# Diagnosing Raindrop Breakup and Coalescence from UAZR and KAZR Observations


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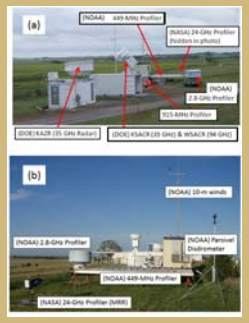
Williams, C.R., R.M. Beauchamp, and V. Chandrasekar, 2016: Vertical air motions and raindrop size distributions estimated using mean Doppler velocity difference from 3- and 35-GHz vertically pointing radars. *IEEE Trans. on Geoscience and Remote Sensing*, **54**, October 2016.


## 1. Motivation

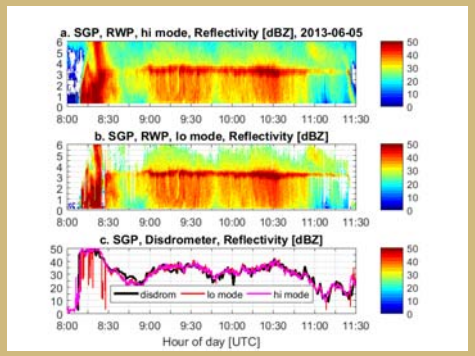
Microphysical processes act on the distribution of falling raindrops such that evaporation and accretion modify the total liquid mass while breakup and coalescence modify how that liquid is distributed between different sized raindrops.



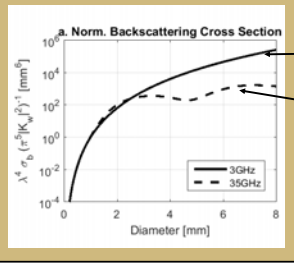

This study uses the 915 MHz radar wind profiler (UAZR) and the Ka-band ARM Zenith Radar (KAZR) observations to first retrieve raindrop size distributions (DSDs) and vertical air motions. Then, these retrievals are used with Vertical Decomposition Diagrams to diagnose evaporation / accretion processes and breakup / coalescence processes.

## 2. Observations

915-MHz profiler was calibrated using surface disdrometer.



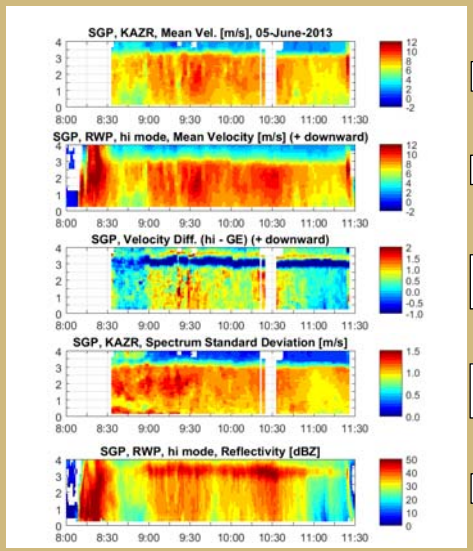

When large rain drops are present (larger than 3 mm), the 915-MHz profiler and KAZR will have different measured radial velocities due to Mie scattering.




Rayleigh Scattering

Mie Scattering

## 3. Sample Event: 5-June-2013




KAZR Velocity

UAZR Velocity

Velocity Difference (UAZR – KAZR)

KAZR Spectrum Breadth

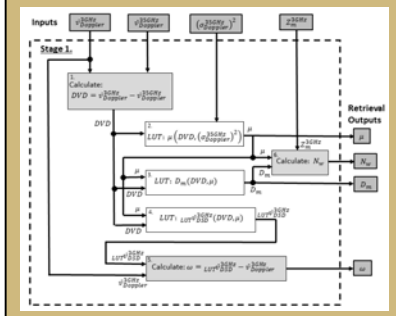
UAZR Reflectivity

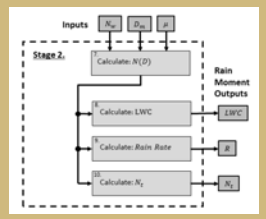
Four radar moments are used to estimate four parameters:

KAZR velocity
UAZR velocity
KAZR spectrum breadth
UAZR reflectivity

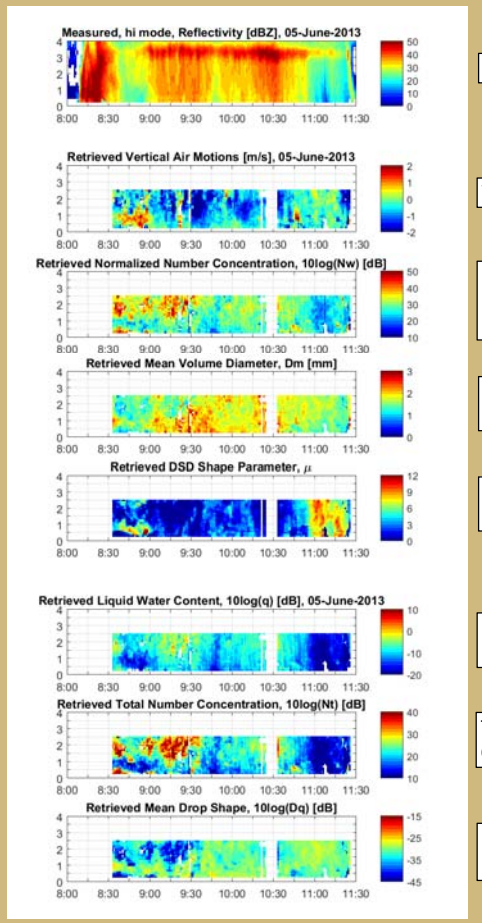
→

Vertical air motion
3-parameters of a gamma raindrop size distribution ($N_w$, $D_m$, $\mu$)




## 4. Retrievals




Reflectivity

Vertical Air Motion

Normalized Number Concentration

Mean Volume Diameter

Gamma Shape Parameter

Liquid Water Content, $q^{dB}$

Total Number Concentration, $N_t^{dB}$

Mean Drop Shape, $D_q^{dB}$

## 5. Concluding Remarks

- By exploiting differences in Rayleigh and Mie scattering of two side-by-side vertically pointing radars, can retrieve vertical air motions and rain drop size distributions.
- Currently processing all UAZR and KAZR rain events at Southern Great Plains (SGP) from 2011-2016.
- Expressing rain parameters in logarithm units enables diagnosing processes in the vertical column:
  Changes in $q^{dB}$ indicate: **evaporation** or **accretion**
  Changes in $N_t^{dB}$ & $D_q^{dB}$ indicate: **breakup** or **coalescence**

## 6. References


More detail of this work is available in peer-reviewed publications:

Williams, C.R., R.M. Beauchamp, and V. Chandrasekar, 2016: Vertical air motions and raindrop size distributions estimated using mean Doppler velocity difference from 3- and 35-GHz vertically pointing radars. *IEEE Trans. on Geoscience and Remote Sensing*, **54**, October 2016.

Williams, C.R., 2016: Reflectivity and liquid water content vertical decomposition diagrams to diagnose vertical evolution of raindrop size distributions. *J. Atmos. Oceanic Technol.*, **33**, 579-595.