

# ARM Climate Research Facility Update

**Jim Mather**  
**Pacific Northwest National Laboratory**

**Joint meeting of the Cloud Modeling and Aerosol Working Groups**  
**Boulder, CO – September 30, 2009**



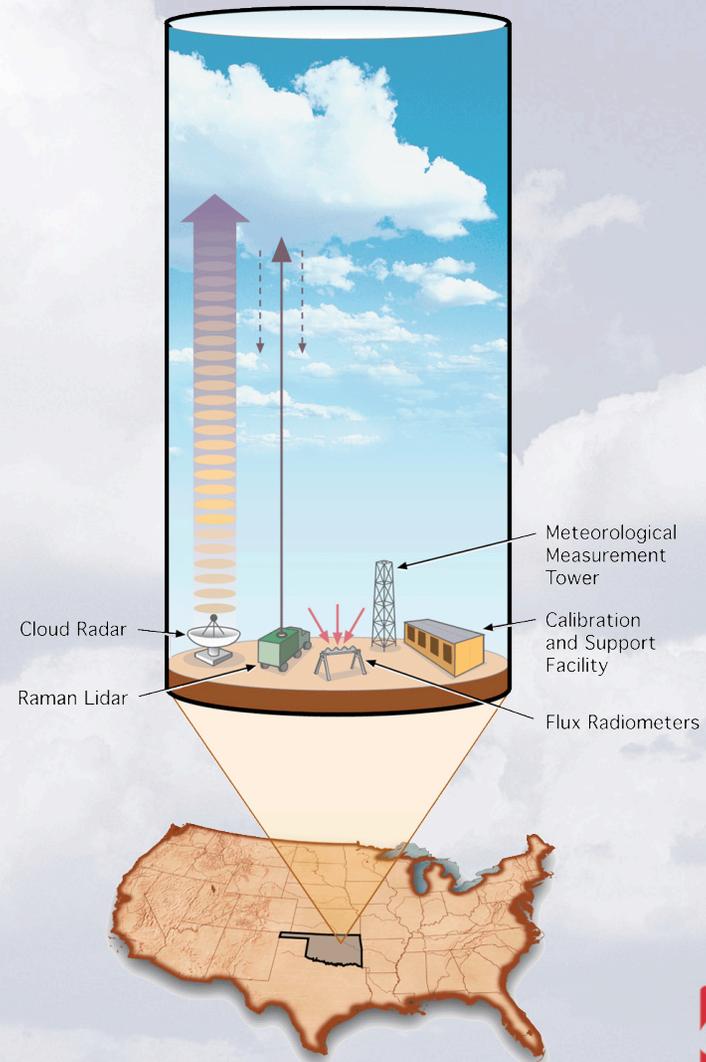
# Overview

- Facility Overview
- Recovery Act Update
- Data Products

# Program Overview

## ACRF Mission and Objective

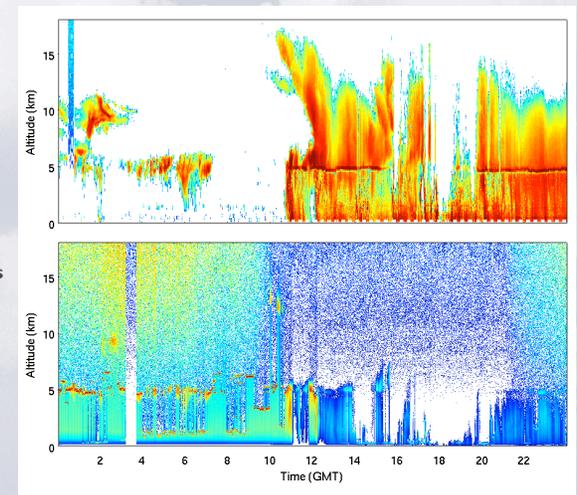
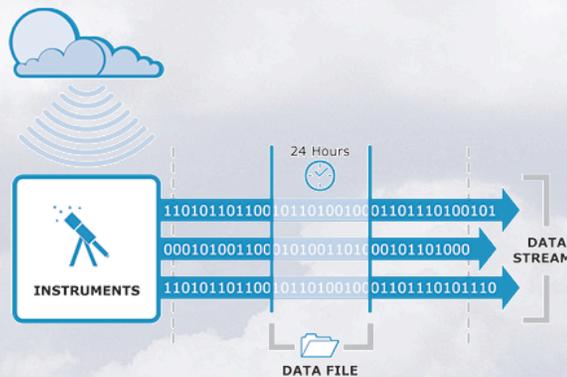
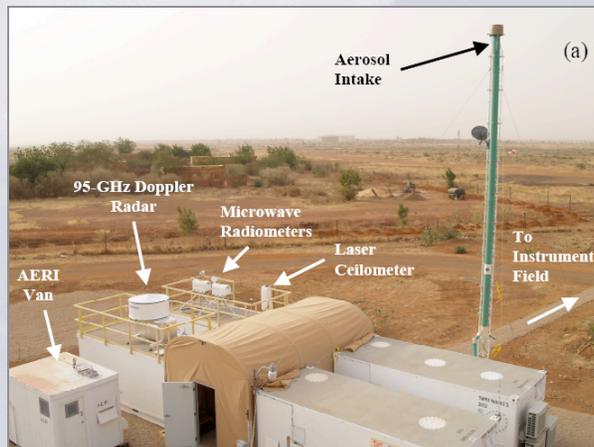
- Provide the national and international scientific community with the infrastructure needed for scientific research on global change
