



Recovery Act Summary

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October 11-15, 2010



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Recovery Act: Introduction

- \$60M from DOE Office of Science for investments in instrumentation and research infrastructure
- 3-dimensional measurements of cloud scale dynamics, microphysics, and precipitation
- Enhanced measurements of;
 - atmospheric aerosol absorption, scattering, composition and chemistry
 - cloud composition
- Use new knowledge to improve the predictive performance of climate change models



Recovery Act: Introduction

- This presentation is a high level summary of instrument and project status
- A complete instrument and location list, progress highlights, and photos are located at this URL:

www.arm.gov/about/recovery-act

The image shows two overlapping screenshots. The top screenshot is the ARM Climate Research Facility website, featuring a navigation menu with links like 'About', 'Science', 'Campaigns', 'Sites', 'Instruments', 'Measurements', 'Data', 'News', 'Publications', and 'Education'. The main content area is titled 'ARM and the Recovery Act' and includes a section for 'Progress and News' dated August 2010, detailing the deployment of new instrument systems and the installation of an X-band scanning ARM cloud radar (X-SAR) at the Southern Great Plains site. A sidebar on the right contains a 'Subscribe' section and 'External Resources'.

The bottom screenshot is a Flickr photostream titled 'ARM Climate Research Facility's photostream'. It displays a grid of photos with captions such as 'Out the Door of the AOS Container', 'Overlooking Christie Peak and the Valley', 'ECOR Temporary Assembly', and 'ECOR Installation Team'. Each photo includes a caption, a date, and a comment count.



Radars

- X-Band Precipitation ●
- C-Band Precipitation ●
- Ka-X Band Cloud ●
- Ka-W Band Cloud ●
- MMCR Upgrades ●



- SGP ● ● ● ●
- NSA ● ● ●
- TWP-D ● ●
- TWP-M ● ● ●
- AMF2 ●
- AMF1 ●

Scanning C- band (4-8 GHz) Precipitation Radar	70
Scanning X- band (8-12.5 GHz) Precipitation Radar	80
Scanning Cloud Radar W-Band (95 GHz), Ka-Band (35 GHz)	60
Scanning Cloud Radar X-Band (8-12.5 GHz), Ka-Band (35 GHz)	60
Millimeter Wave Cloud Radar (Ka-band, 35 GHz) Signal Processor Upgrade	60

Research Sites

% Available for Use



Lidars

- HSRL ●
- Raman ●
- Doppler ●
- MPL ●
- MPL Upgrades ●
- Ceilometer ●



- SGP ● ● ● ●
- NSA ● ● ●
- TWP-D ● ● ● ●
- TWP-M ● ●
- AMF2 ● ● ●
- AMF1 ● ● ●

High Spectral Resolution Lidar (532 nm)	65
Raman Lidar and upgrade (355, 387, and 408 nm)	100
Doppler Lidar (353 nm)	100
Micropulse Lidar (532 nm)	100
Micropulse Lidar upgrades (532 nm)	50
Ceilometer	100

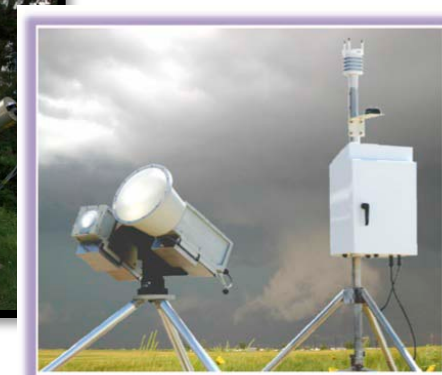
Research Sites

% Available for Use



Radiometry

- Sunphotometer ●
- AERI ●
- AERI-ER ●
- MWR3C ●
- SAS ●



- SGP ● ● ●
- NSA ● ●
- TWP-D ● ● ●
- TWP-M ● ● ●
- AMF2 ● ●
- AMF1 ● ● ● ●

Sunphotometer	100
Atmospherically Emitted Radiance Interferometer (AERI), (3-19.2 microns)	100
Atmospherically Emitted Radiance Interferometer, Extended Range (AERI-ER), (3-25 microns)	95
Microwave Radiometer, 3 Channel (MWR3C), K-Band (20-30 GHz), and W-Band (89 GHz)	100
Solar Array Spectrometer (300 to 2000 nm)	90

Research Sites

% Available for Use



Meteorology

- ECOR/SEBS ●
- RWP ●
- Sonde ●
- SODAR ●
- RBL ●
- PWS ●
- Precipitation ●



- SGP ● ● ●
- NSA ● ● ●
- TWP-D ● ● ●
- TWP-M ● ●
- AMF2 ● ●
- AMF1 ● ●
- MAOS-A ● ●

Eddy Correlation (ECOR)	75
Radar Wind Profiler (RWP) (new 1290 MHz, and existing 915Mhz)	75
Digicora Radiosonde System	100
SONic Detection And Ranging (SODAR) System (1000 to 4000 Hz)	100
Remote Balloon Launcher (RBL)	100
Present Weather System (PWS)	100
2-Dimensional Video Disdrometer (2DVD)	65

