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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Large-eddy simulation of organized precipitating trade wind cumulus clouds" *by* A. Seifert and T. Heus

**Anonymous Referee #1**

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General comments:

Using a set of large eddy simulations, the authors investigated the underlying mechanisms for the formation of cloud clusters and arc shaped cloud mesoscale organizations of trade-wind cumuli. Based on the sensitivity tests and a number of diagnostic analyses, the authors concluded that the cold pool induced by the evaporation of precipitation in the sub-cloud layer provides an important precipitation-moistening feedback mechanism for organizing the precipitating trade wind cumuli. Although I generally agree with the authors that the cold pool plays an important role in organizing precipitating cumuli, to solely attribute the arc shaped cloud mesoscale organizations to the cold pools is something that needs to be further addressed. I don't think that the authors have provided sufficient evidence to approve this conclusion (see my detailed



comment below). Nonetheless, I think the authors made a great effort in both simulations and analyses. The paper is well written. With necessary revisions, the paper is appropriate for publication in ACP.

Detailed comments:

1. In this paper, the authors showed that the cumuli in the standard RICO case run are not well organized. This is in contrast to the moist RICO run in which arc shaped cloud clusters are observed. The authors attribute this important difference in cloud organization to precipitation, which is only marginal in the standard RICO case run but substantial in the moist RICO run. This seems to be true for the time period from 14 h to 24 h that the authors focused on in this paper. However as indicated by Figure 2, there is a decent precipitation rate in the standard RICO case run after 30 h, which is comparable to that in the moist RICO run in the same time period and is only slightly smaller than that in the time period from 14 h to 24 h. The precipitation in the standard RICO case run after 30 h should also induce the cold pools in the sub-cloud layer, then, why clouds are not organized in this case? There are two possibilities here: one is that there must be some other mechanisms to prevent clouds from organizing into the arc shaped cloud clusters, the other is that the mesoscale cloud organizations observed during 14h-24h are not solely caused by precipitation. It would be helpful if the authors could address this issue.

2. From Figure 2, it seems to me that all three simulations eventually reach a fairly similar mean state, say around or after 40 h, regardless of initial conditions and domain sizes. This may be due to the fact that all three simulations are forced by the same external conditions. It is interesting to see what the differences of cloud organization structures are at this stage since all three simulations produce comparable precipitation. I'd suggest the authors to do some analyses on clouds at this stage, which may help us to understand what processes, in addition to precipitation, may have an impact on cloud organizations.

It also seems to me that different setting of simulations (including initial conditions and domain size) requires different time periods to spin up to reach the quasi-steady state. The strong precipitation episode during 14h-24h in the moist runs may be considered as a specific event during the spin-up period. It's quite possible that the precipitation-moistening feedback mechanism only works for certain conditions.

3. In Figure 1, the authors showed the very nice arc shaped cloud organizations from the run with a domain size of 50kmX50km. But as indicated by Figs. 2 and 4, there must be significant differences in the cloud mesoscale structures between the two moist simulations with domain sizes of 50kmX50km and 25kmX25km. Apparently, the cloud mesoscale structures depend on the model domain size. It would be helpful if the authors could address how the cloud organizations change as the model domain increases, and if there is a critical domain size from which the simulated cloud organizations start to converge. Also since most of the analyses in this study are done based on the runs with a domain size of 25kmX25km, it is not clear to what extent the small model domain affects the analysis results.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 1855, 2013.