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Comment on acp-2021-1014

Anonymous Referee #1

Referee comment on "Interaction between cloud–radiation, atmospheric dynamics and thermodynamics based on observational data from GoAmazon 2014/15 and a cloud-resolving model" by Layrson J. M. Gonçalves et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1014-RC1, 2022

This study examines observations of cloud cover, radiation, precipitation and atmospheric thermodynamic variables from the ARM site located in central Amazonian during Go-Amazon and compares them with output from a CRM. The investigation looks for relationships between these variables in the observations and model outputs to see what can be learnt about the interaction of the clouds with their environment and their impact on radiation. The Amazon region provides an excellent environment in which to study the evolution of moist convection and how it relates to the large-scale environment. The use of CRMs is also well established to simulate deep convection and provide additional insight into convective cloud evolution. The authors evaluate various aspects of the CRM's performance including a thorough investigation of the sensitivity of CRM results to the horizontal resolution and show that the standard 2km set does a good job of simulating the temporal variability of clouds, precipitation and radiation although higher resolution better captures the distribution of cloud fraction. The study finds strong co-variations in cloud fraction and surface radiative fluxes at the surface and some correlations between cloud fraction, vertical motion, and column anomalies in temperature and relative humidity. Such relationships are to be expected given the nature of clouds, convection and radiation. In a general sense understanding these relationships better could aid the development and evaluation of cloud parameterizations in large-scale models.
The analysis looks mostly at correlations between the fractional cover of different cloud types and the min/max anomalies of T and RH in the column based on day-to-day variations. This is interesting from an observational point of view in explaining the daily variations in cloud cover and precipitation but the limitation here is that there is only a loose physical connection between these anomalies and what determines the development of these convective clouds. The vertical profile of temperature and moisture and the resulting stability or instability (CAPE, CIN etc) is also a crucial factor that is missing from the analysis, along with broader constraints such as the large-scale convergence of moisture. This may be why the cloud fractions display a lot of scatter in their relationships to the column anomalies of T, RH and omega and relatively low correlation coefficients. Moreover, the relationships observed during these IOPs are unlikely to be generalizable as they assume a certain degree of convective instability and hence sensitivity to the T and RH anomalies. Perhaps there is more that could be gained from this general perspective but it is not obvious from the conclusions how the analysis presented so far could be taken

forward to aid the evaluation and development of parameterizations in large-scale models.
For these reasons I find it difficult to recommend this study for publication in ACP. The study would need to show an increased understanding of the physical interactions involved or a clearer path towards improving the physics in models.