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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Subsiding shells and vertical mass flux in warm cumulus clouds over land" *by* Christian Mallaun et al.

Anonymous Referee #2

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Review on

"Subsiding shells and vertical mass flux in warm cumulus clouds over land"

by Christian Mallaun, Andreas Giez, Georg J. Mayr, and Mathias W. Rotach

This manuscript describes airborne observations of several cumulus penetrations with respect to details of the cloud edges, subsiding shells, and corresponding vertical mass transport in continental clouds. After a brief review of previous observations and LES findings mainly based on maritime clouds the authors motivate their work with the extension to continental clouds under different synoptic situations and terrain.

I have two major comments on this motivation, which are most important for the entire manuscript:

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1) Why should maritime cloud dynamics should significant differ from continental clouds? 2) How can you come up with robust conclusions based on only six flights?

After reading the manuscript, I have the impression that quite similar analysis already published in the cited papers has been applied to just another set of cloud data without really new aspects or findings. Therefore, this manuscript does not give new insight in cloud dynamics and unfortunately lacks of any novelty and, therefore, I suggest significant re-writing. I cannot suggest this manuscript for publishing in ACP in its current form.

I have several other major comments, which might be useful for a revised manuscript.

page 1, line 19: would not call this process "simple"; better "this general concept is illustrated in Fig 1.."

p2, l 6: not sure if one can conclude – based on the cited observations - that the subsiding shell does surround the entire cloud. To my opinion, such conclusion can only be drawn from LES.

p2, l 15 to 20: it is not convincing to me that clouds over land should differ from clouds over the ocean with respect to sub-siding shells. I think one should better motivate why the presented observations are novel and one could get new insight in cloud dynamics

Sec 2.1.& 2.3 One of my main concerns about the observations themselves is the lack of any cloud droplet sensor for a cloud experiment. The cloud identification based on rH is rather crude. It is well known that quite often cumulus clouds are surrounded by almost saturated air (humidity halos) which cannot be distinguished from droplet-free air with your criterion of cloud edges.

Another more technical question is if there is a special inlet to avoid droplets entering the Lyman-alpha system, which might influence the readings when leaving the cloud that might bias the data interpretation. I do not generally question the rH measurement but this should be clarified and/or discussed in detail because it is important. I think for

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the Lyman-alpha there are better and more fundamental references such as Buck et al.

Sec 2.2: At some point it would be essential to get more information about the sampled cloud fields, e.g. cloud base height and cloud tops, temperature and so on. From this information one could at least estimate the adiabatic LWC, which give us a range for the liquid water mixing ratio and, therefore, the maximum error for the calculated buoyancy.

P4, l12: Please discuss a little bit more in detail why you didn't simply applied criteria used for previous observations. This would have the advantage to better compare the results with each other. You should have good reasons to introduce new criteria!

Sec 2.4.2 LWC – in particular for non-adiabatic regions such a cloud boundaries is a highly fluctuating parameter. To assume a constant value is a very strong simplification. Please discuss in detail the consequences and a maximum error for the derived buoyancy. Without such a discussion the presented buoyancy is highly questionable. I suggest ignoring the LWC and discussing the maximum error for B; this might be more straightforward compared to use a constant value for LWC – the error will be small and not alter your results. The variation of LWC as seen in Wang et al describe more the deviation from the adiabatic LWC which itself is a function of height and cloud base temperature.

Discussion, line 23ff: You mentioned that a certain fraction of the sampled clouds do not show a subsiding shell on both sides. Based on this finding I have serious concerns how representative an estimated mass flux distribution is? One should remember that a flight through a cloud is one single realization and more a "spaghetti-like" penetration.

P11, line 1 "We find a positive correlation of vertical wind and buoyancy (i.e., r _ 40%). Near the cloud gaps this indicates mixing of cloud air with environmental air" I cannot follow this logic; the first part of this statement simply states that about 40% oft he data shows an actively growing cloud (following Katzwinkel's nomenclature) but how can you conclude that this means mixing around cloud gaps? Cloud gaps are most

probably the consequence of mixing. Please explain your conclusion. The intention of next statement is also not clear; it is the nature of turbulence that up- and downdrafts can be observed close to each other so why should one be surprised to find this in cumulus clouds? Maybe this is simply a misunderstanding on my side. . ..

P11, l12" On the downwind side of active clouds the broad region of downdrafts is explainable by a humidity halo as observed by Perry and Hobbs (1996)."

Why can broad regions with downdrafts be explained by humidity halos. By the way, if you cannot measure LWC but instead define your cloud boundary by relative humidity you cannot identify humidity halos, which are characterized by almost saturated conditions but no cloud droplets.

It was quite often concluded that your observations are similar to previous observations – so the reader is left with the question "What is new in your study¿'

"An investigation of size, turbulence statistics and scaling with the cloud size in future research is desirable to understand the dynamics of shallow convection over land."

Why not starting with answering these questions in this paper?

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