ARM Data Product Development in Support of the Cloud Lifecycle Working Group

Michael Jensen, Shaocheng Xie, Scott Collis and Scott Giangrande

Edwin Campos, Maureen Dunn, Jonathan Helmus, Karen Johnson, Edward Luke, Renata McCoy, David Troyan, Yunyan Zhang, Chaunfeng Zhao

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ASR Science Team Meeting
Potomac, MD

CLWG Science Questions

What cloud and environmental processes control the transition from shallow to mid-level to deep convection and how does the transition differ over land and ocean? (S2D)

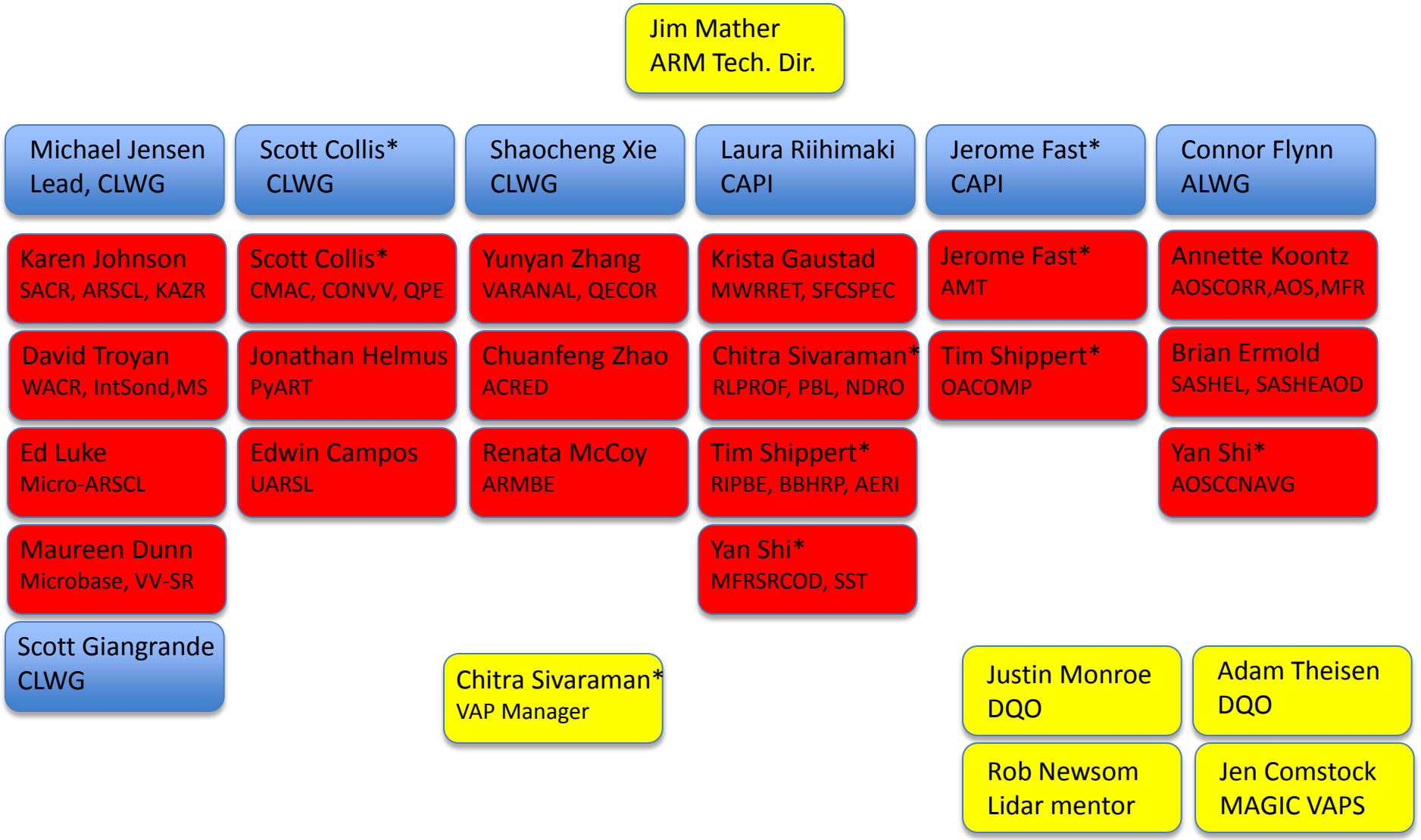
Under what environmental conditions does convection organize into mesoscale structures and why? What processes determine the persistence of the stratiform rain and anvil regions? (Deep)

What processes determine the formation, persistence, and evolution of cumulus, stratocumulus and stratus clouds in warm and cold climates? (StSCu)

What processes control the partitioning of phase in mixed-phase clouds of all kinds (Arctic stratus, midlatitude nimbostratus, and deep convective)? (MP)

What processes determine the temporal evolution and vertical distribution of the ice particle size distribution in ice clouds of all kinds? (ICE)

ARM VAP Development Team



ARMBE (former CMBE) Update

S2D/Deep/StSCu/MP/ICE

Released

- **ARMBE-CLDRAD**
  - Cloud fraction profiles
  - Total clouds
  - LWP/PW
  - Surface radiative fluxes
  - TOA radiative fluxes
  - Satellite retrieved clouds
- **ARMBE-ATM**
  - Soundings
  - NWP analysis data
  - Surface heat fluxes
  - Surface precipitation
  - Surface temp, RH, and winds

