Mesoscale Aggregation of Shallow Cumulus Convection Over The Oceans

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Over the oceans, shallow cumulus convection, often mixed with patchy stratocumulus, is a common cloud type. It is usually 'aggregated' into mesoscale patches or polygons of deeper cumuli, with possible consequences for the mean vertical structure of cloud cover and cloud-precipitation-aerosol interaction. Large-eddy simulations (LES) covering domains 50 km or more across also exhibit mesoscale aggregation of shallow cumulus convection, but it is not fundamentally well understood. To further that understanding, we analyze the development of convective aggregation in multiday LES of a 108x108 km doubly periodic domain simulating mean summertime conditions at a location east of Hawaii. The simulated convection aggregates within 12 hours. Vertically resolved heat and moisture budgets on mesoscale subdomains elucidate this process. Shallow cumulus deepen preferentially in more humid regions of the boundary layer, stimulating net moisture convergence into those regions. Sensitivity studies show that the aggregation does not require precipitation. Aggregation is weakened but not prevented if radiative cooling and surface fluxes are horizontally homogenized. A unifying conceptual model explains these findings.

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