ARM
CLIMATE RESEARCH FACILITY

The Atmospheric Radiation Measurement (ARM) Climate Research Facility

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2010 ASR Science Team Meeting, Bethesda, MD

U.S. DEPARTMENT OF ENERGY | Office of Science

Programmatic Mission

The goal of ASR, in partnership with the enhanced ARM Facility, is to quantify the interactions among aerosols, clouds, precipitation, radiation, dynamics, and thermodynamics to improve fundamental process-level understanding, with the ultimate goal to reduce the uncertainty in global and regional climate simulations and projections.

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ASR / ARM Objectives

- 4 objectives listed in ASR Science Plan
- First two are really ARM Facility objectives:
  - Maintain and augment the collection of comprehensive and continuous long-term data sets that provide measurements of CARDTP at several fixed and mobile sites
  - Supplement long-term data with lab studies and field campaigns to target specific atmospheric processes in a wide variety of conditions
- Other two objectives are ASR focused

Coupling between ASR & ARM

- Section 3 of the science plan outlines the observational and modeling approach
- To paraphrase:

The observations informs the modeling

and

The modeling informs the observations

ARM Facility Resources

- Fixed ground-based sites
  - Southern Great Plains (CF at Lamont, BFs, and EFs)
  - Tropical Western Pacific (Manus, Darwin, Nauru)
  - North Slope of Alaska
- Two mobile facilities
  - California, Niger, Germany, China, Azores, Colorado
- Airborne facility
  - Many missions
- Data processing system and archive

Airborne Facility

AAF Supports...

- Intensive observation periods
  - Short-term campaigns
  - Non-hardened instruments
- Routine observations
  - Long-term campaigns
  - Hardened instruments (hands-off)
- Instrument development
  - Moving proven instruments closer to ‘hands-off’ ops

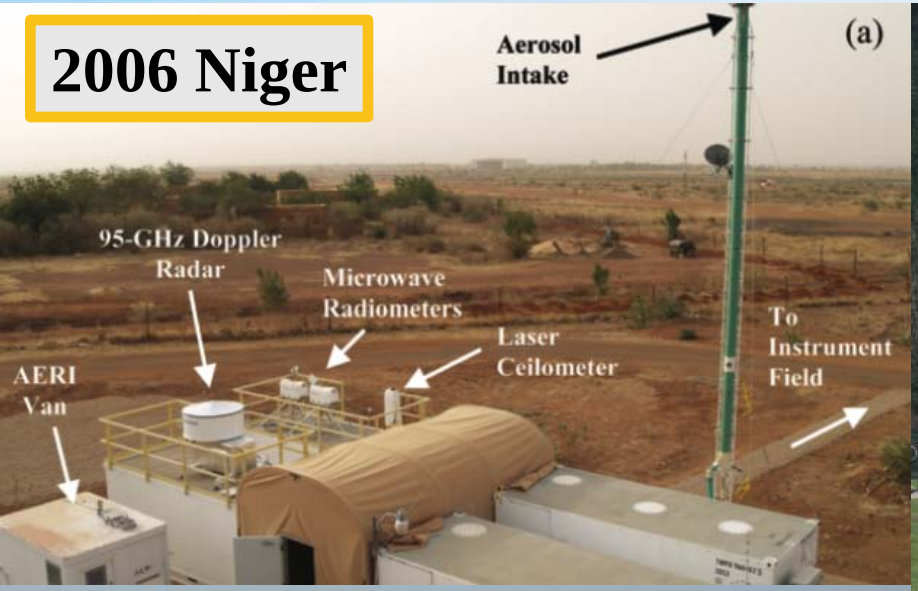
AAF Routine Flights

- Regularly scheduled flights with instruments that are largely automated
- Objective: generate better statistics by flying in a wide range of conditions
  - Less reliance on “golden days”
- Four examples to date:
  - In-situ aerosol profiling (IAP): 2000-2007
  - Warm, thin liquid water clouds (RACORO): 2009
  - Small ice crystals in cirrus (SPartICus): 2010
  - Airborne carbon measurements (ACME): 2008-2011

Mobile Facilities

- Mobile facilities have the same core instrumentation as fixed facilities
- Deployed for 6 months to 2 years
- Can be requested by ASR investigators or scientific community
- Two AMFs
  - AMF-1: est 2005; currently on its 5th deployment
  - AMF-2: starting its first deployment in Colorado
- Mobile ground-base aerosol facility