Coming Soon …

- **ARMBE-cloud/aerosol properties ACRED+RIPBE**
  - LWC/IWC
  - liquid re, ice re
  - LWP/IWP
- **ARMBE - Land**
  - Soil temperature, soil moisture, soil heat flux
  - CO2 concentration and density
  - photosynthetic photon flux density
- **ARMBE - AMF**
  - Selected AMF deployments
- **ARMBE – Domain-AVG**
  - Only for SGP

ARM CLIMATE RESEARCH FACILITY

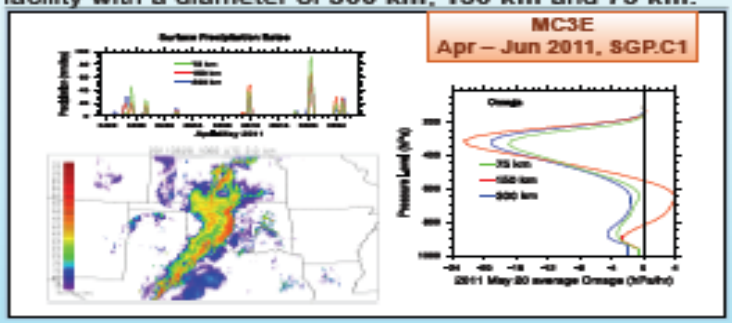
U.S. DEPARTMENT OF ENERGY | Office of Science

Large-scale Forcing Development – A Major Effort in FY13

S2D/Deep/StSCu/MP/ICE

MC3E Multiscale Forcing

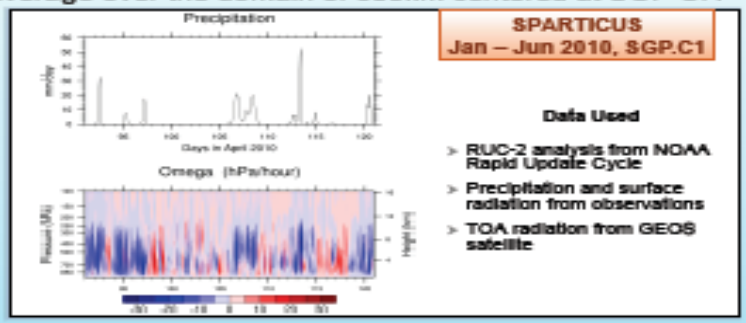
The multiscale-domain forcing data with improved sounding was updated for domains centered at central facility with a diameter of 300 km, 150 km and 75 km.



Data Download:
http://iop.archive.arm.gov/arm-iop/0eval-data/xie/scm-forcing/iop_at_sgp/

SPARTICUS Forcing

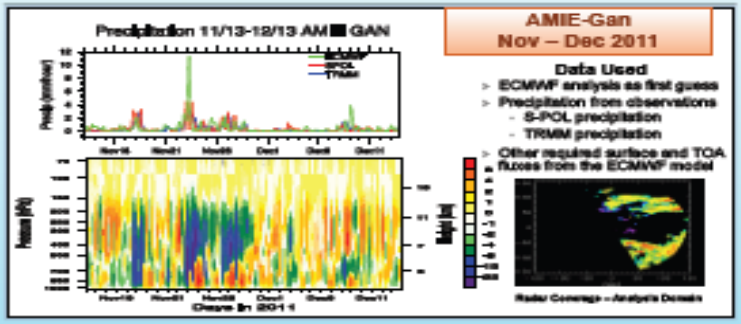
The large-scale forcing data is available for SPARTICUS IOP covering the period **1/1/2010 to 6/30/2010**. This is an average over the domain of 300km centered at SGP CF.



Data Download:
http://iop.archive.arm.gov/arm-iop/0eval-data/xie/scm-forcing/continuous_at_sgp/2010/

AMIE-Gan Forcing

Large scale forcing data was developed for the AMIE-Gan IOP over the 2nd MJO period (11/13/2011- 12/13/2011) covering the S-POL area analysis domain. The data is 3-hourly and has 25 mb vertical resoluiton.



MC3E: multi-scale forcing over a domain with a size of 300km, 150km, and 75km. Sounding-based for April-June 2011, SGP. (released)

