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Impact of drizzle and 3D cloud structure on remote sensing of effective radius

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Remote sensing of cloud particle size with passive sensors like MODIS is an important tool for cloud microphysical studies. As a measure of the radiatively relevant droplet size, effective radius can be retrieved with different combinations of visible through shortwave infrared channels. The resulting effective radii are often quite different, indicative of different penetration depths for the spectral radiances used. Operational liquid water cloud retrievals are based on the assumption of a relatively narrow distribution of droplet sizes; the potential impact of precipitation on these distributions is neglected. MODIS observations sometimes show significantly larger effective radii in marine boundary layer fields derived from the 1.6 and 2.1 μm channel observations than for 3.7 μm retrievals. Possible explanations range from 3D radiative transport effects and sub-pixel cloud inhomogeneity aspects to the impact of drizzle formation.

To investigate possible factors of influence, we use LES simulated boundary layer cloud situations in combination with 3D Monte Carlo simulations of MODIS observations. LES simulations of warm cloud spectral microphysics for cases of marine stratus and broken stratocumulus, each for two different values of cloud condensation nuclei density, produce cloud structures comprising droplet size distributions with and without drizzle size drops. From 3D radiative transport simulations considering the full individual droplet size distributions synthetic MODIS observations are obtained. On these scenes the operational MODIS effective radius retrievals are applied and the results are compared to the given LES microphysics.