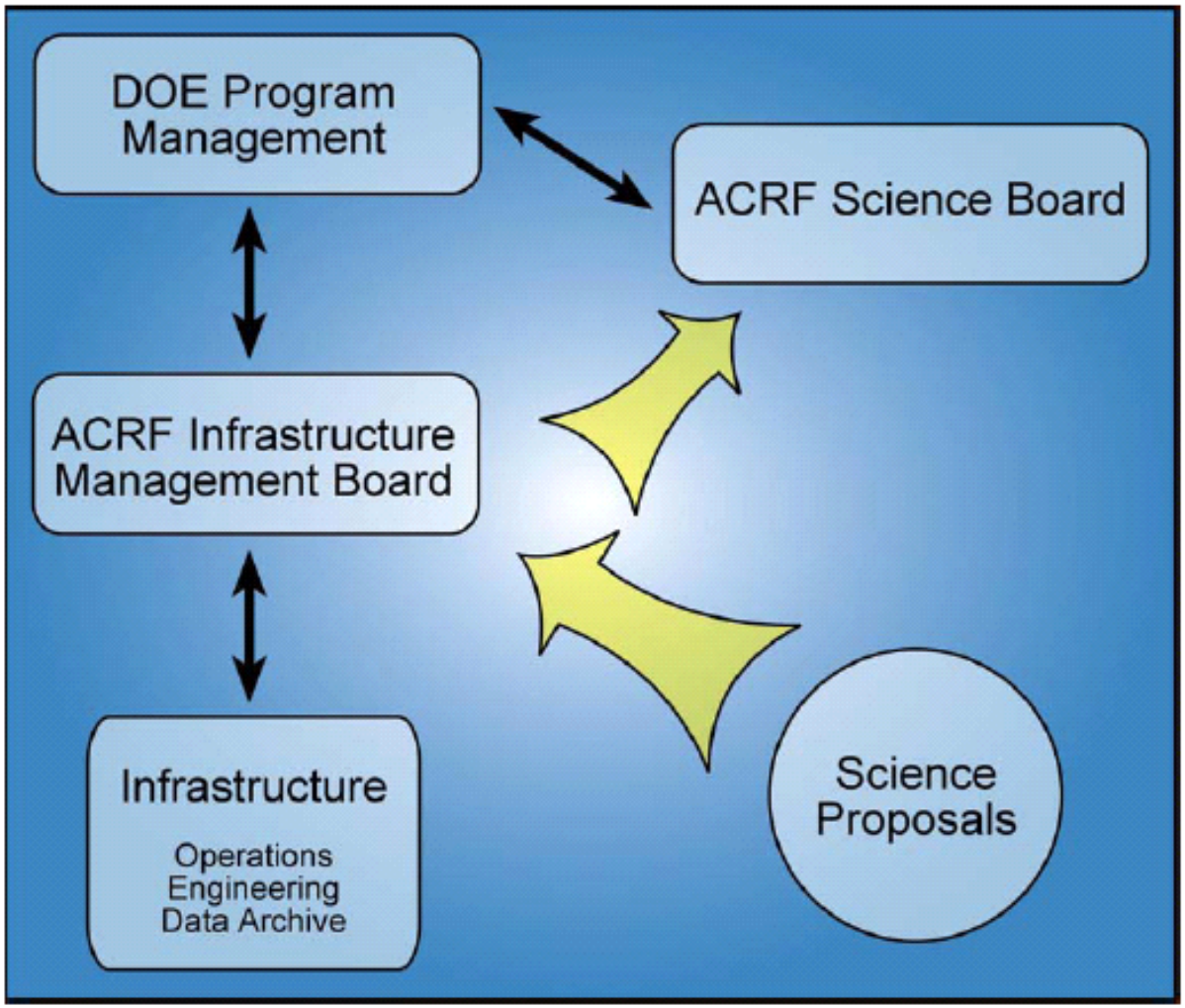
ACRF Field Campaign Pre-Proposals



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ACRF Field Campaign Proposal Process
The Short Version

- Principal Investigator submits pre-proposal
- Pre-proposal screened for feasibility
- Full proposal invited
- Proposal receives scientific and logistic reviews
- Decision made by U.S. Department of Energy (DOE) Program Manager

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ACRF Field Campaign Proposal Process
Review Process

- Pre-proposal phase
  - Feasibility and logistical reviews entered for Infrastructure Management Board to read and add comments
- Full proposal phase
  - Private site open for Science Board comment only – may be supplemented by mail reviews

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DOE National User Facility

WWW.ARM.GOV

QuickTime™ and a
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