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Calibration of operational dual-polarization weather radar using disdrometer observations

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Single-polarization weather radars need accurate absolute calibration to be used for quantitative applications such as rainfall estimation. For dual-polarization systems, the relative imbalance between the two channels (horizontal and vertical) also needs to be routinely assessed. This is commonly addressed as the radar's differential calibration, i.e. Z_{dr} (the ratio between the horizontal and vertical reflectivity) is expected to be 0 dB for spherical targets. Several techniques have been developed for the radar absolute and differential calibration [1,2], although many of them require ad hoc measurement settings and interruption of the operational radar scan.

Disdrometers provide a detailed view of rainfall processes, allowing direct calculation of the reflectivity from the observed drop size distribution (DSD) through electromagnetic scattering simulations. The reflectivity obtained from the DSD can be compared with the radar observations, offering the possibility to calibrate the radar without interfering with routine operation [3]. Some disdrometers provide additional information about the shape of the raindrops, allowing direct calculation of the differential reflectivity as well. However, for most commercial instruments (like the Thies-Clima laser disdrometer used in this study) this information is not available, implying that some assumption about the drop's shape is needed to calculate the differential reflectivity from the DSD information alone.

In this work, we present the current implementation of an automatic and operational procedure for the daily absolute and differential calibration of the Bric della Croce C-band weather radar in Italy. The disdrometer used for the calibration is located just 6 km from the radar, contributing to limit the impact related to the different sampling volumes of the two instruments. While absolute calibration necessarily requires co-located observations, the calibration of Z_{dr} is realized through a statistical method involving a large number of observations to mitigate the effects of observation errors and the impact of the height difference between the radar measurements and the ground (about 400 m). In this approach, the theoretical decreasing trend of Z_{dr} with low reflectivity in drizzle/light rain (whose electromagnetic response is dominated by small nearly spherical drops) is used as a constraint for actual radar observations. The results will be discussed and compared with other techniques available in the literature.

References

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