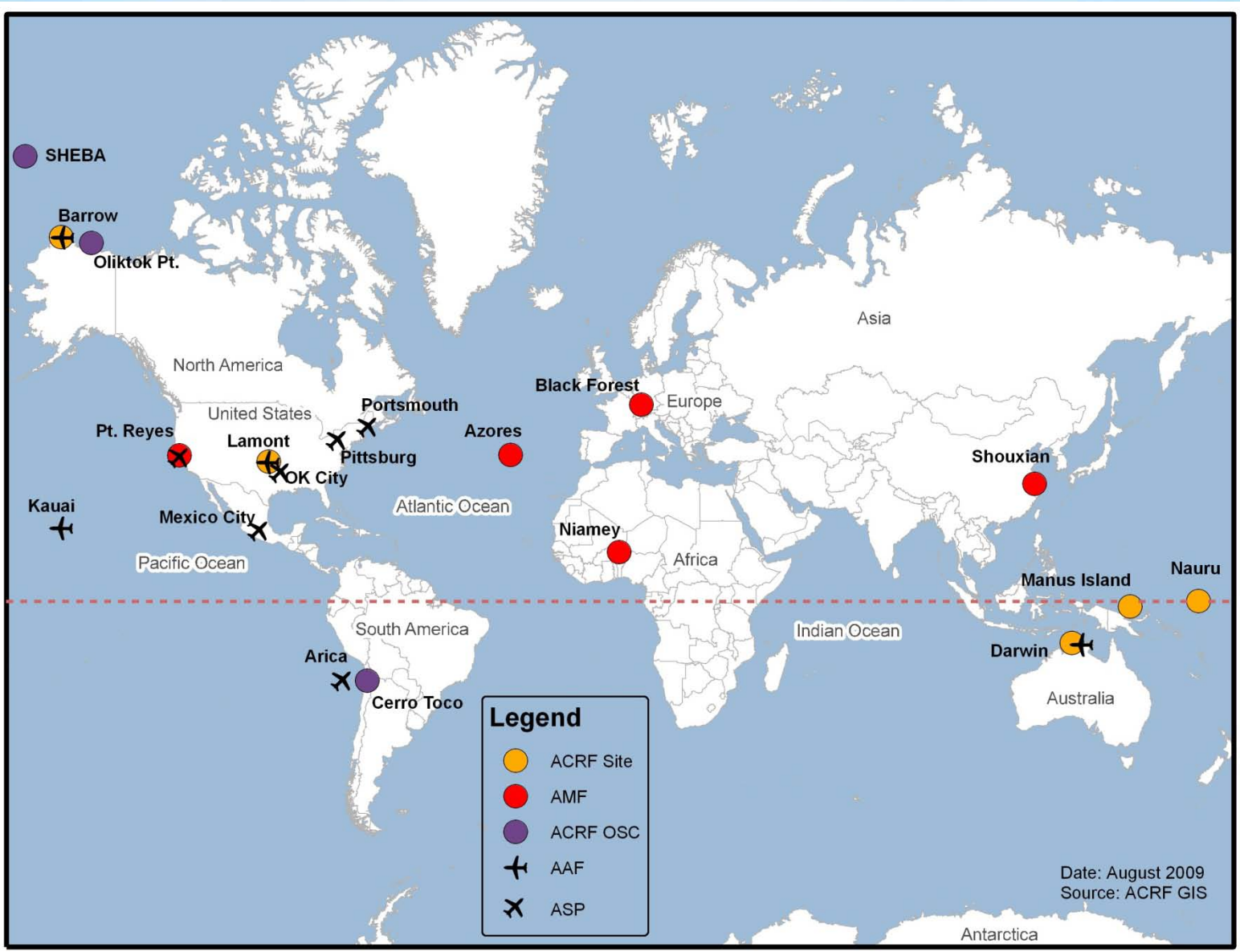
Mobile Facility Deployments



Fixed Sites

- Different climatic regimes
- Long-term data sets (decades)
- Wide range of instrumentation
  - Ground-based in-situ (e.g., basic met, flux stations)
  - Airborne in-situ (e.g., radiosondes)
  - Active remote sensors (e.g., radars, lidars)
  - Passive remote sensors (e.g., radiometers, spectrometers)

