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Cloud microphysical properties of stratus and stratocumulus over East China Sea observed during the A-FORCE camaign

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Because of rapid growths of economical and industrial activities in the East Asian region, emissions of aerosols and their precursors have significantly increased in recent years. As a consequence, there is a concern that the increase in these anthropogenic aerosols affects regional climate directly and indirectly. An increase in aerosol concentrations can cause indirect effects by changing the cloud microphysics, such as an increase in cloud albedo, an increase in cloud lifetime, and a reduction/enhancement of precipitation. An objective of this study is to characterize microphysical cloud properties in East Asia through in-situ aircraft measurements of non-precipitating stratus and stratocumulus over East China Sea made during the Aerosol Radiative Forcing in East Asia (A-FORCE) aircraft campaign.
During the A-FORCE campaign, 21 research flights were made over East China Sea in March-April 2009. To study cloud microphysics and their relationships with aerosols, measurements with a special flight pattern, so-called 'cloud maneuver', were conducted in 9 cases during 7 flights. Cloud maneuvers were conducted for three cloud types; namely, clouds within cloud-street and clouds in association with warm and stationary fronts. Cloud microphysical parameters were measured using a Cloud Aerosol and Precipitation Spectrometer (CAPS). Cloud liquid water content (LWC) data measured by two independent techniques (CAS and hot-wire sensor) agreed well within their uncertainties, indicating a reliability of the measurements.
Data obtained during the cloud maneuver show that within a same cloud system, both LWC and effective diameter of cloud droplets were greater at higher altitudes. These results are quantitatively consistent with the theoretical predictions from cloud physics. A positive correlation between number concentrations of below-cloud accumulation mode aerosols and cloud droplet was found. This result suggests that variations in cloud droplet number concentrations were likely due to variations in below-cloud accumulation mode aerosol number concentrations.
Compared with cloud droplet number concentrations observed at various places and seasons reported in literatures, those observed in this study are greater by factors of 4-10. It was also found that cloud droplet effective diameters observed in this study were smaller than those observed in previous studies when data with same LWC are compared. These results suggest unique microphysical characteristics of clouds observed in this study.