Cloud Radar Products

Profiling and Scanning

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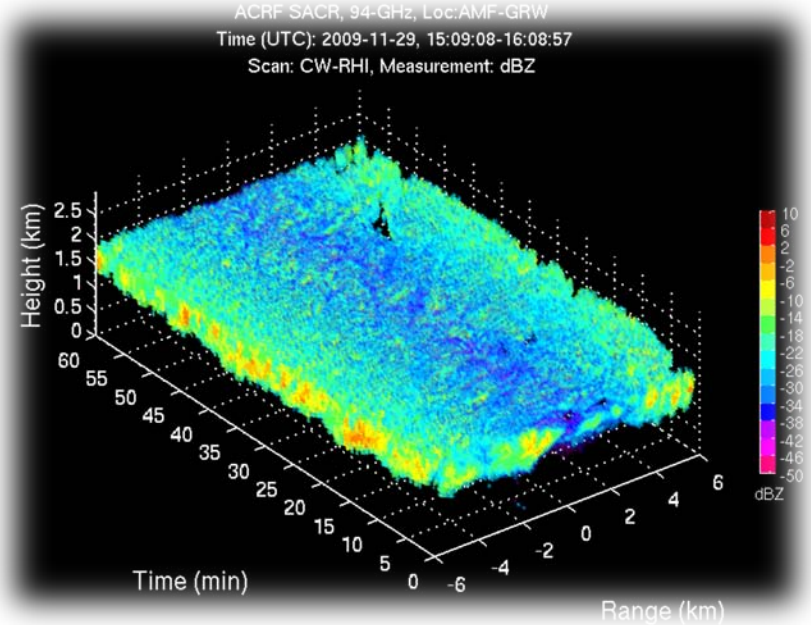


Pavlos Kollias
Ieng Jo
Aleksandra Tatarevic

McGill

ASR Cloud Life Cycle Working Group Meeting

Fall 2010

Profiling Radars

Extending ARM'S legacy radar data record:

Next-Generation ARSCL

ARSCL data (Clothiaux et al., 2000) is widely used, but the VAP will be revised to:

- Handle the new MMCR operating modes that will be used following the hardware upgrade

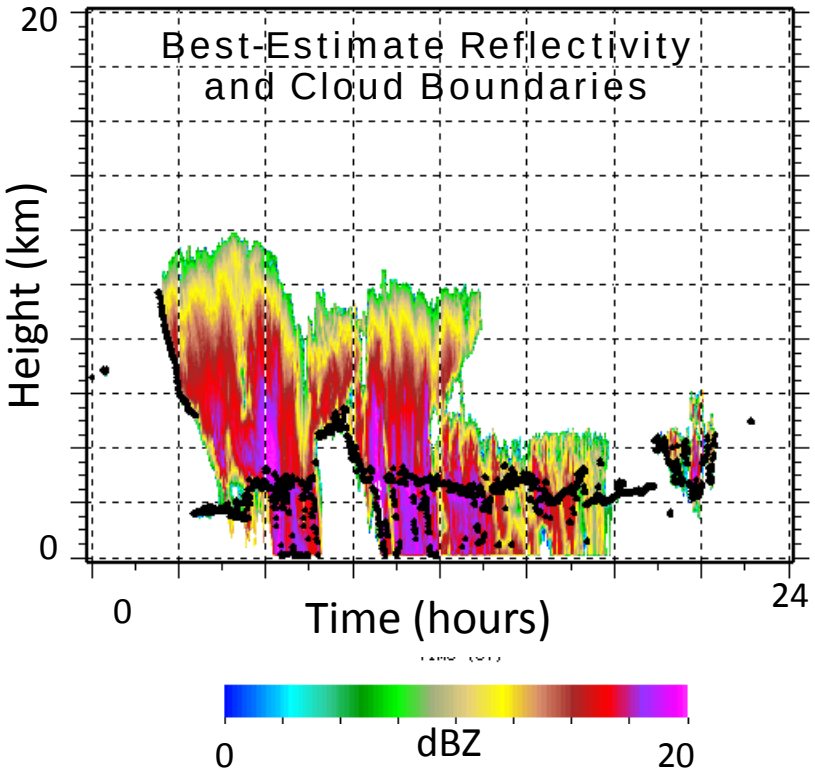
- Address known ARSCL limitations

  e.g., manual editing, mode interpolation artifacts, insect removal, velocity folding

Detailed analysis of multi-year ARM radar data (moments and spectra) has shown that higher spatial and temporal resolution can substantially increase the value of the ARSCL VAP for cloud and precipitation microphysical and dynamical retrievals

Profiling Radars: MMCR and WACR

Next-Generation **ARSCL**



ARSCL input is changing…

- MMCR ‘Upgrade’
  - Time, height resolution improve
  - Better cross-polar isolation
  - Higher Nyquist velocity
  - Closer to ‘artifact-free’ modes
- New MPL cloud mask product
- Merged Sounding

