Contribution ID: **29** Type: **Talk**

Spontaneous clustering of convection in simple models, cloud resolving models and observations.

Monday, 16 May 2022 09:35 (30 minutes)

This talk address convective aggregation on the mesoscale in idealized cloud resolving models, in highly simplified stochastic models and in the latest observations in the tropical western Pacific.

Cloud resolving models run in idealized conditions of radiative convective equilibrium often show randomly distributed convection switching to a state in which the convection is highly clustered, leading to a much drier mean state, which in turn impacts radiative budget. If this organization of convection is sensitive to surface temperature, it could thus represent a facet of climate sensitivity missing from the current generation of climate models. The CRM experiments show that the relative strengths of diabatic feedbacks are model dependent, and therefore to increase understanding, I will present the results of a minimal physics, stochastic reactive-diffusive model for water vapour in the tropical atmosphere, which reproduces the general behaviour of the full physics models. Using this simplified model we derive a dimensionless parameter which predicts which model parameter settings, and domain/resolution frameworks, lead to clustering or random convection.

Given that clustering occurs in idealized frameworks, the next question is whether it is relevant for the real atmosphere on the mesoscale, where ocean SST contrasts driven by dynamics largely determine the distribution of convection. It has been difficult so far to assess aggregation in observations, due to the lack of ability to observe convective core location from space until Doppler radar is available, and the overlapping of cirrus anvils which complicates the assessment of convective organization from TOA longwave observations. Using a novel analysis method to examine a combination of state-of-the-art retrievals of clouds, water vapour, precipitation and sea surface temperature available since 2016, I will present observations that appear to demonstrate convective aggregation operating in the tropical western Pacific region on the sub-1000 km scale, in a region with very weak spatial gradients in sea surface temperature. Convection is generally seen to be in a highly aggregated state, but intermittently and rapidly flips to a random state when low wind conditions prevail, associated with thin mixed ocean layers which oppose aggregation. These events generally persist for a few days to a week or more before convection transitions back to a clustered state. We believe this to be the first direct evidence of this "switching" of clustering state occurring on the meso-scale in the tropics. However, a preliminary analysis indicates that the meso-scale organization actually has little overall impact on the top of atmosphere radiative budget at these scales; the reasons for which will be discussed. If confirmed, these results may indicate that convective clustering at the meso scale is much less important for assessing climate sensitivity than the idealized CRM experiments may suggest.

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Session Classification: Convective concepts