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Sensitivity to horizontal resolution and turbulence parametrization on high-resolution idealized simulations of thunderstorms

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Idealized simulations of deep moist convection are performed with the Meso-NH model at kilometric and sub-kilometric scales.
To trigger convection a thermal perturbation is inserted in the low levels, superimposed on a homogeneous initial state whose temperature, wind and humidity profiles come from Weisman and Klemp (1982, 1984) studies. The experiments are carried out without land surface, radiation scheme, orography nor Coriolis force.
In this idealized framework, we have analysed:
- the impact of horizontal grid spacing (4km, 2km, 1km and 500m);
- the impact of one dimensional turbulent (T1D) versus three dimensional turbulent (T3D) parametrization in the clouds.

The simulations generate one cell which splits into two convective systems: a left-moving multicellular system and a right-moving supercell with typical features (hook echo, FFD, RFD, mesocyclone).
Results show that the accumulated rainfall and the size of convective systems increase with increasing resolution. The area of updraft cores also increases but their intensity decreases as shown by vertical profiles of the 90th percentile vertical velocities.
The ratio between resolved TKE and total TKE decreases with increasing resolution. This results is not consistent and shows the limit of the turbulence parametrization in convective clouds. The subgrid TKE is mainly due to dynamical processes at high resolution, with maxima located at the upper part of the convective systems. Parametrization of dynamical production of TKE is a function of resolved horizontal and vertical wind shear. At low resolution, there is a deficit of production of subgrid TKE, likely due to poorly resolved gradients.
Furthermore, subgrid TKE is lower in T1D runs than in T3D runs. Indeed, kinetic energy spectra show a deficit in subgrid mixing for the T1D runs at smallest wavelengths.

To further investigate the structure of turbulence inside the clouds, LES simulations of convective clouds will be carried out.