**ARM Radar Organization**

*To provide enhanced coordination with ASR science team to ensure well characterized, observational, and advanced multisensor data products at temporal, dimensional, and spatial scales necessary for improving climate model physics*

![ARM Radar Organization Diagram](image)

**1st Radar Workshop, Feb 21-22 2013**

Brenda Dolan  Nitin Bharadwaj  Kevin Widener  Pavlos Kollias
Matt Shupe  Scott Collis  Courtney Schumacher
Bruce Albrecht  Jim Mather  Mark Miller  Jimmy Voyles
Mike Jensen  Scott Giangrande  Andrei Lindenmaier  Ieng Ho
Roger Marchand  Adam Theisen  Ed Luke  Chandrasekar V. Chandra
Karen Johnson  Alexander Ryzhkov  Jay Mace  Jonathan Helmus
Eugene Clothiaux  David Troyan  Silke Troemel
Key topics at the workshop

- Radar operations and science
- VAP development
- Radar calibration
- Ingest VAP’S and DQR
- Data products
- Operational challenges
- Radar science challenges
ARM Radar operations

- 25 radars around the world
- 7 new radars will be added by 2014

DMF

Re-Processing

DQR

Storage Process

Data corrections

VAP

Mentors

DQO

DMF

Site scientist

Developers

Mentors

Translators

End Users

Site Ops

Mentors

Site scientist

Radar Science

Data

Archive

• calibration
• configuration
• scan strategy

End Users

3/29/2013
Cloud radar calibration

- A triangular trihedral corner reflector is used as a standard target at all ARM radar sites.
- The advantage of a corner reflector calibration is that it includes the antenna.
- Unique setup enables calibration of zenith pointing radar with scanning radar.

Corner reflector deployed on Manus Island, Papua New Guinea

Corner reflector observation with scanning radar

Cross-calibration of zenith pointing radar with co-located scanning radar. Scanning radar is calibrated with corner reflector.
Automated corner reflector observations in scan strategy

Monitoring the status of the antenna. Observation of corner reflector at TCAP. The antenna was replaced under warranty. Very important for AMF because antenna is shipped for every ARM field campaign.
Data products and algorithms:
Precipitation radars

Velocity unfolding

KDP Estimation

Multi-Doppler @SGP

Rain Rate Estimation

GLPK based phase processing
Question: How to best leverage community algorithms and to build a dynamic collection of utilities?

- Part of what we are trying to do is build the best architecture for the easy interaction with radar data.
- To make it as easy as possible to test and implement ideas for retrievals through an abstract interface to the data.
- To do this we work in a Python based scientific environment.
- This is the Python-ARM Radar Toolkit Py-ART.

**Diagram:**

- Ingest
- Antenna coordinate based calculations
- Py-Radar object
- Mapping
- Py-Grid object
- Retrieval
- Py-Grid object
- Write
- CF-Grid NetCDF
- CF-Grid NetCDF

3/29/2013
Scanning cloud radar VAPS

- **Big picture**
  - ✓ Quality control
  - ✓ Gridded data
  - ✓ Horizontal winds from VAD
  - ✓ Hydrometeor boundaries
  - ✓ Advanced products

- **Quality control**
  - ✓ Significant detection or feature mask
  - ✓ Gaseous attenuation correction
  - ✓ Velocity dealiasing
  - ✓ Insect detection
  - ✓ Second trip echo identification
SACR VAPS: Water vapor attenuation correction

**Raw Reflectivity**

**Ka-SACR**

**W-SACR**

**Attenuation-Corrected Reflectivity**

**Ka-SACR**

**W-SACR**

AMF1, Cape Cod
SACR VAPS: Insect filtering

Distribution of Clear Sky, 0 – 3 km, Ka-SACR LDR measurements vs. elevation angle (summer 2011)

Ka-SACR, Nyquist ±10.5 m/s

Hydrometeors^{LDR \ [dB]} \rightarrow \text{Insects}

W-SACR, Nyquist ±4 m/s

Ka-SACR LDR Summer SGP

- Observed
- First Guess
- Unfolded
Radar spectra data

- Doppler spectra is stored for all zenith pointing radar operations for cloud radars
- The scanning radar operating in zenith pointing mode as part of its scan strategy and store spectra
- Doppler spectra from dual-frequency radars operations is stored
- The data size of the spectra is large
- Processing spectra data with the computing facility at the archive can be utilized
- Processing and analyzing spectra is a big challenge. However, there is a wealth of information in Doppler spectra for retrievals.

