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Sensitivity of LES simulations of the stratocumulus-topped boundary layer to turbulent mixing and radiative cooling

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The influence of various physical processes on the evolution of the stratocumulus-topped boundary layer (STBL) is investigated in large-eddy simulations using the anelastic model EULAG. Experiments are based on a setup presented in Stevens et al. (Mon. Wea. Rev. 2005) and motivated by observations during the DYCOMS-II field campaign. The simulations expand the analysis presented in Kurowski et al. (*Quart. J. Roy. Meteor. Soc.* 2009) by investigating the impact of imposed changes in: (i) the prescribed radiative cooling at the top of the cloud; (ii) the subgrid-scale mixing; and (iii) the representation of evaporation of cloud water during turbulent mixing of cloudy air with warm and dry air entrained into STBL from above the inversion. The changes in radiative cooling are included through a simple multiplication of the model-calculated radiative cooling by a factor between 0.5 and 2. The changes in the subgrid-scale mixing include modifications of the ratio between the mixing coeficients for momentum and for scalars, that is, the turbulent Prandtl number. The delay of a phase change associated with turbulent entrainment and mixing is included following the approach of Grabowski (*J. Atmos. Sci.* 2007). In this approach, the evaporation of cloud water due to parameterized mixing is postponed until the subgrid-scale mixing reaches spatial scales close the Kolmogorov microscale. According to the results, the largest contribution to the domain statistics comes from the changes in the subgrid-scale mixing. The influence of radiative cooling is significant only if the change in the forcing near stratocumulus top is strong enough to disturb stability of the system, otherwise it is rather weak. The delay of phase changes during the parameterized mixing seems to be of a less importance than other processes.