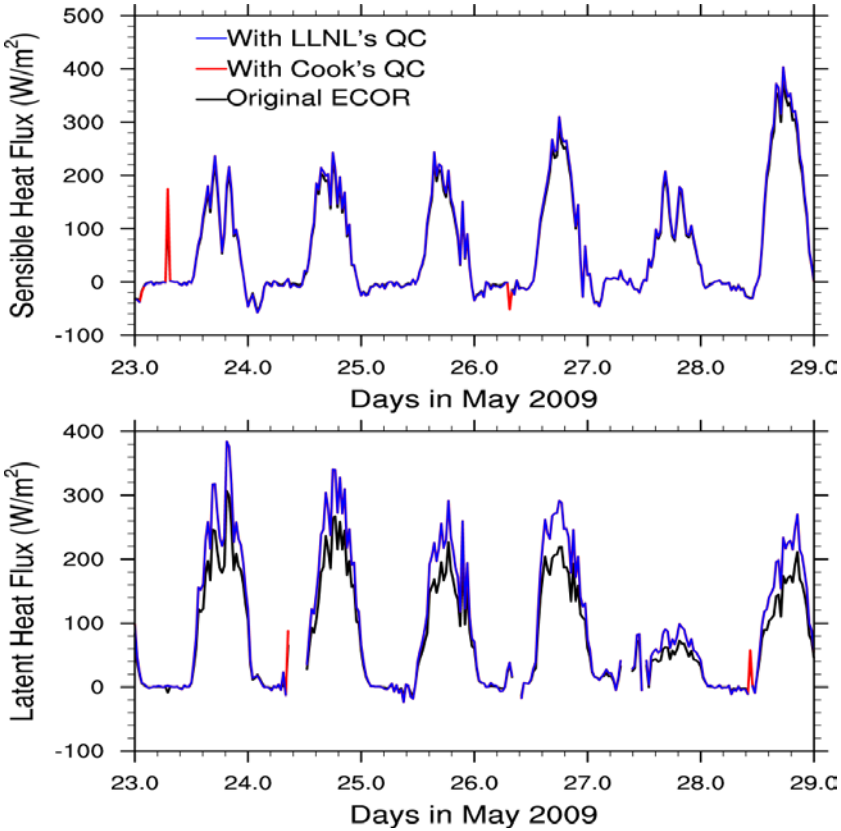
SPARTICUS: RUC-based continuous forcing for 1 Jan – 30 Jun 2010, SGP with a domain size of 300km. (released)

AMIE-Gan: ECMWF-Based constrained with SPOL precipitation for 13 Nov – 13 Dec, 2011, GAN with a domain size of 150km. (will be released soon)

Other VAPs

QCECOR

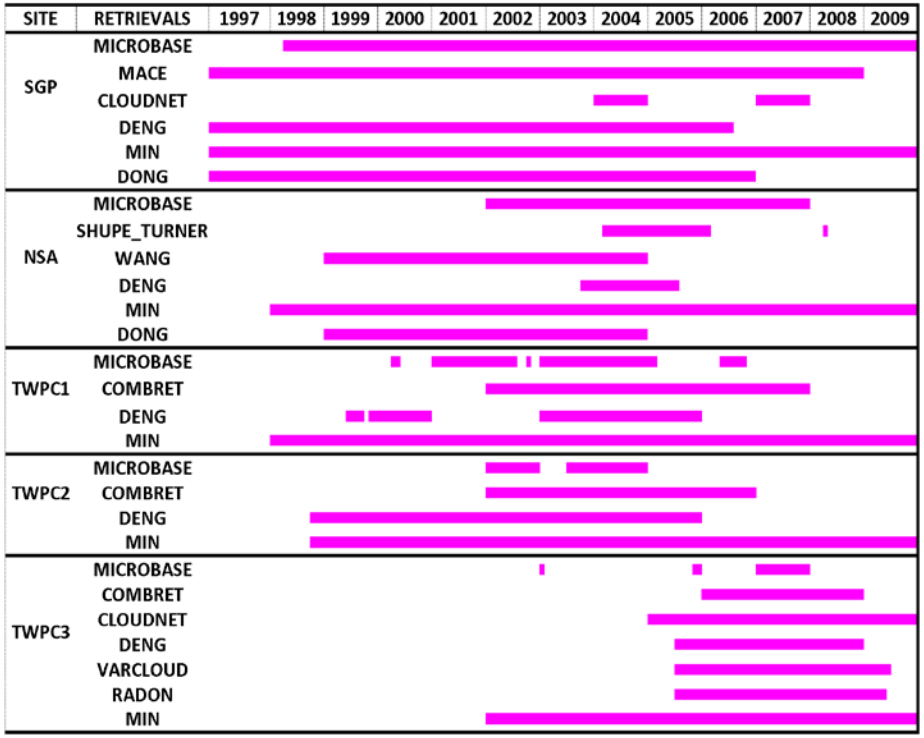
S2D/Deep/StSCu



Quality Controlled ECOR SGP and AMF sites

ACRED

StSCu/MP/ICE



ARM Cloud Retrieval Ensemble Dataset (11 different retrievals for all 5 ARM sites)

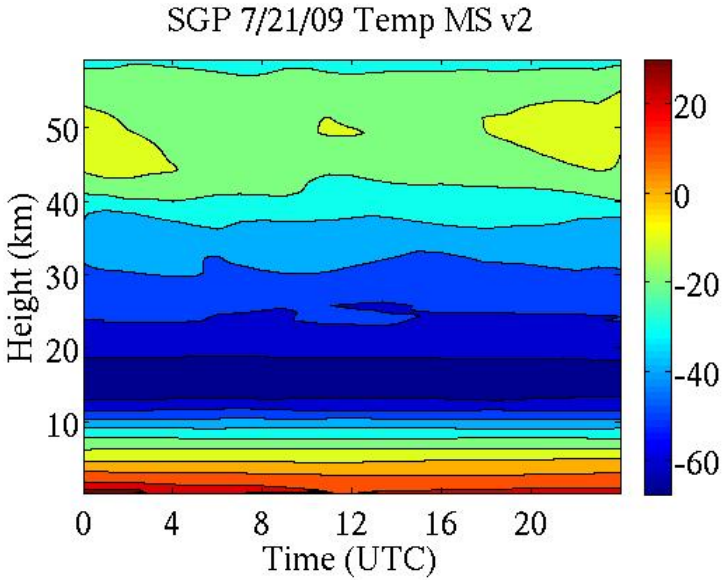
CLIMATE RESEARCH FACILITY

ARM Sounding Products (Developer: David Troyan)

