1.7 POLARIMETRIC RADAR RETRIEVALS OF LOWER ORDER DSD MOMENTS: CASE STUDIES USING CSU-CHILL RADAR

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Polarimetric radar-based retrieval of rain rate which is proportional approximately to the 3.67^{th} moment of the DSD ($M_{3.67}$) has now reached a mature stage with many operational systems at S-, C- , and X-bands. The retrieval of lower order moments (M_0-M_3) which are important in numerical modeling of collisional, break-up and evaporation processes has largely been neglected by the radar community as the radar observables are strongly dependent on the higher order moments ($M_{4.5}$-M_6). Most algorithms are based on the gamma DSD model with the shape parameter set a priori at $\mu \approx 3$ or empirical (μ-Λ) polynomials based on disdrometer data (Parsivel, 2DVD or Joss) which due to resolution or sensitivity issues cannot measure the concentration of the small drops (D<0.5-0.7 mm) which control the lower order moments. Thus, the basis for comparing or evaluating microphysical schemes that predict M0 and M3 with radar retrievals needs more research, leading the way to data assimilation in numerical models in the future.

In this study we use and extend the approach of Raupach and Berne (Atmos. Meas. Tech., 10, 2017) to retrieve the lower order moments. The method developed at X-band uses the double-moment normalization of the DSD using two reference moments [M_3 and M_6] along with the intrinsic shape h(x) where x=D/(M_{63})1/3 and M_{63}=M_6/M_3. The h(x) is assumed to be generalized gamma (GG) with two shape parameters (μ,c). The M6 is retrieved using radar Zh whereas M3 is retrieved using [Zdr, Kdp] with (μ,c) based on average h(x) assumed to be "stable". Essentially, the DSD variability with rain rate for example, is attributed mostly to variability in [M_3,M_6] and much less due to h(x) deviating from its stable shape. The caveat is that h(x) be measured over the entire size range from drizzle sizes (0.1-0.7 mm) to maximum drop sizes (<8 mm) which cannot be done with a single disdrometer. Once [M_3,M_6] are retrieved the lower order moments are derived as power laws of [M_3,M_6] with (μ,c) based on theoretical GG DSD model.

We use the CSU-CHILL radar which is a dual-band system (S/X) and collocated high resolution (50 microns) Meteorological Particle Spectrometer and moderate resolution (170 microns) 2D-video disdrometer located at 13 km range. This combination of disdrometers accurately measures both the small and large drop ends as well as the frequently-observed plateau region in between. We propose to use the X-band measured [Z_h,Z_{dr},Kdp], as well as S-band [Z_h,Z_{dr}] and X-band [K_{dp}] with the dual-band method chosen to avoid attenuation-correction uncertainties, especially for two convective events chosen as case-studies (23 May 2015 multi-cell storm with >55 dBZ echoes and 19 August 2015 which was a combination of stratiform rain and rain showers).