Radar Science and Operations

ASR Radar Science Group

Pavlos Kollias, Eugene Clothiaux, Silke Tromel, Courtney Schumacher, Matthew Shupe

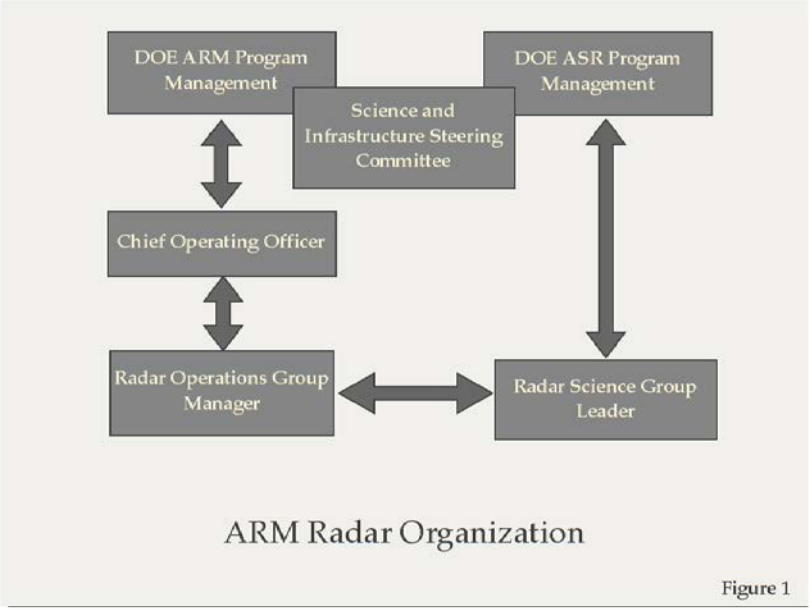
ARM Radar Engineering and Operations

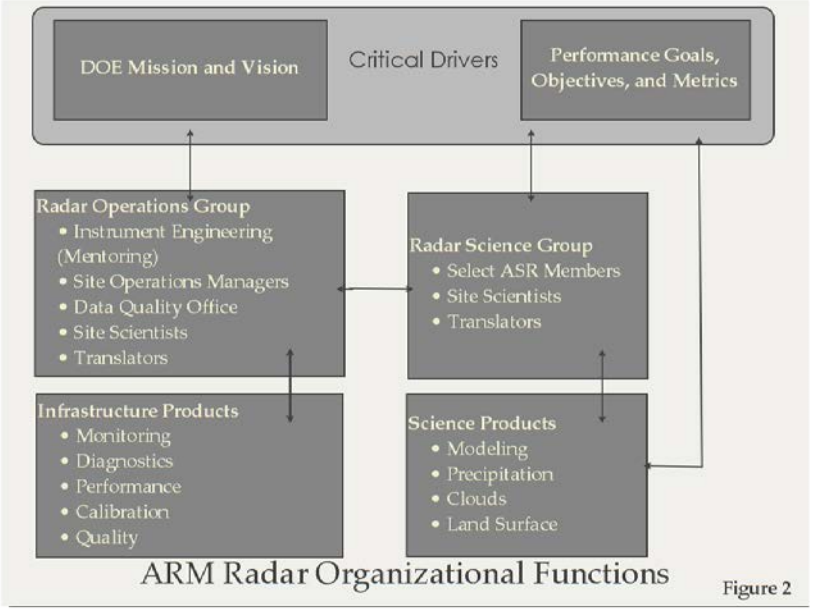
Kevin Widener, Nitin Bharadwaj, Scott Collis, Karen Johnson, Andrei Lindenmaier, Vijay Venkatesh and Jimmy Voyles

ASR Science Team Meeting, March 18-21, 2013.

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





Voyles, J. 2012, DOE/SC-ARM-12-009

1st Radar Workshop, Feb 21-22 2013

Brenda Dolan
Kevin Widener
Pavlos Kollias
Nitin Bharadwaj
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
Jonathan Helmus
Eugene Clothiaux
David Troyan
Jay Mace
Silke Troemel

