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Observations and modeling of drizzling marine stratocumulus

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This paper describes a study of microphysical processes in drizzling marine stratocumulus using aircraft observations and a simple cloud model. The overall goal is to further the understanding of the indirect effects of atmospheric aerosols on climate. The observations come from the Meteo-France Merlin aircraft during the Second Aerosol Characterization Experiment (ACE2) and the NCAR C-130 aircraft during the Dynamics and Chemistry of Marine Stratocumulus Experiment (DYCOMS-II). In both experiments, the cloud droplet spectra were measured with the Fast Forward Scattering Spectrometer Probe and One-dimensional Array Probe Particle Measuring Systems 200X (for ACE2) and 260X (for DYCOMS-II). In eight flights during ACE2, the cloud droplet concentration (CDNC) varied from 50 up to 250 cm-3, with the cloud depth ranging from 160 to 270 m. In DYCOMS-II, the stratocumulus was thicker (from 200 to 550m) and CDNC varied from 100 up to 270 cm-3. As anticipated, the observed amount of drizzle was positively correlated with the stratocumulus depth and negatively correlated with CDNC. To separate the impact of the CDNC from the cloud depth effect, an idealized cloud model with prescribed idealized flow pattern and detailed microphysics (including droplet nucleation and growth by condensation and collision/coalescence) was applied in a series of simulations. In these simulations, the characteristics of cloud condensation nuclei and the cloud depth were systematically varied. Model results compared favorably with the few observed cases and suggest scaling relationships that can be used in parameterizations of indirect aerosol effect on marine stratocumulus.