- Global change research includes the study of alterations to climate, land productivity, oceans, water cycle, atmospheric chemistry, and ecological systems



# Program Overview

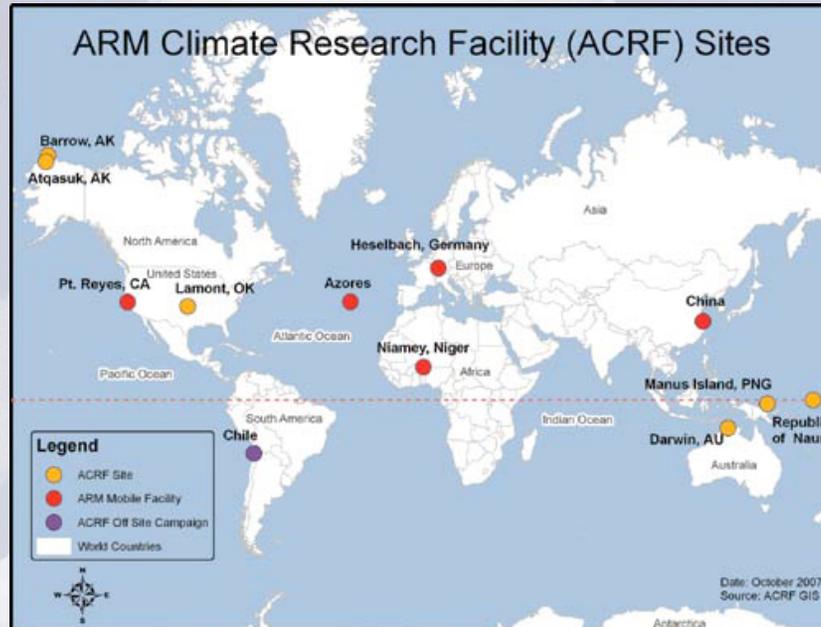
## ACRF Components

- Fixed research sites
- Mobile Facility
- Aerial Facility
- Data processing
- Data Archive
- Data quality office
- Support for ground-based and airborne field campaigns



# Program Overview

## Research Sites



- Southern Great Plains (1993)
- North Slope of Alaska: Barrow (1998) and Atqasuk (1999)
- Tropical Western Pacific: Manus (1996), Nauru (1998), and Darwin (2002)
- First ARM Mobile Facility (2005); (Second AMF coming in 2010)
- ARM Aerial Facility (2007)

