Comment on acp-2021-80

Anonymous Referee #1

Referee comment on "Cloud droplet formation at the base of tropical convective clouds: closure between modeling and measurement results of ACRIDICON–CHUVA" by Ramon Campos Braga et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-80-RC1, 2021

The manuscript compares measured cloud droplet concentrations with simulated values produced by a parcel mode. The manuscript lacks a significant amount of background information and information pertaining to the case studies in general. The main points of the article are either unclear, based on assumptions and at times drawn from similarities between cited other studies and not evidence.

The introduction takes a very general approach to providing background information. Including specific results and findings would help put your results into perspective. For example you indicated w has a large uncertainty, but how sensitive were previous studies shown to be sensitive to w? How does that sensitivity compare to other variables? How do past studies that used parcel models and equilibrium models compare? This information and other details from previous studies are necessary to understand the what is important and what assumptions are flawed. I suggest more work be put into including previous results that are relevant to your analysis.

A number of questions remain about the measurements used in the study. Why are the CDP and CAS droplet measurements so different? What measurements were actually used during the flight? Was the entire flight averaged? Were cloud edges excluded? Were the aerosol measurements collected relatively close to the cloud droplet measurements?

While the manuscript presents data from a valuable dataset, the analysis is not thorough, substantial amounts of detailed about the case study are missing and the conclusions are weak, and not evidence based. Based on my assessment, I suggest rejecting the manuscript.

Specific comments:

Line 69 - please define AC. It would be more useful for the reader to name the cases by their attributes than their flight number. Something like LPC- low particle concentration, MCP1,MCP2 –moderate particle concentration...etc.

Line 71- What do you mean by environment air? subsaturated air?

Line 73- By "at cloud base" do you actually mean at cloud base or was it slightly above or below cloud base?

Line 78 – where were these size distribution measurements made relative to the cloud measurments? Were they averaged before fitted to log normal distributions?

Line 80 – Please provide more detail on how the Aitken mode was inferred. It is unclear since the UHSAS only measured as low as 60 nm.

Line 91 – did you demean the updraft velocity? What do you mean by passes with only positive w were considered? Surely there were often some Negative values? I am guessing you mean you just excluded negative values?

Line 106 – Was there any drizzle in the measured clouds? It makes sense to exclude collision coalescence in a parcel model since it cannot be parameterized will with a 0D model, however can you confirm with measurements and results from previous modeling studies that Collision/coalescence are negligable in the clouds you studied (at least the lower 70 m).

Line 112 - "In order to determine the height at which $N_{d,m}$ and $N_{d,p}$ should be compared, simulations were performed using the measured aerosol particle size distributions and an assumed hygroscopicity of k= 0.1, together with w measured at cloud base." It is not clear how this I used to determine the height at which $N_{d,m}$ and $N_{d,p}$ should be compared.

Line 114- make it clear that this is a result from your adiabatic parcel model, not measurements.

Line 120 "in the following..." Section?

Line 133 – how do you define best agreement? Absolute concentration? Percentage difference?

Line 145 – For lateral entrainment to increase droplet concentration, the entrained concentration would need to be both CCN active and higher than the below cloud concentration. I have never seen a case where this has occurred. Can you cite a relevant source? Also, even if there was lateral entrainment, at altitudes so close to cloud base, it is unlikely that there is a significant influence from lateral entrainment. Entrainment would also likely dry the air, decreasing the supersaturation, further decreasing the chance of increasing the droplet concentration.

Line 147 – Entrainment typically leads to a decrease in N_d.

Line 150 – why is that unlikely?

Line 155- What evidence is there for this cloud being impacted by marine air? Having a bimodal distribution does not make an aerosol distribution impacted by marine air. It is very likely that all of the particle distributions have a bimodal distribution, however you cannot tell because you are limited to a minimum particle size measurement of 60 nm by the UHSAS. It is still unclear how you obtained an Aitken mode for AC19.

Line 157 – this result suggests that the aerosol you measured and the aerosol that entered the cloud are not from the same population.

Line 165 The following two quotes from your text are inconsistent with your argument "The chemical composition of Aitken mode particles often differs significantly from that of accumulation mode particles, which are more aged and internally mixed" "Marine particles often show similar hygroscopicity in both Aitken and accumulation modes"

Line 168 – You have indicated it is possible that the hygroscopicity of these particles may be inconsistent with the values you used because you think they are marine aerosol. You have the ability to test this hypothesis with your parcel model, but choose not to. Why?

Line 172- you should include sensitivity calculations.

Line 175- do you mean additional aerosol? Additional activation would surely lead to additional activated particles.

Line 178 – "high sensitivities of Nd to the chemical composition of Aitken mode particles might affect cloud properties" This statement is redundant.

Line 179 – comparable in composition? Concentration? This is unclear. This statement about kappa contradicts your statement in line 167.

Line 186- how was this 30% uncertainty calculated?

Line 215 – non-adiabatic conditions like entrainment would not increase particle concentration, only decrease.

Line 217 calculations are necessary to back this claim and could easily be performed.

Line 218 – you should be able to state your conclusions based on the evidence provided in the manuscript, not by citing others work.