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Analysis of the impacts of small-scale orography on the atmospheric boundary layer.Developing ICON-LES for the Perdigão field experiment.

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The response of the boundary layer flow to resolved versus parametrized orographic drag over moderately complex terrain is investigated. The larger terrain scales may trigger propagating gravity waves and generate flow blocking, while the smaller scales (smaller than 5 km) may modify the turbulent boundary layer leading to turbulent orographic form drag (TOFD). We perform high-resolution numerical simulations to evaluate the ability of a TOFD parametrization to reproduce the impact of small-scale orographic features on the flow over complex terrain. The tool selected to perform the simulations is the Icosahedral Nonhydrostatic (ICON) numerical model, a unified modelling system for global numerical weather prediction (NWP) and climate studies. In the present study, the model is used in its limited-area mode. In the TOFD parametrization used for the present simulations, the surface stress and its vertical distribution are formulated in terms of the spectrum of the orography, meaning that it only depends on the orography characteristics in the domain. As a first step simulations using different grid spacings, from the km scale to the 100 m scale, are carried out to reproduce the intensive observational period (IOP) of the Perdigão field experiment. The km-scale simulations in NWP mode are run continuously for the complete 49-day IOP using ERA5 data for initial and boundary conditions. The large-eddy simulations, at O(100 m) grid spacing, are run for selected periods nested into the NWP runs. The initial results of the NWP control simulation show good performance when compared to the tower wind observations for selected periods, but not for the entire IOP. The reasons for the variable performance is investigated.