Research Sites and Components

% Available for Use



Aerosol Observations

- Absorption ●
- Scattering ●
- Composition ●
- Concentration ●
- Size Distribution ●
- Chemistry ●



- AMF2 AOS ● ● ● ● ●
- TWP-D AOS ● ● ● ● ● ●
- MAOS-A ● ● ● ● ●
- MAOS-C ●
- SGP AOS ●

AMF2 Aerosol Observing System (AMF2 AOS)	100
TWP-D Aerosol Observing System (TWP-D AOS)	73
Mobile Aerosol Observing System-Aerosols (MAOS-A)	80
Mobile Aerosol Observing System-Chemistry (MAOS-C)	80



Research Sites and Components

% Available for Use

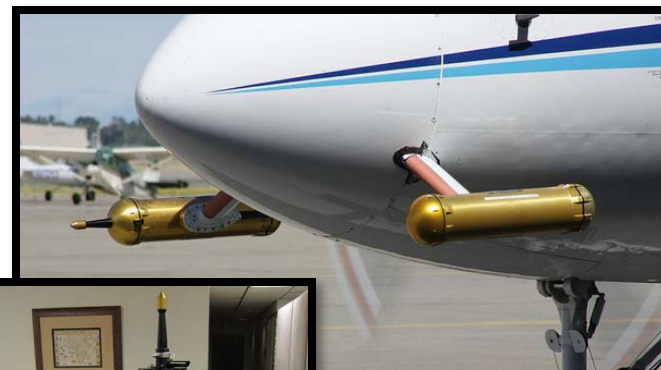




ARM Aerial Facility

- Aerosol
 - scattering, absorption
 - composition, concentration
 - size distribution
 - gases
 - chemistry

- Clouds
 - precipitation
 - size distribution
 - size concentration
 - particle imaging
 - state parameters



- 18 New Aircraft Instruments – including 6 New Cloud Probes

AAF Aircraft Setup and Instrument Integration

90

ARM

CLIMATE RESEARCH FACILITY

Principal Components

% Available for Use



Office of
Science

Progress

% Complete

Project Elapsed Time (May 2009 Start, Jan 2011 End)	81
Project Funds Costed	62.65
Instrument Procurements and Contracts Placed (120)	100
Instrument Procurements Complete (103)	65.9
Instrument Procurements and Builds Available	90.3

- Some activities are spanning into CY2011

Next Steps

Recovery Act Project Flow	% Complete			
Project Plan	100			
Prepare Procurement and Contracting Documents	100			
Execute Procurements	100			
Execute System Builds	90.3			
Site Preparation	53	} Overall Average Estimate of % Complete		
Instrument and Capability Integration	15			
Data Collection and Ingest Ready	57			

Jim Mather

Recovery Act Data Efforts

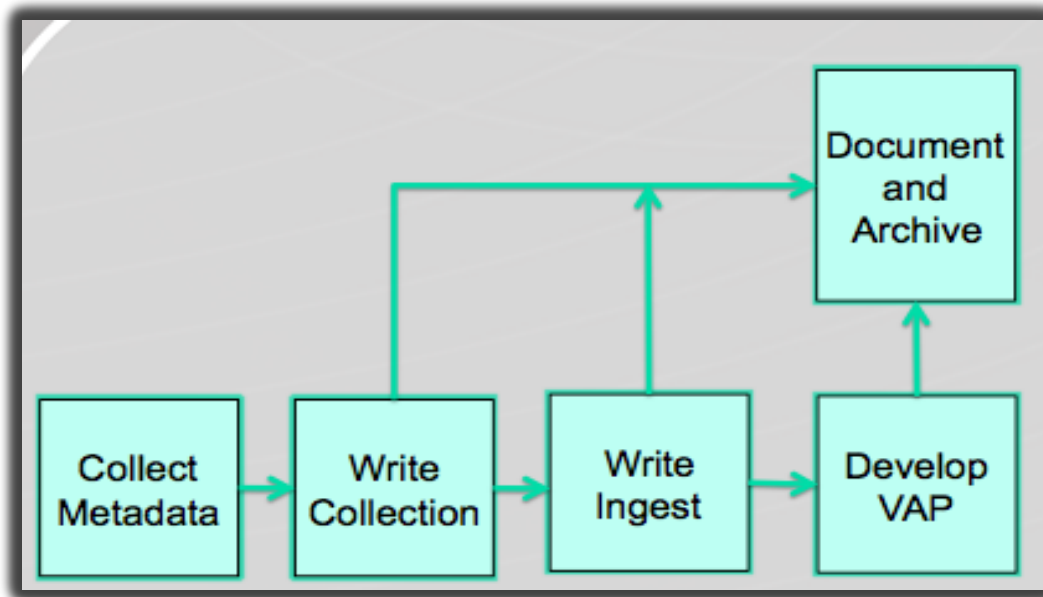
Recovery Act Data Efforts

- Develop ingests (ARM standard NetCDF files) for new instruments where appropriate
- Begin development of Value Added Products for new instruments in special cases (e.g. vertically pointing radar upgrade)
- Developing Integrated Software Development Environment (ISDE) with associated software libraries to facilitate future instrument Ingests and Value Added Products
- Upgrading data infrastructure at sites and archive including development of a “Big Data System” to accommodate expected challenges with large volume of radar and aerosol data

Resulting New or Revised Data Streams

- **Collection, Ingest, and Delivery**

There are approximately 50 different instruments being introduced with a range of requirements.



