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The Diurnal Evolution of Controls on Trade Wind Mesoscale Morphologies

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The diurnal cycle in trade-wind cloudiness is thought to be driven by the diurnal cycle in the relative occurrence frequency of mesoscale cloud morphologies (i.e., Vial et al. 2021). These morphologies can be grouped by their distinct appearance and size into four categories: Sugar, Gravel, Flowers, and Fish. The diurnal cycle in cloudiness is associated with a late afternoon maximum in the smallest (Sugar) clouds that give way to larger, more vertically extensive clouds (Gravel, then Flowers) throughout the night. A remaining question is how sub-cloud dynamics evolve diurnally to facilitate this cycle in cloud morphologies and thus cloudiness. We examine the daily evolution of winter-time trade-wind mesoscale morphologies using observations from the 2020 EUREC4A-ATOMIC joint campaign. Measurements from the Ronald H. Brown research vessel allow us to analyze differences in the daily evolution of boundary layer structure and dynamics between morphologies. We decompose Doppler lidar-derived mass fluxes into their vertical velocity and cloud fraction contributions and examine their effect on diurnal cloud evolution as well as their relationship to environmental controls (e.g., surface wind speeds, energy and moisture fluxes, stability). Relationships between environmental controls and morphologies are extended with the long-term observational record at the nearby NTAS buoy.

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