Merged Sounding (S2D/Deep/StSCu/MP/ICE)

• Uses a combination of radiosonde profiles, MWR integrated water vapor, surface meteorology, and ECMWF model output to provide a thermodynamic profile of the atmosphere at one minute intervals

• Version 2 (available as an Evaluation Product)
  - •Uses ARM radiosondes corrected for using Miloshevich method
  - •315 Altitude Levels to 60 km AGL



Interpolated Sonde

(S2D/Deep/StSCu/MP/ICE)

• Intermediate step in MS processing
• Immediate users – radar VAPs

Sonde Adjust

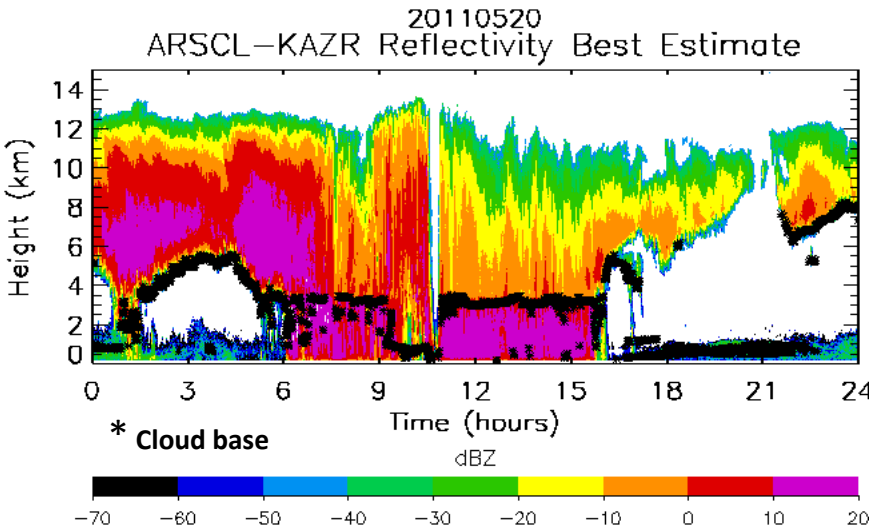
(S2D/Deep/StSCu/MP/ICE)

• Corrects the dry-bias found in Vaisala (RS-80 , RS-90, RS-92)radiosondes
• Employs the correction algorithms described in
  - Miloshevich et. al. (2001, 2004, 2006)
  - Turner et. al. (2003)
  - Wang et. al. (2002)
  - Vomel et. al. (2007)

KAZR Active Remote Sensing of CLouds (KAZR -ARSCL)

(S2D/StSCu/MP/ICE)

cloud radar, micropulse lidar, ceilometer
+ interpolated sonde
+ rain gauge
+ microwave radiometer



Why a *new* VAP?

- New radar operating modes → Simpler mode merging
- Improved polarization modes → LDR used in insect detection
- Insect detection algorithm expanded (LWP, temperature,…)
- Reflectivities corrected for water vapor attenuation
- Improved velocity dealiasing algorithm
- New KAZR-ARSCL software easier to maintain, update
- More timely processing

Data Availability: Evaluation Product - SGP(MC3E), TWP(GAN)

MicroARSCL: A VAP Developed for the GPU

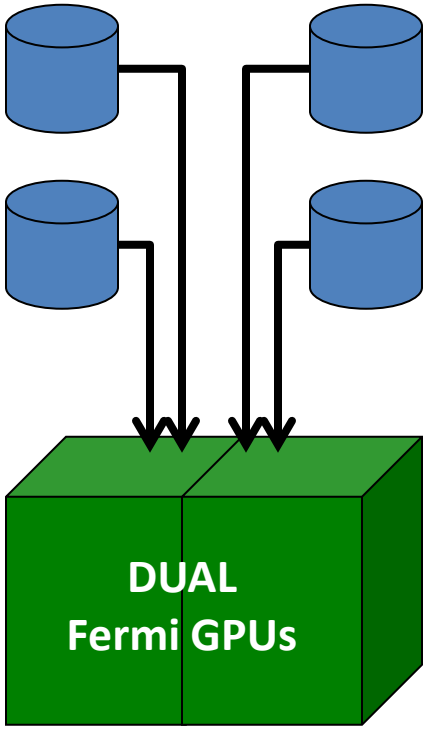
(StSCu/MP/ICE)

New microphysical information from radar Doppler spectra

4 microseconds / spectrum

- Noise Floor Estimation
- Edges Determination
- Primary Extended Moments Computation
- Secondary Extended Moments Computation
- Subpeaks Measurment
- Clutter Detection

- 240,000 spectra/second processed by GPU
- 160,000 spectra/second net including I/O
- ~ 40 minutes to process a year of SGP KAZR
- ~ 17 x 10^{10} spectra in ARM archive (140 TB)
- ~ 12 days to process all spectra in archive
- MicroARSCL can be processed **"on demand"**



160,000 spectra/sec (with I/O)

