FAst-physics System TEstbed and Research Project (FASTER)

Dual Frequency Convective-Stratiform Precipitation and Vertical Velocity Product

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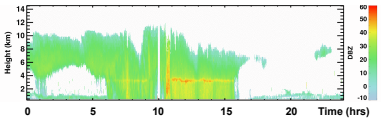
Summary: A dual frequency convective-stratiform rain classification and vertical velocity product has been developed, utilizing observations from the Ka-band ARM Zenith Radar (KAZR) and the UHF ARM Zenith Radar (UAZR) at SGP, for MC3E (2011).

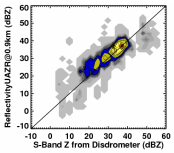
I. Calibrate, Correct and Combine UAZR, KAZR-ARSCL and JWD Disdrometer:

Ka-band ARM Zenith Radar (KAZR-ARSCL) and UHF ARM Zenith Radar (UAZR) observations from the 2011 Midlatitude Continental Convective Clouds Experiment (MC3E) are constrained with JWD impact disdrometer measurements, and integrated to exploit their unique sensitivities.

The locations of the instruments are not precisely the same, and each has a different field of view, resulting in inherent uncertainties. The example here is for the May 20, 2011 event, although our methods were used uniformly over all MC3E events.

UAZR: Calibrated Reflectivity

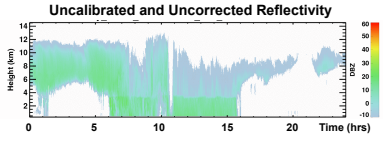


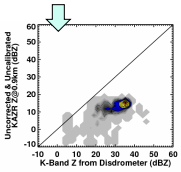


1. UAZR near-surface reflectivity is well-correlated with S-band surface reflectivity calculated from disdrometer measurements

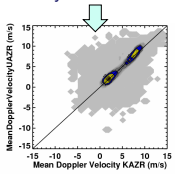
2. KAZR-ARSCL reflectivity, out of the box, is not well-correlated with K-band reflectivity calculated from disdrometer measurements

KAZR-ARSCL: Uncalibrated and Uncorrected Reflectivity

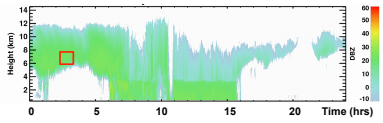




3. KAZR-ARSCL and UAZR Mean Doppler Velocity correlate well



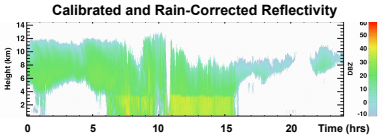
KAZR-ARSCL: Calibrated but Uncorrected Reflectivity

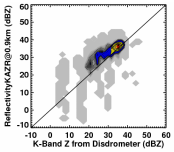


4. Upon comparison of UAZR and KAZR anvil, non-precipitating regions of reflectivity, we estimate initial KAZR offsets to be approximately 10 DBZ too low during MC3E. Application of a 10 DBZ offset produces the reflectivity field at left.

5. Correct KAZR for rain attenuation: *α*[rain rate]*[km in rain],* where, α=0.5 [Matrosov, 2005]

KAZR-ARSCL: Calibrated and Rain-Corrected Reflectivity



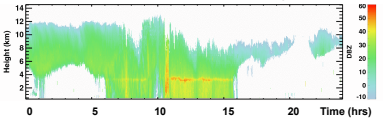


6. Correct for and quantify wet radome attenuation on a profile-by-profile basis: ~10 DBZ

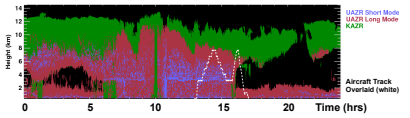
7. Correct for and quantify, preliminarily, uncertainty attributed to inner melting layer attenuation and scattering effects