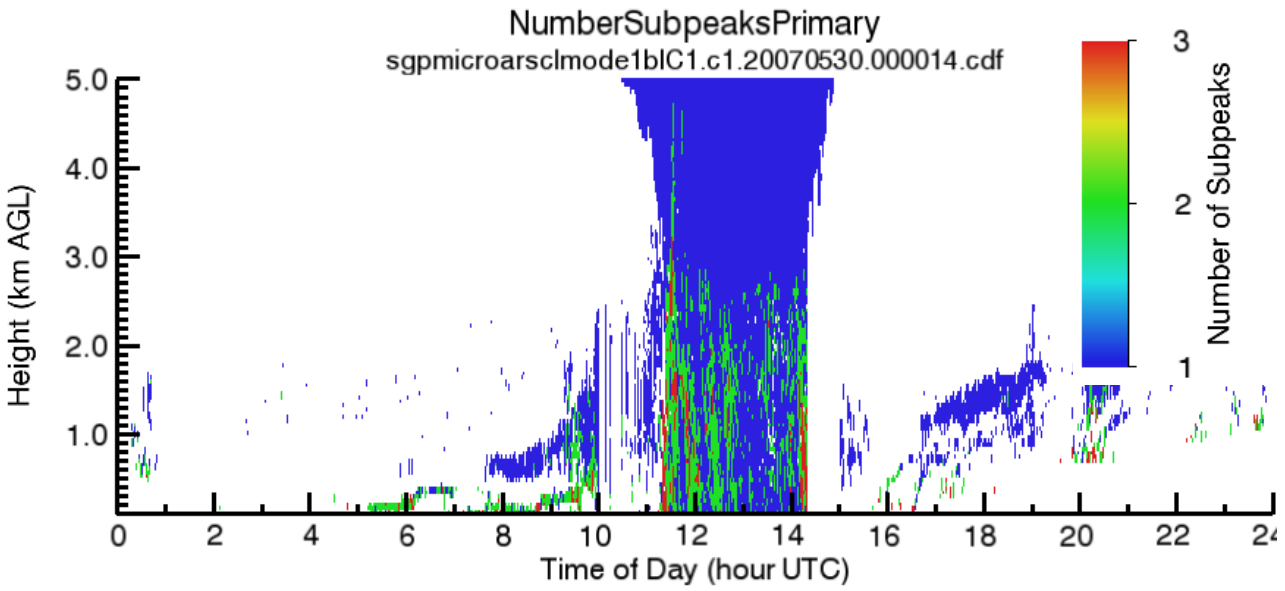
Profiling Radars

Next-Generation ARSCL

	Current ARSCL	New ARSCL
Time Resolution	10 s	~ 4 s
Height Resolution	~ 45 m	30 m
Insect Detection	partially manual	CDR - based
Mode Artifacts	Significant	Less intrusive
Water Vapor Attenuation	--	Corrected
Doppler velocity folding	Partial	Corrected
Processing Paradigm	Manual QC Required	Hands-off Processing
Processing Location	BNL	DMF or BDS
Lag Time	considerable	1 – 2 months
File Size	90 MB	~ 300 MB

Profiling Radars

Micro-ARSCL Product



Spectrum features
- o Skewness
- o # Peaks
- o Kurtosis

Error estimates

QC Flags

Recent work by Kollias and Luke shows that these parameters can be linked to cloud/drizzle microphysics

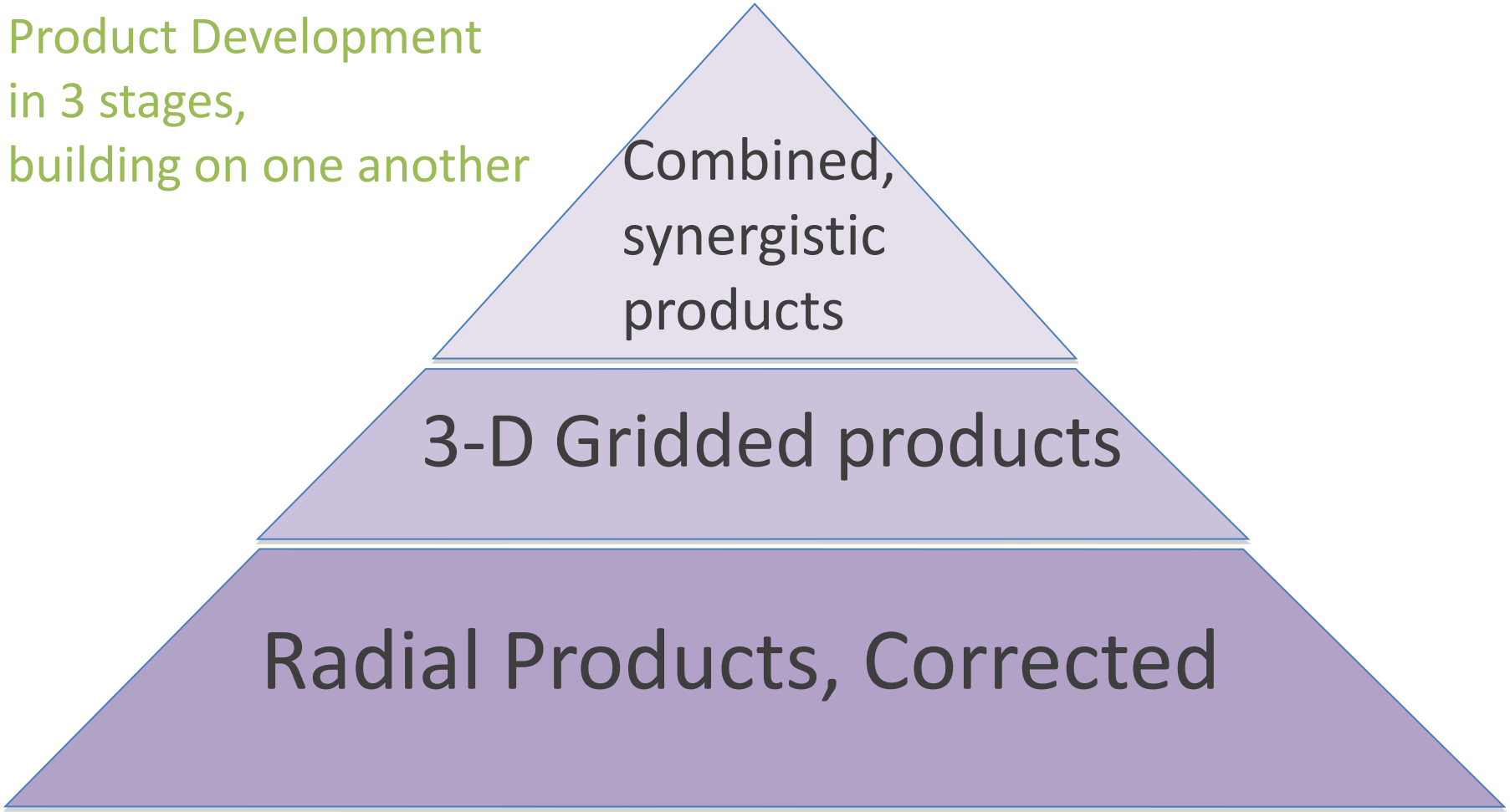
Changes:

