Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2021-20

Anonymous Referee #2

Referee comment on "Use of large-eddy simulations to design an adaptive sampling strategy to assess cumulus cloud heterogeneities by remotely piloted aircraft" by Nicolas Maury et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-20-RC2, 2021

After providing an access review for this article previously, I have now reread it in some more detail. The approach described here is certainly worth pursuing, but I still think the manuscript would greatly benefit from the inclusion of some exploration of the time-evolving case with multiple RPAs. This could be a proof of principle to show that it is possible to characterise the time-evolution of the cloud. For the time-evolving case, some of the transects in the mature phase (e.g. transect 4 and 7 in figure 15) might resemble the full PDF, but these could be "lucky" transects. Moreover, since the analysis is on single transects here, there does not seem to be an advantage over using single passes with a traditional approach. The abstract should at least mention that a single RPA isn't enough to accurately reconstruct individual clouds.

I also think the focus on only 3 clouds (even if these clouds are sampled from multiple starting points) is a weakness of the study. Clouds tend to vary considerably in terms of their shape, especially when they contain multiple updraught cores, so it is hard to see if the results here are generally robust. Showing the LWC convergence for at a few more clouds in the same class size as N2 and N3 would help to establish robustness.

The length scales for GPR currently seem to be chosen by trial and error, but will depend on both the cloud scale and how well the cloud has been sampled. Note that 75m seems to give a good PDF of LWC, but the LWC RMSE is relatively high. It would also be worth pointing out that clouds are fractal objects, and that this is one of the reasons an ellipse/circle reconstruction fails (another reason is that a transect may not pass through the actual centre).

There is another comment on the discussion which mentions the effective resolution of the strategy is 164m. This interpretation does not look right to me, but it would still be good to discuss the practical limitations on resolution that the RPAs may have.

Overall, I think some major revisions would really strengthen the article, and make it suitable for publication. Besides these general comments, I have included a list of minor issues below; these are mostly simple to address though.

General notes:

- Subfigure labels are missing on most plots.

- A non-uniform aspect ratio is used in some figures (e.g. figure 9)

- Some fonts are often too small (e.g. Fig 1, 5-6, 8 and 14-15)

- Figure 6: The black lines in b. are hardly visible

- Figure 7: It is hard to compare the LWC in the reconstructed cloud with the LES field here, though figure 9 clarifies this.

- I think the "(1-\sigma)" notation for standard deviation is confusing. Is the mean +/- the standard deviation meant?

Line-by-line:

- l3: Earth (capitalise)

- l15: "allows to track" ☐ "allows tracking"

- l24" "oceanic surface" ☐ "ocean surface"

- l25: remove "annual"

- l29: "climatic" ☐ "climate"

- l34: "The studies on these processes" ☐ "Studies of these processes"

- l43: "(i.e. the Fast-FSSP (Brenguier et al., 1998) to the HOLODEC" ☐ "(e.g. the Fast-FSSP (Brenguier et al., 1998) and the HOLODEC"

- l47-49: "Some measurement field campaigns have allowed a re-sampling in clouds with aircraft (Burnet and Brenguier, 2007) and with sensors suspended below a helicopter during the CARRIBA campaign (Siebert et al., 2006, Katzwinkel et al., 2014)." ☐ This sentence is not clear.

- l52: "in detail" (singular)

- l64: " microphysic" ☐ " microphysical"

- l68-72: " Section 3 highlights the results of the LES case study with an overview of the cumulus field...We then select one cloud representative of each category and analyze the evolution of their macrophysical and thermodynamical properties, by comparing the exploration strategy and the capacity of the RPAs to reconstruct the microphysical and macrophysical fields for static and dynamic cases." ☐ Both of these sentences are unclear, in particular "an overview of the cumulus field" and "analyze...by comparing the exploration strategy" (which suggests the exploration strategy for static cases is different from that for dynamic cases, it is unclear how "comparing" refers back to "analyze").

- l78: "the period between 22 to 23 June of the Phase 3 of the BOMEX campaign characterized" ☐ "the period 22-23 June of phase 3 of the BOMEX campaign. These days are characterized"

- l81: "LESs" ☐ Rephrase (the plural form is confusing)

- l85: “Well-represented” does this mean the simulations are in line with the intercomparison case? As this is pointed out later, I would leave it out here.

- l87: “is initialized... decreases” ☐ make plural

- l89 and elsewhere: asl ☐ ASL

- l93: “ the piecewise parabolic model” ☐ I think this has not been introduced.

