Review of Roca et al. "The contribution of mesoscale dynamics to the tropical anvil cloud growth rate"

13 November, 2026

Roca et al. investigate the life-cycle of tropical deep convective anvil clouds in radiative-convective equilibrium simulations with three convection-permitting models. A cloud-tracking algorithm is applied to track the life cycle of individual clouds, and the output is used to investigate the growth phase of anvil clouds. A minimal complexity model of cloud area growth is developed with a budget equation that includes a detrainment source term and a sink term. A key finding from this analysis is that the source term from mesoscale circulations, defined as columns of the anvil cloud that are not associated with deep convection, makes a non-negligible contribution to the cloud source term during the growing phase. This is a novel contribution to the literature on minimal-complexity models of anvil cloud development, which have focused on the decay phase rather than the growth phase. For this reason, the paper has potential to be a nice contribution to the field. In my opinion, there are a few areas in which the paper could be improved, which are listed below. The paper may be suitable for publication if these issues are addressed.

General Comments

Framing the tracked clouds in the context of the domain-averages

I find it somewhat challenging to understand how much the tracked clouds contribute to domain-average quantities. This would help to understand the representativeness and climate impacts of the subset of clouds that are analyzed. Would it be possible to compute the fraction of domain-average cloud radiative effect, precipitation, and convective mass flux that are associated with the tracked clouds? Table 1 is helpful, but reporting other quantities with more direct physical interpretability would be helpful.

Also, in Table 1, would it be possible to compare the models to observations over the warm-pool regions, where the approximation of radiative-convective equilibrium is most valid? This seems like it could add value to the paper.

Physical interpretation of the source and sink terms in the MANTA model

The discussion of the MANTA model could be improved by linking the terms in the budget equation to specific physical quantities or processes, when possible. Although it is not possible to run sensitivity tests varying the microphysical parameters (line 635), it seems like there is an opportunity to compare results across the three models to get a sense of what microphysical or radiative properties matter for the anvil growth phase. For example, do models with longer decay timescales have smaller ice particles or slower fall speeds in the anvil? Do models with a greater mesoscale source term have larger latent heating rates in the convective columns or larger radiative heating rates in the anvil? Right now the paper does not draw any clear links between the MANTA model and physical

processes, so any additional links would add value for the interpretation of the results.

Specific Comments

- Are the growth rates and decay timescales sensitive to spatial and temporal resolution of the model output? It would be good to know just for the sake of determining whether the values are robust, in which case they could be revealing something about nature, or if they depend on resolution, in which case the quantitative values need to be interpreted with more caution.
- Line 224: typo - superscript km^2
- Line 288: it is unclear if the vertical velocity thresholds have to be exceeded both above and below the 0C isotherm, or if the threshold can be exceeded in only one to be counted as convective
- Line 307: should the formula for M replace anvil cloud area (A) with grid-cell area?
- Line 515: typo - use symbol for tau
- Line 415: typo - “This result indicates”
- Line 619: typo - “The fact that…” -> “The possibility that…”