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Environments that support organised shallow island convection

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An algorithm is presented with which cloud trails, a form of organised shallow convection associated with the diurnal heating of small flat islands, are identified. This algorithm uses observed 10 m wind direction and visible satellite imagery to distinguish between satellite scenes that depict cloud trail conditions, non-trail conditions, or obscured conditions. The algorithm is then applied to the warm seasons of 2012-2016 for Bermuda - a small flat island in the Western Atlantic Ocean. A climatology of cloud trail activity is developed to better understand the behaviour of this phenomenon. Days that consist primarily of cloud trail activity are compared to days that are without cloud trails – either obscured conditions where larger scale cloudiness is present, or non-trail conditions without a cloud trail present.

We find that the environments that favour cloud trail formation are similar to the environments that are conducive for the growth of shallow cumulus convection. The cloud trail environment is characterised by a warmer and more humid than normal boundary layer. Large scale mid-level vertical motions are generally weak over Bermuda in the cloud trail environment. This is compared to strong mid-level ascent for the obscured case, and mid-level subsidence on non-trail days. The 10 m wind speed is near the 5-year warm season average for the cloud trail case. Additionally, when the flow is parallel to the long axis of the island (from the southwest), cloud trail formation is more likely. Cloud trail activity peaks in July at Bermuda, when the Bermuda-Azores Subtropical High reaches its peak extent and influence across the Western Atlantic bringing warm and humid southwesterly flow across Bermuda with fewer large-scale disturbances. Furthermore, cloud trails are found to occur either transiently in one or two hour periods of activity on a given day, or more rarely, a single long period of cloud trail activity. These results are intended to help inform idealised simulations of organised shallow convection. These simulations are designed to illuminate the meteorological and numerical controls on shallow convection in simulations.