- l98: using a single moment scheme may be appropriate in this case, but there is not really a justification given.

- l104 “four times”

- l108: “outputted” ☐ “stored”

- l109 and elsewhere: “high-resolution”

- l115: It is worth noting the onset of convection is delayed and much more active in MESO-NH.

- l117: Put the year 2003 in parenthesis.

- l124: “cloud entire life cycle” ☐ “entire cloud life cycle

- l126: “the function of time” ☐ “a function of time”

- l130: “isolates..defines” ☐ “isolate...define”

- l132: it is unclear if/where faces, edges, or corners respectively are used in the tracking

algorithm.

- l150: “RPAS” ☐ “RPA”

- l175: It is worth pointing out here that the few clouds in class 3 contribute disproportionally to cloud volume, mass-flux and heat and moisture transport.

- l180: “the minimum and maximum lifetime...over their lifetime” ☐ rephrase

- l184: the smaller clouds may sometimes be remnants where tracking has failed, which would explain their higher cloud base.

- l187: “vertical extension and variations” ☐ what is meant by variations here?

- l193: “The standard deviation is 200 times greater than the average flux for cumulus class 0, while it is only 1.37 times greater than the average mass flux for class 3.” ☐ I am a bit sceptical of the first result. Maybe leave this out, as it is not supported with further data or figures. The large standard deviations could be the result of using large bin sizes for the classes.

- l205: “are followed” ☐ “is followed”

- l215: “summit” ☐ “top”

- l220 and 344: “maturity” or “its mature phase”

- l226: “has permitted [to describe the☐ the description of] heterogeneities [of☐ in] the horizontal and vertical structure of cumulus clouds, in particular with respect to LWC” ☐ Horizontal structure only seems to be described later in the article.

- l244 and elsewhere: “the cloud N2” ☐ “cloud N2”

- l249: “and 4% of grids have a LWC near 0.40 g per m^3” ☐ this description is imprecise

- l252: remove parentheses

- l253: Does the LWC really approach the reference distribution (without reconstruction, at this point)? It seems like high LWC is still oversampled. The description also doesn’t make it clear the PDFs for the later transects are cumulative.

- l255: “and representing 15% of the cloud cross section.” ☐ This is unclear

- l258: “above-mentioned”

- l267-268: “For following...Gaussian” ☐ “Below...GPR”

- l272: \lambda_t = \infinity: do you simply mean temporal variation is not taken into account?

- l287: “with Rosette pattern” ☐ “with a Rosette pattern”

- l288: “is compared” ☐ “are compared”

- l289: Since this is at one altitude only, the units of LWC_{tot} seem incorrect (it may be in gram per meter vertical extent). Similarly, trying to derive this without GPR or an ellipse/circle fitting method (the “method_transect”) seems strange. Looking at figure 7, it may be based on a grid here, but that makes it very dependent on the grid spacing used in that grid.

- Equation 1: Use n_{bin} for the number of bins.

- l312: “Table 2 highlighting a significantly improved mapping the cross section by using the GPR method.” ☐ “Table 2, highlighting a significantly improved mapping of the cross section by using the GPR method.”

- l321: I don’t understand the meaning of “pattern-limited” here. It should still be possible to perform many transects in the smaller cloud and get a good reconstruction, though \lambda may need to be reduced.

- l329: “with time and space” ☐ “with time and in space”

- l329: “and reaches 0.1 by the end of the HFS.” ☐ this is unclear to me

- l331: comma missing before “tracking”

- l338: “continues” ☐ “continue”

- l345: “resembling to” ☐ “resembling that of”

- l348: “ improve the ability to reconstruction of” ☐ “improves the ability to reconstruct”

- l350: “ either via a better sampling strategy of leg adding a second RPA.” ☐ “either via a better sampling strategy or by adding more RPAs.”

- l354: “non-precipitating” ☐ “weakly precipitating”/“without surface precipitation”

- l356: “derived from the observations in” ☐ “, where the simulations are based on observations during”

- l363: “its growth phase, maturity, and dissipation phases”: remove “phase”

- l366: remove spurious “its”

- l373: “assuming a circular” ☐ “assuming circular”

- l391: " with a different trajectories RPA" □ this is unclear. This sentence mentions both " To optimize the dynamic exploration of a cloud" and "in improving our ability to observe the cloud life cycle", which makes it too long.