Location of ARM Facilities



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Office of Science

Pushing the Obs Envelope

- Pioneered the use of autonomous active and passive remote sensing observations of the atmospheric column
  - Millimeter-wave cloud radar (MMCR)
  - Raman lidar
  - Atmospheric Emitted Radiance Interferometer (AERI)
- Developed instruments to sample aerosol particle size, composition, absorption, etc.
  - Photo-thermal interferometer
  - Single particle laser ablation time-of-flight (SPLAT)

Recovery Act of 2009

- Provided an opportunity to dramatically expand observational capabilities of facility
  - $60M in capital investments
- Instrumentation drawn from working group recommendations, DOE workshops, etc.
- Improve data system and infrastructure
- Provide 3-d measm’ts of cloud scale dynamics, microphysics, and precipitation
- Enhanced measm’ts of aerosol composition and chemistry

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Facility Instrumentation

- Millimeter-wave cloud radar (MMCR)
- SGP, NSA, TWP, AMF
- Radar reflectivity, Doppler velocity, cloud boundaries, cloud liquid and ice water content profiles, cloud particle motion

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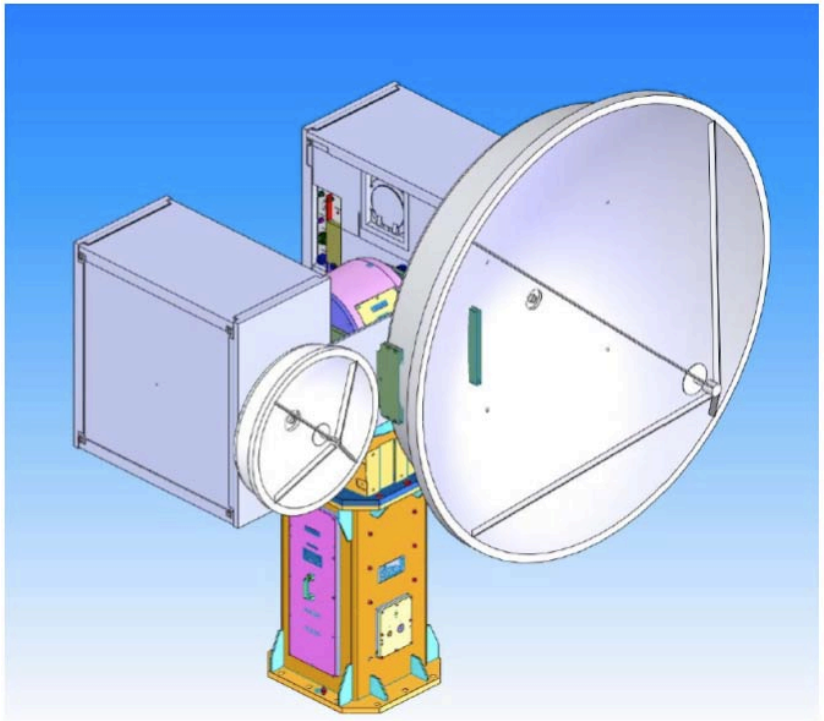
Facility Instrumentation

- Scanning dual frequency cloud radar
- SGP, NSA, TWP, AMF
- Elevation and azimuth scans of: radar reflectivity and Doppler velocity at 2 wavelengths, cloud boundaries, cloud liquid and ice water content profiles, cloud particle motion



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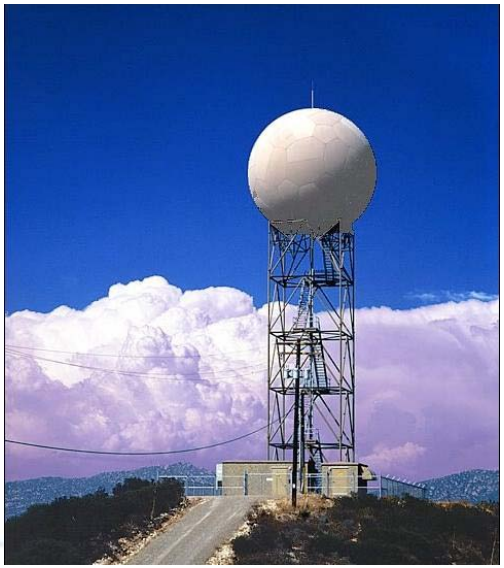
Facility Instrumentation