Data Ingest Tasks

1	Instrument	% done	Planned SW Complete	First Install / Data	Install Date or Data at Archive					
					SGP C1	Barrow (NSA-C1)	Darwin (TWP)	Manus (TWP)	AMF1	AMF2
3	Replacements									
4	Ceilmeter (Vaisala) qty 6	100%	Complete	4/16/10	4/16/10	6/16/10	8/18/10	9/3/10	9/17/10	9/29/10
5	Micropulse Lidar (532 nm)(MPL) (Sigma Space) qty 6 (2 need h	100%	Complete (1)	6/1/10	6/1/10	7/15/10		2/11/11	5/17/11	6/14/10
6	Microwave Radiometer, 3 Channel (MWR3C), K-Band, W-Band	92%	9/21/10	6/29/10	6/29/10	10/1/10	11/1/10	11/8/10	5/17/11	
7	Atmospherically Emitted Radiance Interferometer (AERI), (3-19.	100%	Complete	9/1/10	10/1/10	9/1/10	11/22/10	11/1/10	5/17/11	
8	Atmospherically Emitted Interferometer, Extended Range (AERI	100%	Complete	9/18/10		9/18/10				
9	AOS (NEPH3, CPC10, CPC2.5, PSAP, CCN, CCN2, WXT 520,	74%	11/5/10	10/1/10						10/1/10
12	Millimeter Wave Cloud Radar (Ka-band, 35GHz) Signal Process	2%	11/2/10	11/15/10	11/15/10	12/5/11	1/15/11	2/5/11		12/15/10
14	Raman Lidar and Upgrade (355, 387 and 408 nm) (Sandia)	63%	11/16/10	11/15/10	11/15/10		12/10/10			
18	Fixed Ground Deployments									
19	EDY Correlation (ECOR) (FLUX, flux) (ANL) qty 15	91%	11/3/10	7/20/10	12/1/10	7/20/10	7/22/10			
21	Present Weather Sensor (PWS,PWD) (Vaisala) qty 5 + spare	100%	Complete	7/22/10	7/31/10	8/31/10	7/22/10	11/8/10		
22	Precipitation Gauge (WBkt) qty 5	96%	10/1/10	8/15/10	8/15/10		9/6/10	2/11/11		
23	Sun Photometer (CIMEL) qty 5 + spare	92%	10/4/10	9/15/10	9/15/10		10/15/10	11/15/10	4/15/11	9/15/10
26	X-band Scanning ARM Precipitation Radar (RadTec Engineering)	38%	10/5/10	11/1/10	11/1/10	1/15/11 (2)				
27	Doppler Lidar (1500 nm) (Halo Photonics) (SGP, Darwin, AMF1	89%	10/4/10	10/1/10	10/1/10		11/22/10		4/1/11	
28	High-Spectral Resolution Lidar (532 nm) (UWisc) qty 2	2%	11/2/10	10/15/10		1/1/11				10/15/10
29	W-band Scanning ARM Cloud Radar (ProSensing) qty 3	7%	11/24/10	11/30/10	12/15/10	1/15/11			11/30/10	12/15/10
30	Ka-band Scanning ARM Cloud Radar	1%	11/22/10	11/30/10	12/15/10 (3)	1/15/11 (5)	3/15/11 (4)	3/30/11 (4)	11/30/10	12/15/10
31	Solar Radiance Spectrometer (300nm to 2000nm) (Advantes) (S	1%	12/17/10	11/15/10	11/15/10				11/15/10	
32	Solar Irradiance Spectrometer (300nm to 2000nm) (Advantes) (S	1%	12/17/10	11/15/10	11/15/10				11/15/10	
33	C-Band Scanning ARM Precipitation Radar (Adv Radar Corp.) q	79%	12/2/10	12/1/10	12/1/10			2/28/11		
35	X-band Scanning ARM Cloud Radar (ProSensing) qty 3	7%	12/30/10	12/15/10			1/14/11	1/28/11		12/15/10
36	2-Dimensional Video Distrometer (VD) qty 5	0%	1/18/11	12/31/10	12/31/10	12/31/10	3/11/11	2/11/11		
39	Sonic Detection And Ranging (SODAR) System (1000 to 4000 f	1%	TBD	4/30/11						
40	Radar Wind Profiler (RWP) (new 1290 MHz, and existing 915M	60%	5/3/11	5/1/11						5/1/11
61	Notes:				20	14	18	13	10	17