Key topics at the workshop

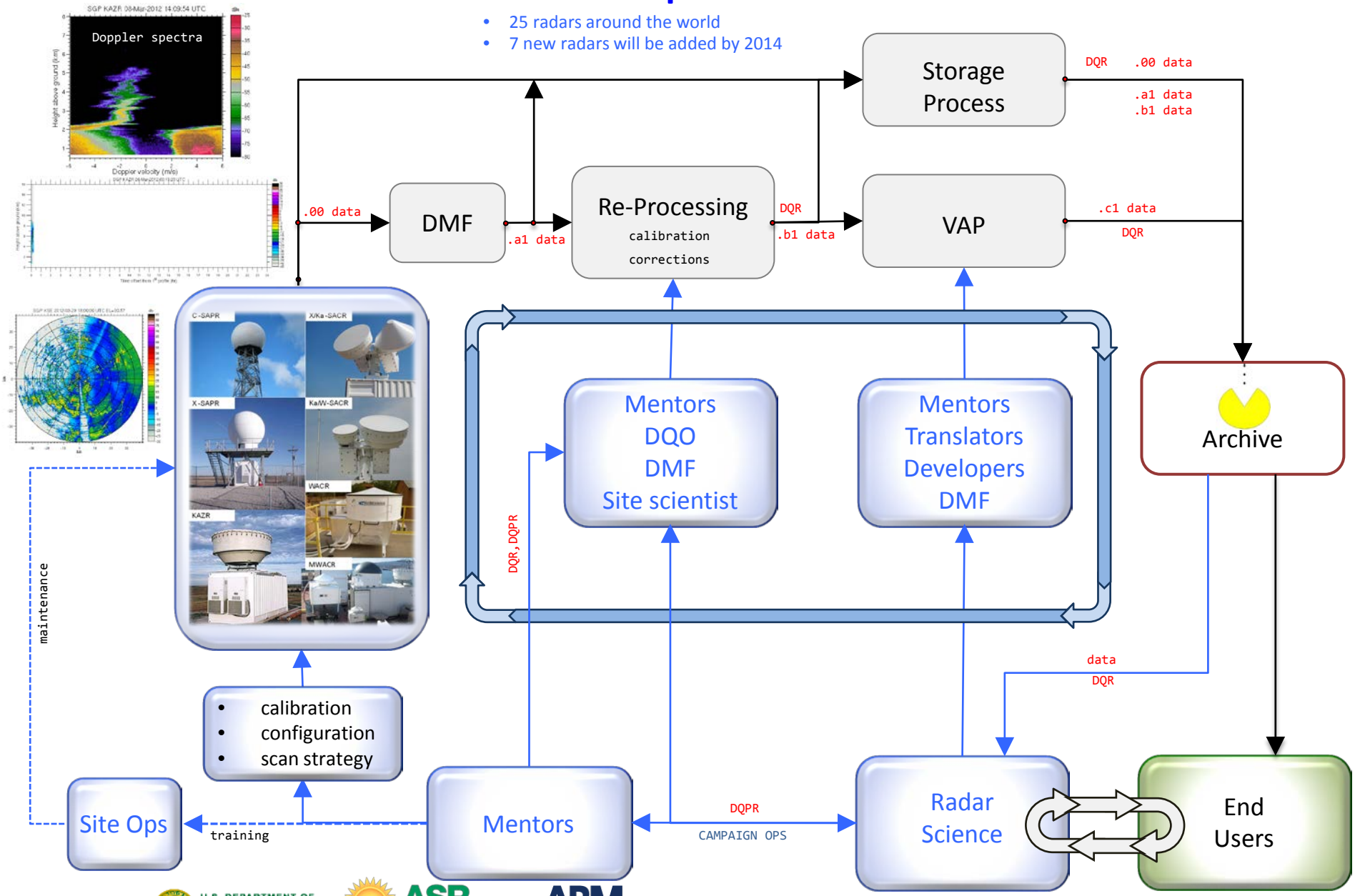
- Radar operations and science

Radars Breakout Session
Monday 1:30 – 3:00 pm

- VAP development
- Radar calibration
- Ingest VAP'S and DQR
- Data products
- Operational challenges
- Radar science challenges

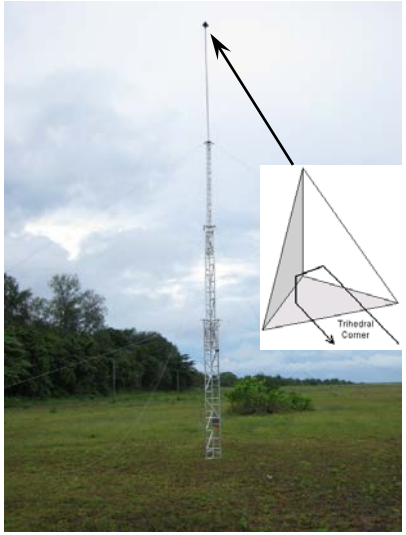
ARM Radar operations

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

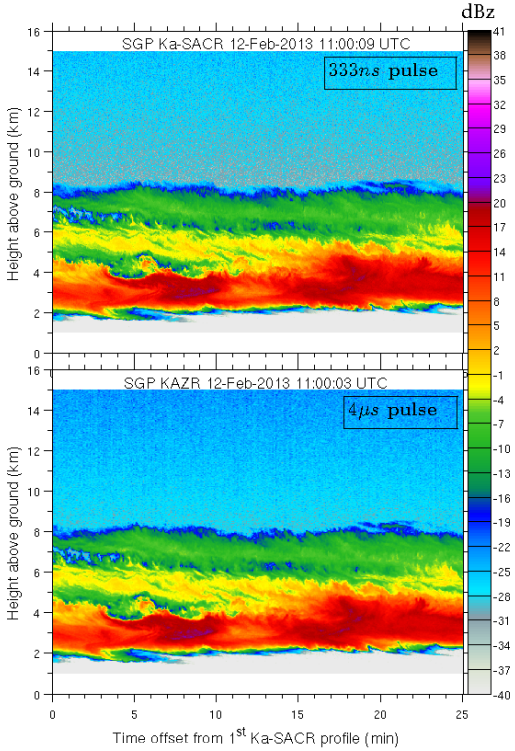


Cloud radar calibration

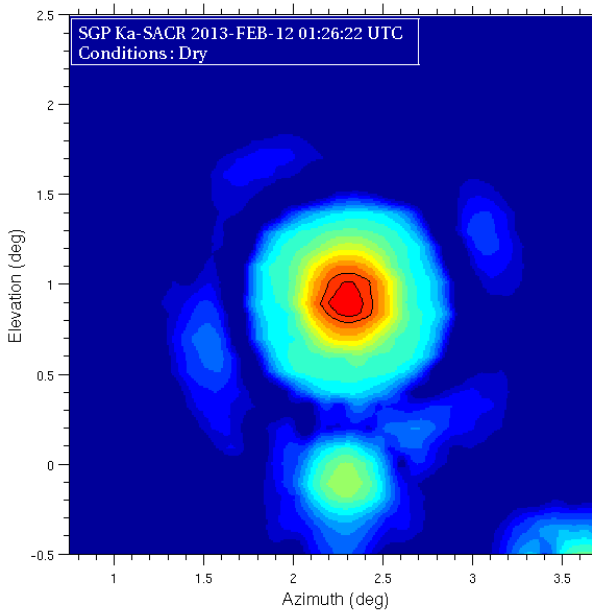
- A triangular trihedral corner reflector is used as a <u>standard target at all ARM radar sites</u>
- The advantage of a corner reflector calibration is that it includes the antenna
- **Unique setup enables calibration of zenith pointing radar with scanning radar**

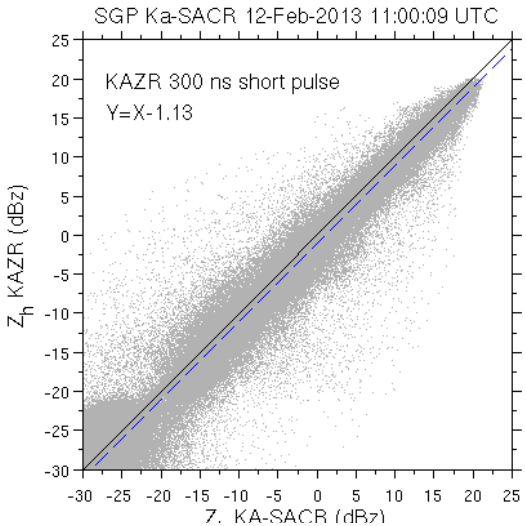


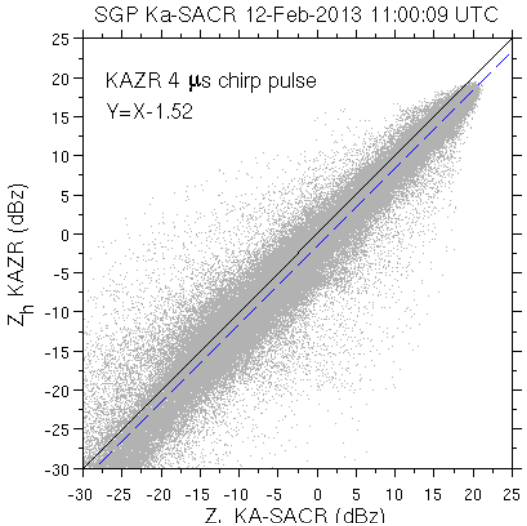
Corner reflector deployed on Manus Island, Papua New Guinea



