Closure between CCN and Cloud Droplet Concentrations for Warm Clouds over Japan Based on In-situ Aircraft Measurements

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Aerosol particles acting as cloud condensation nuclei (CCN) and ice nuclei (IN) determine the microphysical structures of cloud and precipitation, and affect a short-range precipitation forecast and climate change projection. Also an efficiency of hygroscopic seeding is dependent upon the characteristics of background CCN as well as physico-chemical properties of seeding particles and cloud types. Therefore we investigated the physico-chemical properties and CCN ability of background aerosols and cloud microphysical structures using an instrumented aircraft (B200T) over Shikoku district of Japan in the summers of 2008, 2009 and 2010 as a part of Japanese Cloud Seeding Experiments for Precipitation Augmentation.

Number concentrations of CCN activated at SSw of 1% ranged from 400 –3,000 cm^{-3} while number concentrations of CN ranged from 1,000 –30,000 cm^{-3} even during the southerly wind periods. The number concentrations of CCN activated at SSw=1% and aerosol particles larger than 0.1 mm showed a good correlation. Estimated hygroscopicity of the atmospheric aerosols was on the order of 0.1. The aerosol size distributions and CCN spectra in the Pacific Ocean region air masses showed that their shapes were similar to those in the East Asia coastal region air masses, but total number concentrations of aerosol particles and CCN number concentrations were about 1/2 of those in the continental/polluted air masses from the East Asia coastal region. These concentrations were much higher than typical values in maritime air masses, but were close to typical values in continental air masses, suggesting that maritime air mass was very much influenced by pollution from Japan and big cities and industrial areas in the East Asia.

Typical maximum cloud droplet number concentrations near cloud bases were 300~1,500 cm^{-3}. The ratio of cloud droplet number concentration and CCN number concentration activated at SSw=1.0% increased with decreasing the CCN number concentration and increasing updraft velocity. The estimated maximum SSw near cloud bases ranged from 0.2 ~ 1.0% and also increased with decreasing CCN number concentration and increasing updraft velocity.

Keywords: CCN, Cloud droplet, Aerosols