Value Added Products

■ VAP Processes

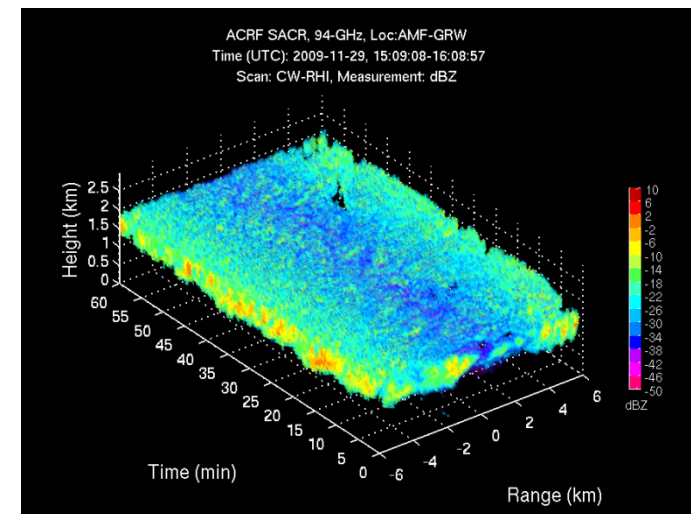
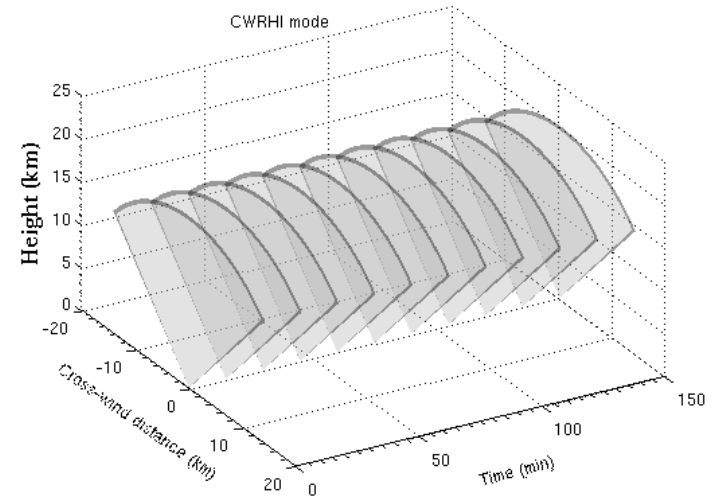
- VAP Status page: https://engineering.arm.gov/data/vap_status.php
- VAP Life Cycle Document and guidelines

■ VAP Highlights

- New versions of Cloud Modeling Best Estimate (CMBE) released for all fixed sites
- WACR-ARSCL released for Graciosa through September
- Surface spectral albedo evaluation product at SGP
- Radiatively Important Parameters Best Estimate (RIPBE) being released as evaluation product.
- Implementation of new VAP development environment

Value Added Products (2)

- **Current plans for FY11 (partial list)**
 - New automated version of ARSCL for upgraded MMCR
 - 3-D ARSCL for scanning cloud radars
 - Release of production versions of microbase and merged sounding
 - Further improvements planned for CMBE
 - Development of cloud retrieval ensemble
 - Tools to use RIPBE for radiative closure testbed
 - Aerosol Intensive Properties for new AOS systems
 - Develop CARES dataset for Aerosol Testbed



Value Added Products (3)

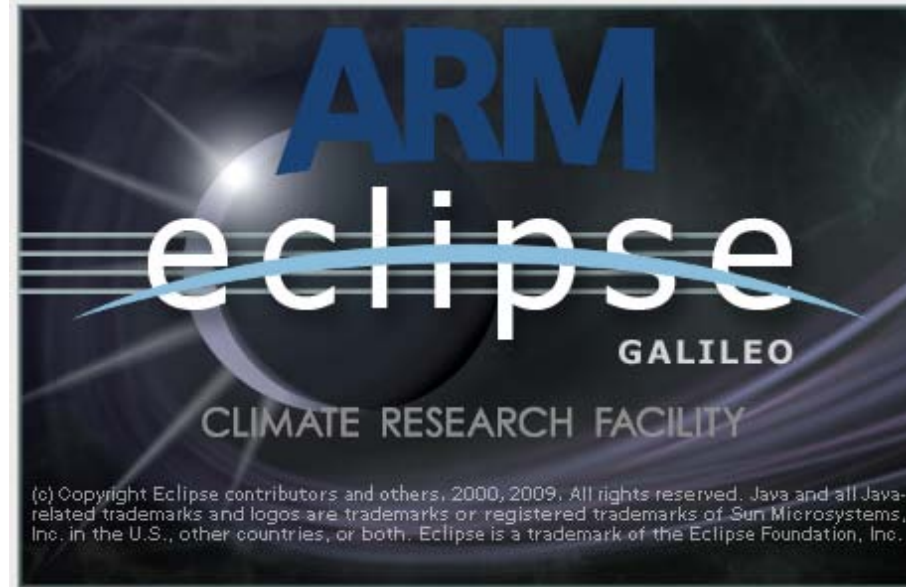
■ Other ideas for new products

- Addition of 90 GHz channel to MWR Retrieval
- Add SW spectrometer and Raman lidar to aerosol best estimate
- CCN at cloud base (Ghan technique)
- Vertical velocity (likely multiple products)
- Major classes of aerosols (using ACSM or AMS as input)
- Aerosol absorption (blending PSAP and PASS)
- Boundary layer height
- Drizzle
- Extension of cloud classification to other sites and add new algorithms
- Precipitation rate from X- and C- band scanning radars
- Drop number concentration