Corner reflector observation with scanning radar

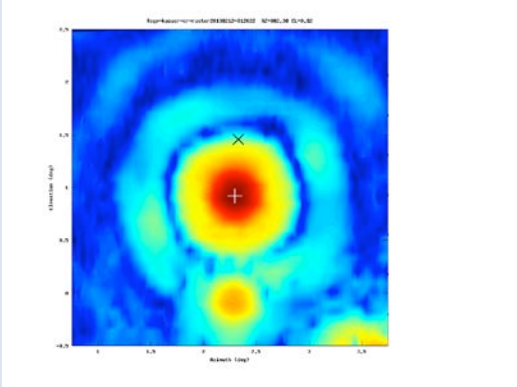


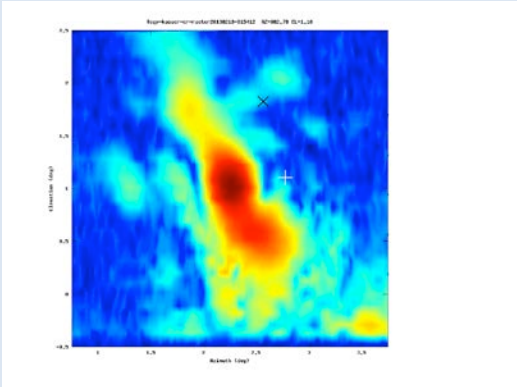


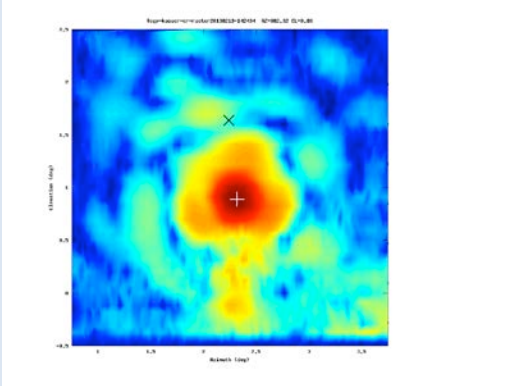


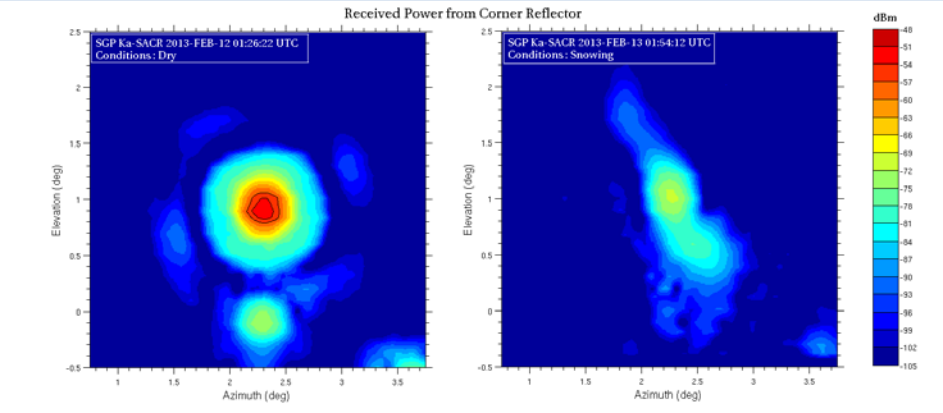
Cross-calibration of zenith pointing radar with co-located scanning radar. Scanning radar is calibrated with corner reflector.

Automated corner reflector observations in scan strategy

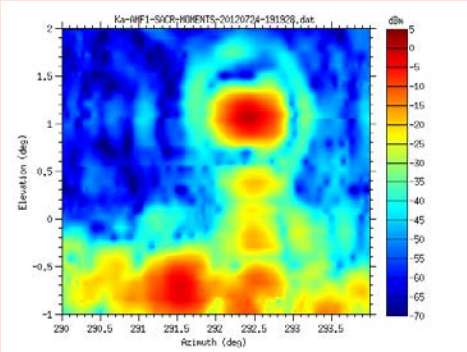








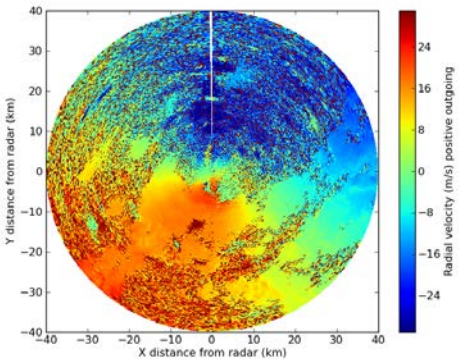
Potential data quality metadata about antenna in precipitating conditions on and around the radar

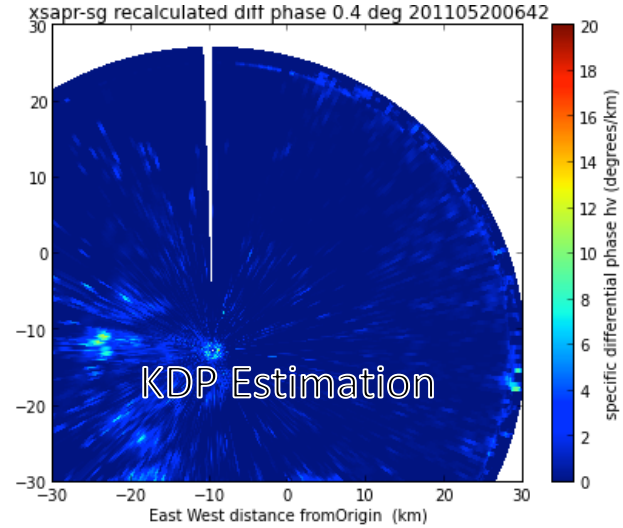


Monitoring the status of the antenna. Observation of of corner reflector at TCAP. The antenna was replaced under warranty. Very important for AMF because antenna is shipped for every ARM field campaign.

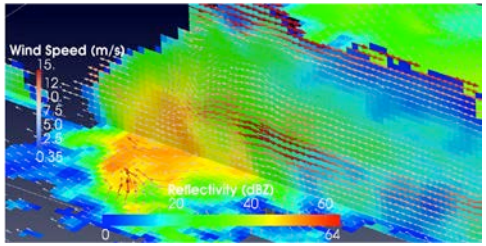
Data products and algorithms: Precipitation radars