- Scanning precipitation radar
- SGP, NSA, TWP, AMF
- Azimuth and elevation scans of radar reflectivity and Doppler velocity at longer wavelengths, rain rate, cloud motion



Facility Instrumentation

- Radiosonde
- SGP, NSA, TWP, AMF
- Profiles of pressure, temperature, humidity, wind speed, wind direction
- Autosonde launcher for NSA

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Facility Instrumentation

- Raman lidar
- SGP, TWP
- Water vapor mixing ratio profiles, aerosol and cloud backscattering and extinction profiles, depolarization profiles, cloud boundaries, cloud and aerosol optical depth, cloud phase

ARM CLIMATE RESEARCH FACILITY

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Facility Instrumentation

- Scanning Doppler wind lidar
- SGP, TWP, AMF
- Radar reflectivity, Doppler velocity, cloud boundaries, cloud liquid and ice water content profiles, cloud particle motion

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Facility Instrumentation

- High spectral resolution lidar (HSRL)
- NSA, AMF
- Profiles of aerosol and cloud backscatter and extinction, depolarization ratio, cloud boundaries, cloud optical depth, cloud phase

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Facility Instrumentation

- Microwave radiometer (MWR)
- SGP, NSA, TWP, AMF
- Downwelling emission at 23.8, 31.4, and 90 GHz, precipitable water vapor, liquid water path
- Upgraded by ARRA

Facility Instrumentation

- Atmospheric emitted radiance interferometer (AERI)
- SGP, NSA, TWP, AMF
- Downwelling infrared radiance spectrum, temperature and humidity profiles, cloud optical depth and effective radius, cloud phase
- Upgraded by ARRA

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Facility Instrumentation

- Solar spectrometer
- SGP, AMF
- Solar spectral radiance and irradiance, aerosol and cloud optical depth, Angstrom exponent, cloud particle effective radius
- Upgraded by ARRA

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Facility Instrumentation

- Multi-filter rotating shadowband radiometer (MFRSR)
- SGP, NSA, TWP, AMF
- Direct and diffuse solar irradiance in 6 narrow spectral bands, aerosol optical depth, Angstrom exponent, aerosol single scatter albedo, precipitable water vapor

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Facility Instrumentation

- Cimel sunphotometer
- SGP, NSA, TWP, AMF
- Solar irradiance and radiance in 6 spectral channels, aerosol optical depth, Angstrom exponent, aerosol size distribution, aerosol single scatter albedo

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Facility Instrumentation

- Aerosol observing system (AOS)
- SGP, NSA, TWP, AMF, MAOS, AAF
- In-situ aerosol scattering and backscattering, absorption, number concentration, size distribution, cloud condensation nuclei counter, single scatter albedo, asymmetry parameter, hygroscopic growth
- Upgraded by ARRA

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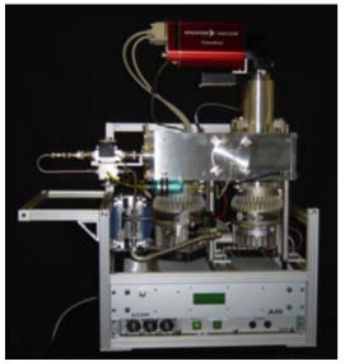
Facility Instrumentation

- Aerosol chemical speciation monitor
- SGP, TWP, MAOS
- Particulate composition for ammonium, nitrate, sulfate, chloride, and organic species



- Photon transfer mass spectrometer
- MAOS
- Gaseous organic compounds

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Facility Instrumentation

- Particle into liquid sampler (PILS)
- MAOS, AAF
- Aerosol chemical composition, water soluble organic carbon

- Scanning mobility particle sizer
- MAOS, AAF
- Aerosol size distribution from 15 nm - 450 nm

Facility Instrumentation

- Cloud in-situ probes
- AAF
- Cloud droplet size distribution, cloud particle images, cloud water content, cloud particle phase

2D Stereo Probe

Cloud Imaging Probe

High Volume Precipitation Spectrometer

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Facility Instrumentation

- 2-dimensional video disdrometer
- TWP, AMF, MAOS
- Droplet size distributions, precipitation rate, liquid water content

- Disdrometer
- SGP, TWP
- Droplet size distributions, precipitation rate
- Upgraded by ARRA

Facility Instrumentation

- Eddy correlation flux measurement systems
- SGP, TWP, NSA, AMF
- Latent and sensible heat flux, turbulence, carbon dioxide flux
- Upgraded by ARRA