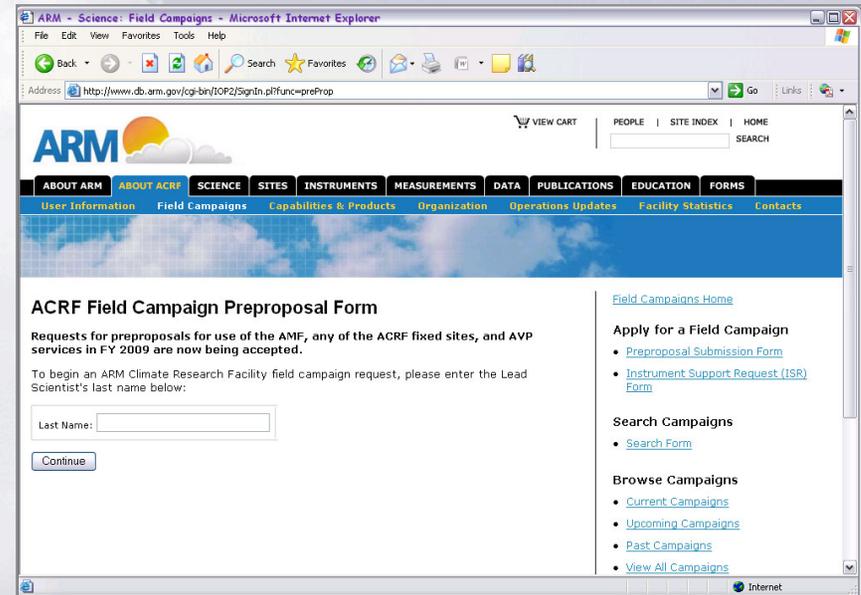
# Field Campaigns

## Recent, current, and upcoming Campaigns

- Routine AVP Clouds with Low Optical Water Depths (CLOWD) Optical Radiative Observations (RACORO); extended airborne observations at the SGP site (Jan – Jun 2009)
- Cloud, Aerosol, and Precipitation in the Marine Boundary Layer (CAP-MBL); AMF deployment to the Azores (May 2009 through 2010)
- Radiative Heating in Underexplored Bands Campaign 2 (RHUBC-II); Chilean Atacama desert (Aug – Oct 2009)
- SPARTICUS – cirrus campaign. Another extended field campaign at the SGP (Nov 2009 – Spring 2011)
- CARES – AAF Carbonaceous Aerosol and Radiative Effects Study; California, (June/July 2010)
- STORMVEX - The first deployment of the second ARM Mobile Facility; Storm Peak Observatory, Colorado (Aug 2010 – Spring 2011).
- ALTOS – Arctic cloud microphysics using tethered balloon (Fall 2010)

# For More Information on ACRF

- Description of sites, instruments, data
- Upcoming campaigns
- Science highlights
- ACRF News (subscribe to RSS feed)
- Wiki pages
- Provide Feedback
- Contacts



Visit the ARM website: <http://www.arm.gov> (look for updates soon)

Or check us out on Facebook (follow the  on the ARM homepage)

Coming Soon: Separate site for Atmospheric System Research to support working groups, science team meeting, research highlights

# ACRF Initiative Recovery Act Introduction

- \$60M in capital investments for Instrumentation and Research Infrastructure Funding received on May 21 – and August 8, 2009
- Provide 3-dimensional measurements of cloud scale dynamics, microphysics, and precipitation
- Provide enhanced measurements of atmospheric aerosol composition and chemistry
- Enhance ACRF measurement base to bridge new knowledge into, and improve, the predictive performance of climate models

<http://www.arm.gov/about/recovery.php>

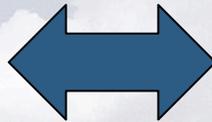
# Organization

**Program Oversight**  
Wanda Ferrell

**Project Manager**  
Jimmy Voyles

**Financial/Reporting**  
Luci Walker  
and Project Controls Group

**Procurement/Contracts**  
Susan Turner  
Joe Burks



**ACRF Infrastructure Management Board**

Wanda Ferrell, Rick Petty,  
Jim Mather, Beat Schmid,  
Jimmy Voyles, Doug Sisterson,  
Raymond McCord

