EMS Annual Meeting Abstracts
Vol. 12, EMS2015-62-1, 2015
15th EMS / 12th ECAM

High-resolution large eddy simulations of stably stratified turbulence in free atmosphere

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Stably stratified turbulence is observed in stable boundary layer and in the free atmosphere. An appropriate representation of the atmospheric turbulence in stably stratified regime is then crucial to effectively forecast daily weather conditions during night-time and winter. It is also important to better represent momentum transfer in the free tropical troposphere and in highly stably stratified polar boundary layer in climate models. However most of numerical weather prediction models currently encounter difficulties to simulate turbulence at high Richardson number : beyond the critical Richardson number $\mathrm{Ri}_c \approx 0.25$, the turbulence regime turns into very weak turbulence which is not represented by NWP models.

Several large eddy simulations of a free atmosphere layer are carried out using the non-hydrostatic mesoscale model Méso-NH developed by the CNRM-GAME (Météo-France and CNRS) and the Laboratoire d'Aérologie. For each LES, the free atmosphere layer is set with constant vertical potential temperature gradient and wind shear. A set of LES is realized with different Ri varying from 0 to 2. An initial perturbation of potential temperature leads to a stationary stably stratified turbulence kinetic energy regime. A first analysis of the LES (resolution up to 10 cm) is presented in terms of variations of the TKE budget with respect to the Richardson number.

These LES will be used as a reference for a one-dimensional turbulence parameterization of the Energy and Flux Budget model inspired by Zilitinkevich et al. 2013. Further work and applications to the stable boundary layer over complex non-flat terrain will be realized and evaluated using data from the PASSY-2015 field campaign conducted in the Northern Alps during the winter of 2014-2015.