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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 has been observed to be driven by the diurnal cycle in the relative frequency of occurrence of mesoscale morphologies (i.e., Vial et al. 2021). These morphologies have been grouped based on their distinct appearance and cloud size into four categories, from small to large sizes: Sugar, Gravel, Flowers, and Fish. The diurnal cycle in cloudiness is associated with a late afternoon maximum in the smallest (Sugar) clouds which give way to clouds of larger size and vertical extent (Gravel, then Flowers) throughout the night. A remaining question is how sub-cloud dynamics evolve diurnally to facilitate this diurnal cycle in cloud morphology and thus cloudiness.

We examine the daily evolution of trade wind mesoscale morphologies with *in situ* observations from the 2020 joint campaign, EUREC^{4}A (Elucidating the Role of Clouds–Circulation Coupling in Climate) and ATOMIC (Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign), that took place in January and February in the Northwest tropical Atlantic. 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 such as surface wind speeds, energy and moisture fluxes, stability, and near-surface air properties. Relationships between environmental controls and morphologies are further extended with the long-term recorded observations at the nearby moored NTAS (Northwest Tropical Atlantic Station) buoy.