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Grey zone issues in boundary layer parametrization

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The “grey zone” is often associated with partially resolved convection at model resolutions between 1 and 10 km. Although turbulence is not resolved in this resolution range, also boundary layer parametrization has resolution dependent aspects. Comparing the ECMWF model at resolutions of 9 and 18 km, it can be shown that parametrized mixing in stable situations increases with resolution. At the highest resolution, the increased mixing leads to warmer night time temperatures. The additional mixing can be traced back to an increase of “mean shear”, which is due to resolution-dependent meso-scale variability.

Current schemes for stable mixing often use a lot more mixing than can be justified on the basis of observations, e.g. in the form of long-tail stability functions. In this contribution, it is postulated that “long tail” formulations are needed to compensate for the lack of meso-scale variability in models. A clear example for flow over orography will be shown. Also the power spectrum of shear from the ECMWF model shows substantial lower values than the observed spectrum along the 200 m mast in Cabauw. Further evidence from literature for this hypothesis will be reviewed. The consequence for parametrization is that stability functions should become resolution dependent. Unfortunately, very little is known about the characteristics of meso-scale variability. Questions are raised like: what is the scaling behaviour of meso-scale shear, does it depend on height above the surface, is it influenced by topography, does it interact with gravity waves and does it depend on inhomogeneous terrain?

It is concluded that shear from meso-scale variability should be studied. To develop a parametrization for meso-scale shear, it is suggested to exploit high resolution turbulence resolving simulations over a large domain to allow sufficient interaction between turbulence scales and synoptic scales.