**ACRF Facility Managers**

Brad Orr (SGP)  
Larry Jones (TWP)  
Mark Ivey (NSA)  
Raymond McCord (Archive)  
Richard Eagan (Data System)

**Project Technical Points of Contact**  
for each project WBS element

# Many Contributors

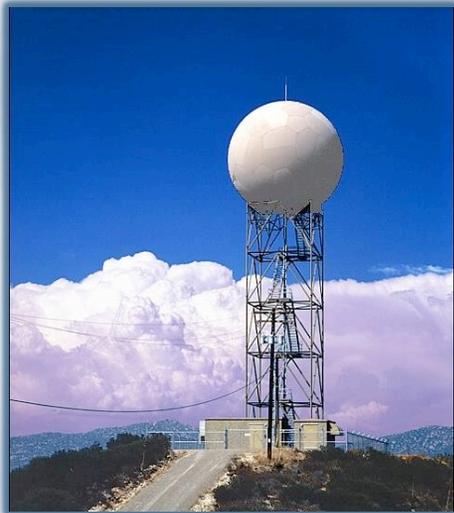
Wanda Ferrell - Jim Mather - Kevin Widener - Jimmy Voyles -  
Jennifer Comstock - Rich Coulter - Vic Morris - Rob Newsom -  
Dave Turner - Maria Cadeddu - Connor Flynn - David Cook - Will  
Shaw - Jason Tomlinson - Greg McFarquhar - Peter May -  
Cortney Schumacher - Alian Protat - John Hubbe - Dan Cziczo  
- Pete Daum - Beat Schmid - Raymond McCord - Mark Ivey -  
Hans Verlinde - Brad Orr - Kim Nitschke - Larry Jones - Dick  
Eagan - Matt Macduff - Todd Halter - Sherman Beus - Mikhail  
Pekour - Manvendra Dubey - Gunnar Senum - Arthur Sedlacek -  
Stephen Springston - Jian Wang - Yin-Nan Lee - John Shilling -  
Nicole Keck - Jackie Marshall - Peter Hoag - Luci Walker -  
Douglas Sisterson - Charlette Geffen - Susan Turner - Joe Burks  
- Kim Williams - Laurel Chapman - Jim Ferry - Doug Shafer -  
Lynne Roeder - Rolanda Jundt - Debbie Trader - Julie Turner -  
Pavlos Kalias - Warren Wiscombe - Paul Bayer - Rick Petty -  
Kiran Alapaty - Ashley Williamson - Laurel Chapman - Kevin  
Ensign - Mike Thompson - Scott Tingey - Tracie Cowen

# Procurement Status

- Specifications, Sole Source Justifications, Request for Information, and Statements of Work are complete
- Request for Proposals for all Major Items of Equipment are competed (Dual Frequency Cloud Radars and Raman Lidar)
- Inter-Laboratory Contract Procurements are complete
- ~\$27,000,000 of funds committed to date (several large contracts will very soon push this to close to \$50M).

