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The contribution of using an advanced forward operator in evaluating mesoscale atmospheric models

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For evaluation of mesoscale atmospheric models, precipitation radar data provide detailed information, given their high spatial and temporal coverage. However, a direct comparison between observation and model forecast is complicated as radar measures reflectivity (Z in dBZ), a quantity that is not forecast by atmospheric models. One method to circumvent this problem is to use a so called 'model-to-observation' approach, in which the observed variable is derived from forecast model fields, using a forward operator.

In this study the additional value of using an advanced forward operator over using a simple forward operator is investigated. We integrated two mesoscale atmospheric models for three contrasting precipitation cases, which allows us to gain insight in the contribution of an advanced operator in both stratiform and convective weather conditions and to test the consistency of these results among different models.

Both the simple forward operator of Smedsmo et al. (2005) and the more advanced Radar Simulation Model (Haase and Crewell 2000) were applied to the Advanced Regional Prediction System (ARPS) and the COSMO-LMK models in order to calculate radar reflectivities at any grid point within the mesoscale atmospheric models. These simulated reflectivity measurements can be directly compared with observed reflectivities from the Zaventem C-band radar, owned by Belgocontrol and the Wideumont C-band radar, owned by the Royal Meteorological Institute of Belgium. The intercomparison of observed and modelled reflectivities was performed using the SALverification method (Paulat 2006). This object-based approach makes a distinction between errors due to structure, amplitude and location of the precipitation feature and is capable of providing much more insight in the model performance than the more frequently used skill scores. Three precipitation cases were selected in order to perform this work. A first was a dynamically driven intense convection case, a second a thermodynamically driven intense convection case and a third a stratiform precipitation case.

This work fits into a framework of a more extensive evaluation taking into account also satellite imagery and in situ observations, gathered during the General Observation Period of the German project ‘Quantitative Evaluation of Regional Precipitation Forecasts using multi-dimensional Remote Sensing Observations’ (QUEST). In a further step the model most capable of reproducing extreme precipitation will be used to perform high resolution precipitation simulations over the Belgium loam region which will be used as input in soil erosion models.