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Aerosol-cloud interactions of trade wind cumuli in the sub-tropical ocean

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Representation of warm precipitation not well parameterized, especially in the trade wind cumulus common over Sub-tropical Ocean. The Small Scale-Processes of Trade Wind Cumuli over Barbados Experiment, which took place in November 2010, was designed to study the links between aerosol particles and shallow cumulus clouds. Previous experiments in this region showed that aerosol concentrations, particularly cloud condensation nuclei concentration (CCN), represent clean maritime conditions. Strong correlations had been found between CCN and cloud droplets – especially droplets larger than 20 micron diameter, which indicate that CCN are important for modulating precipitation.

A miniaturized CCN instrument was deployed on the helicopter-borne ACTOS payload (Airborne Cloud Turbulence Observations System) along with measurements of aerosol size distributions, number concentrations, and cloud microphysical probes. In conjunction with the airborne measurements, CCN concentrations were also measured on the ground for a complete evolution of the CCN spectra during the experiment. CCN concentrations were often low (NCCN,0.3 $\sim$100 /cc) but did vary by an order of magnitude (50 to 500 /cc). These low CCN concentrations imply an enhanced sensitivity of these clouds to aerosol loadings. Back trajectories consistently point to marine sources for the variation in the CCN concentrations. The CCN spectra show the largest variation for supersaturations less that 0.3%.

Vertical profiles of CCN show that the boundary layer is well mixed (up to ca. 500 m); hence, ground-based measurements correlate well with airborne measurements in the mixed-boundary layer. However, concentrations decrease above the clouds, except when aerosol layers are present. The effect of atmospheric processes (e.g., cloud processing and transport) on aerosols will be explored using CCN and aerosol size distributions to infer aerosol hygroscopicity as a function of aerosol size, supersaturation and altitude.