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The role of mesoscale cloud organization in the daily cycle of trade-wind cumuli

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The role of spatial organization of clouds at mesoscale in the daily cycle of shallow cumulus clouds and precipitation is here explored, for the first time, using three years of high-frequency satellite- and ground-based observations. We focus on the four prominent patterns of cloud organization – Sugar, Gravel, Flowers and Fish – which were found recently to characterize well the variability of the North Atlantic winter trades. Our analysis is based on a simple framework to disentangle the parts of the daily cycle of trade cloudiness that are due to changes in (i) the occurrence frequency of patterns and (ii) cloud cover for a given pattern. Our investigation reveals that the contribution of mesoscale organization to the daily cycle in cloudiness is largely mediated by the frequency of pattern occurrence. All forms of mesoscale organization exhibit a pronounced daily cycle in their frequency of occurrence, with distinct 24-hour phasing. The patterns Fish and Sugar can be viewed as daytime patterns, with a frequency peak around noon for Fish and towards sunset for Sugar. The patterns Gravel and Flowers appear rather as nighttime patterns, with a peak occurrence around midnight for Gravel and before sunrise for Flowers. The cloud cover for a given pattern, however, always maximizes at nighttime (between 00LT and 03LT), regardless of the specific pattern. The daily variability in the occurrence of Sugar, Gravel and Flowers together seem to reflect the evolution of the daytime shallow cloud population (peaking around sunset) and of the nighttime population of deeper cumuli (peaking near dawn), which were identified in previous work. Finally, some insight on the role of large-scale environmental conditions shows that the near-surface wind speed can explain a large part of the diurnal variability in pattern frequency and cloudiness.