Comparison of Two X-Band Polarimetric Drop Size Distribution Retrievals: Evaluation and Applications

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Motivation:

Ground validation of useful rain retrievals and cloud resolving model parameterizations.
Physical validation of radar/radiometric measurements and cloud model simulations of stratiform and convective precipitation.
Support data needs for small scale basins and urban catchments.

What do we need:

Accurate evaluation of rain rates at high spatial and temporal resolution and of the hydrometeors’ size distribution and phase.

Our research questions:

How accurate X-Band Dual-Polarization Radar Rainfall Observations can be in estimating rainfall drop size distribution (DSD) parameters at high resolutions?

Systems Overview:

**XPOL:**
- 9.375 GHz at 50/25/15 km peak power;
- 0.9 deg beam width; variable pulse length (40–300 ms);
- 200 km max range with ~400m resolution, 550 gates and 940 Hz PRF;
- Horizontal and Vertical Polarization;
- 1.5 deg beam width; pulse length 0.5µs;
- 80 km observation range;
- 2.3 dB Noise Figure;
- -10 dBm minimum detectable signal;

**MP-X:**
- 9.375 GHz at 50/25/15 km peak power;
- Horizontal and Vertical Polarization;
- 1.3 deg beam width; pulse length 0.5µs;
- 80 km max range with ~400m resolution, 550 gates and 940 Hz PRF;
- Horizontal and Vertical Polarization;
- 1.4 deg beam width; pulse length 0.5µs;
- 50 km observation range;
- 2.3 dB Noise Figure;
- -10 dBm minimum detectable signal;

Algorithm Formulation:

\[ N(D) = N_0 D^3 \exp(-AD) \]
\[ \Delta D = 3.67 + \mu \]

Gamma distribution model (Ulbrich, 1983):

\[ N(D) = N_0 (D/\mu)^{\gamma} \exp(-D/\mu) \]
\[ \gamma = (3.67 + \mu)/\mu \]

DSD parameter retrieval:

Once X-band data has been corrected for attenuation (Anagnostou et al. 2004; 2006, Matrosov et al. 2002; 2005, Park et al. 2005) it is possible to proceed with the estimation of the governing parameters (Nc, Dc) that control the gamma drop size distribution.

Algorithm Evaluation From Measured DSD Spectra

For the evaluation of the relations, disdrometer data from the Typhoon case in Japan are used. We compare the technique-retrieved DSD parameters, i.e., parameters retrieved from the simulated radar parameters using the two techniques, to those directly calculated from the measured raindrop spectra.

Conclusions and on-going research:

- We examined two well documented DSD retrieval algorithms that has been tested using observations from S and C-band frequencies; We reproduced the algorithm for X-band frequencies and we compared with unattenuated frequencies and in-suite JW disdrometers.
- From the analysis we concluded that the -beta method is more noise and unstable in low measurements exceed the thresholds of 0.2 (km-1) for KDP, and 35.0 (dBZ) and 0.2 (dB) for ZDR, respectively:
- For KDP < 0.2 (km-1) and ZDR > 35 dBZ and ZDR < 0.2 dB:
  - Dc = 1.38Nc (mm) \[ N_c = 18.87 \times \frac{Z_{DR}}{D_{c}} \]
  - ZDR > 35 dBZ and ZDR < 0.2 dB:
  - Dc = 4.40Nc \[ N_c = \left( \frac{Z_{DR}}{D_{c}} \right)^{0.47} \times 1.465 \]

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