Cloud Trails Past Bermuda

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Introduction

Cloud trails are observed downwind of oceanic islands globally, particularly in the tropics and subtropics. Cloud trails offer a real-world test case for the initiation of shallow convection and the transition from shallow to deep convection in a simple domain. Understanding the behaviour of cloud trails on small islands will then help inform the set-up of idealised numerical simulations.

What are cloud trails?

Small, relatively flat, heated islands generate a local area of deeper boundary layer mixing. It is expected that when low-level moisture is sufficient, rising parts of this region can reach their ICL and clouds can form. This locally deeper mixed layer air is advected downwind forming a ‘plume’ in the lee of the island, often capped with shallow cloud (Fig. 1).

Observations have shown that some environments support transition from shallow to deep convection.

Questions about the larger scale environment that supports shallow cloud trails and particularly the transition from shallow to deep convection could be answered via a combination of an observational study and idealised simulations.

Cloud Trail Algorithm

1. Mask clouds using a reflectance (albedo) threshold (Fig. 2)
2. Take daily mean cloud masks as cloud frequency (Fig. 3)
3. Split the area 0.25° around Bermuda into 16 sectors centred on the cardinal directions
4. Use cloud level wind direction to define upwind and downwind sectors
5. Consider the mean cloud frequency in the domain to split into obscured, not-obscured
6. Of the not-obscured cases, consider the difference between downwind and upwind cloud frequency to split further into cloud trail and not-trail cases

Study Island: Bermuda

• Bermuda is a small (54 km²) relatively flat (76 m) island in the central western Atlantic
• More than 1000 km from the nearest land in North America and the Caribbean
• Bermuda is in the subtropics and is influenced by the Atlantic sub-tropical high during the warm season

Summary/Future Work

• Cloud trail algorithm is a simple objective way to discriminate between cloud trail, non-trail, and obscured days
• Obscured days have a more stable boundary layer, are similarly humid in the boundary layer, but much more humid in the free atmosphere when compared to cloud trail days.
• Non-trail days have comparable potential temperature profiles but are drier than cloud trail days through much of the lower troposphere
• High resolution idealised simulations are planned varying wind speed, direction, shear, large scale environmental characteristics, and island size.
• Assessment of representation at coarse resolutions.

References


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