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A new LES–model for flow of a moist atmosphere over highly complex terrain

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A new LES-model is presented which is particularly well suited to simulate air flow and clouds above highly complex terrain. The model is fully three dimensional, non-hydrostatic, and uses the anelastic approximation. The governing equations are discretized on a Cartesian grid. Arbitrarily steep orography is accounted for with the help of "viscous topography". All prognostic variables are advected with explicit numerical schemes of second order accuracy. The effect of unresolved scales is parameterised with a standard SGS-Model of the Lilly-Smagorinsky type. The resulting turbulent fluxes are taken into account by the use of the Alternating-Direction-Implicit method of Douglas and Rachford. Warm clouds are represented with the help of a two moment microphysical bulk scheme.

The dynamical core is validated through standard tests like the rise of a warm bubble and the spread of a density current. In addition, the model is shown to successfully simulate air flow around surface mounted obstacles like, for example, in the vicinity of a cube or a backward facing step.

The model is applied to investigate the dynamics of orographic banner clouds in the lee of steep ridges and their interaction with cloud physics. Sensitivity tests indicate a significant influence of the atmospheric static stability on the structure of the leeward vortex associated with a banner cloud. The results are evaluated in the light of continuous meteorological measurements as well as additional data from a recent field experiment at the German Zugspitze, which help to disentangle the effect of pure dynamics and moist physics.