**Improvements to ARM’s Widely-Millimeter Wavelength Radar Product**

The ARSCL VAP

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15+ Years of Cloud Radar Products: The ARSCL VAPs

The ARSCL VAPs has historically converted ARM’s 350Hz MMWR observations, combined with microwave and cloud measurements, into

- Best-estimate Cloudbase
- Cloud (hydrometeor) Boundaries
- Best-Estimate Reflectivities, Vertical Velocities, and Spectral Widths

A similar product exists for deployments of the first ARM Mobile Facility (AMF1), the WACR-ARSCL, based on the 95 GHz W-band ARM Cloud Radar (WACR).

Recent work focuses on the potential for including vertical profile measurements from the 95 GHz Wind Profiler, in addition to the ARSCL product (see below).

**KAZR-ARSCL VAP**

Currently an Evaluation Product

Stage 1: Corrected Moments

Examples of KAZR-ARSCL Products

Stage 2: Merged Instruments

**KAZR-ARSCL**

In 2011, the ARM’s MMCRs were upgraded to become the Ka-band ARM Zenith Radars, or KAZRs (see box, far right) and a complete overhaul of the ARSCL VAP was done. (See details, right). Improvements include:

- Fully automated processing
- Higher temporal and spatial resolution
- Improved velocity dealiasing
- Gaseous attenuation correction
- LIDAR-based ice detection

**KAZR-ARSCL plus 915 MHz Profiler?**

Recent work focuses on the potential for including vertical profile measurements from the 915 MHz Wind Profiler, in addition to the UAZR (see box far right) to further enhance the KAZR-ARSCL product (see below).

**Relative KAZR Calibration**

Starting from a KAZR-ARSCL reflectivity field corrected for gaseous attenuation, one can selectively identify suitable in-cloud areas where intrinsic KAZR and UAZR reflectivity factors are expected to match (for example, see below, near the base of anvil cloud regions labeled “0” and “1”).

As a complement to absolute calibration measures (e.g., corner reflector), the bottom panel illustrates KAZR-ARSCL reactivity after addition of a relative 10 dB calibration correction offset that was identified from the analysis of KAZR and UAZR data from the MCRE campaign.

**KAZR-ARSCL + UAZR / Disdrometer**

Potential to Enhance the KAZR-ARSCL Product

Research is underway to reconcile and merge KAZR-ARSCL products with colocated UAZR and Ioss-Waldvogel impact disdrometer measurements during the Spring 2011 Midlatitude Continental Convective Clouds Experiment, M3C1, at the SGP site. Results show that there is significant value to be gained by routinely colocating the UAZR with KAZR in ARM deployments. The combination can provide the following value to the existing KAZR-ARSCL VAP:

- Measure higher reflectivities in the presence of KAZR saturation in rain
- Higher unambiguous velocity (up to 20 m/s vs. 6.0 m/s for KAZR), of interest through deep convective storms
- Supply a measurement that does not appreciably attenuate in precipitation
- Provide an additional relative calibration source / reference for KAZR

**Attenuation and Wet Radome Correction**

Assuming a well-calibrated KAZR system, one can propose further relative corrections for the 2 offsets associated with coupled attenuation in rain and wet radome effects. Within stratiform regions in particular, e.g., those having a well-defined bright band and more homogeneous rain conditions (see region “2” in the images at left), it may be safe to apply standard linear attenuation correction relationships as a function of surface (disdrometer) rainfall rate (e.g., Matsui 2005). Similarly, “transitional” regions at the periphery of convection may also be viable targets, with a correction extending up to an average bright band height estimate.

**Merged KAZR-ARSCL / UAZR**

An eventual goal is a merged KAZR-ARSCL and UAZR reflectivity product providing continuous temporal coverage for the column of clouds and precipitation. These merged fields can provide the foundation for subsequent products including column cloud and echo classification, velocity and latent heat profile retrievals.

**Summary**

The ARSCL family of VAPs is being extended and improved with the new KAZR-ARSCL VAP, currently available as an ARM Evaluation product at:

http://www.arm.gov/data/eval/kazr

Research suggests that use of data from a colocated UHF ARM Zenith Radar / Disdrometer has the potential to significantly enhance the product.

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