- Matching new ARSCL in time, height
- Seamless transition from ARSCL moments to Micro-ARSCL spectra, with “best-mode” spectrum being processed
- Support for next-generation microphysical products

Scanning Cloud Radars: Ka, W, X

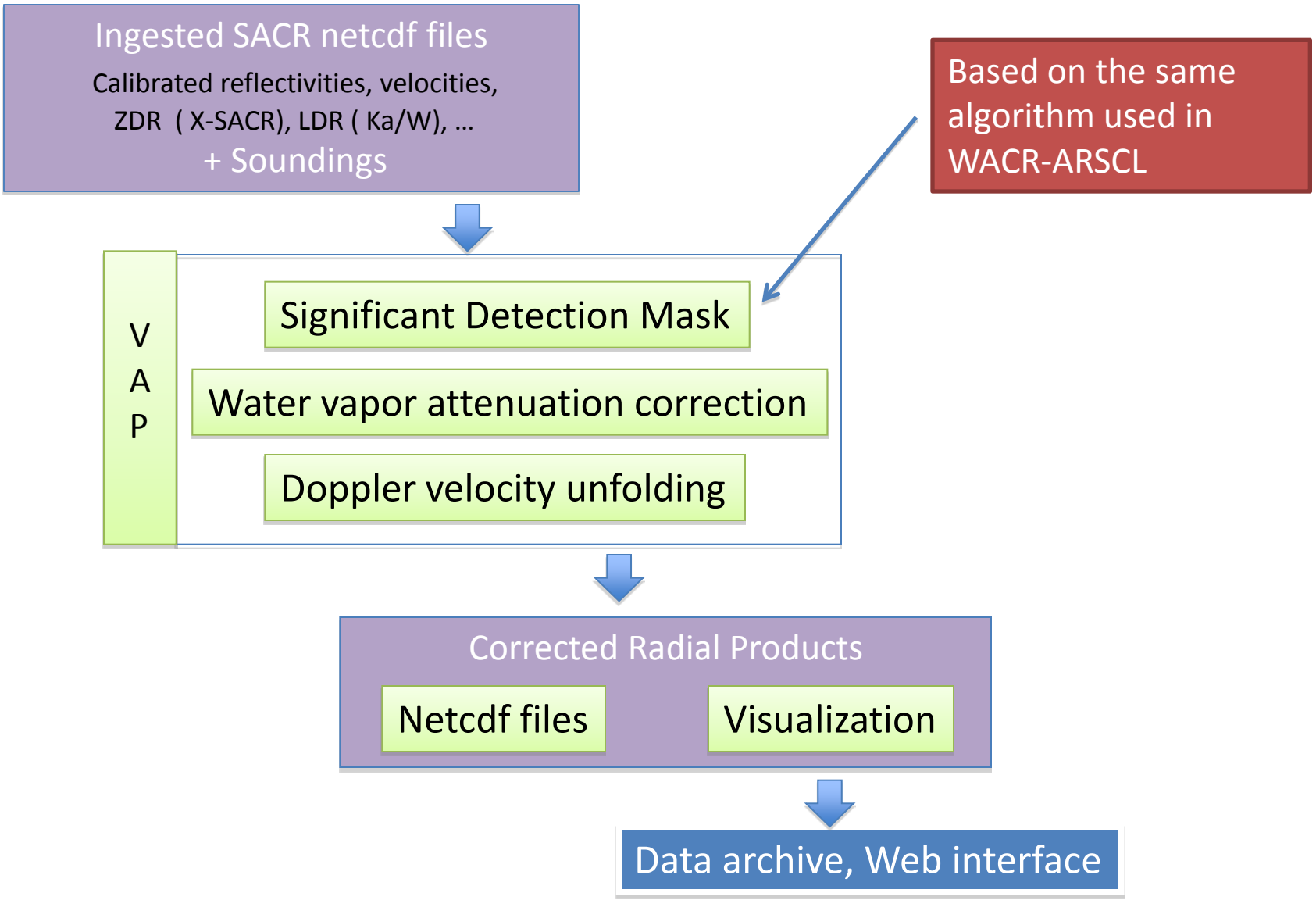
From Ingest to Products

