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Large eddy simulation of a cold air outbreak with stationary model domain

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Cold air outbreaks along with organised convection were frequently examined in the last two decades within the scope of large field experiments as well as by numerical models. So far, in three dimensional large eddy simulations (LES) of cold air outbreaks small model domains moving with the mean wind were applied; that is, periodicity at the lateral boundaries was assumed. Using this technique, no mesoscale spatial gradients in the meteorological quantities can evolve. For instance, in reality the boundary layer height in a cold air outbreak has an inclination in direction of the mean flow since its depth is increasing with distance to the ice edge. On principle, in simulations with cyclic boundary conditions the boundary layer is not slanted and therefore possible influences of this inclination on the flow will not be considered. Furthermore, such boundary conditions may bias the development of the flow structures directly.

For the first time, a simulation of a cold air outbreak was performed using a stationary model domain which was large enough to capture the evolution of the large scale organised structures ($200\,\mathrm{km} \cdot 26\,\mathrm{km} \cdot 3\,\mathrm{km}$), while the small scale unorganised turbulence was explicitly resolved (grid sizes: $25\,\mathrm{m}$ vertically, $50\,\mathrm{m}$ horizontally). Thus, the explicit consideration of interactions between these two scales were rendered possible. With $3 \cdot 10^8$ grid points this simulation was one of the most extensive LES of meteorology so far. The results of this study will be presented in this contribution.

During the simulation, convective rolls, extended through the whole bondary layer, were formed which showed the typical characteristics as observed in nature, such as significant increasing aspect ratios with increasing distance from the ice edge and orientation of the roll axes in direction of the mean wind shear vector. The patterns of the rolls can be found in the fields of the liquid water content and of the velocity compo-

nents as well as in the field of the shear stress, which is consistent with observations from satellites using the SAR-interferometry technique.