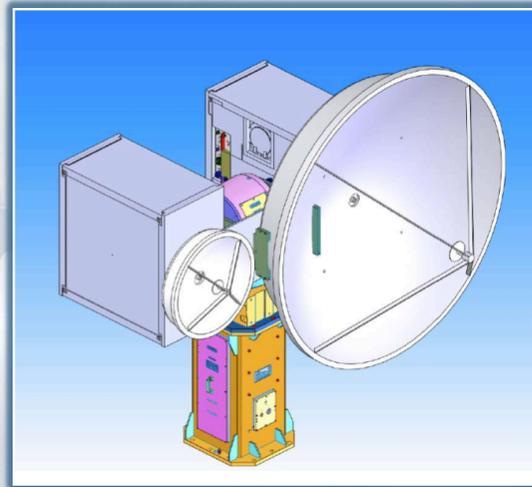
# Instrumentation and Measurements

Scanning  
Precipitation  
Radars



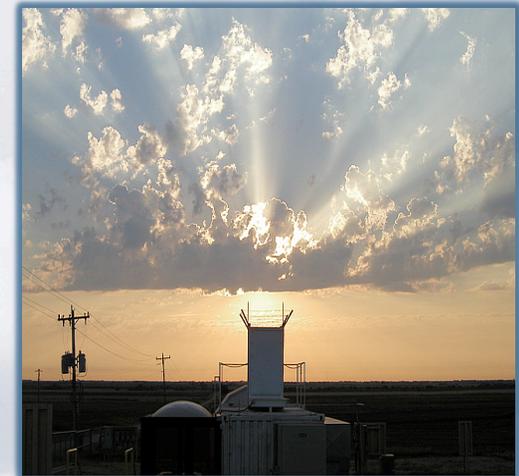
3-Dimensional  
Precipitation  
Patterns

Scanning Dual  
Frequency Cloud  
Radars



Microphysical  
Structure  
Of Clouds

Raman, High Spectral  
Resolution, and  
Doppler Lidar



Cloud and aerosol  
Properties,  
Updraft Velocities,  
Water Vapor

# Instrumentation and Measurements

3 Channel  
Microwave  
Radiometers



Precipitable Water  
Vapor and  
Liquid Water Path

Infrared and Solar  
Spectrometers



IR and Solar  
Radiation, Water  
Vapor, and  
Aerosols

Expanded Surface Flux  
Network

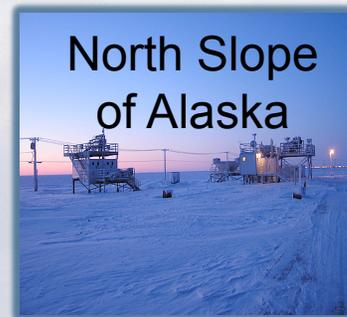
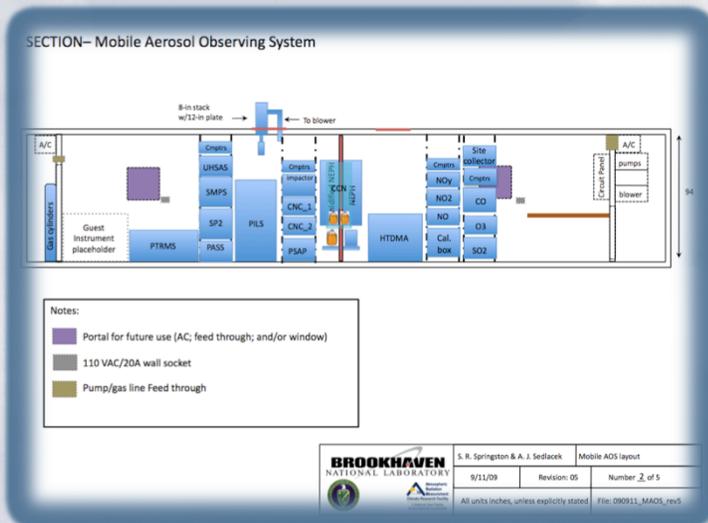


Water Vapor Fluxes,  
Latent and Sensible  
Heat, Carbon Dioxide

# Instrumentation, Measurements and Infrastructure

## Atmospheric Aerosols and Chemistry

## Research Site Infrastructure



Size Distribution,  
Concentration, Composition,  
and Chemistry

New Instrumentation  
Siting and Operational  
Upgrades

# Recovery Act Instruments/Data

Recovery Act instruments will include 6 dual frequency cloud radars and 6 precipitation radars for a total of 18 new radars.

Combined with current radars, expect total data volume to exceed 250 GB/day or ~8 TB/month.

