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Effects of aerosol organics on cloud condensation nucleus (CCN) concentration and first indirect aerosol effect

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Abstract. Aerosol microphysics, chemical composition, and CCN properties were measured on the Department of Energy Gulfstream-1 aircraft during the Marine Stratus/Stratocumulus Experiment (MASE) conducted over the coastal waters between Point Reyes National Seashore and Monterey Bay, California, in July 2005. Aerosols measured during MASE included free tropospheric aerosols, marine boundary layer aerosols, and aerosols with high organic concentration within a thin layer above the cloud. Closure analysis was carried out for all three types of aerosols by comparing the measured CCN concentrations at ~0.2% supersaturation to those predicted based on size distribution and chemical composition using Köhler theory. The effect of aerosol organic species on predicted CCN concentration was examined using a single hygroscopicity parameterization. For aerosols with organics volume fraction up to 70%, such as the marine boundary layer and free troposphere aerosols, CCN concentration and the corresponding first indirect aerosol effect are insensitive to the properties of organics, and can be accurately predicted with a constant hygroscopicity for all organic species. This simplification can facilitate the prediction of indirect aerosol effects using physically-based parameterizations in large scale models. However, for the aerosols within the thin layers above clouds, organics contributed up to 90% of the total aerosol volume, and an accurate knowledge of the overall organic hygroscopicity is required to accurately predict CCN concentrations. Derivations of organic properties in future closure studies, when aerosols are dominated by organic species, would help constrain the descriptions of organics and aerosol-cloud parameterizations in large scale models.

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