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Multifrequency radars retrievals of rain microphysics: evaluation of the rain representation in the WRF Model

Frederic Tridon[1], Celine Planche[2], Kamil Mroz[3], Alessandro Battaglia[3], Sandra Banson[2], Greg Thompson[4], Marie Monier[2], Joël Van Baelen[2], Wolfram Wobrock[2]

[1]Institute for Geophysics and Meteorology, University of Cologne, Germany; [2]Laboratoire de Météorologie Physique, CNRS-INSU, Université Clermont Auvergne, France; [3]Earth Observation Science, University of Leicester, UK; [4]NCAR, Boulder CO, USA

This study investigates how multi-frequency radar observations can be used to evaluate the representation of the rain microphysics in the WRF (Weather Research and Forecasting) model for a squall line system observed over Oklahoma on 12 June 2011. A recently developed retrieval technique combining observations of two vertically pointing cloud radars (located at the South Great Plain (SGP) Central Facility of the U.S. Department of Energy Atmospheric Research Measurement (ARM) program) provides quantitative description of the Drop Size Distribution (DSD) properties of the transition and stratiform regions of the squall line system with unprecedented vertical and temporal details.

The comparison between the retrieved properties of the DSD (i.e., the concentration parameter and the mean volume diameter) and the same parameters modeled using either the Morrison or the Thompson bulk microphysics parameterization (BMP) highlights significant discrepancies in the evolution of the vertical profile of the rain DSD. These discrepancies suggest an issue in the representation of the rain drops breakup and self-collection, and/or excessive size sorting associated to sedimentation in bulk schemes.

Focusing on the rain layer, numerical sensitivity analysis are performed to investigate the sources of these differences. Results show that the vertical evolution of the DSD is strongly dependent on the representation of the breakup/self-collection parameterization and the melting process. In the Morrison scheme, the simulations with more efficient breakup can reproduce the DSD properties with better fidelity by dominating the effect of drop size sorting due to sedimentation. Nevertheless, this latter artifact has a non-negligible influence on the DSD profile and should therefore be avoided, i.e., by using bin microphysics in future work for a proper evaluation of the breakup parameterization. This study also investigates how the inaccuracy in the representation of the DSD properties strongly influences the evaporation rate and hence could impact not only the rain rate at the ground but also the atmospheric buoyancy and the cold pool intensity through latent heat exchange.