Product Development
in 3 stages,
building on one another

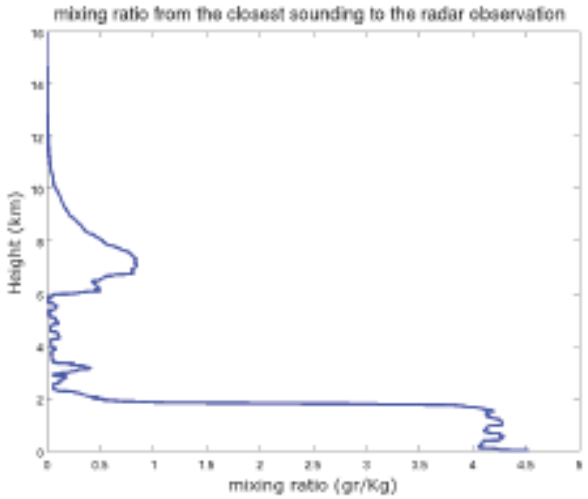


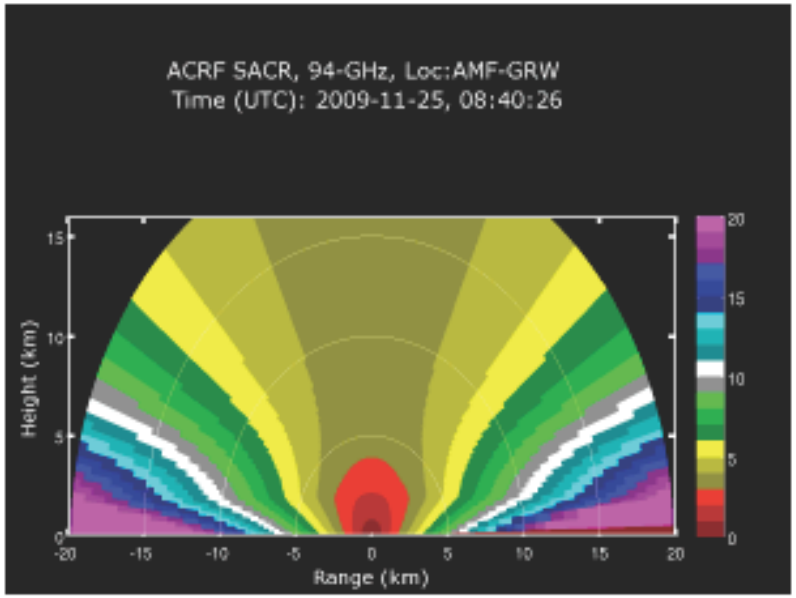
Scanning Cloud Radars: Ka, W, X

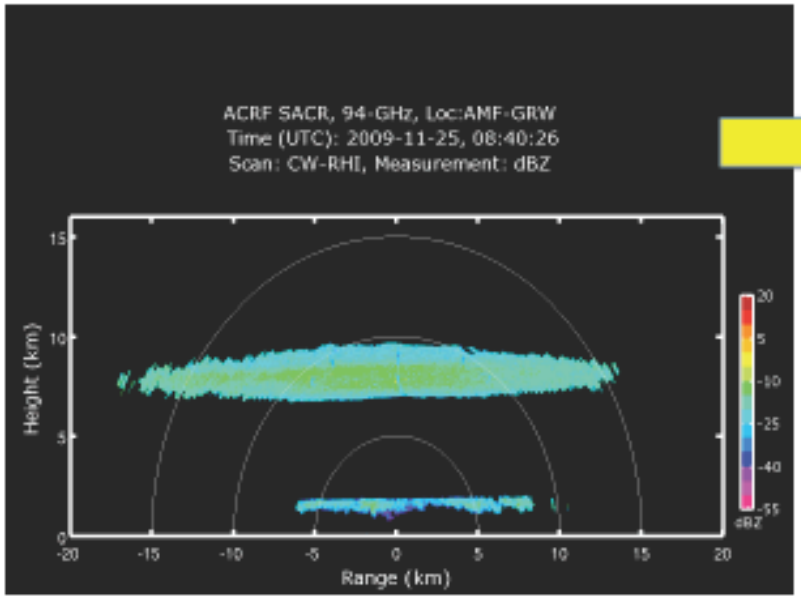
Stage 1: Quality-controlled, hydrometeor radar observations

