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Comment on acp-2021-656

Anonymous Referee #3

Referee comment on "Subgrid-scale Horizontal and Vertical Variations of Cloud Water in Stratocumulus Clouds: A case study based on LES and comparisons with in-situ observations" by Justin A. Covert et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-656-RC3, 2021

The paper uses a small suite of LES simulations to investigate the cloud parameters responsible for an in-cloud enhancement factor used in parameterisations of warm rain processes. The paper is straightforward and succint. I would recommend for publication following some minor changes.

Main comments

1/ The mean and variance of qc are from in-cloud only values based on the 0.01g/kg threshold. These are then used to derive in-cloud Eq and IRV.
It is important to point out that the final grid mean autoconversion rate depends upon both any in-cloud value of E and a cloud fraction.
So the grid-mean autoconversion will then be E*f(qc, Nc)*Cloudfraction. The case study indicates that E is in the range 1-3, but Cloudfraction can potentially vary by an order of magnitude or more. Both of these need to be considered for coarse models.

2/ l312 Looking at fig7 in Zhang et al. 2021 it looks like the mode of the qc distribution is below 0.01g/m-3, the threshold used here. The distribution of qc is therefore more like the upper part of a lognormal. In fact, the underlying total humidity distribution (qvapour+qc) is more likely to be normal with the upper tail of it representing the condensed out qc.
If the qc distribution is represented by a truncated distribution how does this impact the results and discussion?

3/ l393. Important to caveat this work.
For this case a constant E is definitely a bad idea and overestimates the process rates by large amounts. But...
It is for one case (in part of the diurnal cycle).
It is unclear what this would look like for trade cumulus?
It is unclear what this would look like for Nc significantly greater than 100/cc (e.g. 400/cc).

minor points

l38. 'many' might be a slight exageration - only one is cited.

l52. You do introduce it later on but it might be worth a sentence here to note that accretion is also important for precipitation production. Furthermore it complicates the situation further by having to deal with the colocation of 'rain' and 'cloud' species. This will be even more important for cumulus.

l146. There is an opportunity here to also analyse the data as 10km and 1km legs to show the scale dependence. It will be of interest to see if E is significantly different to 1 at 1km scales.

l151. Where does the measured qc and nc come from? FSSP, CDP, King probe? I appreciate that all the observational details are not too important for this, but does the observed qc include all liquid droplets including ones that might be considered rain by the autoconversion parameterisation?

l156 fig1b. Could add on points for 10km and 1km legs.

l159. It would be useful to define how E is derived before this point in the text.

l215. 0.01g/kg : is this the same threshold as the aircraft observatons?

l301. Does the good agreement between the model profiles of IRVqc, Eq and observed profile mean that there is no need to worry about independently varying Nc?

l381. Give the range for this case.