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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Role of updrafts in aerosol-cloud interactions: lidar observations of layered warm clouds over central Europe" *by* J. Schmidt et al.

Anonymous Referee #3

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General Comments:

This manuscript presents results of Raman lidar observations of shallow altocumulus clouds for 29 cases over a 2-year period observed in Leipzig Germany. The cases are analyzed to understand the aerosol-cloud-interactions (ACI) for these shallow clouds and the impact of updraft velocity on ACI parameters. The analysis relies on the Raman lidar retrieved LWC, effective radius, and extinction parameters to compute the ACI parameter and use a Doppler lidar to infer vertical wind. The results are intended to show that weak updrafts tend to diminish the effects of aerosols on cloud droplet number in comparison to strong updraft scenarios.

The topic presented in this manuscript is an important one and I am very supportive of examining and improving understanding of the role of cloud dynamics in controlling aerosol effects. However, I am concerned about the lack of rigorous analysis of measurement errors and uncertainties, and the propagation of those uncertainties into retrieved parameters. The uncertainty in the retrieved parameters is crucial to making a convincing argument concerning the manuscript conclusions. The authors reference the Schmidt et al 2013 Applied Optics paper (and a Ph.D. dissertation that I do not have access to) regarding the measurement uncertainties and error analysis, but do not discuss those uncertainties in the context of these results. I think that by doing so, the authors' arguments will be much stronger and more convincing. For these reasons, I recommend that this paper be accepted only after this major issue has been addressed. I have supplied some specific comments below, which should also be addressed before accepted.

Specific Comments:

1) Introduction: I think one of the primary motivations for making long-term observations is that they provide necessary constraints for processes that are difficult to represent in models. The processes examined in this manuscript are active on the sub-grid scale relative to the GCM grid scale. A large number of observations are required to produce statistically significant constraints on sub-grid scale parameterizations, many of which are developed based on a few cases studies. This is an important motivation that should be emphasized in the introduction. While you are examining cases over 2-yr, it is only 29 cases. Is this number statistically significant? Also in the introduction, suggest also referencing ARM since it has a much longer continuous record than CLOUDNET and was established before CLOUDNET.

2) The cloud cases are chosen only for altocumulus clouds, which can often have ice virga falling out of the cloud. Your retrieval of LWC and effective radius relies on the assumption that the clouds are liquid. What steps are taken to ensure that ice conditions are not included in the dataset?

ACPD
14, C12234–C12236, 2015

3) Section 2: Please provide a short summary about the cloud properties retrieval and the uncertainty of parameters used in the study. What is the uncertainty in the ACI indices that are computed using these parameters? Are your results robust given these uncertainties? How is the number concentration (N) retrieved? I did not see this in the referenced Schmidt et al 2013 paper. What is the uncertainty on the Doppler lidar updraft velocity measurements in cloud?

4) Last sentence in Section 3.4: I don't think that you can make any concrete conclusions about downdrafts, turbulent mixing and entrainment processes with out using model simulations to support your conclusions.

5) Figure 7 – can you annotate the figure to show which references include vertical wind in their analysis?

6) Your discussion of spatial scales in Section 4 (Literature Review) is key to the significance of your findings. It would be useful to quantify the sub-grid scale variability and the impact of this variability on the ACI conclusions and package it in a way that can be used to constrain model simulations and parameterizations. It really is not all that surprising that the influence of aerosol will be enhanced by stronger updrafts. Quantifying this phenomenon will increase the impact of your results.

7) Figures 3 and 4: the error bars are huge (orders of magnitude) and correlations and between parameters (i.e. R-squared Fig 6) are very small. In Fig. 5 the ACI index is 0.5 with +/- error bar of 0.4. This lends question to the robustness of your results/conclusions. Please provide a more thorough discussion of these error bars. It may help to compare with the uncertainties in other studies discussed in the literature review, which currently is not very quantitative in nature (in terms of uncertainty).

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 31409, 2014.