ARM Integrated Software Development Environment (ISDE)

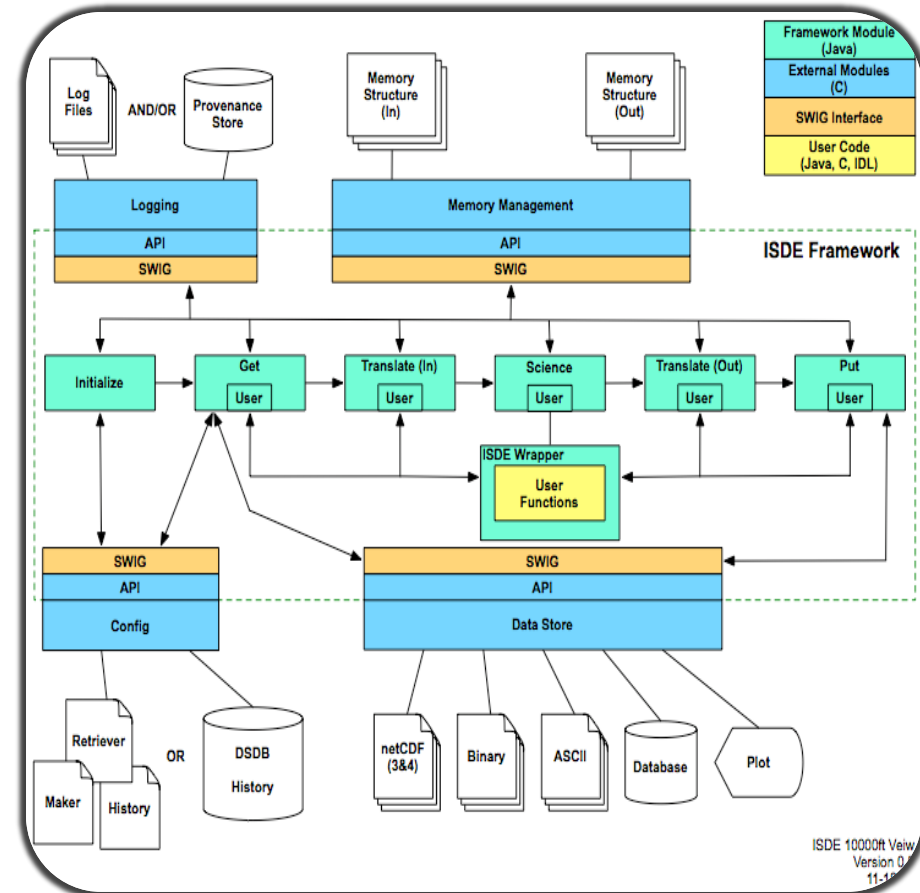
ISDE Goals

- Concentrate on science algorithms rather than the infrastructure to read, write, and translate the data in support of the algorithm.
- Standardized ARM products around a common way of retrieving, manipulating, and storing sensor data
- Enable a community approach to write code that can be shared, reused, and built upon by the community



Integrated Software Development Environment

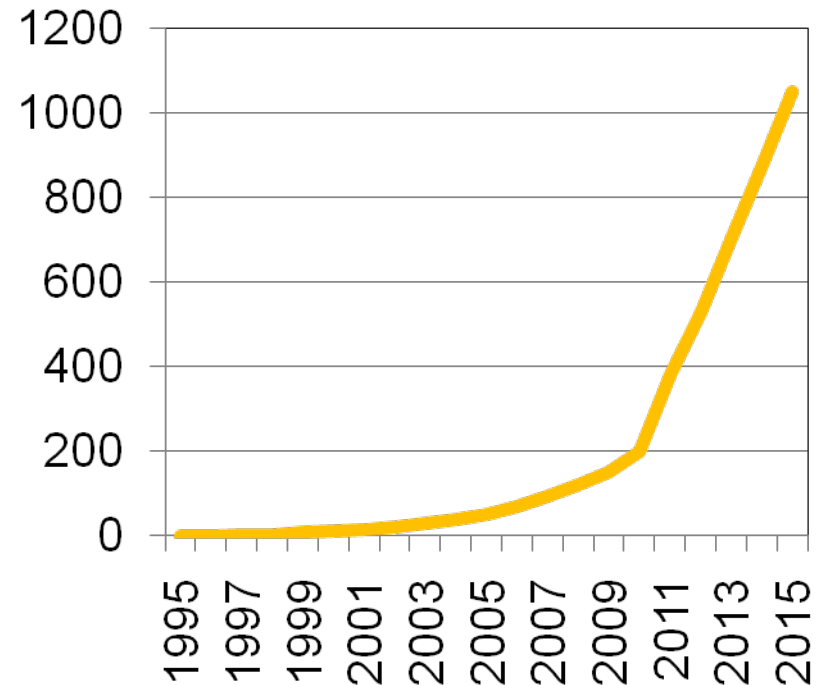
- Environment hosted at the ARM Archive
- Provides an improved user experience for scientist
- Standardized retrieval, translation, and storage
- Community approach to code development
- Framework to analyze and process large data sets
- Capability for external code integration
- Access to ARM development tools



