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Parameterization testbed 2.0: Orography-capturing nested large-eddy simulation at an observational supersite

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High-resolution simulations can help us to understand cloud processes and develop and improve cloud parameterizations. To this purpose parameterization testbeds have been developed around supersites, combining local fine-scale simulations with measurements. A key ingredient for the success of these efforts is the long-term application, by which statistical significance can be obtained. Typically, time varying forcings for idealized Large-Eddy-Simulations (LES) are derived from large-scale models and local observational datasets, enabling the model to "see" the synoptic weather while still allowing resolved small-scale turbulence to happen freely. However, the computational burden of such efforts has been a limiting factor, which has so far motivated the use of a (semi-) idealized setup, featuring homogeneous forcing and terrain, as well as periodic boundaries, in a relatively small domain. The new ICON-LEM framework offers the possibility to step beyond these limitations: to include topography, spatially varying land-surface properties and open boundaries, while still being computational feasible. In this study we compare semi-idealized LES with these new simulations and investigate what we can gain by adding this complexity. First evaluations of the ICON-LEM simulations at the JOYCE observational site in Germany show that, when the large-scale forcing is reasonable, the model is able to reproduce the general synoptic situation as well as the timing and structure of summertime boundary layer clouds to a satisfactory degree. These encouraging results suggest that this model framework can well be used for sensitivity studies for investigating the influence of i) the land surface ii) topography and ii) advected mesoscale structures on the low level flow and the cloud field. Results from various comparisons and sensitivity studies underpinning this conclusion, as well the potential for future studies, will be discussed.