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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Statistical analysis of a LES shallow cumulus cloud ensemble using a cloud tracking algorithm" *by* J. T. Dawe and P. H. Austin

Anonymous Referee #2

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The article uses cloud tracking to study individual shallow cumulus clouds in a statistical way. The first part focuses on describing the algorithm, and on cloud life time statistics. The second part extends the Nature vs. Nurture discussion, on whether clouds are a slave of their properties at cloud base and below, or that they are ruled by entrainment and detrainment events in the cloud layer.

I find the article overall very interesting and definitely recommend publishing it. There are however some points that I would like to give as considerations before acceptance.

First of all, the article reads to me almost as two separate studies. The first one (everything up to section 4.1), about actual cloud tracking and the statistics thereof, suffers

from being not very thorough, or at least not adding a lot to previous articles by the authors as well as the work by Heus et al. That is, the automated algorithm is an excellent achievement in itself, but I don't see the additional statistics being used a lot.

The second part of the article is the part that really shines to me. However, one could argue that that part of the article suffers from only starting at page 13 of the article, thus easily overlooked. I wonder what the reason of the authors was to put this all together in one article.

Overall, I really applaud the statistical rigidity of the analysis, complete with confidence intervals. This is something that is not often enough done in our field.

Detailed comments:

- Shouldn't the title be ...analysis of *an* LES shallow....?
- p23235, l.14 and other places: Couvreux is spelled without the 'a'
- p23236, l.13: Enforcing condensed points to be a subset of the plume points is fine I'm sure for studies on transport, but isn't it giving a bias in that it neglects passive clouds?
- p23236 the definition of cloudlets is not completely clear to me, and not always consistently used in the article, I believe. What is the difference between clouds and cloudlets?
- p23236, l.21: How is a split cloudlet being divided over 2 cloudlets, exactly? I assume by some proximity to the center or mass, or something like that, but this is not clear.
- p23237, second and third paragraph: This is a rather technical discussion, that could benefit from a better graphicial depiction. All actions should be depicted in some sense (and cross referenced between the figure and the text). Also, from

figure 2 it isn't clear to me what the difference between cloud 2/3 and 4 really is. Given that the description of the algorithm is an important goal of the paper, more care to clarity here is necessary.

- p23238 The implicit definition that Zhao&Austin, and Heus et al, used for a cloud is a connected area in space and time that emerges and decays within the window of observation, including the entire lineage of splitting and merging 'cloudlets'. That means that many of your 3171 do not qualify as such, because they either are involved in splitting and merging events, or have a lifespan that reaches over the boundaries of the observation window. So: How many clouds according that definition are actually tracked? How long does the tracking algorithm need in terms of CPU time? This is relevant because you claim to have significantly better statistics with less human effort. So how does this compare to the tens of clouds selected by Heus et al, in a process that took maybe a few days of cherry picking?
- p23239/Figure 3: This cloud worries me a bit. Its cloud fraction at cloud base seems to be close to 1 percent, that is: Close to the entire cloud field of BOMEX. It also has a duration that is a big part of the measurement window. How dominating is this cloud within the sample?
- p23240/Fig 5: What are the bin widths? This is important here to understand what the relative numbers are.
- p23240/Fig 5: This is a figure that with the tracking algorithm in place, a lot more can be done with. For instance, your figure 1 shows that some cloud bases rise at the end of their life time, but not all. A 2D pdf of Cloud base and Cloud height vs relative cloud life time would be more interesting to me than these plots (c and d at least), that are not all that different from what can be done without tracking.
- p23241: If I understand this right, the cloud size distribution is still an instan-

taneous property, merely to validate your cloud sample as something that is a realistic reflection of the entire cloud field. I'd be interested to see a discussion here on the role of the lifecycle in skewing the cloud size distribution. I could imagine that taking the lifecycle-average cloud size has a similar effect: Small clouds may become bigger later in their life time, and large clouds have on average a smaller size during their lifetime. So what does the distibution look like for average and/or maximum cloud size over its lifetime?

- p23242: Like with for example Neggers, a scale brake at 1km is not all that surprising, given that your domain is only 6.4km wide. And while your λ agrees well with the literature, a range between 1.7 and 2.3 is a fairly big range. Does your study shed some light on what could be the reason for the differences between the various studies? Does the air plane bias towards older clouds (one can't aim for clouds that haven't popped up yet) or the 2D bias of satellite observations play a role here?
- p23243/ Fig 7: I assume these correlations are on the in cloud minus slab averaged values? Otherwise, strong correlations are perhaps not so surprising.
- p23243: It is interesting to see the strong correlation between M and a, in contrast with the small correlation between w and a. Can the authors comment on that a bit more?
- p23246: An interesting extension of Romps indeed. Especially the correlation in dynamics, but the lack thereof in thermodynamic quantities is interesting. A 'nature-like' approach would suggest that big area cloud bases would result in less entrainment/detrainment (as shown by Fig 12), which would maintain the cloud. If sample size allow it, it would be interesting to see whether there is a bit more of a spatial correlation in q_t if looking at only the biggest cloud (bases).
- p23247/Fig13: What is the added value of this plot? I would at least plot the

domain averaged q_t to get a feeling for the deviation there.

- Table 1: This table contains a lot of information, but it is not always immediately clear where to look. A color/grey background gor the significant ones could help a lot already. Also, the headers are a bit cryptic.

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