240,000 spectra/sec

SACR CORMASK VAP: Feature Mask and Moments Correction

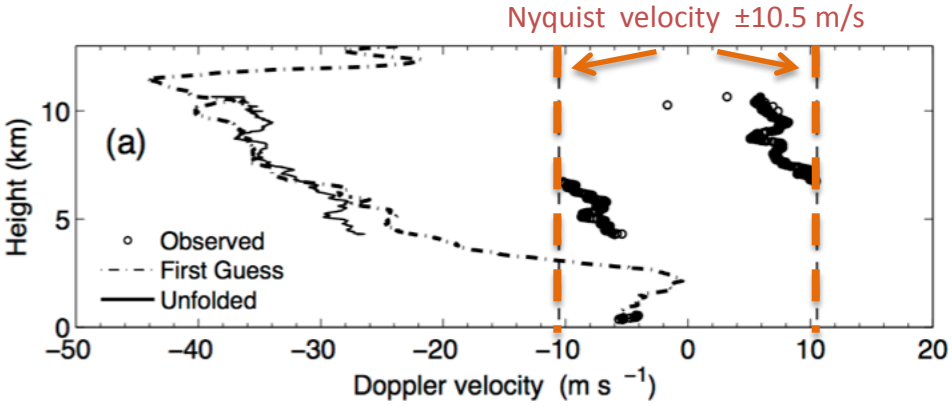
Velocity Dealiasing

(S2D/Deep/StSCu/MP/ICE)

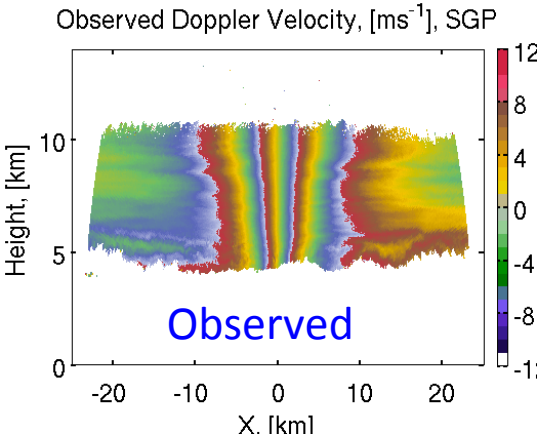
Low SACR Nyquist velocities lead to multiple velocity foldings, especially for upper level clouds.

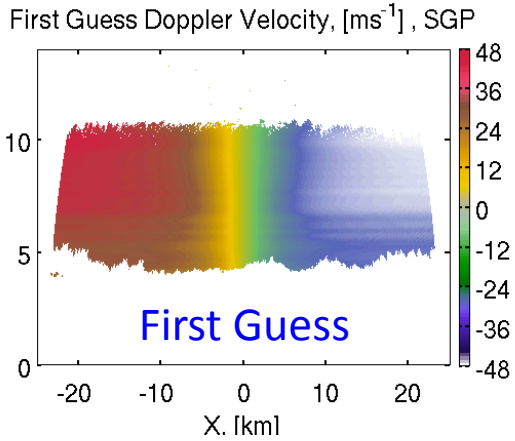
First guess of expected velocities: Winds from interpolated sounding are projected onto the radial plane.

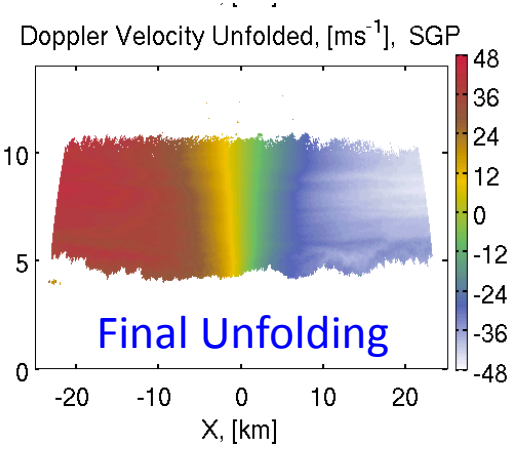
Ka-SACR Velocity Profile



Initial unfolded velocities are fine-tuned assuming velocity at the top of each hydrometeor layer is correct and requiring continuity in range.

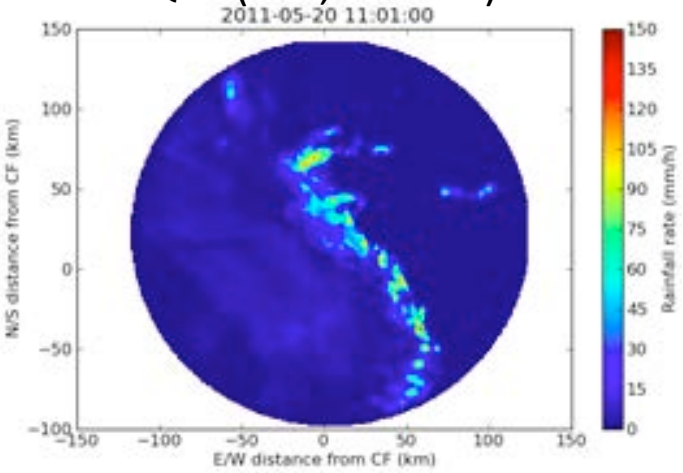




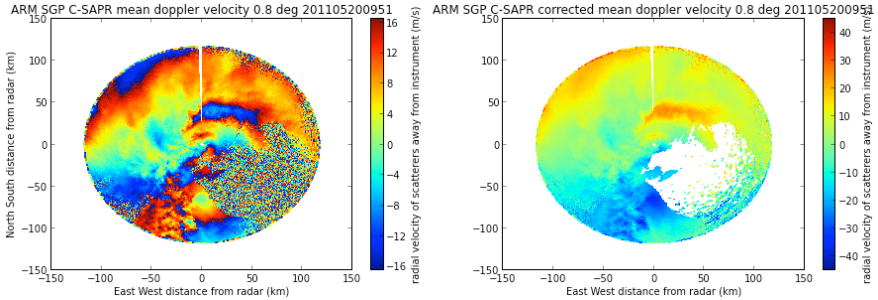


Value added products released to evaluation (S2D/Deep/StSCu/MP/ICE)