In addition, new instruments will require data processing; in some cases Value Added Products

# Data Processing Initiative

Taking multiple steps to prepare for new instruments:

- Investing in computing infrastructure (Sites, Data Management Facility, Archive)
- Implement a community data processing system at the archive for preliminary data viewing, large jobs, algorithm development, etc.
- Implement standardized and portable development tools (e.g. data I/O, gridding, merging, visualization)

**(Look for a survey coming very soon; via email, ARM News page, and Facebook page)**

# Value Added Products

Value Added Products (VAPs) provide additional information relative to basic ARM datastreams:

- Improved Retrievals (physically-based LWP)
- Higher order geophysical parameters (LWC, IWC, flux profiles, cloud classification, variational analysis)
- Data QC (radiation quality assessment)
- Synthesis Products (Cloud Modeling Best Estimate)

# VAP Organization

## ARM Oversight

Wanda Ferrell  
Rick Petty

## ASR Oversight

Kiran Alapaty  
Ashley Williamson

## Infrastructure Management Board (IMB)

Wanda Ferrell, Rick Petty,  
Jim Mather, Beat Schmid, Jimmy Voyles,  
Doug Sisterson, Raymond McCord

## Working Group Chairs

Ann Fridlind, Allison McComisky,  
Matt Shupe, Dave Turner

## Science and Infrastructure Steering Committee (SISC)

## ARM Translators

Connor Flynn, Mike Jensen,  
Sally McFarlane, Dave Turner,  
Shaocheng Xie

Infrastructure

Focus Groups

Science Team/  
Working Groups

# Radiatively Important Parameters Best Estimate (RIPBE)

Inputs to Broadband Heating Rate Profile (BBHRP) radiative transfer model (RRTM) including variable source and QC: T, RH, Cloud Properties, Aerosol Properties, Surface Properties, Trace Gases

- Extension of Cloud Modeling Best Estimate (CMBE) to provide additional parameters for evaluation of models
- Enable use of BBHRP as a retrieval testbed
- Provides framework for identification of “Best Estimates”: clouds, aerosol, ...
- Simplify development of new VAPs using RIPBE parameters

# Radiatively Important Parameters Best Estimate (RIPBE)

Discussion from RIPBE Breakout (2 weeks ago)

- Family of products w/common grid or single file
- Time resolution – High resolution and averaged
- Data levels – Constant, climatology, obs1, obs2, ...
- Data quality levels – none, auto run-time, auto post, DQR
- Uncertainty estimate for normal conditions

Forming a focus group to work through details (Contact Sally McFarlane; [sally.mcfarlane@pnl.gov](mailto:sally.mcfarlane@pnl.gov))

Need for additional Best Estimate products?

# Geophysical Parameters

## Organizing ARM data as a virtual showcase dataset

- **Atmospheric State:** Temperature, humidity, 3-D wind
- **Cloud Properties:** Liquid and ice water content and size
- **Aerosol Properties:** Optical and chemical properties
- **Precipitation Properties:** Rate, phase, drop size distribution
- **Surface Properties:** Radiative properties, heat fluxes
- **Radiative fluxes/radiance:** Surface and profiles, broadband and spectral

