COMMENTS RECEIVED FROM REVIEWER #2

General comments

This paper by Cecchini et al describes the use of the German HALO aircraft, with a very comprehensive payload for studying atmospheric physics and chemistry, and powerful performance characteristics in range and altitude, to study clouds forming over Amazonia. The results are important because Amazonia is an understudied region which is capable of having a profound influence on the Earth's climate. They appear to show a clear dominance of the influence of particle number concentration in air entering the cumulus clouds on their further development. Other factors such as updraft speed have less influence as does height above cloud base. The paper is well written in the most part and is acceptable for publication subject to dealing with the comments below.

Authors answer

We would like to express our gratitude for the anonymous Reviewer #2 for taking the time to review this manuscript. Your suggestions are addressed in detail in this document, please see the list below.

Specific comments from Reviewer #2

1.
    a. **(Question)** It would be much easier to read this paper if it contained a table defining the many physical quantities in the equations, and in the diagrams. Ideally this should be Table 1.
    b. **(Answer)** Added the requested table as Table 1.

2.
    a. **(Question)** Page 7, line 22: The text refers to supplementary material in the form of figures S1-S4. These are not shown in the manuscript. Are these shown in an appendix somewhere?
    b. **(Answer)** Figures S1-S4 (as well as Tables S1-S18) are part of the supplement material provided. It can be found in this link: http://www.atmos-chem-phys-discuss.net/acp-2017-89/acp-2017-89-supplement.pdf.

3.

a. **(Question)** The real physical significance of Figure 2 could be better explained by describing the shape of the lines drawn in the figure as the droplet size 'D' increases particularly the significance of the inflexions. Reasons could be given for why droplet size continues to increase with altitude. To some extent this is dealt with in the concluding remarks but for clarity should be included when the figure is described in detail.

b. **(Answer)** The patterns and inflexions in the curves can be explained by the following concepts. Basically, the balance between the water vapor condensation/evaporation and the collision-coalescence process will ultimately define the DSD curve. Initially the droplets grow by condensation, but latter in the cloud lifetime they also go through the collision-coalescence process. This process occurs when the bigger droplets collide with and collect the smaller droplets. This results in enhanced concentrations of big droplets in detriment of smaller ones. Additionally, there can also occur droplet breakup during the collisions. Both the droplet breakup and the collision-coalescence result in wider DSDs – that is why they are wider higher in the clouds. It is usually considered that measurements higher in the clouds are relative to later stages in the cloud lifetime (because clouds grow from cloud base and upwards). Therefore, the droplet growth with altitude is a result of continuous condensational/collection growth. We added the following sentences to the first paragraph in Section 3.1: "In general, all profiles show droplet growth with altitude as they continually go through the condensational and collision-coalescence processes. The enhanced DSD widening with altitude presented in Figures 2a,b suggest relative predominance of collision-coalescence. Those observations also support the choice of *H* as proxy for cloud lifetime".

4.

a. **(Question)** The axis labelling and figure caption shown in Figure 2 needs improvement. In particular, is the vertical axis na – is the same quantity as shown in Table 1. Some linkage between the numbers referred to in Table 1 and Figure 2 would be helpful.

b. **(Answer)** The vertical axis in Figure 2 is actually the DSDs. They represent droplet number concentrations in each cm^{-3} of air and in a log-space diameter interval. That is why we represent it as dN/dlogD. We added the following text in parenthesis to the second sentence in Section 3.1 to make it clearer: "This figure shows DSDs (<u>dN/dlogD in the vertical axis</u>)…".

5.

a. **(Question)** It appears from Table 1 that there is a significant difference in particle number or CCN, and possibly chemical composition, between maritime and continental cumulus clouds. Are there obvious differences in cloud appearance and shape associated with the differing input parameters? This would be suggested from their conclusions regarding the importance of particle number on cloud development.

b. **(Answer)** It is important to highlight the differences between cloud macro- and microphysical aspects. The microphysics is concerned with smaller-scale processes such as droplet growth and water phase changes. On the other hand, aspects such as cloud shape, size, volume, and so on are related to the cloud macrophysics. The results presented in this study pertain to the clouds microphysics. That is, the properties of the droplets in small volumes inside the clouds. The overall appearance and shape of the clouds is beyond the scope of this work. That said, maritime and continental clouds can have different visual aspects, resulting not only from the different pollution levels but also from different meteorology. Even though aerosols have a determinant role in the cloud microphysics, their overall (macroscale) aspect will be determined by the meteorological conditions. For instance, different vertical wind shear produce different shapes of clouds, where they are tilted under strong vertical wind shear. Additionally, turbulent processes around the cloud edges can also influence its shape. When there is strong entrainment mixing at the cloud edges, the overall size of the cloud can be reduced because of evaporation. Such aspects are briefly mentioned in the text, but are not the focus of this study.

6.

a. **(Question)** Is there any information on the chemical composition of particles entering the different clouds, and in particular regarding the contrast with flight AC19 and the rest? Figure 2 suggests there should be.

b. **(Answer)** Yes, we expect different aerosol chemical composition between the different regions. While the maritime aerosols contain mainly sea-slat, aerosols over the Amazon forest can have a predominance of biological material. Urban or biomass-burning pollution will add inorganic particles to the aerosol population over the forest. The sources and characteristics of the aerosols over the Amazon were reviewed by Martin et al. (2010) – cited in the paper. We added the following sentence on the end of paragraph 2 in Section 2.2 to make it clearer that we won't focus on aerosol chemical composition: "In this study, we will focus on aerosol number concentrations and their chemical composition will not be addressed".

7.

a. **(Question)** Is there a diagram showing the total aircraft instrumentation package and its capabilities in the series dealing with the overall experiment in Amazonia? Perhaps this is described elsewhere and if so should be referenced. Perhaps the Wendisch et al 2016 paper covers this.
b. **(Answer)** Yes, this can be found in Wendisch et al. (2016). This reference contains the overall informations regarding the ACRIDICON-CHUVA campaign.