6A.2 INTERCOMPARISON OF POLARIMETRIC RADAR, PROFILER AND DISDROMETER OBSERVATIONS OFTROPICAL PRECIPITATION DURING CAMEX-4/KAMP

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INTRODUCTION

Many attempts have been made since the Marshall-Palmer (MP) Z-R relationship in 1948 to improve the ability to estimate rainfall with weather radar. Efforts to refine the single parameter MP formulation are near exhaustive. Recent technological advances have increased the quality and availability of polarimetric radar observations, opening up a new vista in radar rainfall estimation. Multi-parameter polarimetric observations allow constraints in rainfall estimation to account for the natural variability of rain drop size and shape. Rainfall estimations utilizing specific differential phase (K_{dp}) are advantageous because they are not dependent upon radar calibration, rain attenuation or partial beam blockage. The first part of this paper will discuss comparison of multi-parameter rainfall estimation methods utilizing X-band polarimetric radar (X-POL) observables with rainfall estimates from a 915 MHz wind profiler and measurements from a Joss-Waldvogel Impact Disdrometer (JWD). A benefit to using X-band observations is the enhanced sensitivity to light rainfall compared to the longer wavelengths of C- and S-band.

The raindrop size distribution is a fundamental quantity to describe the cloud microphysical and dynamical processes in rain. The variability of the drop size distribution in different precipitation regions is not well known. The accurate measurement of the rain drop size distribution is very important for the improvement of radar estimates of rainfall intensities and for understanding the microphysical processes in precipitation. Disdrometers provide a representative sample of the DSD at the surface. However, to understand the vertical structure and evolution of precipitation, other instruments, such as profilers and polarimetric radars, are necessary. The second part of this paper will describe DSD retrievals from 1) polarimetric radar information and 2) profiler doppler spectra. Retrievals near the surface will be compared with DSDs from the disdrometer.

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EXPERIMENTAL SETUP

The Keys Area Microphysics Project (KAMP) was conducted from 15 August to 28 September 2001 as part of NASA's Fourth Convection and Moisture Experiment. The instrumental layout is described in Tokay et al. (2003). Througout the study, the Mobile Integrated Profiling System (MIPS, described at http://vortex.nsstc.uah.edu/mips) was collocated with a JWD and multiple rain gauges approximately 5.57 km from X-POL at 274 degrees azimuth. Coordinated RHIs from X-POL provided reliable polarimetric data up to 4 km over the profiler site.

The case analyzed in this paper is from 10 September 2001 between 1730 and 2000 UTC. On this date, a tropical MCS developed from a low associated with the development of Tropical Storm Gabrielle to the northwest of both the X-POL and profiler locations and moved toward the southeast. As the system passed, weak convective elements were observed, followed by variable stratiform precipitation.

PRELIMINARY WORK

Initially, the disdrometer was used to calibrate the profiler reflectivity as described in Gage et al. (2000). Figure 1 shows a time series plot of disdrometer and calibrated profiler reflectivity (112 m AGL). There is good agreement between the two instruments during heavier stratiform rain between 1837 and 1910 UTC.

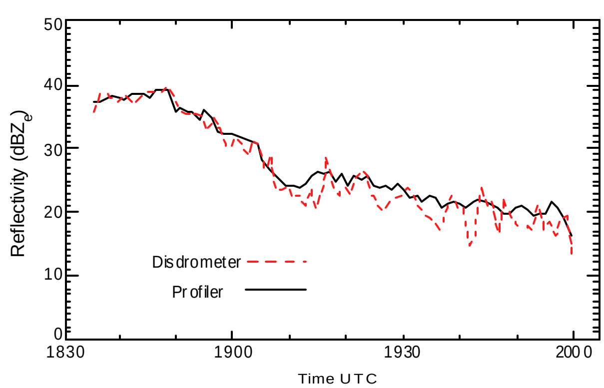

Figure 1. Time series plot of disdrometer and profiler reflectivity during stratiform rain.

