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Effects of turbulent fluctuations on phase partitioning in adiabatic mixed-phase cloud parcels

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Several microphysical processes determine phase partitioning between ice and liquid water in a mixed-phase cloud. Here we investigate the collective growth of ice particles and liquid droplets affected by turbulent fluctuations in temperature and water vapor fields. All cloud particles, including inactivated nuclei (both CCN and IN), are described by Lagrangian super-particles. To account for local variability in the turbulent cloud environment we apply a Lagrangian microphysical scheme, where temperature and vapor mixing ratio are stochastic attributes attached to each super-particle. In addition, a simple linear relaxation scheme models turbulent mixing of the scalar fields probed by each super-particle. The limit of a locally homogeneous growth environment corresponds to an infinitely short turbulent mixing timescale. The impact of our Lagrangian microphysical scheme on phase partitioning is tested in adiabatic cloud parcel simulations. Results are confronted with idealized reference simulations that use bulk microphysics based on an assumed (temperature-dependent) phase partitioning function. Our study suggests that accounting for local variability in a turbulent cloud is important for reproducing steady-state mixed-phase conditions.