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Plain Language Summary: This study investigates, if atmospheric models with horizontal resolutions of 100 m to 2 km are able to better simulate key features, like clouds and precipitation, of the climate system than currently used models employing much coarser resolution and parameterized convection. Precipitation characteristics are much more realistic in the simulations with explicitly convection, already at kilometer resolutions. Increasing resolution to hectometer scales improves the simulation of precipitation only modestly, but substantially improves the simulation of clouds. The results suggest that new climate models, which explicitly resolve convection and the interaction with its environment, offer exciting opportunities to learn about the climate system.

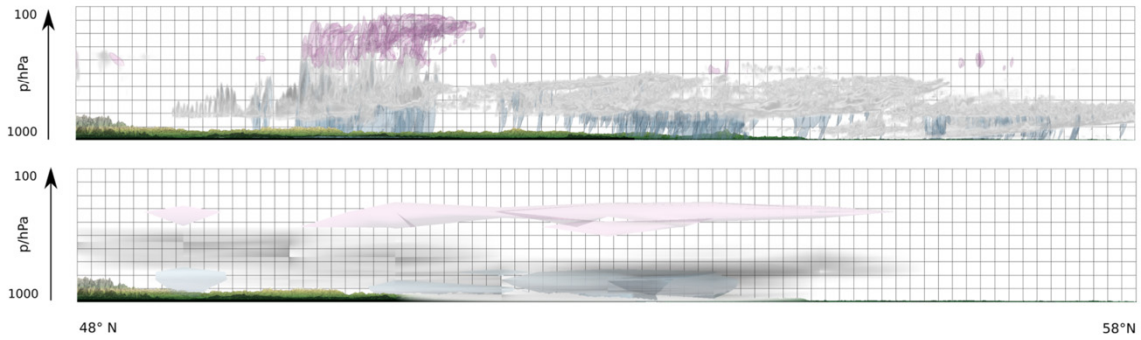

Figure 1. Visualization of convective processes associated with a frontal passage for a simulation with 156m grid spacing (top) and a model with 40km grid spacing (bottom) over Germany. Both simulations are for simulations of 24 April 2013. The colors denote ice (pink), liquid clouds (grey) and precipitation (blue).

- In almost every respect, the representation of the vertical motion leads to an improved, and more physical, representation of clouds and precipitation as compared to models using parameterizations to represent clouds and convective processes.
- Most improvements for precipitations statistics are already achieved at kilometer scale resolutions, compared to models using parameterized convection.
- The representation of clouds improves further, when increasing resolutions to hectometer scales.