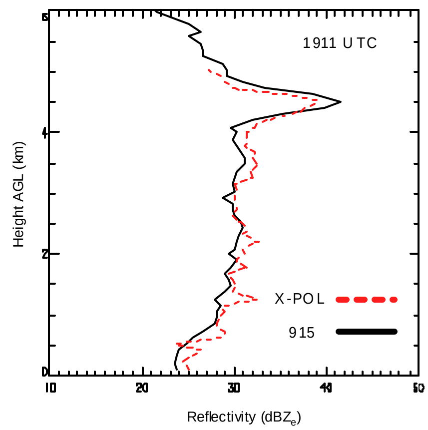

Figure2. Profiler and matched X-POL reflectivity profiles for 1911 UTC.

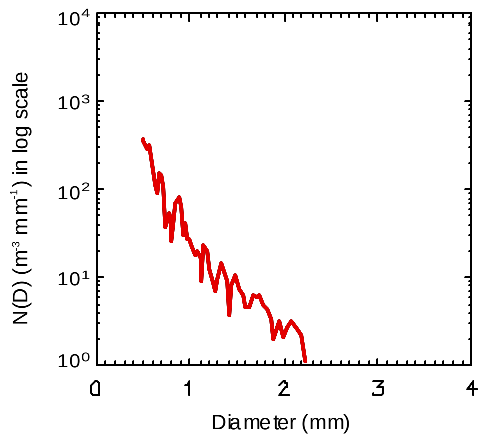

Figure 3. DSD retrieved from profiler using integrated moment SAM model. Observation is from 1911 UTC at 3473 m AGL.

Next, the profiler was matched with X-POL profiles that were coincident with the profiler beam. Figure 2 shows profiles of reflectivity from the profiler and X-POL at 1911 UTC. X-POL reflectivity is 1-2 dB higher than the profiler. More work will be done to determine the reason for this discrepency.

RAIN RATE ESTIMATION

The relatinship between reflectivity and rainfall rate can be expressed as

$$Z = AR^B. \quad (1)$$

For this event, it was determined from disdrometer data that A and B are 262 and 1.45, respectively.

Using these values for A and B, rain rates were calculated from disdrometer reflectivity at the surface and profiler and XPOL reflectivities at 112 m AGL. Preliminary comparisons with rain gauge data, not shown here, demonstrate good agreement between the 4 sensors.

Polarimetric retrievals of rain rate, also not shown here, demonstrate varying levels of success. Methods utilizing K_{DP} did not perform well, especially in light precipitation. More work must be completed to determine the quality of K_{DP} measurements, and if these rainfall estimates can be improved.

Once the quality of surface rainfall rates has been maximized, vertcial profiles of rainfall rate will be estimated using both profiler and X-POL observations.

DSD RETRIEVAL

DSDs are directly measured from JWD measurements. In this study, DSDs will be retrieved and compared from both the profiler and the X-POL. DSDs from profiler measurements will be obtained using 1) the integrated moment sans air motion (SAM) model and 2) the spectral SAM model, both described in Williams (2002). The spectral SAM model provides the added benefit of estimating vertical air motion. Figure 3 shows an example DSD using the integrated moment SAM model.

DSDs will be retrieved from polarimetric radar observations using techniques described in Gorgucci et al. (2002). This technique utilizes Z_e, Z_{DR} and K_{DP} to estimate D_o and N_w and parameterize μ.

FUTURE WORK

Upon completion of the tasks already mentioned in this paper, we will attempt to extend the DSD retrievals to ice regions of precipitating systems. In particular, we plan to use profiler measurements and retrievals to help understand the microphysical processes occuring in landfalling hurricanes. This information will also provide insight on the behavior and characteristics of the bright band region.

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Acknowledgements. This research was supported by the National Aeronautics and Space Administration under grant NCC8-200. Program manager for the NASA CAMEX-4 project was Dr. Ramesh Kakar.