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Assimilation of dual-polarization radar observations into convective scale models

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The main purpose of this study is to examine how dual-polarization weather radar observations could be used to improve the analyses and the short-term forecasts of convective scale atmospheric models.
First, a polarimetric radar forward operator has been added to the Meso-NH mesoscale model (Lafore et al., 1998) by taking advantage of the detailed mixed-phase microphysics of the model. Comparisons between simulated and observed polarimetric variables have been conducted at S, C and X-band on two mid-latitude deep-convection cases and have demonstrated a rather good agreement between observations and simulations (Augros et al., 2015). These comparisons have been used to validate the forward operator that was subsequently deployed into the Météo France convective scale operational model AROME (Seity et al. 2011) that has the same 1-moment microphysics scheme as Meso-NH.
Next, the 1D+3D-Var assimilation scheme, used operationally to assimilate the reflectivity (Caumont et al, 2010; Wattrelot et al, 2014), has been extended to test the assimilation of the differential phase Zdr and the specific differential phase Kdp. In this indirect assimilation scheme, a 1D Bayesian method is used to infer vertical profiles of humidity at the observation location, from a linear combination of background humidity profiles, with weights determined by the difference between observed and simulated variables. The retrieved humidity profiles are then assimilated together with the other observations in AROME using 3D-Var.
The impact of the use of Zdr or Kdp on the retrieved humidity profiles is discussed and the profiles are validated by comparison with IWV (Integrated Water Vapor) from ground-based GPS observations.
Assimilation experiments have then been conducted, for two convective cases. The impact of the assimilation of Kdp was particularly evidenced in a case of strong convection and partial beam blockage. The impact of DPOL observations on precipitation forecast was found globally neutral, but slightly positive for the periods of intense convection. The examination of a larger number of cases with strong attenuations and/or in regions affected by partial beam blockage is necessary to comfort their benefit on precipitation forecasts.

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