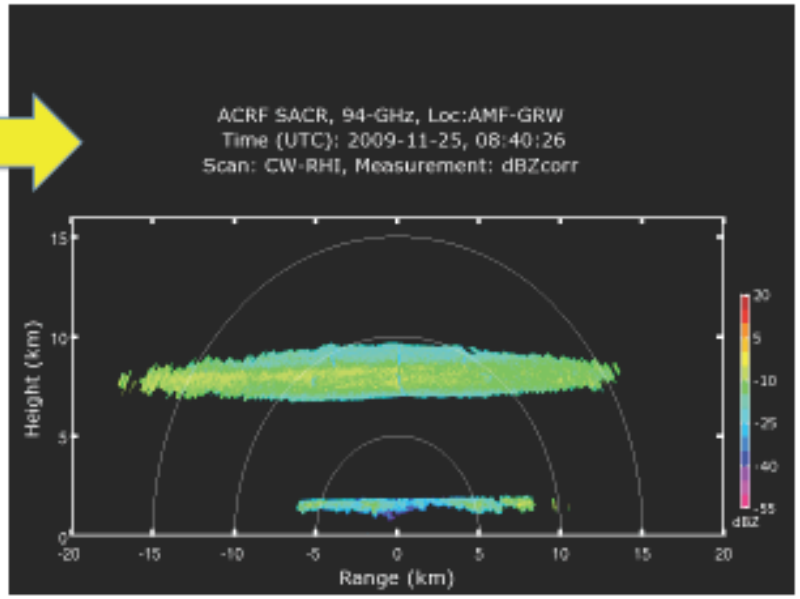


Water vapor attenuation correction

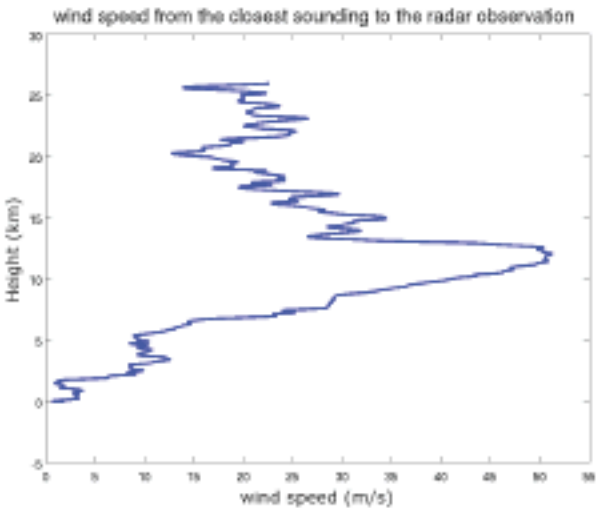


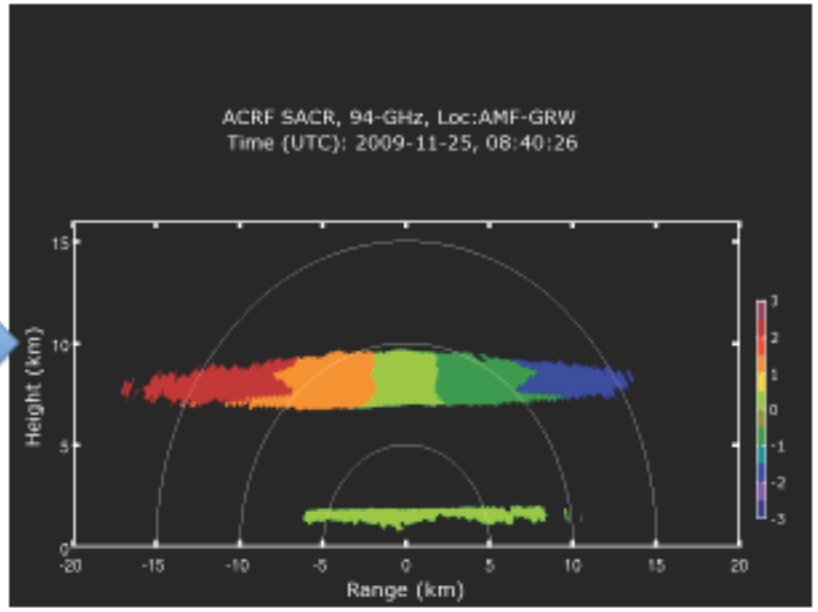


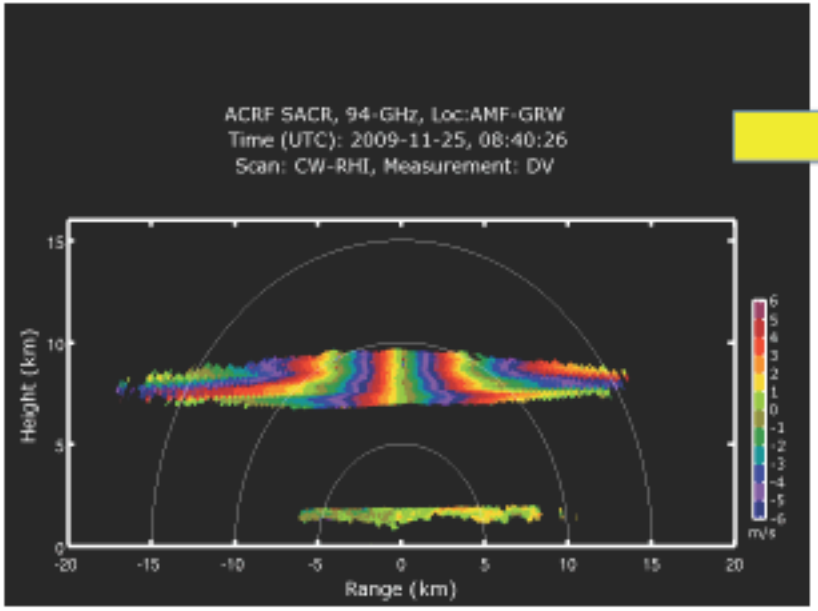


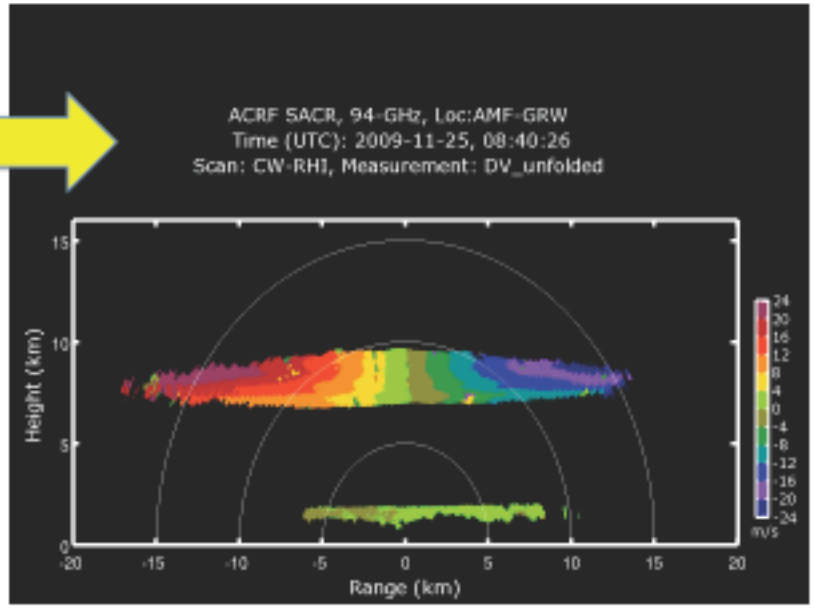


Doppler Velocity Unfolding

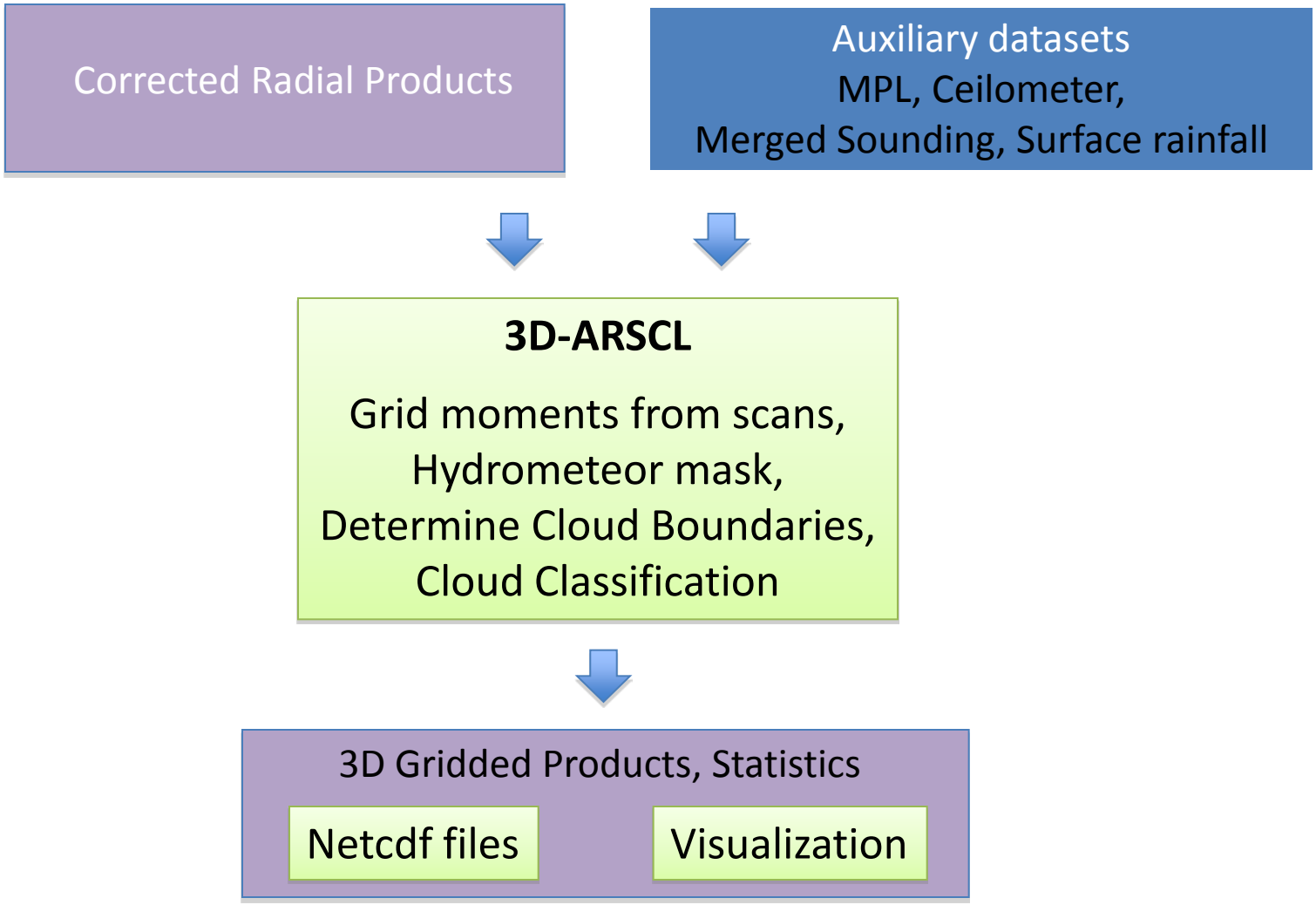