Velocity unfolding

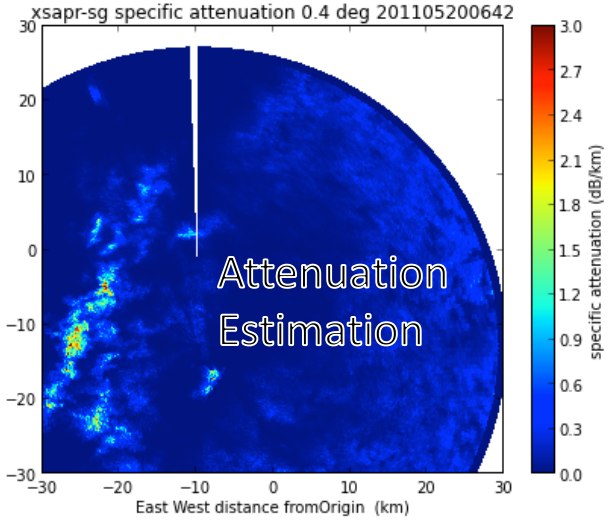




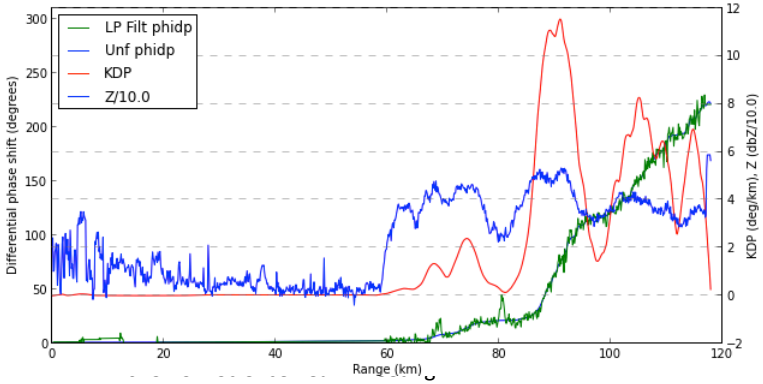
Multi-Doppler @SGP



Rain Rate Estimation

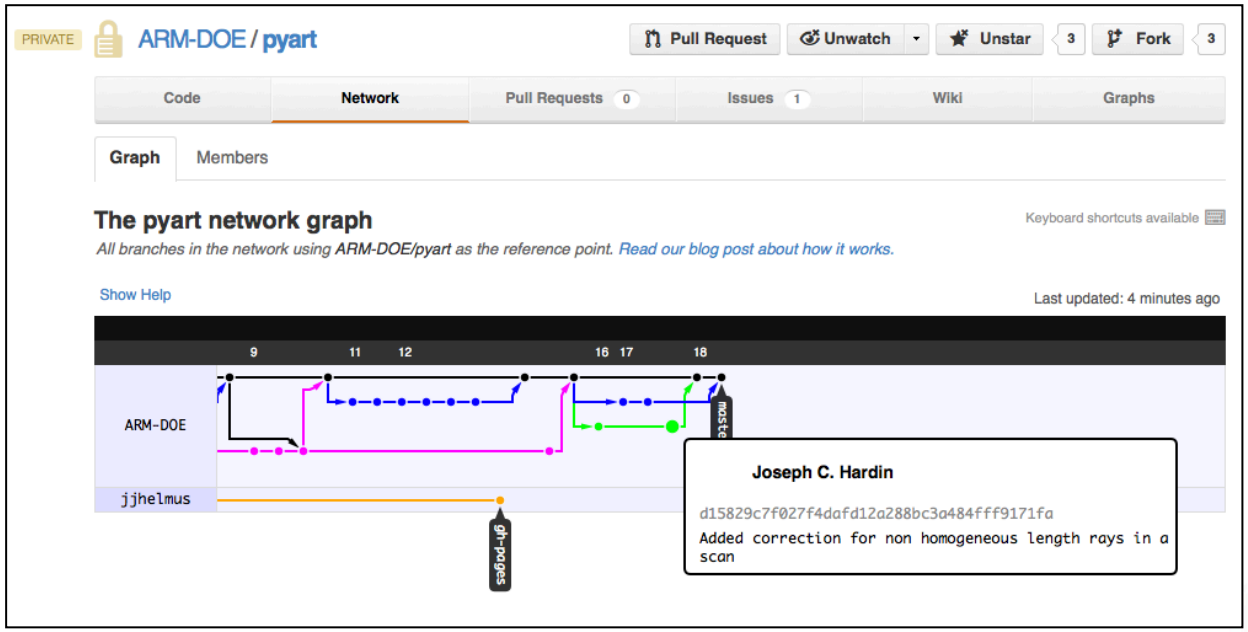


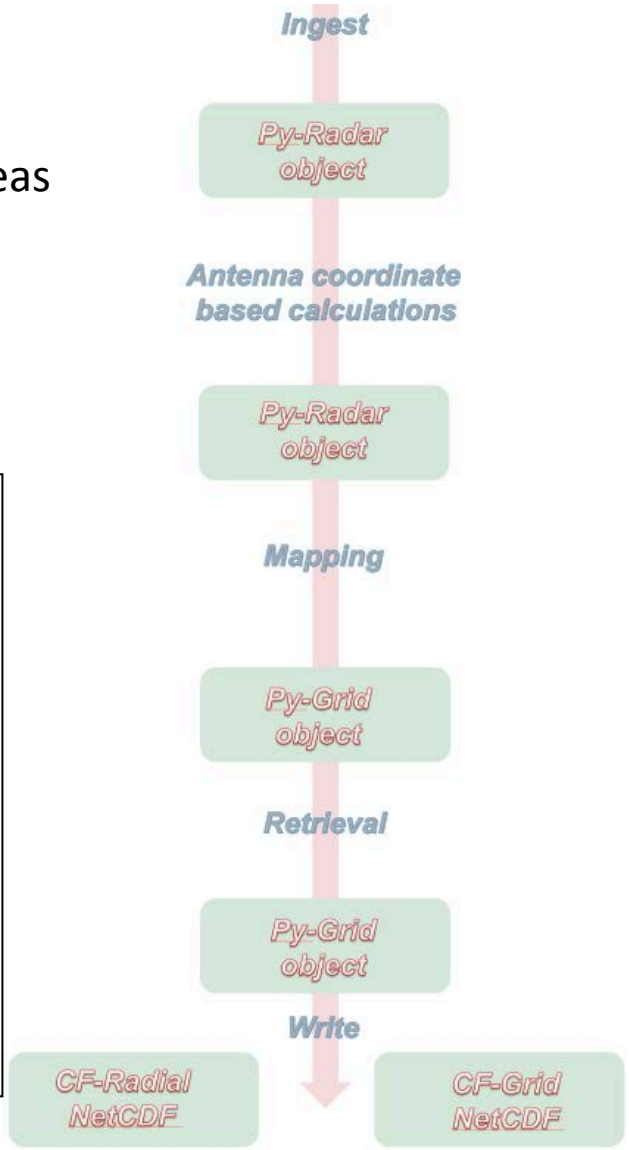
GLPK based phase processing



