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Intercomparison of different subgrid-scale models for the Large Eddy Simulation of the diurnal evolution of the atmospheric boundary layer during the Wangara experiment

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The study of a whole diurnal cycle of the atmospheric boundary layer evolving through unstable, neutral and stable states is essential to test a model applicable to the dispersion of pollutants. Consequently a LES of a diurnal cycle is performed and compared to observations from the Wangara experiment (Day 33-34). All simulations are done with Code_Saturne [1] an open source CFD code. The synthetic eddy method (SEM) [2] is implemented to initialize turbulence at the beginning of the simulation.
Two different subgrid-scale (SGS) models are tested: the Smagorinsky model [3],[4] and the dynamical Wong and Lilly model [5]. The first one, the most classical, uses a Smagorinsky constant Cs to parameterize the dynamical turbulent viscosity while the second one relies on a variable C. Cs remains insensitive to the atmospheric stability level in contrary to the parameter C determined by the Wong and Lilly model. It is based on the error minimization of the difference between the tensors of the resolved turbulent stress (Lij) and the difference of the SGS stress tensors at two different filter scales (Mij). Furthermore, the thermal eddy diffusivity, as opposed to the Smagorinsky model, is calculated with a dynamical Prandtl number determination.
The results are confronted to previous simulations from Basu et al. (2008) [6], using a locally averaged scale-dependent dynamic (LASDD) SGS model, and to previous RANS simulations. The accuracy in reproducing the experimental atmospheric conditions is discussed, especially regarding the night time low-level jet formation. In addition, the benefit of the utilization of a coupled radiative model is discussed.

References:
[1] Archambeau F., Mehitoua N., Sakiz M., "Code_Saturne: a finite volume code for the computation of turbulent incompressible flows", International Journal on Finite Volumes 1(1), 2004.
[2] Jarrin N., Benhamadouche S., Laurence D., Prosser R., "A synthetic-eddy-method for generating inflow conditions for large-eddy simulations", International Journal of Heat and Fluid Flow, 27, 585-593, 2006.
[3] Smagorinsky J., "General circulation experiments with the primitive equations", Monthly Weather Review, 91, 99-164, 1963.
[4] Lilly D. K., "On the application of the eddy viscosity concept in the inertial sub-range of turbulence", National Center For Atmospheric Research, Manuscript 123, 1966.
[5] Wong V. C. and Lilly D. K., "A comparison of two dynamic subgrid closure methods for turbulent thermal convection", Physic of Fluids, 6(2), 1016-1023, 1994.
[6] Basu S., Vinuesa J. F. and Swift A., "Dynamical LES modeling of a diurnal cycle", Journal of Applied Meteorology and Climatology, 47, 1156-1174, 2008.