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Testing a technique for retrieving the rain drop size distribution moments from X-Band polarimetric radar data during a warm rain event

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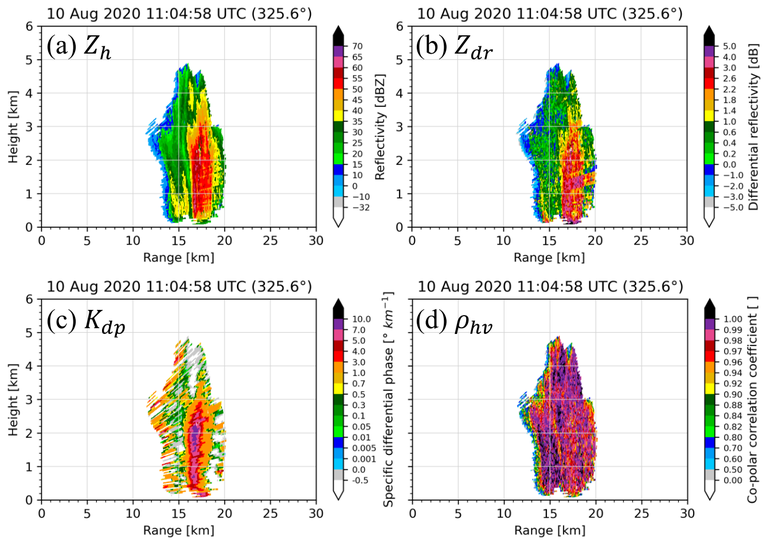
INTRODUCTION & AIM

- A method (Bringi et al., 2020) for retrieving the moments of rain drop size distributions (DSDs) from X-band polarimetric radars is tested using data from a warm rain event.
- The method had been previously tested for an event in Greeley, Colorado, USA, and had resulted in very encouraging results.
- Here we apply the same method to an isolated warm rain cell which occurred during the summer season of 2020 in Incheon, Republic of Korea.

DATA & METHOD



Z_h : Radar reflectivity

Z_{dr}: Differential reflectivity

K_{dp}: Specific differential propagation phase

ρ_{hv}: Specific attenuation

Fig. 1. RHI images (vertical scan through the warm rain cell) of (a) Z_h, (b) Z_{dr}, (c) K_{dp}, and (d) ρ_{hv} at 11:05 UTC, Aug 10, 2020.

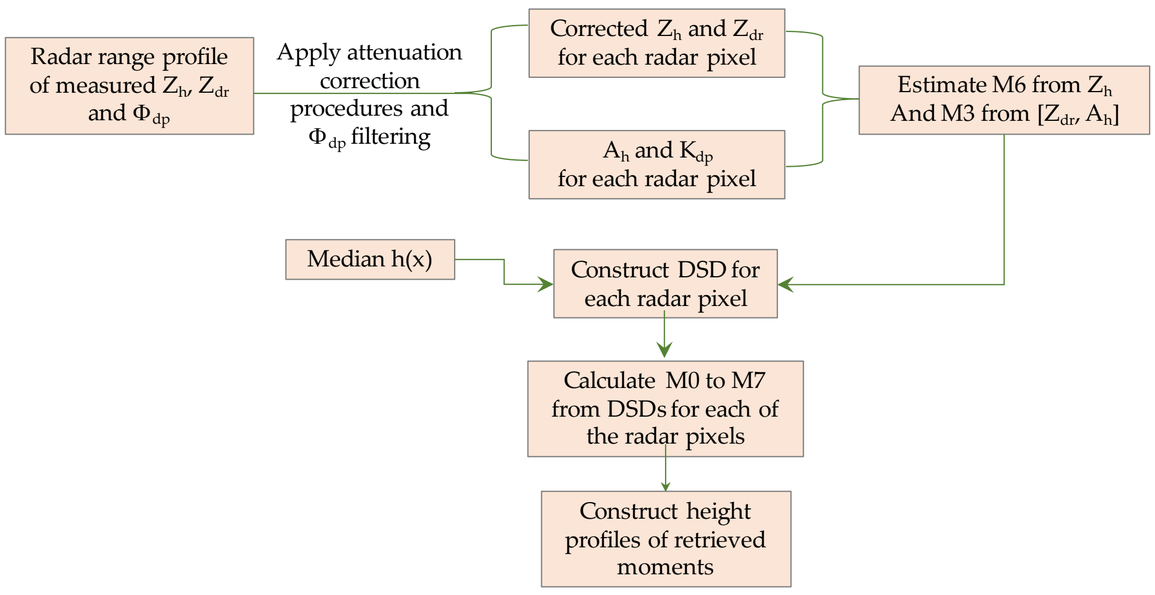


Fig. 2. The main steps involved in the retrieval method.
Mn: nth moment of the DSD
A_h: Specific attenuation