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

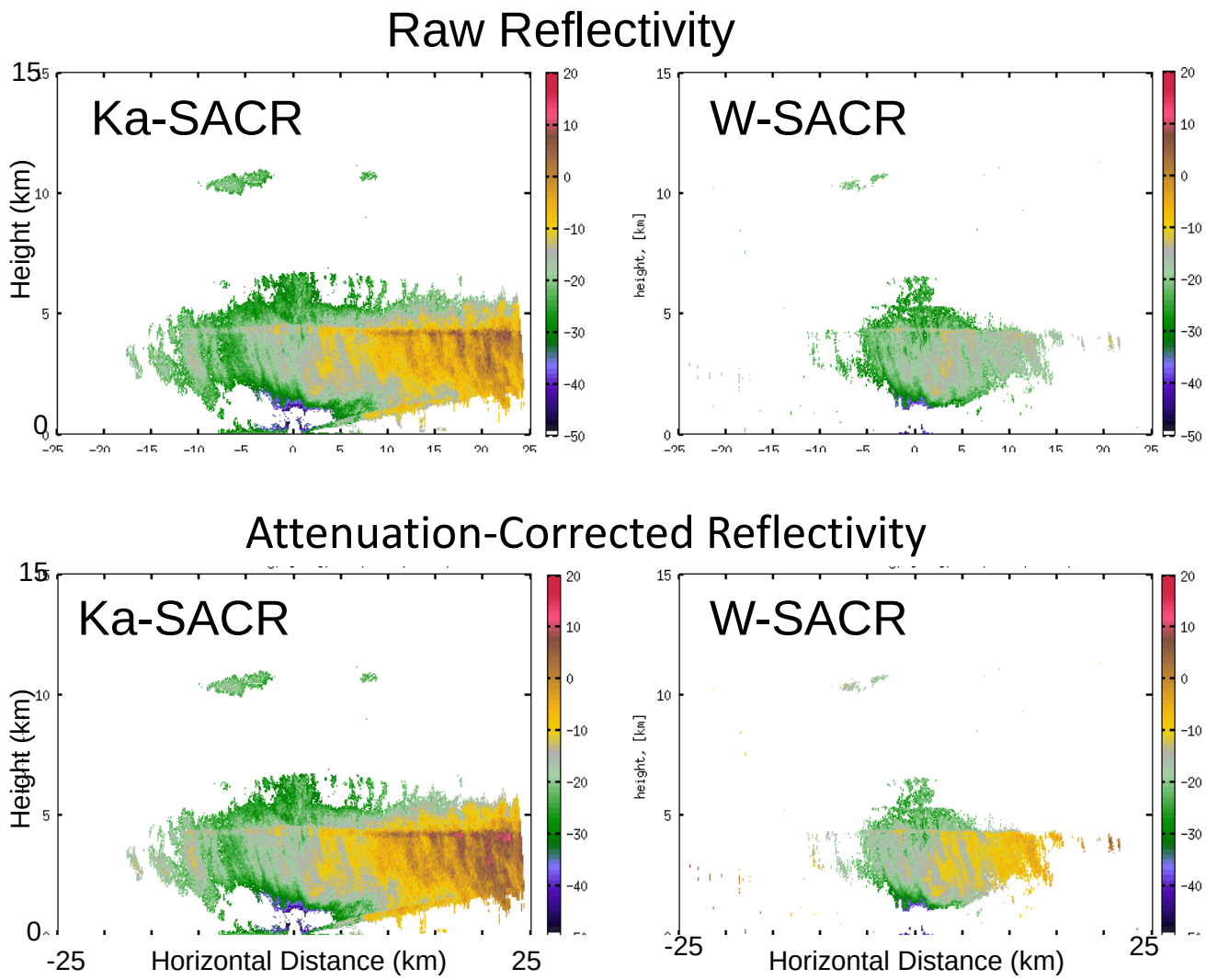




Scanning cloud radar VAPS

- 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

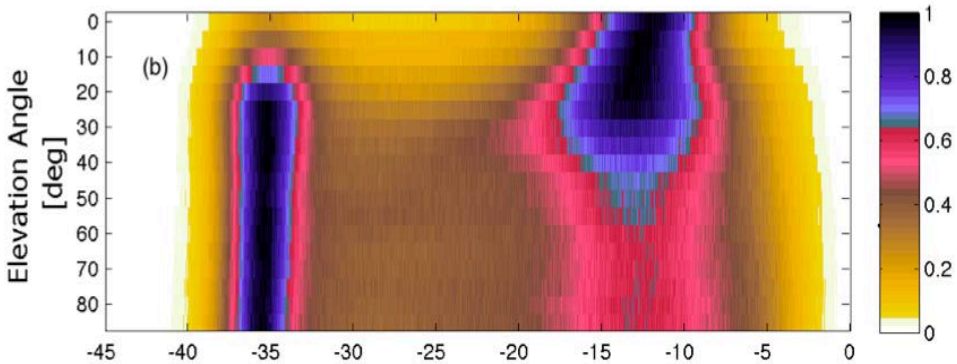
SACR VAPS: Water vapor attenuation correction



