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EOF Analysis of Green Cumulus Mesoscale Organization

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Warm convective clouds play a key role in the Earth's radiative and water budgets. Nonetheless, they still comprise the largest source of uncertainty in climate model's prediction of cloud feedback and climate sensitivity. The latter might be affected by the variety of patterns that warm convective clouds form on the mesoscale, an effect which is largely uninvestigated, and even more so over land. A large subset of continental shallow convective cumulus (Cu) fields was shown to have unique spatial properties and to form mostly over forests and vegetated areas thus referred to as green Cu. Green Cu fields form organized mesoscale patterns, yet the underlying mechanisms, as well as the time variability of these patterns, are still lacking understanding. In this work, we characterize the organization of green Cu in space and time, by using data-driven organization metrics, and by decomposing the high-resolution GOES–16 data using an Empirical Orthogonal Function (EOF) analysis. We extract and quantify modes of organization present in a green Cu field, during the course of a day. The EOF decomposition shows the field's key organization features such as cloud streets, and it also reveals hidden ones, as the propagation of gravity waves (GW), and the development of a highly ordered grid of clouds that extends over hundreds of kilometers, over a time span that scales as the field's lifetime. We then use cloud fields that were reconstructed from different subgroups of modes to quantify the cloud street's wavelength and aspect ratio, as well as the GW dominant period.