Improvements to ARM's Widely-used Millimeter Wavelength Radar Product
The ARSCL VAP

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15+ Years of Cloud Radar Products:

The ARSCL VAPs

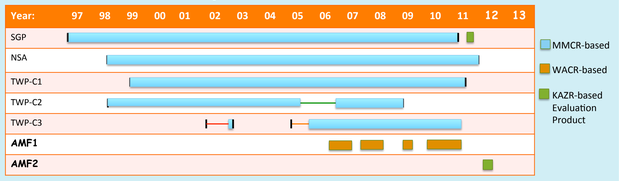
Active Remote Sensing of CLouds Value-Added Products

The **Active Remote Sensing of CLouds Value-Added Product**, or **ARSCL VAP**, has historically converted ARM's 35GHz Millimeter Cloud Radar (MMCR) observations, combined with Micropulse Lidar and Ceilometer 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 VAP**, based on the 95 GHz W-band ARM Cloud Radar (WACR).

Availability of ARSCL Products



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
- LDR-based insect detection

KAZR-ARSCL, plus 915 MHz Profiler?

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

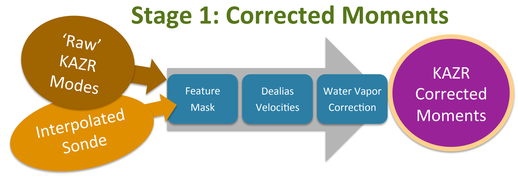
KAZR-ARSCL

+ UAZR

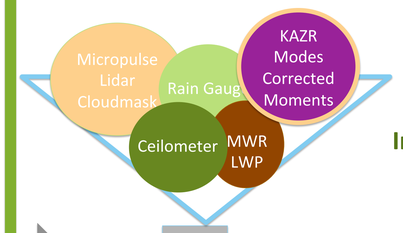
KAZR-ARSCL VAP

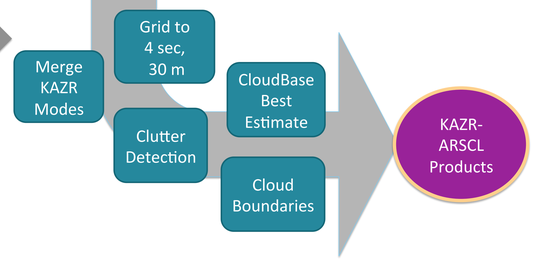
Currently an Evaluation Product

Stage 1: Corrected Moments



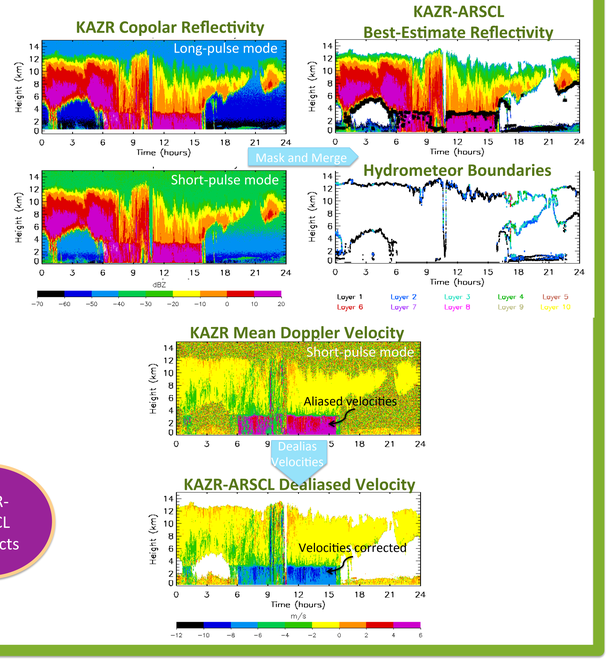
Stage 2: Merged Instruments





Examples of KAZR-ARSCL Products

SGP 2011.05.20



ARM's Newest Profiling Radars:

KAZR, UAZR

KAZR: Ka-band ARM Zenith Radar

The vertically-pointing KAZRs are a major upgrade from ARM's long running MMCR radars. The KAZRs provide fully digital generation and control of transmit signals. The radars have higher sensitivity with fewer contaminating artifacts. The dual-polarization KAZRs currently run two modes simultaneously, a short-pulse 'General' mode and a long-pulse mode with enhanced sensitivity. Calibration is facilitated with additional environmental and power monitors and temperature controls. ARM continuously operates KAZRs at four fixed sites: Southern Great Plains (SGP), North Slope of Alaska (NSA), and two Tropical Western Pacific sites. KAZR is also deployed as part of the ARM Second Mobile Facility, currently aboard ship as part of the MAGIC deployment.

915 Wind Profiler (a.k.a 'UAZR')

The ARM Program's 915 Radar Wind Profilers have recently been reconfigured to add modes at vertical incidence, sampling profiles up to 15 km in height. In zenith mode, the radars are sometimes referred to informally as UHF ARM Zenith Radars, or UAZRs. They have 9° beamwidths, 200 m gate spacing and time resolution of 5 s. The two alternating zenith modes differ in pulse length, Nyquist velocity and maximum range.

