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Forecasting of severe weather with the convection-resolving model COSMO-DE

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Since April 2007 the operational NWP system of the Deutscher Wetterdienst (German Weather Service, DWD) has been extended to the convection-resolving scale by the introduction of the 2.8 km grid-spacing limited-area model COSMO-DE. The new high-resolution model COSMO-DE aims towards the explicit forecasting of severe weather phenomena on the meso-gamma scale, for example severe weather events related to deep moist convection or interactions of the flow with topography like strong orographic precipitation or downslope windstorms.

One of the most interesting features of a meso-gamma model is that it no longer needs a parameterization of deep convection. Instead, COSMO-DE resolves at least the coarse modes of deep convection explicitly. The different representation of deep convection can be seen e.g. in the average stratification of the model atmosphere during summertime: while the 7 km model has a too stable stratification, due to a too rapid convective overturning, the convection-resolving COSMO-DE shows a slightly too high potential instability probably due to an underestimation of convective activity. To represent the smaller scales of convection the shallow convection part of the Tiedtke cumulus parameterization is used. This parameterization contributes significantly to the vertical transport of moisture from the boundary layer to a height of about 3-4 km and therefore avoids the overestimation of low cloud coverage.

A meso-gamma model has special requirements concerning data assimilation. At this scale high resolution, rapidly updated observations are needed, which can in principle be delivered by radar data with a horizontal resolution of roughly 1 km. Currently only the two-dimensional precipitation scans are assimilated by the latent heat nudging (LHN) approach. One basic assumption of the LHN is that the latent heat release in a vertical column is proportional to the surface precipitation rate. Unfortunately, this basic assumption is in contradiction to the use of a prognostic precipitation scheme. This problem can to some extent be resolved by several refinements of the conventional LHN scheme, including an undelayed reference precipitation defined by a vertical integral of the precipitation flux.

The aim of the lecture is to summarize the experiences with an about one year operational use of a convection-resolving model. Examples will be shown where lines of thunderstorms are simulated more realistically with COSMO-DE than with parameterized convection. But there are also examples for the lack of convection initiation mostly in air mass convection situations.

Especially the ability of the model to simulate supercells will be demonstrated. As a direct indicator the ’supercell detection index’ (SDI) (Wicker et al., 2005) was implemented. In contrast to commonly used ’Tornado-indices’ as PBL wind shear or CAPE, which inspect the properties of the large scale flow, the SDI is sensitive directly to strong and persitent correlation between vertical velocity and vertical vorticity occuring in supercells. A case study of 13 May 2007 will be presented where tornadoes were observed in the western part of Germany.