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Interactive comment on "The source of discrepancies in aerosol–cloud–precipitation interactions between GCM and A-Train retrievals" *by* Takuro Michibata et al.

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In their submitted contribution to ACP, the authors investigate the reasons behind the discrepanies in cloud and precipitation response to changes in the number of cloud droplets dN_C in observations (satellite) and an aerosol climate model (MIROC-SPRINTARS). By doing so, the cloud and precipitation response under conditions of changing aerosol concentrations is investigated (if a positive relationship between dN_C and increasing aerosol concentrations is taken for granted). Overall, the authors find that the modelled sensitivity of cloud and precipitation responses to dN_C are in disagreement with observations and that this disagreement most probably stems from the simplistic parameterization of autoconversion in the model. This has been known for

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Discussion paper

quite some time now (see references in the submitted manuscript), therefore rendering the submission as yet another study showing the limitations of current generation aerosol-climate models to adequately reproduce observed aerosol-cloud interactions. The limitations of satellite observations for this purpose must also be kept in mind though. Unfortunately, the authors miss the opportunity to present at least some suggestions for future model improvements, which - given the wealth of data and diagnostics presented - would add significant punch to the submission.

In light of the above, I find the global distributions of d ln LWP / d ln N_C shown in Figure 2c,d of the submitted manuscript very intriguing and investigating the shown relationships further would potentially add more substance to the science presented.

Although the magnitude and even the sign of the shown relationships in Fig. 2 differ significantly between observations and the model, the overall pattern is similar: the relationship becomes weaker towards the tropics - although still of wrong sign. The reason for this could be high natural variability and the dominance of cloud dynamical processes compared to microphysical ones (e.g. Peters et al. (2014)). The same processes could be at work in the model used in the present study.

From the model description presented in the manuscript, it appears that the prognostic cloud scheme used in MIROC-SPRINTARS accounts for subgrid-scale variability of clouds. If possible, it would be very interesting to investigate the response of cloud properties to dN_C as a function of subgrid-scale variability as diagnosed in the cloud scheme. If there does exist a systematic relationship between cloud subgrid-scale variability and the cloud response to dN_C in the model, such an analysis could provide important insights into the model physics and provide useful suggestions for improving the parameterisation of cloud microphysics.

References:

Peters, K., Quaas, J., Stier, P. and Graßl, H. (2014): Processes limiting the emergence of detectable aerosol indirect effects on tropical warm clouds in global aerosol-climate

model and satellite data, Tellus B, 66, 24054, doi:10.3402/tellusb.v66.24054.

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