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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling microphysical effects of entrainment in clouds observed during EUCAARI-IMPACT field campaign" *by* D. Jarecka et al.

Anonymous Referee #1

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This paper is a description of LES simulations of a stratocumulus over cumulus field, as observed during the EUCAARI-IMPACT field campaign. I find the paper solid, but very descriptive. While going through the introduction, I found myself wondering why I want to be interested in this work. This was fixed later when studying the figures in depth and coming up with some questions. Up to a point, it is fine to be a descriptive paper when it is part of a special issue about the field campaign. However, there are some interesting points in this work that I think can be better highlighted, improving the overall interest of this paper. Since this may require some thinking and rearranging on the side of the authors, I am recommending major revisions for this paper.

- The introduction does not state any real goal for the paper, other than doing a simulation of a particular cloud deck at a particular time and place. What could the paper mean beyond that? For instance, it could serve as a paper to (further) validate the mixing model, or emphasize the necessity of it. But for that you would need to show the impact of the model on the mean quantities of your simulation. Or the focus of the paper could be on the physics of the cloud edge mixing. Then, some more explanation of why the results are the way they are would be in order (why is the evaporation time scale almost equal to the mixing scale? What happens at the cloud top?).

- There are many minor grammatical errors in the text that reveal that this manuscript is not written by native speakers. Specifically, many articles are missing. The first one is in the title: I would say *the* EUCAARI field campaign. These errors do not prohibit the understanding, so for now it is fine, but I would recommend proof reading by a native speaker.

- I cannot access JGMP13 (is Hugh Morrison one of the authors? if so, he is missing in the references), but I would appreciate to know what is already done in that paper. There is a potential for overlap with this paper, and I'd like to know how well the subgrid model is validated in that paper. I assume that JGMP13 focused on conventional shallow cumulus?

- As far as I know, the method is based on filaments of cloudy air being ripped away from the cloud, and after that slowly evaporating. This is a process that I much more heavily associate with cumulus than with stratocumulus, and I've always read the Andrejczuk in the cumulus context. How well is the model validated for stratocumulus?

- Does the resolution of your simulations suffice? Sandu and Stevens (JAS, 2011) use a 35/5 m grid. Especially at the stratocumulus top I would expect that to be

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necessary. Also, a horizontal resolution of 50m means that the 3 smallest cumulus clouds in figure 7 have a width of $2\Delta x$ or less. Given that this paper is not just about being able to simulate a certain field, but about gaining understanding of the mixing around the cloud edge, I suspect a significant resolution dependency here. Also, for these cloud sizes and resolutions, does the assumption of $\Lambda = \Delta$ still hold? Given all of this, I would recommend redoing the simulations preferably with a 25/10m resolution. This should still be very well doable on most present days machines.

- Figure 1: Segments instead of sedments
- Figure 3: What is the definition of the cloud base here? Local lowest level of cloudiness, global lowest level, first level with a cloud fraction over, e.g., 80%, etc? Also, the line in fig b is undefined.
- Figure 5a: Is this the potential temperature, or the liquid water potential temperature?
- Figure 8b: I assume this is q_l conditionally sampled over cloudy regions? If not, entrainment cannot be blamed of dilution using this graph. Could you plot the 1g/kg/500m line as a reference in this graph?
- p1499, l2: The cloud fraction for cumulus being .1 and for stratocumulus .9 is a rather trivial result.
- p1500, l 19: Section 3, not the previous section
- p1500, l 22: "Most of the mixing occurs at the edges of cu and the top of StCu" Where else? Would you have expected more mixing further removed from the cloud, or inside the cloud after a strong entrainment event? The thing that is interesting here is the combination with the timescales of Fig. 13. In 2 minutes, $(= \tau_{mix})$, I'd expect the mixing parcel to have moved a fair amount.

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- Figure 13: These timescales are interesting. For instance, the mixing timescale is close to the Brunt Vaisala timescale, although I believe no information on buoyancy is explicitly present in the calculation of it. Is there a buoyancy correction in your sub grid model? Or is it just the mixing time of a grid box, meaning that there is a resolution dependency here. Even if you don't know why the time scales are the way they are, I would enjoy some educated guesses. The evaporation time scale is a lot longer than I would have expected it, and certainly suggests that the usual all-or-nothing approach of traditional LES models is not valid. Could you comment on this? Do you know what the impact is on the mean quantities (e.g, in precipitation, or cloud top entrainment)
- Figure 15: Many of your entrainment events seem to sit at λ_0. Although the length scale should come straight out of theoretical turbulence, there is significant room for alterations to this parameter. Could you comment on the sensitivities?

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 1489, 2013.