

## ***Interactive comment on “Prognostic precipitation with three liquid water classes in the ECHAM5-HAM GCM” by V. Sant et al.***

**Anonymous Referee #1**

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Review of “Prognostic precipitation with three liquid water classes in the ECHAM5-HAM GCM” by V. Sant et al.

General: This paper describes the introduction of a new prognostic precipitation scheme in a global model. The precipitation has three classes with drizzle. In general this is well written and provides a good description of the scheme. The subject is appropriate for ACP.

However, I have a few general concerns, and think this should be published in ACP with some important clarifications and revisions. First of all, there is not enough discussion of sensitivity of the scheme: what is the drizzle mode doing? That is really the new part here, and there is no sensitivity test that just focuses on the drizzle mode: does it

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matter in going from a 2 class to 3 class prognostic precipitation scheme. In general, as noted below, a few more sensitivity tests focusing on the main science questions would be helpful.

Also, the aerosol indirect effects (AIE, or Aerosol-Cloud Interactions, ACI) are sort of a null result: less sensitivity to aerosols is shown diagnostically, but this does not seem to be the case in the simulations performed. The uncertainty levels (25% or ACI) are higher than any signal (10%) and it is of the wrong sign. I think breaking out the ACI by regime may be illuminating: why is the new scheme less sensitive, but has larger ACI (FNet).

With some more sensitivity tests and a bit more analysis of the details of the results, I think this will make a nice publication.

P7784, L15: more realistic how? What metrics?

P7786, L10: has led to a negative...

P7786:L15: GCMs have been shown to overestimate...these aerosol-cloud-precipitation ...

P7789, L9: the tuning is unclear to me: you imply nothing was tuned. Does that mean that both models have the same radiative balance? Or did you retune the model? If they are not in the same balance, please state that, or if tuning was done state that.

P7794, L21: some further questions: does the time splitting vary or is it fixed in both the calculation and sedimentation loops? I'm guessing fixed from below. Is the run time total model run time increase, or micro physical parameterizations only? Also: it would be nice to show some plots of autoconversion and accretion rates if you do not do it later.

P7794,L6: so the high frequency data are from month 4 of the simulation? That seems perhaps minimal for spin up of the land surface. Does it matter? If you only run 5 years and have large enough variability that you cannot distinguish a 15% change in ACI,

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perhaps you should run longer. Another option is to remove interannual variability in SST and sea ice and fix one year or a climatology.

P7796, L10: is the difference in cloud cover between CNTL and PROG significant?

P7797, L2: I'm not sure your impression of the hydrologic cycle lifetime is correct. PROG has less LWP, so one would expect less cloud, and you have not constrained the in cloud LWP. I do not think you can argue that fewer clouds = faster hydrologic cycle.

P7797, L24: this clarifies my earlier point about tuning.

P7798, L23: I do not think the re analysis LWC and IWC should be used for comparisons: they are not that well constrained and are the product of model physics in a different model.

P7799, L10: could you test this theory about redistribution through precipitation by a sensitivity test to change the fall speed of precipitation? Can you estimate the mass of precipitation in the control model to compare precipitation?

P7800, L10: can you estimate the fraction of precipitaton formed that remains in the atmosphere? It would probably be the ratio of the PRECIP/tendency of formation. This would be a good way to estimate the importance of prognostic precipitation, and the difference with CNTL.

P7800, L20: for figure 7, what region is this? It would be nice to divide this into different regimes: stratus regions, stratocumulus, storm tracks, continental mid-latitudes. A single global bar does not do this justice. Also, what about comparison to observations (e.g. TRMM)? Also: have you shown the maximum? That is not really clear.

P7801, L28: but isn't this also a function of the width of the drop size distribution? Is that constant here? Having a few large particle may matter quite a bit?

P7802, L5: are these aggregation and accretion rates for ice or liquid or both: it is not

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clear from the text or notation ( It looks like accretion due to snow). What is ACi?

P7803, L28: what is the uncertainty on these regression lines? Also, does the regression vary by region or cloud regime?

P7894, L16: can you show a map of FNet and the differences? How much of this is direct effect: I.e. Only the cloud part is shown in Figure 13.

P7804, L21: what is 'this' referring to? The explanations here are not that convincing. If the sensitivity goes down, and the accretion goes up relative to the total, why are the aerosol-cloud effects on radiation increasing? You might need to do some sensitivity tests related to precipitaton.

P7804, L24: what happens to precipitation in the radiation code? Is it treated or does it not exist for purposes of radiation?

P7895, L15: a bit more on why this is valuable to have a drizzle class would be warranted: what really justifies it? Could you construct a sensitivity test without drizzle?

P7805, L23: if you tried this, then I would probably show it. You speculate it is important, but then show it is not?

P7806, L17: versatile is not the right word here. Variable?

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 7783, 2015.

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