KAZR-ARSCL + UAZR / Disdrometer

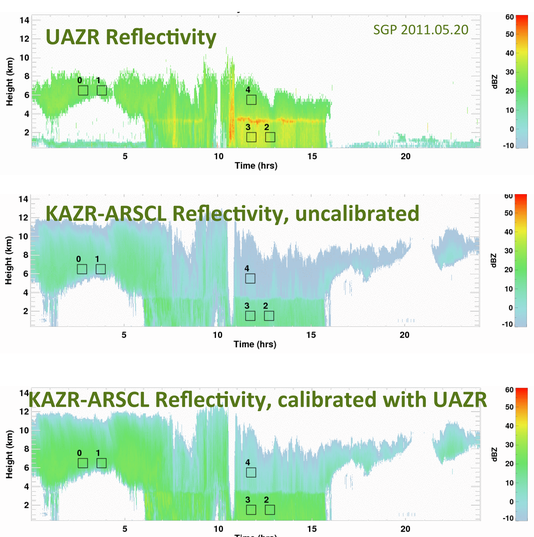
Potential to Enhance the KAZR-ARSCL Product

Research is underway to reconcile and merge KAZR-ARSCL products with collocated UAZR and Joss-Waldvogel impact disdrometer measurements during the Spring 2011 Mid-latitude Continental Convective Clouds Experiment, MC3E, at the SGP site. Results show that there is significant value to be gained by routinely collocating the UAZR with KAZR in ARM deployments. The UAZR/Disdrometer 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

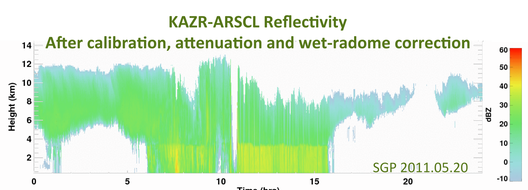
Relative KAZR Calibration

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 reflectivity after addition of a relative 10 dBZ calibration correction offset that was identified from the analysis of KAZR and UAZR data from the MC3E campaign.

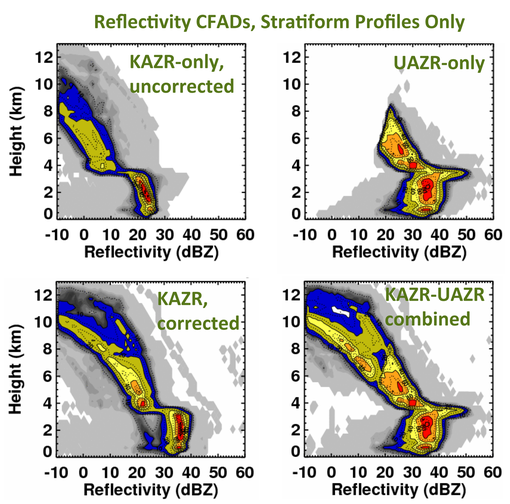


Attenuation and Wet Radome Correction

Assuming a well-calibrated KAZR system, one can propose further relative corrections for the Z 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., Matrosov 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.



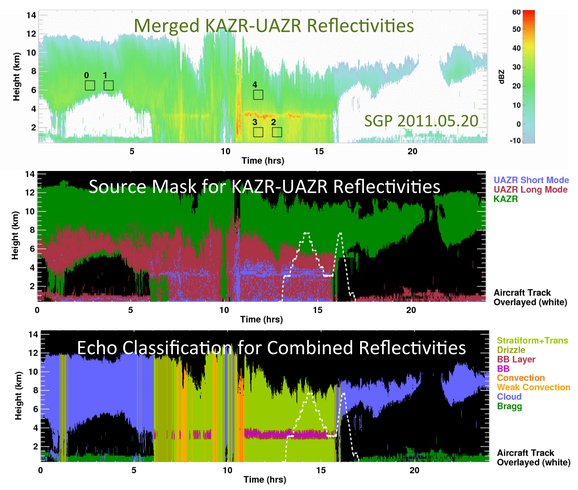
Once attenuation in rain is estimated below the freezing level, remaining KAZR to UAZR reflectivity offsets within rain or ice regions may be considered. The residual offsets are largely attributed to a KAZR 'wet radome' effect that fluctuates during significant precipitation events. Here, the combined contribution for these effects may be determined on a profile-by-profile basis. Assuming standard attenuation-in-rain corrections in stratiform regions are reasonable, initial test cases indicate the magnitude of wet radome effects during MC3E to be on the order of 10 dBZ.



The CFADS are normalized by the pixel, within the grid with the highest count. That pixel would have a density of 100%. Solid, filled contours are at >0%, 10%, 20%, 40%, 60% and 80% of the maximum count; dotted contours are at 5%, 15%, 30%, 50%, 75% and 90%; a solid line contour is at 95%.

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/61

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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