AMF1, Cape Cod

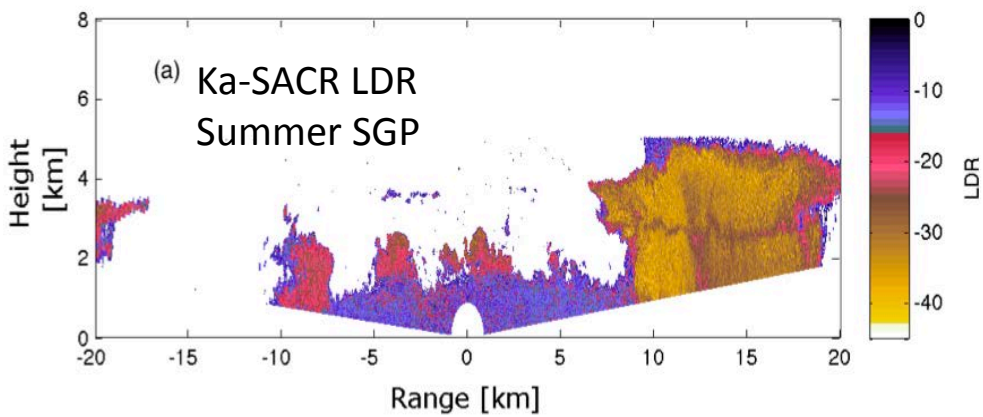
SACR VAPS: Insect filtering

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



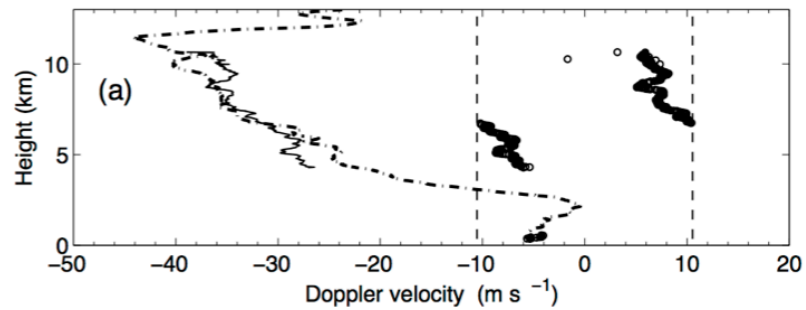
Hydrometeors

Insects

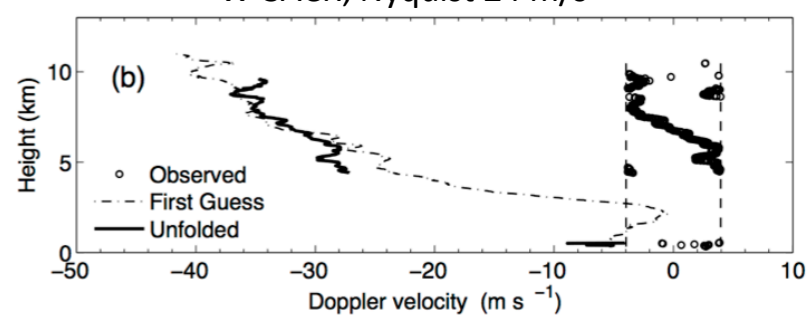


SACR VAPS: Velocity dealiasing

Ka-SACR, Nyquist ±10.5 m/s

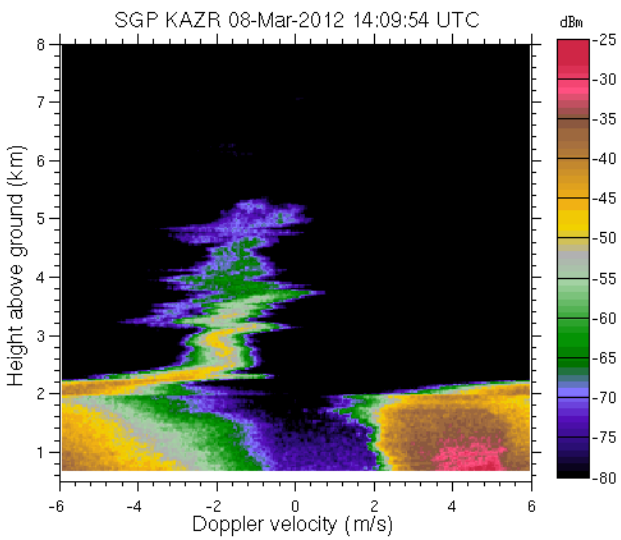


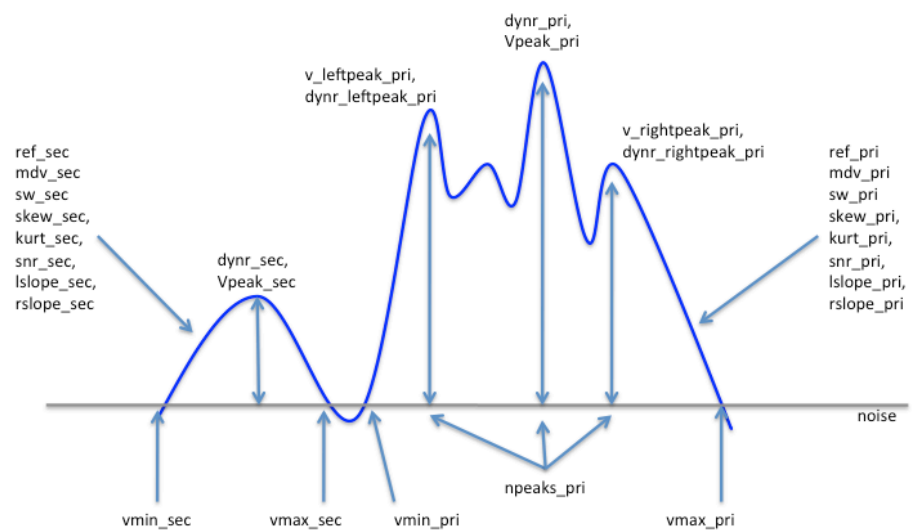
W-SACR, Nyquist ±4 m/s



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



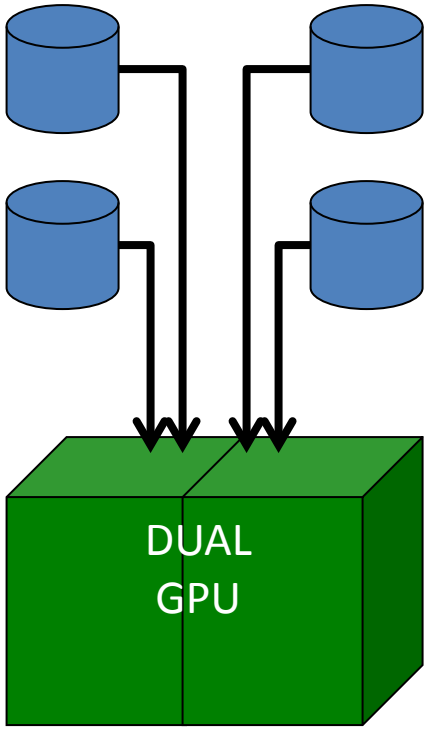


MicroARSCL is a value added product that distills radar Doppler spectra into a set of their most relevant microphysical descriptors.

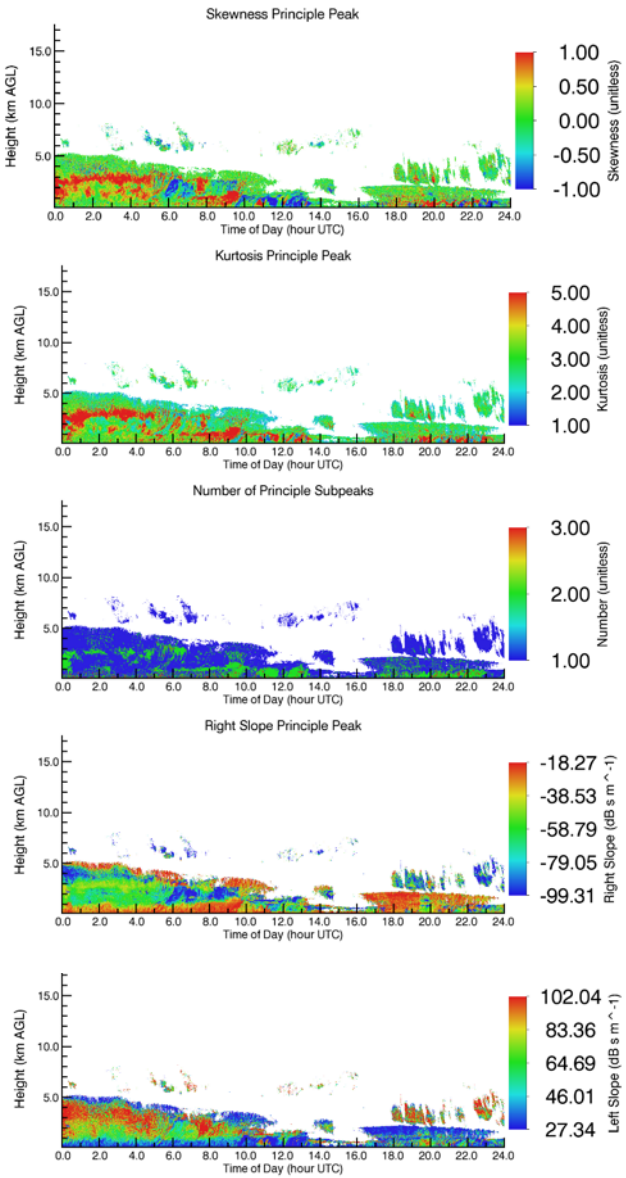
Radar spectra data: MicroARSCL developed for the GPU