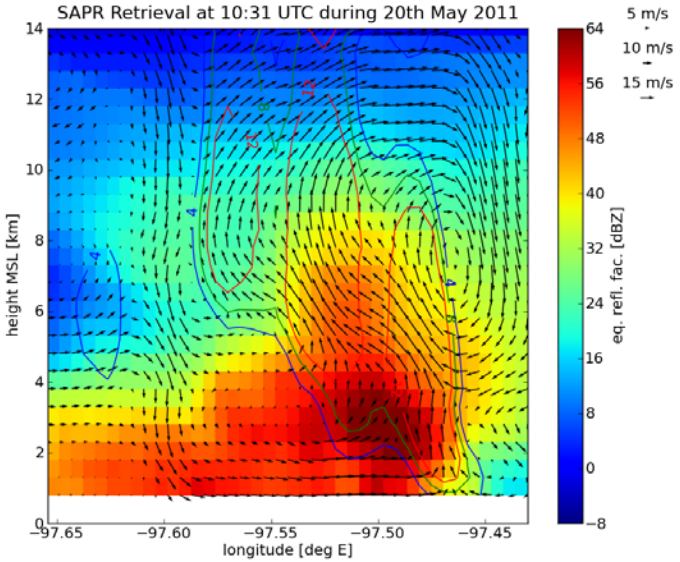
QPE (SGP, TWPC1)



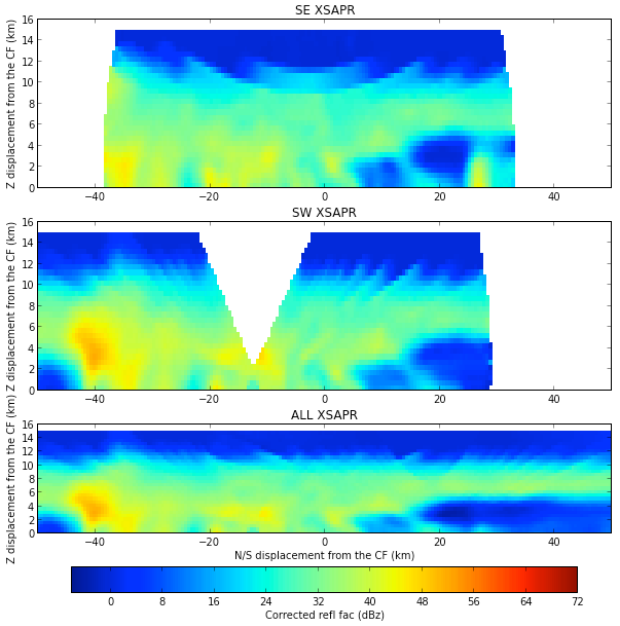
CMAC (SGP, TWPC1)



CONVV (SGP)