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Facility: More than Instruments

- Site infrastructure
- Data processing system
  - Data management facility
  - Archive
  - External data center
  - Metadata databases
- People
  - Program office
  - Site operations
  - Instrument mentors
  - SW Developers
  - Contracts / Financial
  - Outreach
  - Communications

Data Archive

- All ARM data stored
  - Raw data, and higher data levels
- Simple web interface
- Improving data ordering and visualization
- Expanding rapidly to handle the explosive growth in data volume
  - E.g., radar spectra

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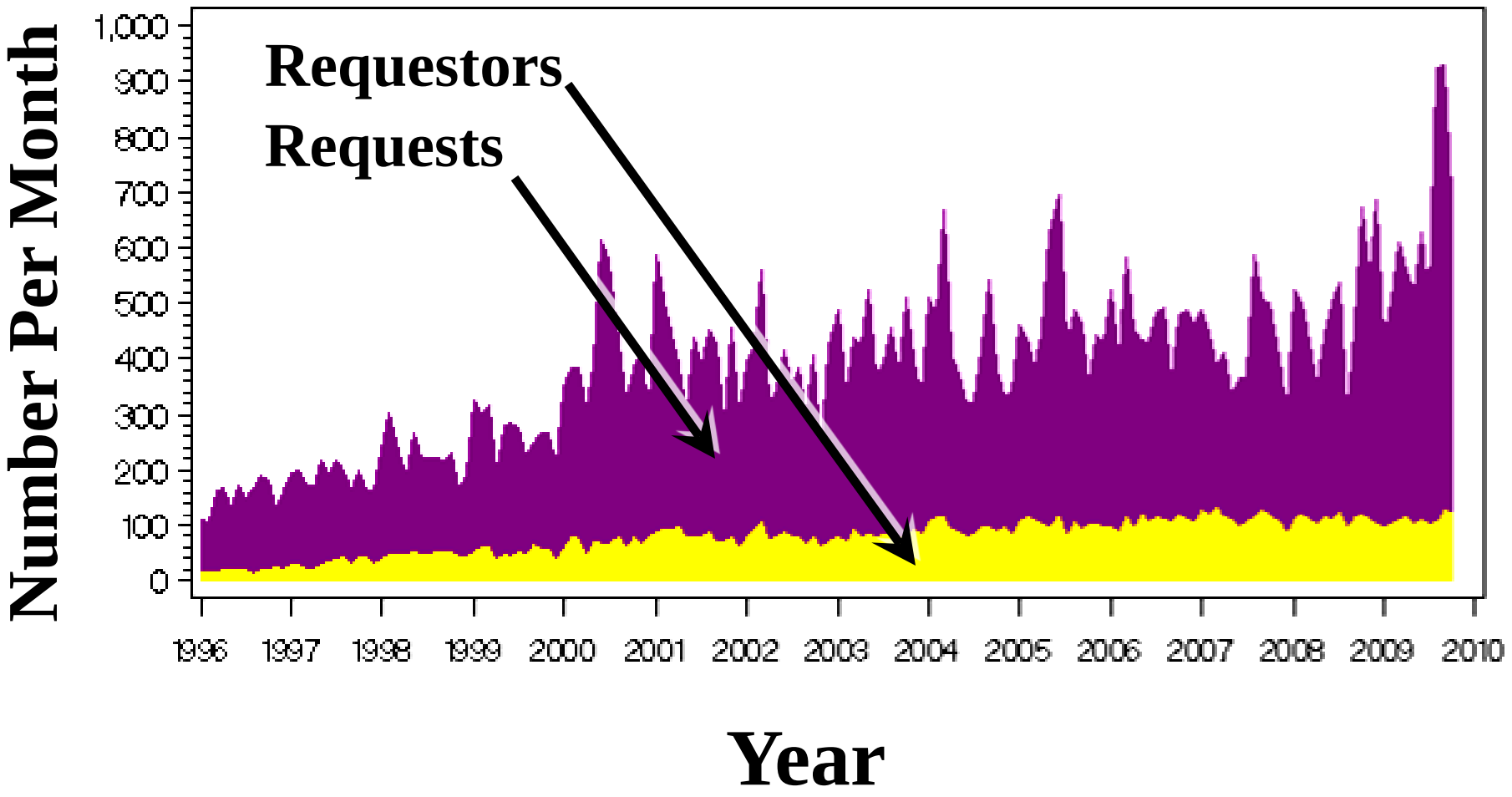
ARM Archive User Requests



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Which SGP ARM data streams are the most requested from the Archive?