Recovery Act – Data Impact

- Recovery Act instruments will include 6 dual frequency cloud radars and 6 precipitation radars for a total of 18 new radars.
- Single particle aerosol instrument generates ~70 GB/day
- Combined with current radars, expect total data volume to exceed 500 GB/day or ~15 TB/month.
- In addition, new instruments will require data processing; in some cases advanced processing will be required (e.g. gridded products for radars)

ARM Data (TeraBytes)



Archive Data System for Improving Access to Large Data Sets

- **Two systems (nearly identical)**
 - Large scale data processing (batch mode)
 - Interactive visualization (and limited software development and testing)
- **Initially focused on new, large data streams**
 - Focused on reducing processing turn around
 - Engaging users with new types of data; too big for routine systems
- **Hardware**
 - 4 CPU's, 6 cores each
 - 256 GB of memory
 - ~44 Tb of disk spread across 6 RAIDs
 - Tape library for local backup
- **Software**
 - RedHat Linux OS
 - Normal suite of compilers
 - IDL, MatLab, etc.
 - ARM Integrated Software Development Environment

Archive Data System: Status

- Test system has been operating for several months
- All equipment for permanent system delivered
- Batch data processing system
 - Will be installed in next 1-2 weeks
 - Ready to use in the next 3-4 weeks
 - Initial WACR spectra reprocessing task waiting as a test case.
- Interactive visualization system
 - Will be installed in next 1-2 weeks
 - Need additional feedback for requirements
 - Strategy for “login access” needs development and review

Thank you!

ARM Recovery Act Instruments

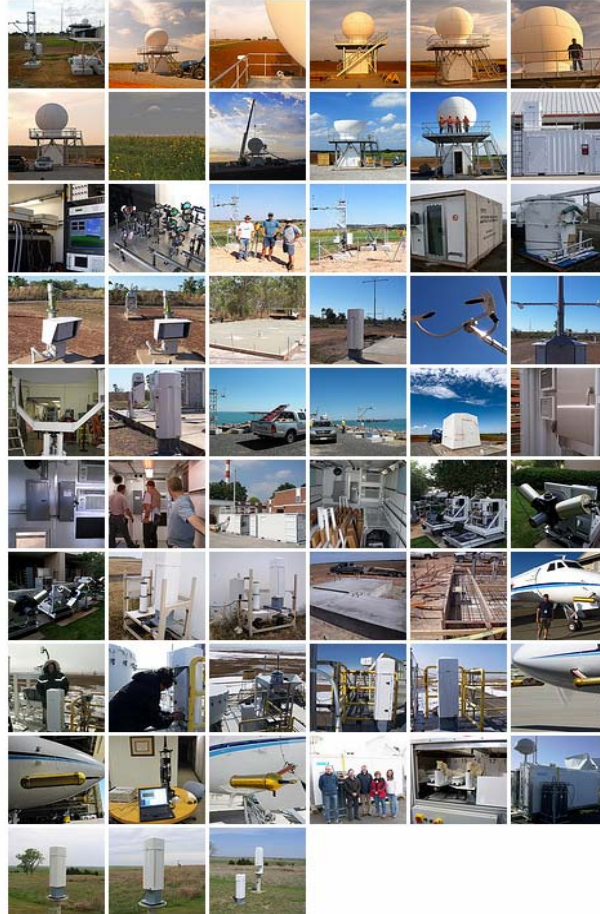
[Thumbnails](#) [Detail](#) [Comments](#)



Through the American Recovery and Reinvestment Act of 2009, the U.S. Department of Energy's Office of Science received \$1.2 billion, with \$60 million allocated to the ARM Climate Research Facility. With these funds, ARM will purchase and deploy dual-frequency scanning cloud radars to all the ARM sites, enhance several sites with precipitation radars and energy flux measurement capabilities, and invest in new aerosol sampling and aerial instrumentation. This is just a small sample of the planned enhancements that will result in 143 new instruments and increased research capabilities for the ARM user community.

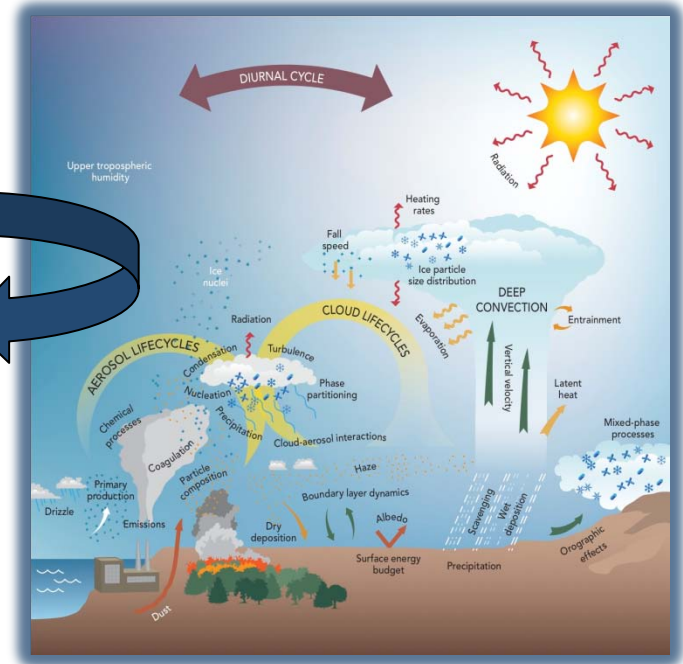
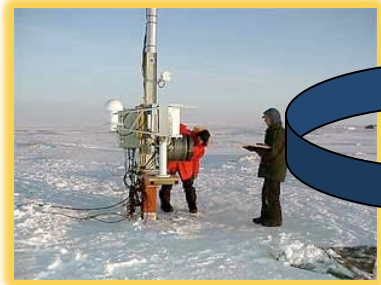
57 photos | 108 views