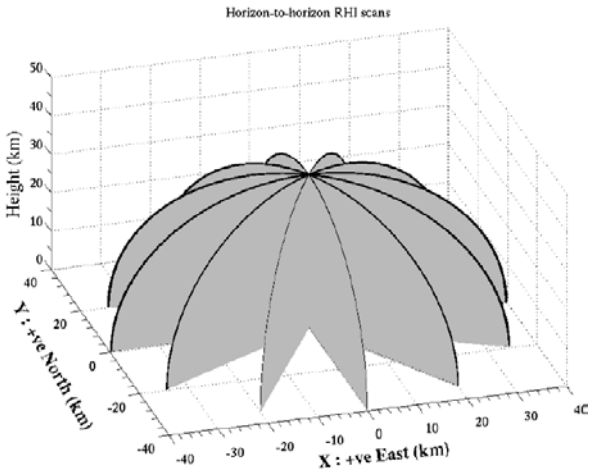




Scanning Cloud Radars: Ka, W, X
Stage 2, Gridded Radar Observations

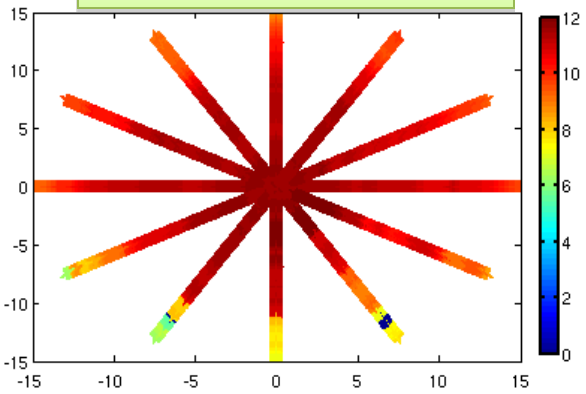


HS-RHI Gridding

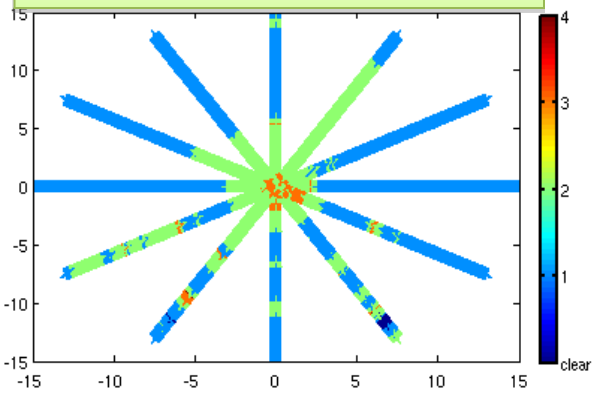


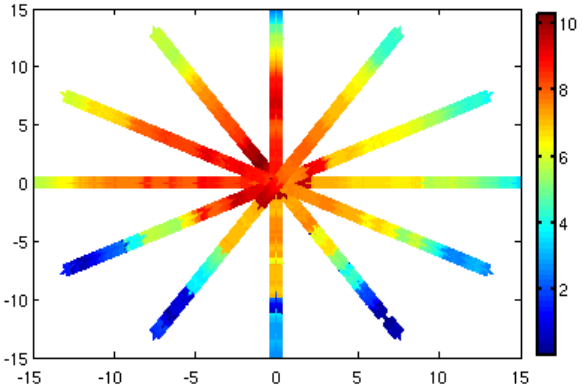
Repeat scan sequence every 30 minutes

Cloud Tops

