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Atmospheric Measurement Techniques Discussions

Interactive comment on "Synergy of Active- and Passive Remote Sensing: An Approach to Reconstruct Three-Dimensional Cloud Macro- and Microphysics" *by* Lucas Höppler et al.

Anonymous Referee #2

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This paper presents a method to infer 3D cloud fields of macro- and micro-physical properties using a synergy of 2D cloud imagery (vis, NIR + microwave), lidar and dropsondes. The method is an adaptation of the Barker et al,. 2011 cloud reconstruction method whereby the vertical structure of the clouds is inferred by extrapolating information from a central track under the assumption that profiles with similar radiances have similar vertical profiles. The method differs from the Barker et al., 2011 approach by using lidar and radiosonde to retrieve cloud top height and cloud base height respectively in the central track, rather than radar reflectivity. The application of the method is also different; measurements from instruments aboard the German research aircraft HALO are used rather than satellite data allowing finer resolution measurements of

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cumulus clouds which are difficult to observe from e.g., CloudSat.

The overall scope of the paper is definitely relevant to AMT and has the potential to be a great paper of interest to a broad audience. However, often frustrating to the reviewer, the paper feels unfinished at times, particularly in the results section. The paper has a number of co-authors and it is surprising that some of the quite obvious issues with the paper have not been ironed-out. As a simple example, many of the figure captions need work to be clear; the captions of Fig. 10. and 11 feel rushed and it is not clear if the figures are from the same cloud field. I therefore strongly suggest that the paper is reviewed carefully amongst co-authors before submission of the revised version.

General comments

- The manuscript does not contain sufficient information to reproduce the results in its current form. How many different scenes were used to generate the statistics in Table 1? Is the same scene used in all the Figures?

- How was the radar used in the study? There is a brief mention in the introduction on page 3 line 17 'The radar is used to determine multiple cloud layers', and then is not mentioned again (apart from to define its frequency in Section 2.2). Could the radar be used to define a more accurate cloud base? Could the profiling information of the radar be used to improve the microphysical retrievals?

- The introduction lacks focus, particularly in relation to '3D'. How will 3D cloud fields help reduce uncertainties in cloud processes? What other 3D cloud retrievals are available?

- The abstract makes a subjective claim that the consistency check shows 'good agreement'. Do you think that can be claimed given the disagreements in the radiance histograms i.e. Fig 16c) and 16f)? What would be a good agreement? Does the method outperform a 'dumb' retrieval of assuming a constant cloud base height (perhaps by taking the average cloud top height seen by the lidar for a given cloud scene)

- How justifiable is the assumption of constant cloud base between dropsondes?

- Would an infra-red channel allow cloud-top temperature to be used to better retrieve cloud top height as is done for e.g., MODIS cloud top height retrievals? If an infra-red channel was available on HALO would the method become obsolete? Perhaps I am not understanding something here.

- The discussion of 'shadowing' in the paper could be elaborated. In the introduction you state 'Shadow effects can be eliminated', which led me to think that the method would somehow account for shadowing in the retrieval, but I don't think this is the case- perhaps 'Shadow affected clouds can be removed. . .' would be more appropriate. How much does solar zenith angle affect the results?

Specific comments

- I do not think that the diagram of specMACS in Fig 1 adds much to the paper. Would it not be more useful to include a schematic/flow diagram of how the method works?

- What does 'flight security' mean on page 5 line 22?

- In Fig.5 Why does the liquid water content for a=0.5 appear more than half of a=1.0? Perhaps it appears that way because the axes do not start at '0'.

- What does 'm' mean in Fig 6?

- What data/measurements are used as input to Fig 7? This figure would be impossible to reproduce without this information!

- What does 'px' mean in the figures? Pixel? How is that a time? Why is the range different in Fig 16. Compared to Fig 18 (0-300 vs 0-1600)?

- Would other statistics., e.g., RMSE, be useful in evaluating the reconstructions in Section 5.5?

- How is the error of 10% in effective radius (page 29 line 12) justified when the previous

paragraph says 20%?

- In Fig 12., wouldn't a shallower sun angle be more appropriate to show an example of the shadow mask? SZA=3.6 degrees is almost overhead, where shadows would be minimized anyway.

- Why isn't the cloud mask applied before reporting the cloud effective radius in Fig 10? It would be useful to see what cloud effective radius is retrieved near cloud edges.

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