8. Combine UAZR and KAZR

KAZR-ARSCL + UAZR: Final Combined Reflectivity

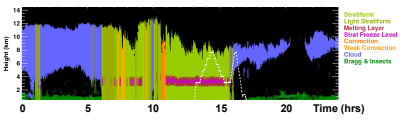


Radar Selection Mask

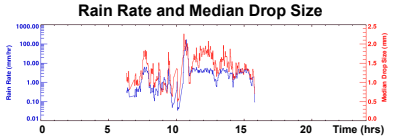


9. Classify echo according to precipitation type

Echo Classification Mask



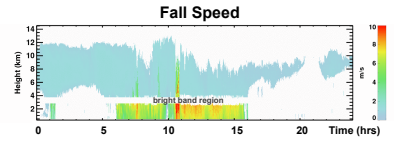
Rain Rate and Median Drop Size



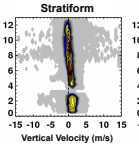
II. First Products:

Fall speed and Vertical Velocity are estimated for rain, cloud ice (for a variety of crystal habits), and convective cores

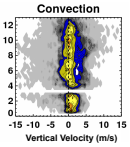
Fall Speed



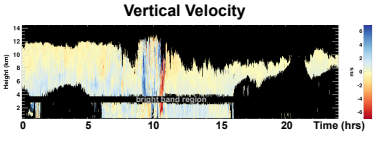
Stratiform



Convection

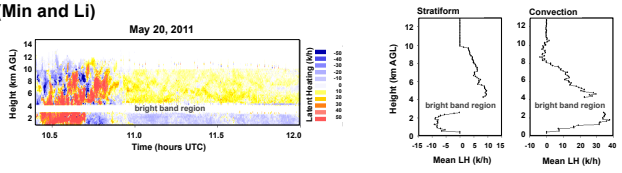


Vertical Velocity

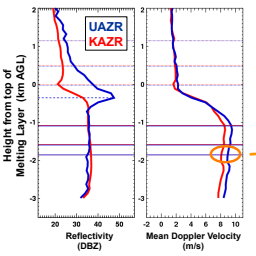


III. Future Directions:

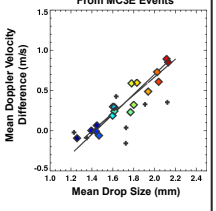
- **Estimation of latent heating profiles based on vertical velocity retrievals (Min and Li)**



- **In Stratiform: Connect properties of vertical radar profiles to column (ice, rain) and surface precipitation conditions (Giangrande, Toto, Dong, Tian)**

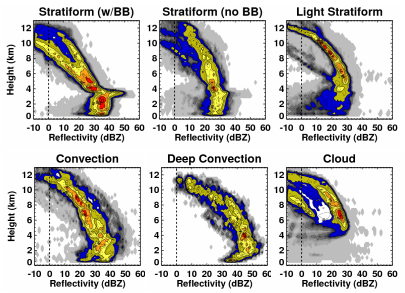


Mean Stratiform Profiles Filtered by Surface Reflectivity And Mean Drop Size From MC3E Events



- **Pairing UAZR/KAZR observations with in-situ microphysical properties**

Combined Reflectivity CFADS



Notes on frequency of occurrence plots:

The frequency of occurrence plots are normalized by the pixel, within the grid, with the highest count. That pixel would have a density of 100%.

>0-10%
>10-20%
>20-40%
>40-60%
>60-80%
>80%

References:

Giangrande, Scott E., Scott Collis, Jerry Straka, Alain Protat, Christopher Williams, Steven Krueger, 2013: A Summary of Convective-Core Vertical Velocity Properties Using ARM UHF Wind Profilers in Oklahoma. *J. Appl. Meteor. Climatol., 52,2278–2295.*

Matrosov, S. Y. (2005), Attenuation-based estimates of rainfall rates aloft with vertically-pointing Ka-band radars, J. Atmos. Oceanic Technol., 22, 43–54.

For more information, to download data, and to see quicklooks: