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Effects of Large Scale Atmospheric Conditions on Marine Stratocumulus-Topped Boundary Layer: A Large-Eddy Simulation Study

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The large scale atmospheric conditions directly influence cloud formation and affect dynamical, thermodynamical and chemical structures of the atmospheric boundary layer by modifying the entrainment process. In this study a series of large-eddy simulations (LES), using BabyEULAG model, is performed to investigate how the large scale subsidence and free-tropospheric temperature and humidity influence the properties of inversion and cloud (in particular the liquid water path (LWP) budget). We vary the large scale subsidence velocity from 0 to 5 mm/s and modify the free-tropospheric temperature and humidity to change the cloud-top entrainment instability (CTEI). The set-up of the simulations is based on the measurements from Flight TO05 of the Physics of Stratocumulus Top (POST) research campaign. The LES results show that the amplitudes of temperature and humidity jumps across the inversion have remarkable influence on all properties of the inversion itself and the underlying cloud. In contrast, the large scale subsidence has a small influence on the inversion thickness. It just pushes the inversion/cloud top down almost in the same way and with the same speed under the different environmental conditions. The increased subsidence velocity leads to a remarkable reduction of LWP and cloud thickness due to entrainment of a warmer and drier air from above the cloud.