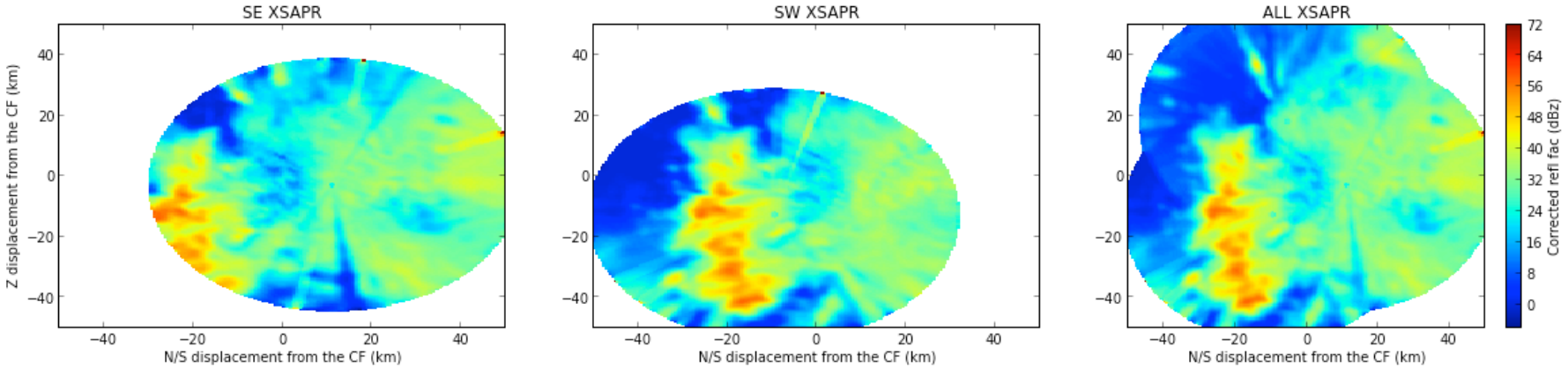


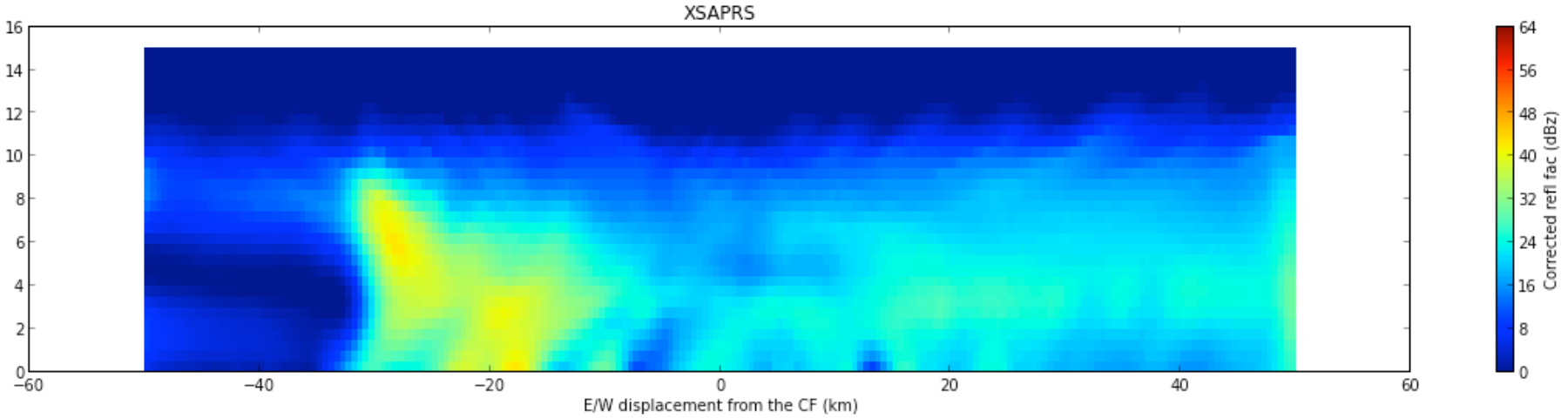
MMCG (SGP, TWPC1)



Active development: Network Map

(S2D/Deep/StSCu/MP/ICE)