RESULTS & DISCUSSION

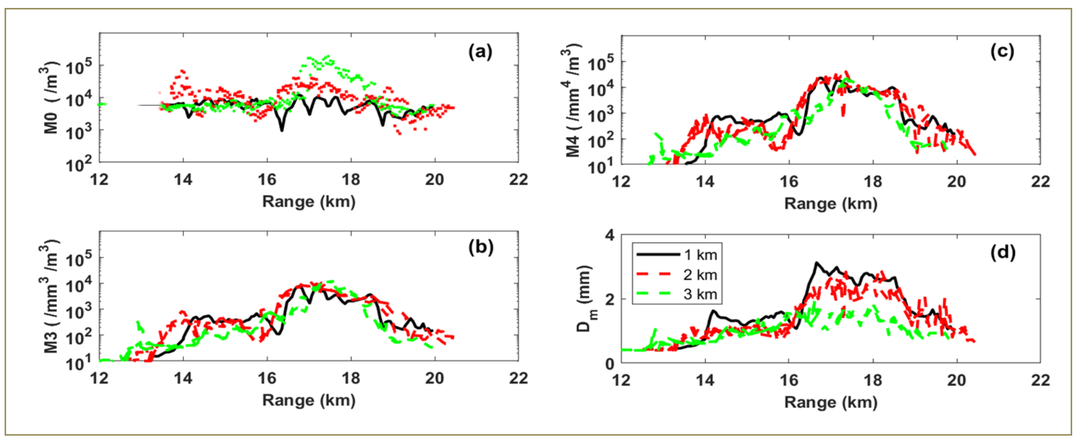


Fig. 3 Range profiles at various heights: (a) M_0, (b) M_3, (c) M_4, (d) D_m.

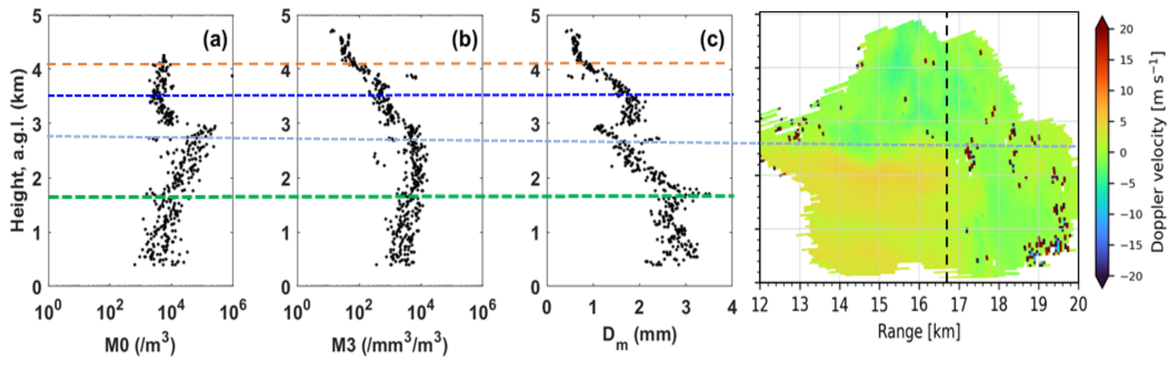


Fig. 4. Height variations of (a) M_0, (b) M_3, (c) D_m, and (d) Doppler mean velocity, height versus range of Doppler mean velocity.

- From ~4 km a.g.l. down to 3 km the dominant microphysical process was drop growth via water vapor condensation indicated by a steady increase in M_3 and D_m. This is consistent with the Global Energy and Water Exchanges (GEWEX) Process Evaluation Studies related to Warm Rain (PROES-WR) working group which states that the 'warm rain formation process generally starts with condensation, through which the particle size tends to increase with height from cloud base'.
- Around 3 km a.g.l., a sudden increase in M_0 and a sharp decrease in D_m strongly indicate the occurrence significant drop break-up in this region. This is consistent with the RHI plot of radial Doppler velocity which clearly shows a convergence region at the same location. Collision induced drop break-up is highly likely here.
- Well below the 3 km height, collision-coalescence mechanism appears to be the dominant process, at least down to 1.5 km height, indicated by a gradual decrease in the number of drops (M_0) and a corresponding increase in D_m, together with a stable M_3. This is also consistent with the GEWEX PROES-WR which states that 'Once the particles become large enough, the coalescence process begins. In that stage, the particles fall and further collide with and collect smaller droplets lying in their path'.
- The application of our retrieval method results in very plausible results in terms of the dominant microphysical processes associated with this warm rain event.

REFERENCE: V. Bringi, K. V. Mishra, M. Thurai, P. C. Kennedy, and T. H. Raupach, "Retrieval of lower-order moments of the drop size distribution using CSU-CHILL X-band polarimetric radar: A case study," Atmos. Meas. Tech., vol. 13, pp. 4727–4750, 2020.

Tribute: We wish to offer our deep gratitude to the late Professor V.N. Bringi for his guidance and inspirational discussions.