Estimation of raindrop drop size distributions and their vertical profile using ground based disdrometer and FMCW vertically pointing radar

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An experimental setup composed of one or more disdrometers at ground and the profilers has been adopted in several field experiments conducted within the Ground Validation programme of the NASAA/JAXA Global Precipitation Measurement (GPM) mission in several climate regions of the Earth. A typical implementation of this scheme consists of a pair of K-band vertically pointing micro rain radar (MRR) and a 2D video disdrometer installed close each other [1]. Among DSD measurements collected by ground based disdrometers with different measurement principles, those form 2DVD are considered to be more accurate within all the typical sizes of drops and are frequently exploited for DSD studies. Since 2DVD estimates are referred to the ground level, the co-located profiling instrument is supposed to provide complementary DSD measurements referred at different heights of the rain "column" above. MRR is an affordable continuous wave frequency-modulated radar (CWFM) typically used at vertical incidence. In the configuration used, DSD profiles are estimated from Doppler spectra determined by drops falling at different velocities and at different heights from almost ground level to 1000 meters with a height resolution of 35 meters and time resolution up to 10 seconds [2]. Importance of these measurements is related to the influence of vertical gradients within measurements cells of rain and microphysics retrievals based remote sensing instruments such as the dual frequency radar of GPM and ground based weather radars [3]. However, MRR standard processing is based on several assumptions that, along with some characteristics of the implementation of the Continuous Wave Frequency modulated scheme such as spectra aliasing and height-Doppler ambiguity, limit the usefulness of this instrument for heavy precipitations or in convection [4]. Using disdrometer measurements as a reference, a critical assessment of the microphysics retrieval in different rain regimes will be illustrated. In particular, the synergy between 2DVD and MRR, properly reprocessed, will be exploited to reduce uncertainty on MRR profiles estimates.

[1] Hou A. Y., Kakar R. K., Neeck S., Azarbarzin A. A., Kummerow C. D., Kojima M., Oki R., Nakamura K., Iguchi T., 2014: The Global Precipitation Measurement mission. *Bull. Amer. Meteor. Soc.*, 95, 701–722.

[2] Tokay, A., P., Hartmann, A. Battaglia, K. S., Gage, W. L. Clark, and C. R., Williams, 2009: A field study of reflectivity and ZR relation using vertical pointing radars and disdrometers. *Journal of Atmospheric and Oceanic Technology*, 26, 1120-1134

[3] Gorgucci, E., L. Baldini, 2014, Influence of beam broadening on the accuracy of radar polarimetric rainfall estimation, *Journal of Hydrometeorology*, (under review).

[4] Roberto, N., E,. Adirosi, L., Baldini, D., Casella, S., Dietrich, P., Gatlin, G., Panegrossi, M., Petracca, P., Sanò, and A. Tokay, 2015: Multi-sensor analysis of convective activity in Central Italy during the HyMeX SOP1.1. *Quarterly Journal of the Royal Meteorological Society,* (under review)