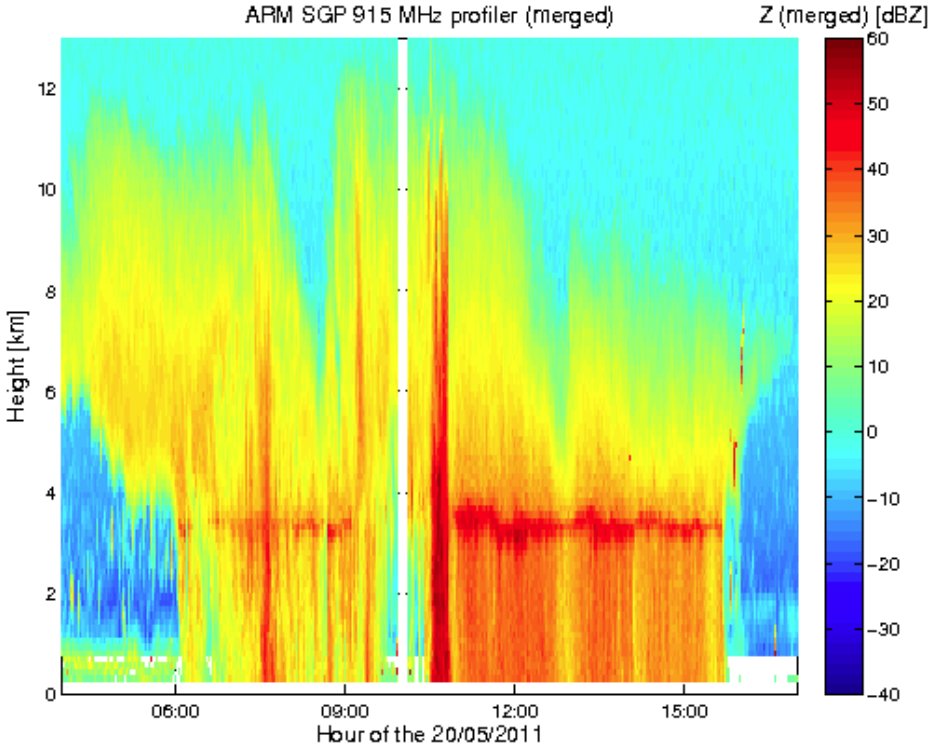


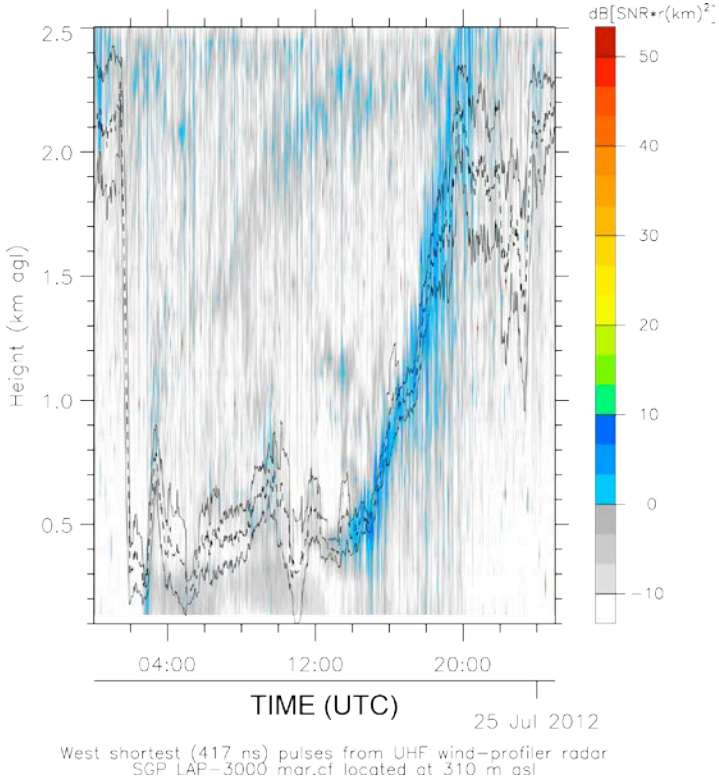


Active development: UAZR-ARSAL

“Active Remote Sensing of Atmospheric Layers”

(S2D/Deep/MP/ICE)





ARM radar VAP development for ASR science: Py-ART

- Lots of code gets generated in the process of developing VAPs
- The ARM radar products team is releasing all code, under an open BSD license as a toolkit.
- This toolkit abstracts the radar data to an Py-Radar object.
- PIs can build on the suite of retrievals in Py-ART
- The best way for PIs to share code is to “submit a pull request” on GitHub..
- ***We are here to help! Especially PIs who are submitting code!***

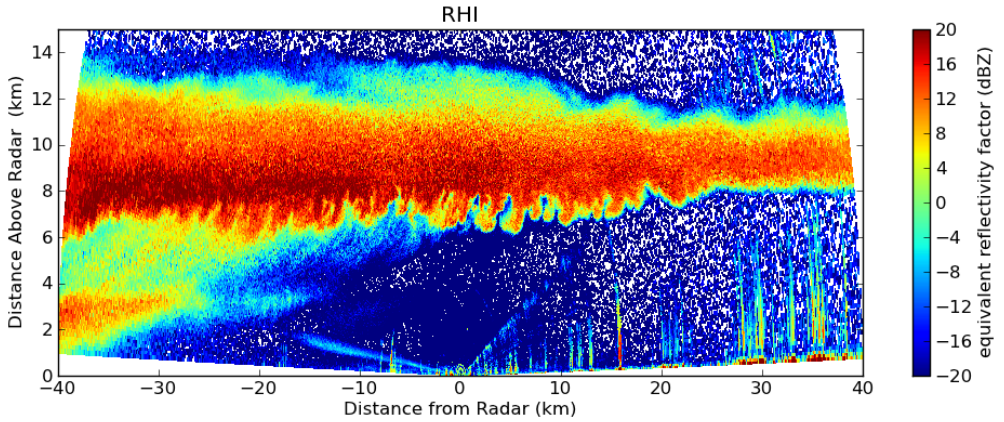
```python
#! /usr/bin/env python

import matplotlib.pyplot as plt
import pyart

radar = pyart.io.read_netcdf('sgpxsaprrhicmacI5.c0.20110524.015604_NC4.nc')
display = pyart.graph.RadarDisplay(radar)

fig = plt.figure(figsize=(12, 4))
fig.subplots_adjust(hspace=0.4)
ax = fig.add_subplot(111)

display.plot_rhi('reflectivity_horizontal', 0, vmin=-20, vmax=20, title='RHI',
                 ax=ax)
display.set_limits(ylim=[0, 15])
fig.savefig('rhi_plot.png')
```



Fork me on GitHub

https://github.com/ARM-DOE/pyart

How can CLWG PIs help with VAP development?

- PI products [http://www.arm.gov/data/pi]
- Code sharing
- Science sponsorship
- Beta testing [During evaluation phase]
- Feedback [To translators/developers at any time]
- Express needs and priorities [ASR STM/WG, surveys, translators, new tool]

ASR Funding Opportunity Announcement

Projects focused on algorithm and dataset development should include methods for estimating uncertainty on retrieved variables. Investigator-generated data products should be provided to the ARM data archive as PI Data Products (http://www.arm.gov/data/pi) and methods/algorithms provided to ARM (http://www.arm.gov/data/docs/procedure) so that improved retrievals and analyses may be incorporated into ARM products.

ARM PI Products

Contact one of the ARM translators:
Scott Collis (CLC), Jerome Fast (ALC), Connor Flynn (ALC), Michael Jensen (CLC), Laura Rihiimaki (CAPI), Shaocheng Xie (CLC)

Provide description of product:

- Brief description of scientific/research scope
- ReadMe file that describes data format and character
- Relevant references

Translator team discusses fit and utility of data product

If accepted, Infrastructure Representative stages data

Archive announces and hosts PI product

http://www.arm.gov/data/docs/procedure

Questions?

Michael Jensen (mjensen@bnl.gov)

Scott Collis (scollis@anl.gov)

Shaocheng Xie (xie2@llnl.gov)

Scott Giangrande (sgrande@bnl.gov)