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Rain from shallow oceanic convection: the role of cloud turbulence

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Shallow oceanic convection plays an essential role in the Earth climate system and holds the key to the climate change. Cloud turbulence has been argued to play a significant role in the development of precipitation in these clouds through its impact on collision/coalescence processes. In recent years, we developed collision kernels that include effects of cloud turbulence on collisions between cloud droplets. The turbulent collection kernel depends on the characteristics of the small-scale turbulence, the turbulent dissipation rate in particular. We quantified the impact of turbulent collisions in simulations with increasingly complex setups, from the evolution of the initial droplet spectrum with collision/coalescence alone; through rising adiabatic parcel simulations that included droplet activation, diffusional growth and growth by collision/coalescence; in idealized rising thermal simulations mimicking processes within a single cloud; and in several-hour simulations of a field of shallow convective clouds based on the Barbados Oceanographic and Meteorological Experiment (BOMEX). In the latter simulations, turbulent enhancement of droplet collisions is calculated based on local cloud conditions. Single-cloud simulations show that cloud turbulence not only leads to earlier rain formation, but also results in higher precipitation efficiency of a single cloud. The latter comes from earlier (in the cloud lifecycle) formation of initial drizzle drops through the autoconversion phase of rain formation which leads to more cloud water available for the rest of the cloud lifecycle for the accretion phase. Initial cloud field simulations show that the mean surface precipitation rate can be on average two to three times higher when effects of cloud turbulence are included. Such an enhancement is beyond what we expected and need to be further quantified in follow-up simulations. These results will be presented at the conference and potential implications for the tropical and subtropical shallow oceanic convection layer will be discussed.