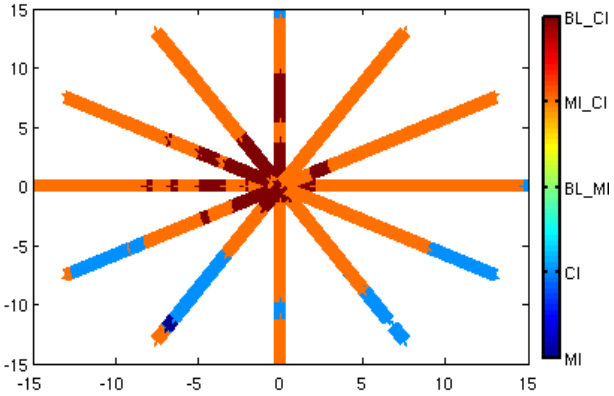


Number of Cloud Layers





Max. Cloud Thickness

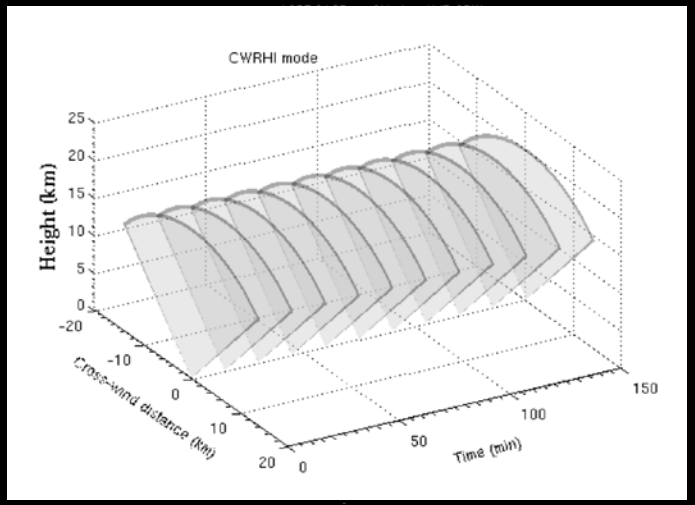


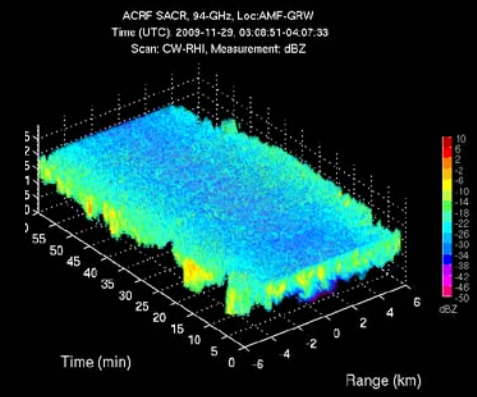
Cloud Type

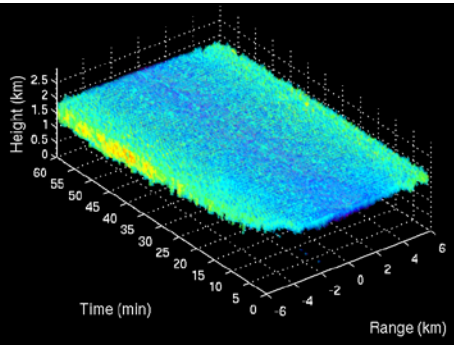
McGill

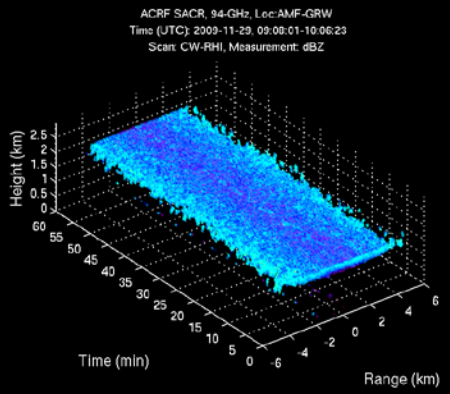
3D cloud field: Diurnal evolution from the CW-RHI mode