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

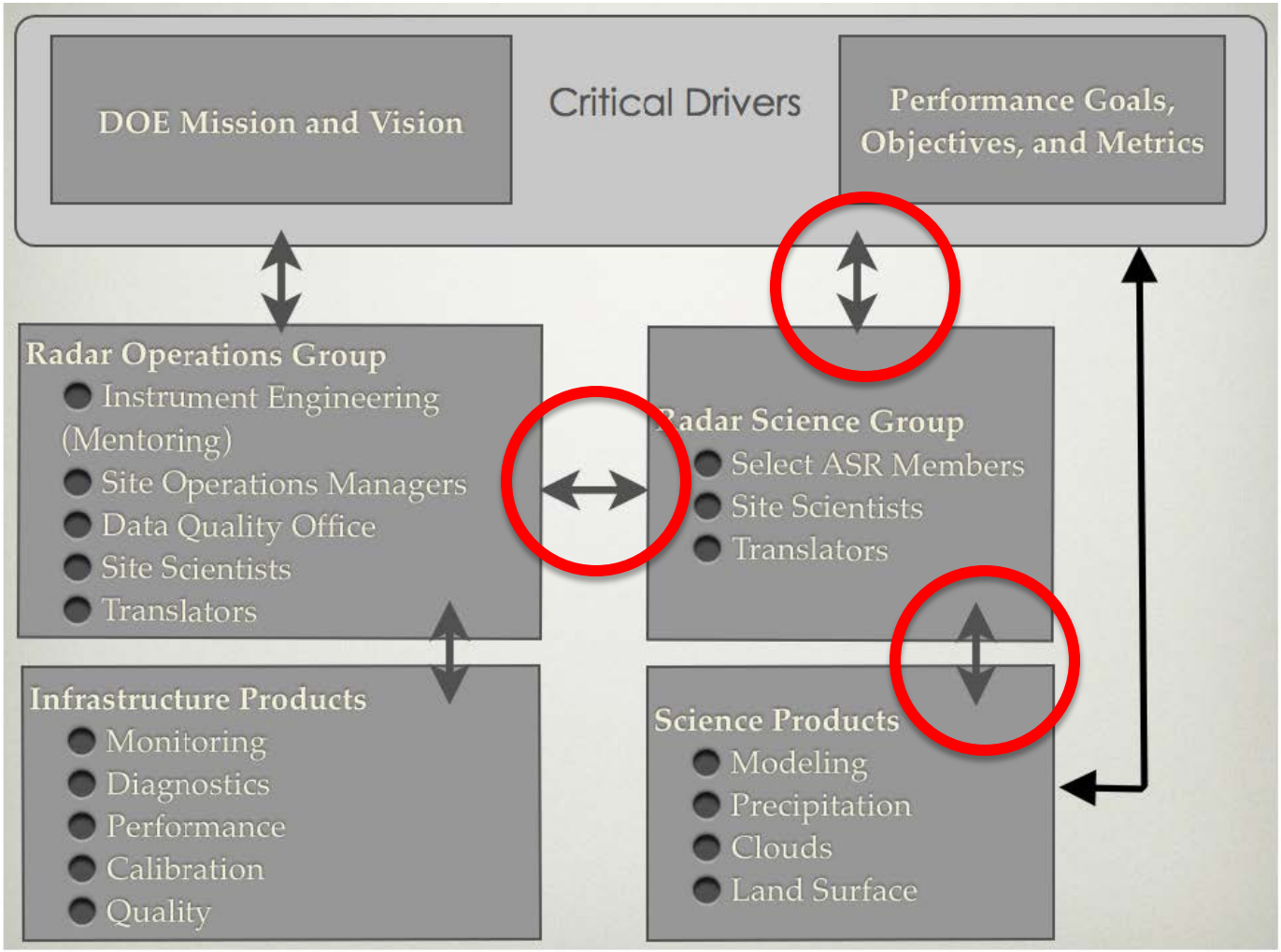
160,000 spectra/sec (net)



240,000 spectra/sec

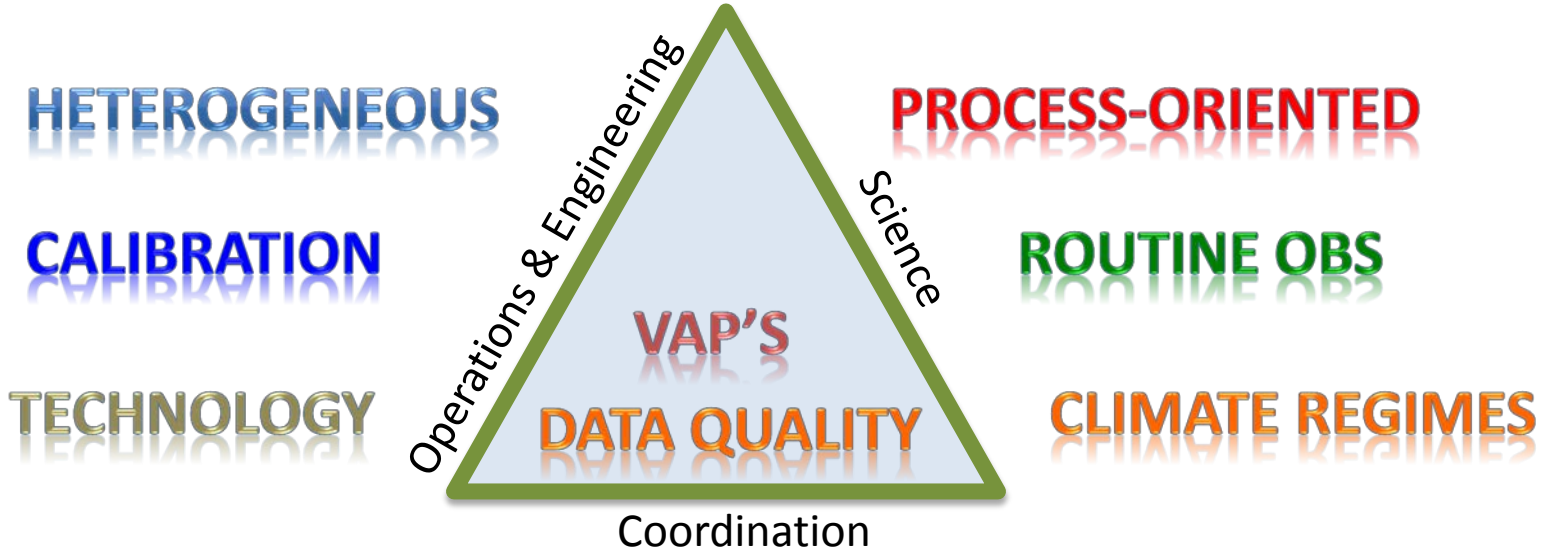


ARM Radar Organization: To support this complex measurement network, ARM is implementing a multi-faceted operational strategy. This radar organizational structure is new and is expected to be effective at optimizing radar operations, data quality, and data product delivery.