Items are from between 13 Apr 2010 & 06 Oct 2010.



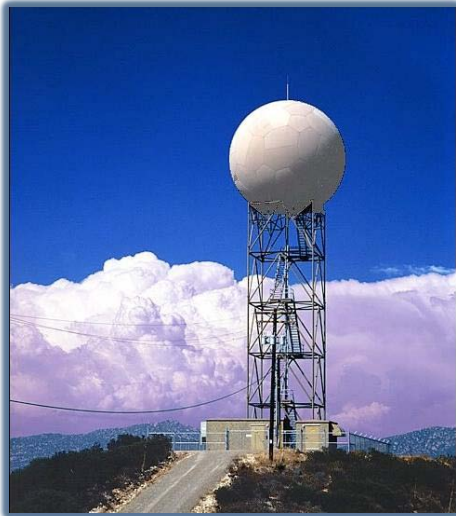
Recovery Act

Contributing to ARM Infrastructure and ASR Research



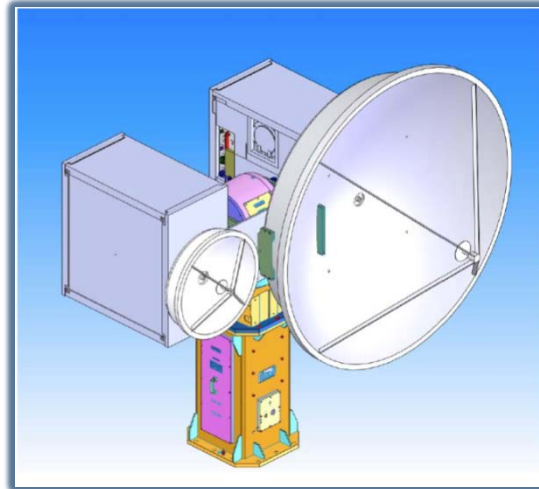
Recovery Act: Instrumentation and Measurements