1

2

3

4

5

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Which SGP ARM data streams are the most requested from the Archive?

- **Radiosonde**
- 2
- 3
- 4
- 5

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Which SGP ARM data streams are the most requested from the Archive?

- Radiosonde
- Microwave Radiometer
- 3
- 4
- 5

Which SGP ARM data streams are the most requested from the Archive?

Radiosonde

Microwave Radiometer

ARSCL (MMCR)

4

5

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Which SGP ARM data streams are the most requested from the Archive?

Radiosonde

Microwave Radiometer

ARSCL (MMCR)

Raman lidar

5

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Which SGP ARM data streams are the most requested from the Archive?

- Radiosonde
- Microwave Radiometer
- ARSCL (MMCR)
- Raman lidar
- W-band cloud radar (WACR)

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Value Added Products

- Create new data streams by from others
- Different levels of VAPs:
  - Convert raw instrument data into geophysical data
    - Liquid water path and precipitable water vapor retrieved from microwave radiometer
    - Water vapor mixing ratio data from Raman lidar
  - Optimally combine data from different sources to provide a best estimate or higher order dataset
    - Active remote sensing of cloud locations (ARSCL)
    - Objective analysis data product for modelers

Value Added Products

- VAPs greatly enhance the scientific utility of the facility
  - Make the data more useable to the community
- New suite of instruments will require VAP development to:
  - Derive basic geophysical variables from the new obs
  - Combine data from existing and new instruments into unique and powerful new data sets
- VAP process is being scrutinized to improve the efficiency of the development process

Value Added Products

- Only works if the scientists are engaged!
- Need PIs to:
  - Develop prototype algorithms and datasets
    - And archive the PI-generated data in the archive!
  - Prioritize the implementation by the infrastructure
  - Use the data and provide feedback
- Need to start using the ARRA instrumentation immediately, which means we need VAPs
- We need your expertise, creativity, and time!

ARM Web Page

http://www.arm.gov

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Summary

- The ARM facility has pioneered the use of advanced observational tools in a routine manner to collected a unique and powerful dataset
- These data have greatly advanced the science over the last 20 years
- The ARRA enhanced facility will provide new ways to view our atmosphere and the processes at work within it
- Teamwork: infrastructure + science team

ASR Web Page

http://asr.science.energy.gov

Atmospheric System Research

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ABOUT | SCIENCE | MEETINGS | FACILITIES | DATA | PUBLICATIONS | NEWS | CONTACTS

Science team meeting | Fall working groups | Presentations

The *Atmospheric System Research (ASR)* science and program plan is now available.

- Meeting Home
- Registration
- Hotel Floor Plan
- Breakout Request
- Agenda
- Posters & Abstracts
  - Poster Session Layout
  - Design Guidelines
  - View Abstracts
- Presentations
  - Slide Guidelines
- Logo Competition

Welcome

The first Science Team Meeting of the Atmospheric System Research (ASR) program will be held March 15-19, 2010, at the Marriott Bethesda North Hotel & Conference Center in Bethesda, Maryland. ASR is a new U.S. Department of Energy climate research program formed from the merger of the Atmospheric Radiation Measurement (ARM) Program and the Atmospheric Science Program (ASP).

The ASR Science Team Meeting officially begins on Tuesday, March 16, with a plenary session, followed by a full schedule of formal presentations by invited speakers and breakout sessions through Thursday. Orientation for new Principal Investigators and special focus meetings will be held on Monday, March 15. Poster session receptions will be held on Tuesday and Wednesday to review research results. **Working group meetings will be held on Thursday.**

Meeting Info

See the meeting agenda. Be sure to catch the new PI orientation on Monday and working group meetings on Thursday. See the hotel floor plan.

Registration

Registration is now closed. On-site registration will **begin Monday, March 15, 2010, at 7 a.m.**

Poster Abstracts

Poster abstracts are no longer being accepted. Please contact Dana Dupont with any questions or for assistance.

Travel Information

The DCA, IAD, and BWI airports serve the Bethesda area. The hotel website offers driving directions and more information on transportation, including public transportation options.

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