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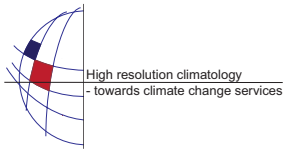

Merging RANS & LES approaches in submesoscale modeling

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Merging LES and RANS simulation is important for extending the application range of mesoscale models to the sub-mesoscale. Hence many traditional mesoscale modeling groups are currently working on adding LES capabilities to their models. To investigate the differences, which occur by switching from RANS to LES approaches, simulations with the METRAS and METRAS-LES (Fock, 2007) are presented. These differences are investigated in terms of effects caused by the choice of the computational grid and the sub-grid scale closures.

Simulations of convective boundary layers on two different grids are compared to investigate the influence of vertical grid spacing and extension. One simulation is carried out on a high-resolution vertical homogeneous grid and the other with a vertical stretched grid, which has coarser resolution in higher altitudes. The stretched grid is vertical defined, as it would be done in the standard setup for the mesoscale model. Hence, this investigation shows to what amount the eddy resolving capabilities of a LES model is effected by the transition of the grid to a grid, which is vertically the same as typically used in mesoscale modeling.

The differences, which occur by using different approaches for subgrid scale turbulence, are quantified and compared with the effects caused by the computational grid. Additional some details of the used LES SGS closure (Deardorff, 1980) are investigated. These details deal on evaluating the importance of the reduced characteristic filter length scale for stable stratification. But the main focus is on comparing RANS and LES and discussion of combination in a mixed turbulence scheme, which applies a the LES closure in the atmospheric boundary layer and a RANS based turbulence model in the stable atmosphere above.

References:

Deardorff J. W. (1980): Stratocumulus-capped mixed layers derived from a three-dimensional model. Boundary-Layer Meteorology. 18. (4). 495-527. DOI:10.1007/BF00119502

Fock B. H. (2007): METRAS als Grobstruktursimulationsmodell. Diplomarbeit. Meteorologisches Insitut, MIN-Fakultät Universität Hamburg. 89 p. http://www.mi.uni-hamburg.de/fileadmin/files/Diplomarbeit_Fock.pdf