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Estimation of raindrop drop size distribution vertical profile from simultaneous micro rain radar and 2D video disdrometer measurements

Elisa Adirosi (1), Luca Baldini (1), Nicoletta Roberto (1), Mario Montopoli (1), Eugenio Gorgucci (1), Patrick Gatlin (2), and Ali Tokay (3)

(1) CNR – Istituto di Scienze dell'Atmosfera e del Clima, Rome, Italy (elisa.adirosi@artov.isac.cnr.it), (2) NASA Marshall Space Flight Center, Huntsville, Alabama, (3) Joint Center for Earth Systems Technology, University of Maryland Baltimore County, Baltimore, Maryland; and NASA Goddard Space Flight Center, Greenbelt, Maryland

Experimental field campaigns of rain precipitation usually require the coexistence of several ground and satellite based observations in order to guarantee a more complete analysis of the collected case studies at the various spatial and temporal scales of interest. In the framework of the Ground Validation programme of the NASAA/JAXA Global Precipitation Measurement (GPM) mission, several climate regions of the Earth have been interested by various field campaigns involving experimental setup which include one or more ground based disdrometers and profilers. In such situation a typical implementation of the measurement scheme consists of a pair of K-band vertically pointing micro rain radar (MRR) and a 2D video disdrometer (2DVD) installed close each other. Since 2DVD estimates are referred to the ground level, the co-located MRR is supposed to provide complementary vertical profiles of drop size distribution (DSD) measurements. However, if not properly processed MRR and 2DVD raw data can lead to erroneous interpretations of the underlying microphysics. In this work, we investigate some typical issues occurring when dealing with MRR and 2DVD observations proposing techniques to ensure the adequate data quality required in typical field validation campaigns.
More in detail, MRR is an affordable continuous wave frequency-modulated radar (CWFM) typically used at vertical incidence. In the MMR configuration used, DSD profiles are estimated from Doppler spectra determined by drops falling at different velocities and at different heights from 1000 meters almost up to the ground level with a vertical resolution of 35 meters and time resolution up to 10 seconds. The importance of the microphysical measurements from MRR are related to the effects of the vertical gradients of rain precipitation at the sub-resolution scale of the measurements based remote sensing instruments such as those provided by the dual frequency radar of GPM as well as by ground based weather radars. However, MRR standard processing is based on several assumptions that, along with some characteristics of the implementation of the CWFM scheme such as spectra aliasing and height-Doppler ambiguity, limit its usefulness for heavy precipitations or in convection. This is particularly true when the influence of air motion on DSD retrieval is not negligible. In this work some of these limitations are investigated through simulations and through a comparison with ground based disdrometers. It is shown that the synergy between 2DVD and MRR measurements, when properly reprocessed, can be exploited to reduce the uncertainty on MRR profiles estimates.