

A three-dimensional turbulence scheme for the gray zone in a convective boundary layer

Yuji Kitamura (kitamura@mri-jma.go.jp)

Meteorological Research Institute, Japan Meteorological Agency,
Atmospheric Environment and Applied Meteorology Research Department

While a convective flow in a planetary boundary layer can be partly captured with the horizontal resolution less than 1 km, a turbulence scheme suitable for such the resolution is not sufficiently established. This issue is often called the gray zone problem for a boundary layer. Several schemes applicable to the gray zone has been proposed in recent years. Most of them are designed in the basis of a vertically one-dimensional (1D) scheme which is usually employed for a RANS model. On the other hand, Honnert and Masson (2014) indicated that the effect of the horizontal shear production, which cannot be taken into account in a 1D model, is not negligible.

In the present study, we modify the three-dimensional (3D) scheme proposed by Kitamura (2016). The new scheme improves underestimation of the vertical gradient of the velocity and temperature in the surface layer seen in Kitamura (2016). The effect of the horizontal shear production in the new 3D scheme is analyzed. The horizontal shear production is comparable to the vertical one and is not negligible in comparison with the buoyancy production in the gray zone. This result suggests that use of a 1D model induces underestimation of the turbulence kinetic energy in the subgrid scales.