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Homogeneity of subgrid-scale turbulent mixing in a large-eddy simulation of boundary-layer clouds

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Mixing of cloud with dry environmental air changes the cloud droplet spectrum and crucially affects optical properties of clouds. This effect is still poorly understood and it is a significant source of uncertainty in aerosol indirect effects. The issue is whether the mixing results in the reduction of only the droplet size (as in the homogeneous mixing), only the droplet concentration (as in the extremely inhomogeneous mixing), or both the concentration and the size (as in the inhomogeneous mixing). On the theoretical grounds, homogeneity of mixing depends on the relative magnitude of the time scales for droplet evaporation and turbulent homogenization. Results from DNS suggest that a simple relationship exists between the ratio of the time scales and the slope of the mixing line on the diagram representing the relative change of the droplet concentration versus the change of the droplet radius cubed. These results were used in a LES model applying a double-moment microphysics scheme (i.e. with the droplet concentration and the mixing ratio predicted) to predict the homogeneity of mixing, locally at each model time step, as a function of local conditions. Results from double-moment LES model EULAG with the new subgrid scale mixing scheme will be presented. The model was used to simulate shallow convective clouds from the BOMEX experiment and stratocumulus clouds observed during the EUCAARI-IMPACT campaign.