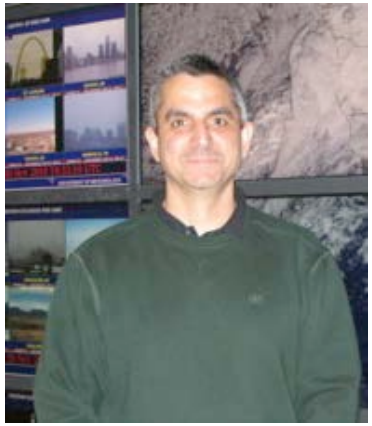


Importance of the ARM Radar Organization

- 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)

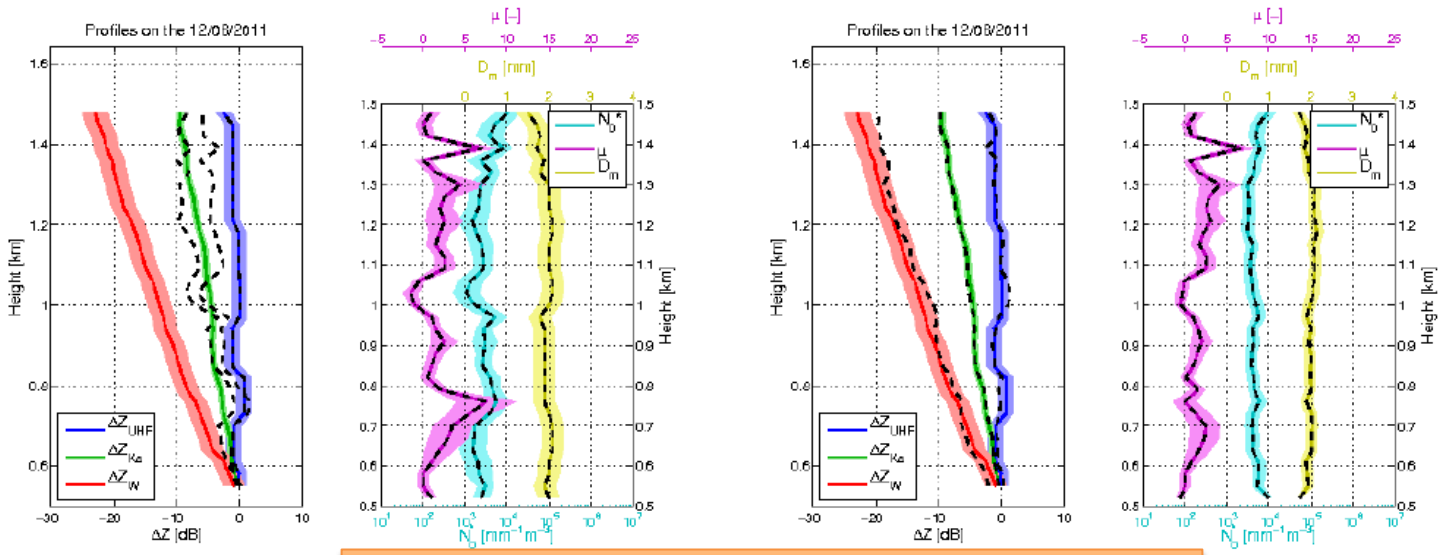


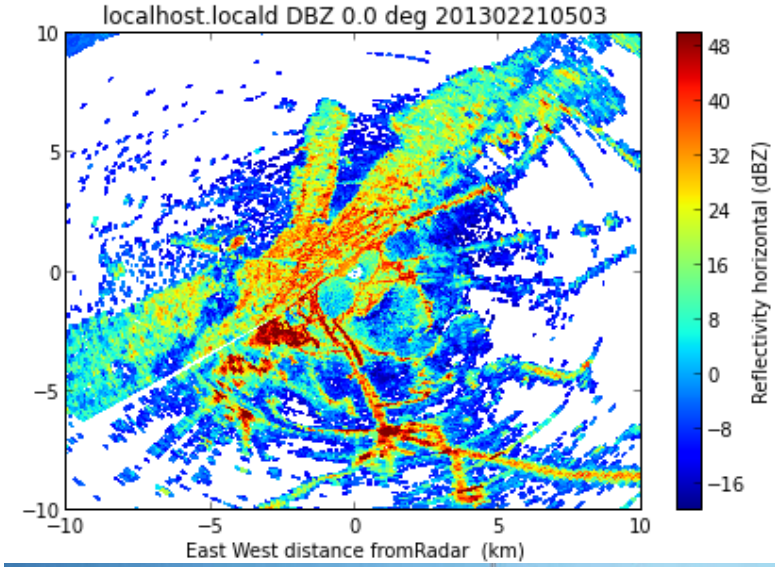
Image provided by F. Tridon (U. Leicester)

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



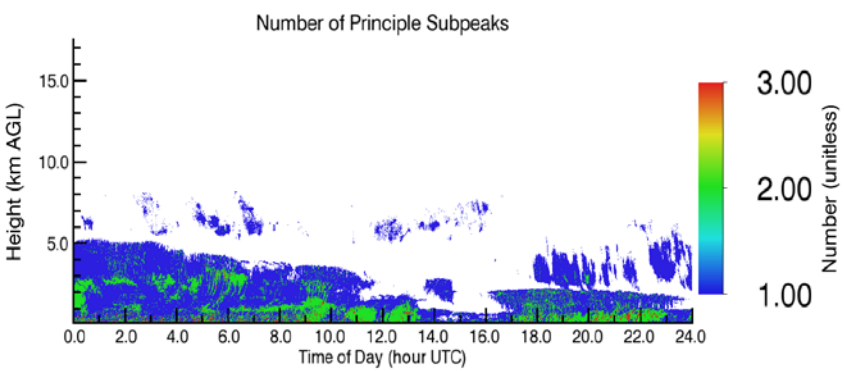
- SGP (Lead, Roger Marchand)
  - ✓ Fall 2013
  - ✓ Evaluate SACR scan strategies
  - ✓ 3-D cloud radar products

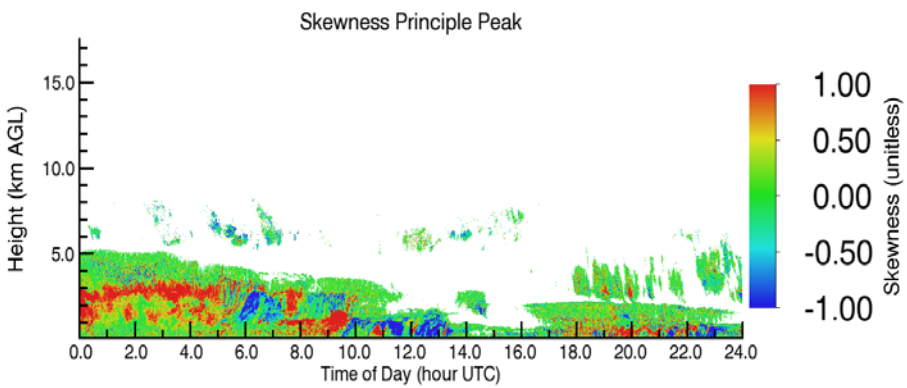
Assist ARM to develop high quality radar products

- 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

Category	Task #	Action Item	Priority (1-5)			
		g radar data more useful to modelers	2	Shumaker/Tromel		