MicroARSCL is a value added product that distills radar Doppler spectra into a set of their most relevant microphysical descriptors.
Radar spectra data: MicroARSCl developed for the GPU

- Noise Floor Estimation
- Edge Detection
- Primary Moments Computation
- Secondary Moments Computation
- Sub-peaks Measurement
- Clutter Detection

160,000 spectra/sec (net)

240,000 spectra/sec
ARM Radar Organization: To support this complex measurement network, ARM is implementing a multi-faceted operational strategy. This radar organizational structure is new and is expected to be effective at optimizing radar operations, data quality, and data product delivery.
Importance of the ARM Radar Organization

- Radars are a large part of ARM/infrastructure expenses, thus we need to ensure that we are most effectively operating the ARM radar network.
- Radars play a critical role in understanding cloud/precipitation processes, which are one of the primary drivers of uncertainties in GCMs.
- Uncertainties with the radar (1-3 dB or more) can have profound impacts on our ability to accurately characterize some important properties.
ASR Radar Science Steering Committee

Eugene Clothiaux (PSU)  
Data Quality  
Cloud Products

Silke Troemel (Bonn)  
Link to end users  
Precipitation products

Matthew Shupe (NOAA)  
ASR Science  
Cloud Radar Products

Courtney Schumacher (TAMU)  
Data Quality  
Precipitation Products
Radar Science Highlights

- Provide recommendations for SACR/SAPR specifications at Oliktok Point and Azores

- Work with ARM DQO to develop visualization tool that compare KAZR and SACR modes (Science DQR).

- Co-organize with ARM radar operations and engineering the first ARM/ASR Radar Workshop
ARM/ASR Radar workshop highlights

- Strengthening the 1-D (column) observations is a core, guiding principal
- Novel operational methodology for calibrating the cloud radars
- Great participation, feedback

Z profiles computed from the a priori  Profiles after convergence (5th iteration)

Image provided by F. Tridon (U. Leicester)
Prioritization

- Consolidate input from ARM operations & engineering and ASR science

- Priorities reflected in ARM allocation of resources/scheduling

- Priority sites: NSA, AMF1 and AMF2
Upcoming Radar IOP’s

- **NSA (Lead, Hans Verlinde)**
  - Spring 2013
  - Collect raw data
  - Test new sampling modes
  - Evaluate X-SAPR and SACR

- **SGP (Lead, Roger Marchand)**
  - Fall 2013
  - Evaluate SACR scan strategies
  - 3-D cloud radar products
Assist ARM to develop high quality radar products

☑ Submit Data Quality Reports
  ✔ Help the infrastructure to identify data issues

☑ Help ARM to develop radar VAPs
  ✔ Monthly teleconference with VAP developers

☑ Participate in radar-focus IOP’s
  ✔ Define best sampling strategies
  ✔ Assess quality of raw radar measurements
Short-term radar science initiatives (revisit them at the Fall WG Meeting)

- Assemble a team to develop **cloud sensing algorithms** using the specialty X-band radars at Azores and NSA
- Catalog all available **radar simulators**
- Spin-up process-oriented research using radar **Doppler spectra** observations
From radar to end-users (What modelers want)

- Modelers like to do their **own statistics**!
- Data products suitable for **fundamental science**
- **Going beyond verification**: Demand for data products that help to learn something about the reasons for the deficiencies of the model and how to make them better

**Radars and Science Seminar Series**
“5 things end users should know about the ARM radars”
Monday 1:30 – 3:00 pm
# Radar operations priority

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<th>Task #</th>
<th>Action Item</th>
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