Reply to Reviewer #3:

We thank the reviewer for the time and efforts she/he spent reading our manuscript and providing valuable advices. Please find below a discussion of the reviewer's comments (italic). Changes/additions made to the text are underlined and given in quotes.

P4, L14: Is humidity variation small for selected 14 flight cases? If not, influence on the conclusions of this paper should be discussed.

In another publication of the ACRIDICON-CHUVA special issue, Cecchini et al. (2017b) found differences in the cloud base altitudes which are related to the humidity. Deforestation plays a role to explain contrasts between flights in different Amazonian regions. They found less relative humidity (75 %) and a higher cloud base (2000 m) in the southern region (AC13) which is affected by deforestation compared to measurements over the forest in the north (80 % RH and 1500 m cloud base). This results in a 500 m thinner warm layer for the polluted cloud. Since we didn't measure the humidity at cloud base during the entire time frame of the specMACS cloud side observations, it is difficult to a relation between humidity and cloud evolution in this work. Therefore, we refer to the paper of Cecchini et al. (2017b) where other cloud cases also from other flight days where discussed.
We added the following:

<u>The temperature profiles of the three flights show only small day-to-day variations in spite of the different flight directions. In contrast, the relative humidity is variable with flight area and altitude as was shown by Cecchini et al. (2017b). They discussed in particular the relation between cloud base and humidity below clouds for several flights performed during the ACRIDICON-CHUVA campaign. For AC13 they found less relative humidity (75 %) and a higher cloud base (2000 m) due to deforestation than compared to measurements over the rain forest (80 % relative humidity and 1500 m cloud base).</u>

Subsection 2.2.2 (MODIS) should be moved to after Subsection 2.2.4 (CAS-DPOL...) because Subsections 2.2.1, 2.2.3 and 2.2.4 describe the aircraft measurements.

The original intention of the order was to separate remote sensing and in situ instruments. However, we changed the order of chapters as suggested by the reviewer.

P5, L25: The MODIS thermodynamic phase algorithm should be explained in more detail for better discussion (around P12, bottom) on the comparison of aircraft measurement results with the MODIS phase results.

We introduced the retrieval of the cloud top phase as provided by the MYD06 data set in more detail and gave some more references. Now it is clearly stated, that with the latest Collection 6, the "mixed phase" class is now combined with the "uncertain" class, in order that a separation of cloud tops with only mixed phase cannot given.

<u>Since MODIS mainly measures cloud top properties, the timespaceexchangeability of convective clouds as proposed by Rosenfeld and Lensky (1998) is applied and referred to as ensemble method. The cloud particle phase of the cloud tops is directly taken from the MOD06/MYD06 20 product "Cloud_Phase_Infrared" with a 1-km-pixel resolution (Baum et al., 2012). Compared to Collection 5, where the cloud phase product was classified as ice, liquid water, mixed phase, and uncertain using brightness temperatures measured at 8.5</u>

and 11 µm (Platnick et al., 2003), Collection 6 is modified by using additional cloud emissivity ratios (7.3/11, 8.5/11, and 11/12 µm) as reported by Pavolonis (2010) and Baum et al. (2012). Empirically derived thresholds of these emissivity ratios were defined to separate finally between liquid water and ice clouds. Note, that due to ambiguity reasons (see Platnick et al. (2017)) a separate classification of mixed phase cloud pixels is no longer provided in Collection 6. The "mixed phase" and "uncertain" classes from Collection 5 are now combined into a single class specified as "undetermined". Hence, the description of the cloud phase profile by applying the ensemble method on the “Cloud_Phase_Infrared" product is limited to the liquid water and the ice phase distribution.
Therefore, the cloud particle size product is used additionally to estimate the glaciation temperature as proposed by Yuan et al. (2010).

The description of the phase statistics as derived from the cloud top and phase frequency plot was modified as follows:

In Fig. 9f the frequency of liquid and ice phase observations for altitude bins of about 200 m is presented. Fully developed deep convective clouds with cloud tops between 10 and 14 km (classified as ice cloud) and low level cumulus clouds up to 6 km (liquid water clouds) are detected. Cloud phase information from the assumed phase transition layers is not available in Collection 6.

And later:

The MODIS phase product shows ice cloud tops between 11 and 15 km altitude and liquid water clouds up to 4.5 km.

P6, L24, “The aspherical fraction is the ratio of aspherical particles ... ”: Is this a ratio of number concentration? Other definitions (area, volume, or mass) of the ratio are possible. Please clarify the definition.

We specified the definition as follows:

The aspherical fraction (AF) is determined by a size dependent ratio of the polarized backward scattered and the forward scattered light with respect to their number concentration.

P14, L4, the last sentence of this Subsection, “Also strong downdrafts can ... ”: The last part of this sentence, “whereas in situ measurements inside the cloud only reveal liquid phase particles”, is confusing to me. Why do cloud side observation and in situ measurements show different results?

As in situ and cloud side measurements are not collocated in time and space one of the main reasons is the horizontal variability of cloud properties which causes differences in the determination of the cloud phase. This variability is enhanced for increasing vertical velocity within the clouds. We modified the paragraph as follows:

Also local strong downdrafts can transport ice particles into lower levels, which will be interpreted as mixed phase layer from the cloud side observation perspective. Due to the horizontal variability of cloud phase inside a cloud cluster for example caused by up- and downdrafts, in situ measurements may only reveal liquid phase particles. A direct comparison between the observation strategies is subject to restrictions because of temporal and spatial variability of cloud properties in convective systems.

Typographic corrections

P9, L32, “140 x 40 x 99”: The “x” character should be replaced by the times symbol.

Done. Also exchanged at other places.

P9, L20, “get”: Should be replaced by “become” or something.

Done.

P12, L22, “m s–1”: Make the “–1” superscript.

Done.