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

Recovery Act: Instrumentation and Measurements

3-Channel Microwave Radiometers



Precipitable water vapor and liquid water path

Infrared and Solar Spectrometers



Infrared and solar radiation, water vapor, and aerosols

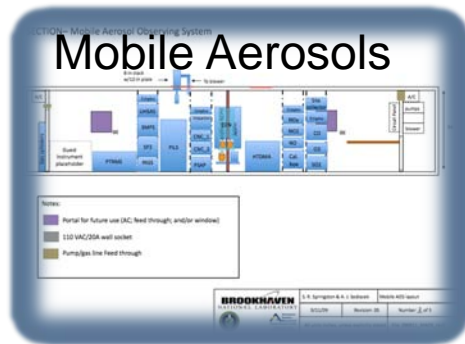
Expanded Surface Flux Network



Water vapor fluxes, latent and sensible heat, carbon dioxide

Recovery Act: Instrumentation, Measurements, and Infrastructure

Atmospheric Aerosols, Chemistry and Cloud Composition



Size distribution, concentration, composition, and chemistry

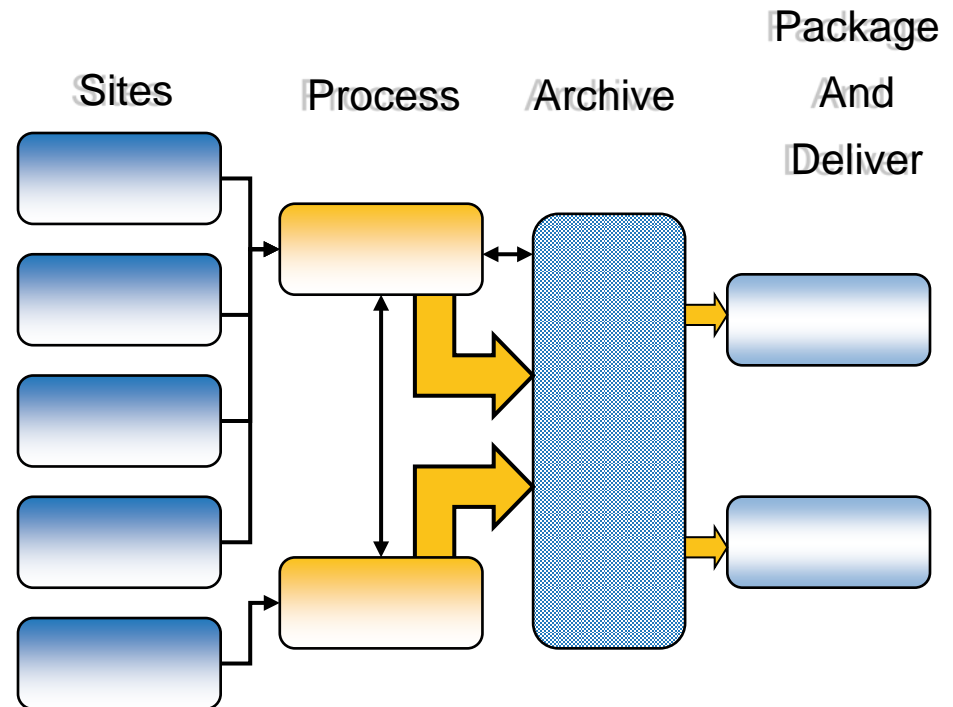
Research Site Infrastructure



New instrumentation siting and operational upgrades

Extensive Upgrades to Computing and Network Capacity

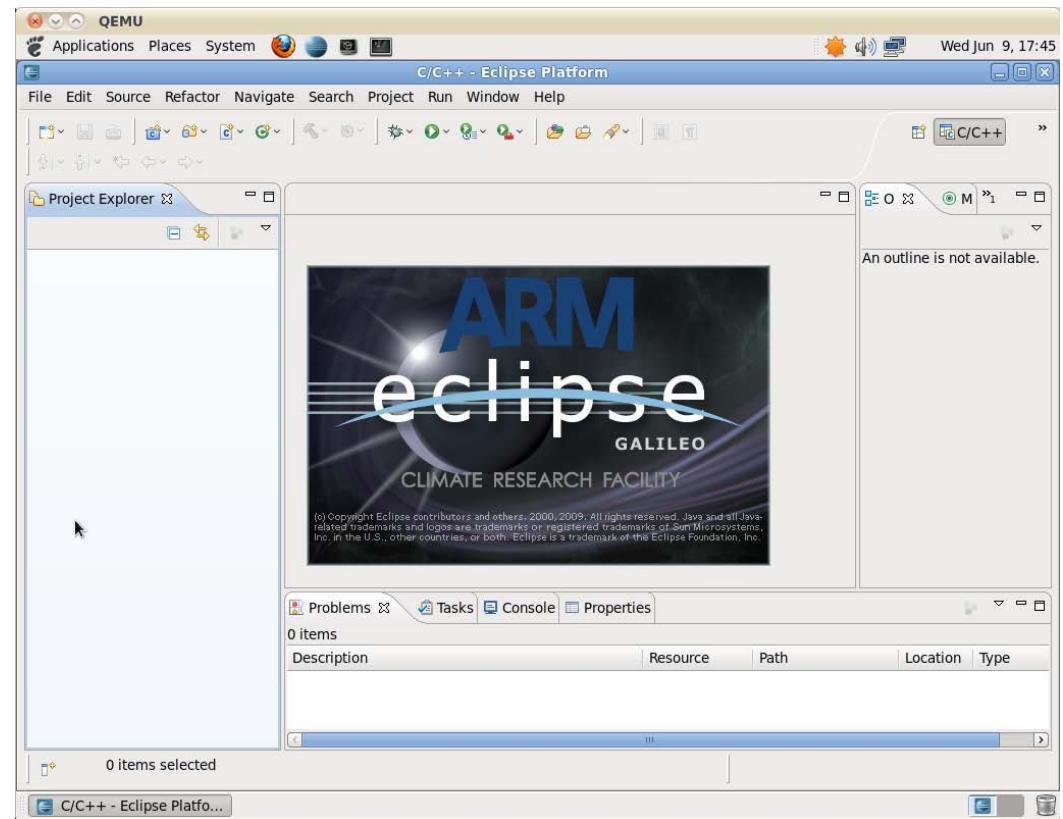
- Research Sites
- Data Management Facility
- Archive
- Network
- Storage



ISDE High Level Overview

The Eclipse IDE

- ISDE workflow
- Access to ARM libraries
- ARM help system
- ARM specific plug-ins
- User plug-ins
- Access to ARM tools
 - Project Builder
 - Metadata Tool Suite
 - Data Dependency Tool
 - Data History Tool
 - Data Browser



Questions (1):

Examples of “batch data processing”

- What input data?
- How much input data?
- Description of algorithm, retrieval, and output products
- Status of your processing software?
- Description of applications software needed?
- Access requirements needed for review and evaluation?

Questions (2):

Examples of interactive visualization

- Typical scope of input data
 - time range,
 - data fields (1 or more?)
 - Dimensional span (e.g., height range)
- What formats of input data? (netCDF or other)
- Type of data manipulations expected?
- What applications (graphics) software needed?
- Expectations for data discovery user interface?
 - Directory tree navigation
 - Embedded within applications software
 - Query interface, data moved to working directory?
- Examples of a good sub-directory structure?
 - Most input data will be locally “on line”
- Requirements to retain temporary data, graphic files, set up files?