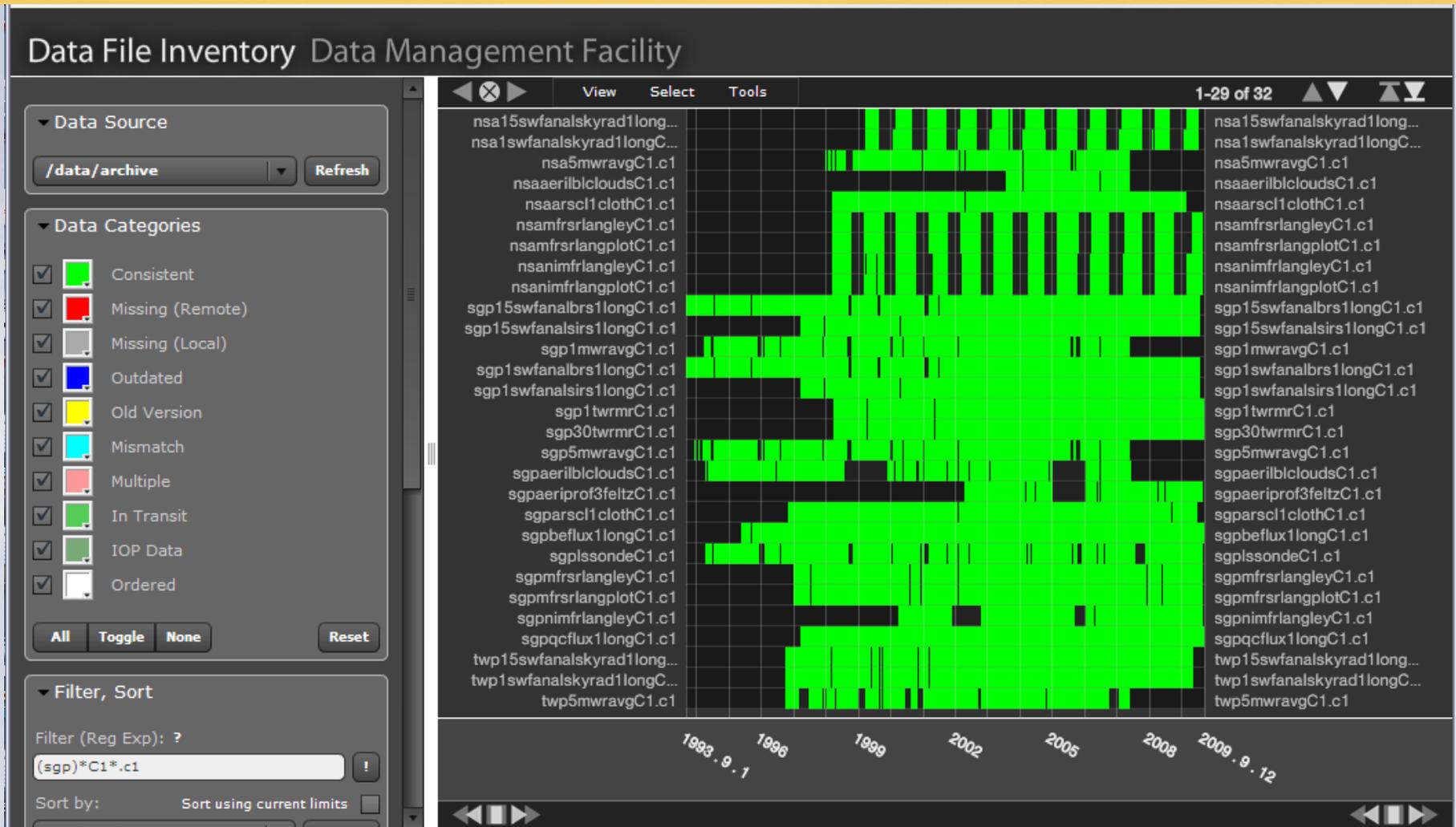
For each, identify: recommended datastream(s), required resolution and uncertainty, status, path forward

# Geophysical Parameters Recommended Datastreams

Relative Humidity (z)	Mergedsonde
Precipitable Water Vapor	MWRRet
Surface Broadband SW Flux	QCRad
Cloud Location	ARSCl
Cloud Liquid Water Content	Microbase
Aerosol Single Scatter Albedo	AIP1Ogren

Have identified a list of ~50 parameters with source datastream

# Data Status View



Display, for each parameter, availability as a function of time/site  
Add information regarding data quality assessment

# Implementing Value Added Products

- Use existing tools and information to make datastream/VAP status transparent
- Identify priorities for parameter research and development of community products – requires identification of overlap between needs and available technology/techniques
- Impose more rigorous VAP development cycle
- Implement community development/analysis environment to streamline internal development and engage the broader community
- Continue to look for efficiency savings in current processes

Send any comments to Jim Mather or the ARM Translators (Shaocheng Xie, Connor Flynn, Mike Jensen, Sally McFarlane)