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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Physics of Stratocumulus Top (POST): turbulent mixing across capping inversion" *by* S. P. Malinowski et al.

Anonymous Referee #1

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General:

The paper provides a conceptual explanation of the entrainment process at top of stratocumulus clouds based on two case studies under different dynamic and thermodynamic conditions. The scientific topic is of great interest because stratocumulus is the prevailing cloud type over comparable cold oceans and covers huge areas. The entrainment mainly controls cloud lifetime and the structure of Sc-fields but is still not sufficiently understood.

I strongly suggest this manuscript for publication after considering a few suggestions

that are presented below. Although I have no major scientifically concerns I suggest that at least a few parts should be carefully edited and maybe re-organized (in particular for Sec 3 – see comments below).

I have to mention that I am not a native speaker and will not make any comments about the language and style; several co-authors are native speakers and can do this job much better than I can.

Specific comments

The introduction provides a nice overview of the problem but maybe it could be at some place more precise instead of listing previous experiments and numerical investigations of the problem. What are the specific findings of these previous investigations and what are the specific problems/open questions in describing entrainment?

Page 15235, line 23, what does "TO" means before the flight numbers?

A discussion of a recently published manuscript by Katzwinkel et al 2011 is missing in the introduction - in particular in that part of the introduction where the presence of an EIL and the need of high-resolution measurements are presented. There results and data interpretation are quite similar compared to the present manuscript and the differences have to be clearly clarified and discussed. I realized that this paper is cited in Sec 4.3 but not really discussed and compared to the findings of the manuscript.

Quite often the vague term "high-resolution" (or similar) is used, what do you mean exactly? What is needed to observe the different details of the EIL and what resolution was actually achieved during POST for the different parameters? (I realized that technical information comes later but I think when mentioning this problem of resolution requirements here it should be clarified what was achieved during POST).

Page 15236, line 20ff: How is the resolution of the PDI defined when it measures individual droplets? Do you mean the integration time for estimating a full droplet size distribution? Should be clarified. You mention "two sets of microphysical probes" –

what are the others?

At the end of Sec 2 on page 15237 one could consider a somewhat more conclusive description of the two cases (classical and non-classical), for example does both cases include shear? A more detailed description follows in Sec 3, which is fine with me but if you already mention the two cases at the end of Sec 2 I suggest to give some more details at this place.

Page 15239, line 12: " It is interesting..." I would avoid such sentences or explain why such an investigation is interesting. I think this sentence is not enough to justify Fig 5. The motivation to show this plot here is not clear and should become stronger because the presented data is interesting.

Figure 6.: It looks like that below 95m below cloud top, the drop size distribution indicates significant smaller droplets compared with the layers above – any idea?

Page 15240, line 14 & 15: I don't really understand this sentence, can you please clarify what exactly you mean? I strongly suggest to quantify the shear in Fig 7 (and 2) and show a profile of sqrt(du/dz ˆ2+ dv/dzˆ2) or so.

At several places you uses phrases such like " this parameter is high above cloud" or so, I suggest being more precise and quantifying these values.

General comment about Sec 3: The two different cases are really interesting and worth to be shown in detail, in particular when it comes to the cloud response in terms of the microphysical properties. However, it was difficult for me to follow all the differences and details between the two cases and I suggest a slightly different presentation of the data. Why not using a non-dimensionalized vertical axis and showing both cases in one plot or at least close to each other. For example combing Fig 2 & 7, which would allow a direct comparison and the differences, would become clearer. With two different plots a few pages separated one has to switch all the time. This is only a suggestion but I feel that this would improve the manuscript significantly and it would become much

easier for the readers to understand and realize all the details and difference of the two cases!

Introduction of Sec 4: Are there, by chance, photos of the different cloud decks available – would be great to illustrate the differences!

Please check the units for the squared wind shear in Fig 12 & 13, I also suggest to label the different layers in the figure instead of only mark them by vertical lines. It will help the reader!

Why do you show the parameters as a function of time including a time series of the measurement height instead of presenting the material as a function of height in general? It would be natural to show a profile as a function of height and the interpretation would be much easier, this comment is also valid for a few previous figures.

Honestly, in Fig 12 I would place the vertical black lines slightly different and in Fig 13 I see no convincing arguments for distinct layer. The explanation in the manuscript seems to be somewhat arbitrary?! Please comment on this.

Why did you use the "i" in the Richardson number as an index? R_i instead of Ri ? I never saw this before.

Is it possible to provide mixing diagrams (e.g., cubed diameter over droplet concentration) for both cases? Are they different? If yes, one could think of including one figure with both cases.

Figure 16: This conceptual figure is nice and illustrative but maybe it could be improved a little bit. The capture is at least in some parts difficult to read and the explanations should be re-ordered. It is difficult to follow all the lines and I suggest mentioning the meaning of dashed and solid lines earlier. In addition, the meaning of the red arrows is not really clear for me. Maybe (just an idea) it would be clearer if you show a straight line for the temperature and LWC instead of fluctuations. At some place in the cartoon there are just too much lines and "scatter".

A final question: Can this conceptual picture help to estimate the amount of entrained air or to estimate an entrainment velocity? How can modelers benefit from you findings?

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 15233, 2013.