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Dependency of mesoscale organization on grid anisotropy in large-eddy simulations at Gray Zone resolutions

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A new generation of operational atmospheric models operating at horizontal resolutions in the range 200 m up to ~ 2 km is becoming increasingly popular for operational use in numerical weather prediction and climate applications. Such grid spacings are becoming sufficiently fine to resolve a fraction of the turbulent transports. Here we analyze LES results of a convective boundary layer obtained by coarsening horizontal grid spacings up to 800 m. The aim is to explore the dependency of the mean state and turbulent fluxes on the grid resolution. Both isotropic and anisotropic eddy diffusion approaches are evaluated, where in the latter case the horizontal and vertical eddy diffusivities differ in accord with their horizontal and vertical grid spacings. For coarsening horizontal grid sizes entrainment at the top of the boundary layer tends to get slightly enhanced for isotropic diffusion. An analysis of the energy spectrum shows that anisotropic diffusion causes relatively more dissipation of variance at smaller length scales. This leads, in turn, to a shift of spectral energy towards larger length scales. This can also be clearly seen from the different kinds of spatial organization. The present study therefore suggests that details with regards to the representation of processes at small scales might impact the organization at length scales much larger than the smallest scales that can be resolved by the model.

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