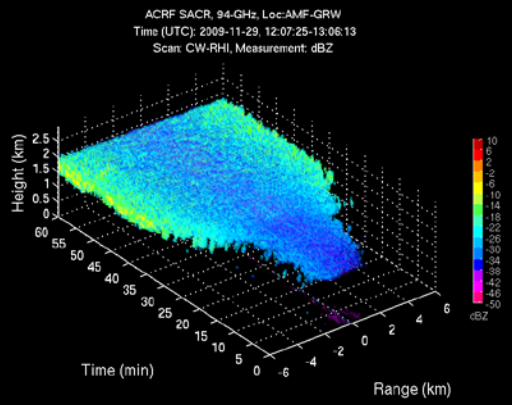
Azores

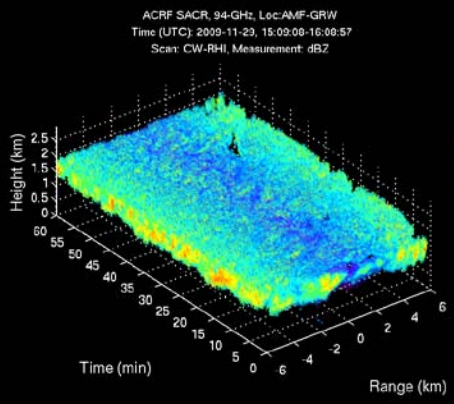


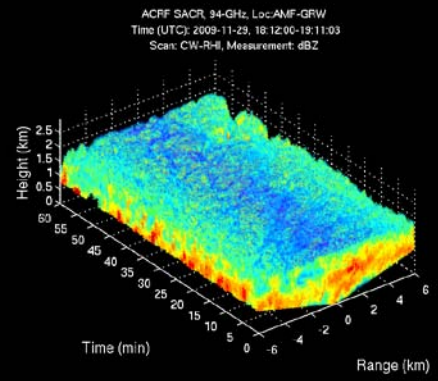


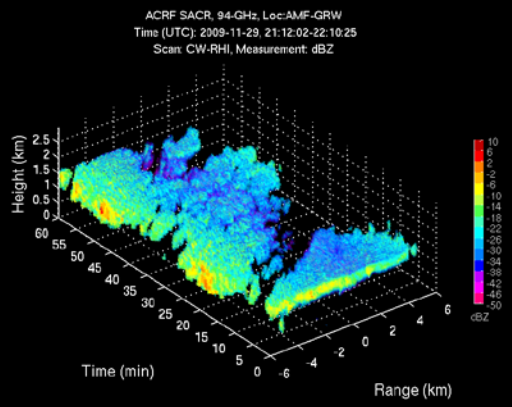








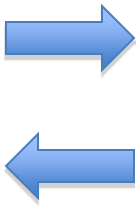




Scanning Cloud Radars: Ka, W, X

Stage 3, Higher-order multi-synergetic products

Use of ARM "multi-synergetic soda-straw" measurements in training radar-based algorithms to apply with 3D-radar observations



Use of scanning cloud radar observations (e.g., polarimetric) to improve cloud retrievals in the ARM column

Examples of SACR's multi-parametric observations that can be used for cloud and drizzle retrievals:

- Derive hydrometeor phase and shape information using polarimetric radar observations (Sekelsky and McIntosh, 1996)

- Extract cloud LWC using of 35/95-GHz dual-radar reflectivity ratio under Rayleigh scattering conditions for both radars (Huang et al., 2009)

- Extract size parameter information using 35/95-Ghz radar reflectivity ratio under non-Rayleigh 95 GHz scattering conditions (Giangrande et al., 2010)

- Derive cloud turbulence information using 35-GHz Doppler observations

Projection: SACR – Algorithm Development Roadmap

Algorithm reference number	Algorithm Name	Maturity	Importance	Number of months
	Milestones Algorithm Development >>			
	K-band (35-GHz)			
K-001	Significant detection mask	Mature	Mandatory	24
K-002	Water-vapor attenuation correction	Mature	Mandatory	24
K-003	Velocity Unfolding	Mature	Mandatory	24
K-004	3D-ARSCL	Novel	Mandatory	24
K-005	Visualization	Novel	Mandatory	24
	W-band (94-GHz)			
W-001	Significant detection mask	Mature	Mandatory	24
W-002	Water vapor attenuation correction	Mature	Mandatory	24
W-003	Velocity unfolding	Mature	Mandatory	24
W-004	3D-ARSCL	Novel	Mandatory	24
W-005	Visualization	Novel	Mandatory	24
	X-band (9.4-GHz)			
M-001	Significant detection mask	Mature	Mandatory	24
M-002	Rain Attenuation correction	Novel	Mandatory	24
M-003	Velocity unfolding	Mature	Mandatory	24
M-004	3D-ARSCL	Novel	Mandatory	24
M-005	Visualization	Novel	Mandatory	24
	Synergetic Algorithms (W/K and X/K)			
S-001	Significant detection mask	Novel	Important	22
S-002	Velocity unfolding	Mature	Important	22
S-003	3D-ARSCL	Experimental	Important	22
S-004	Visualization	Experimental	Important	22