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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Explicit representation of subgrid variability in cloud microphysics yields weaker aerosol indirect effect in the ECHAM5-HAM2 climate model" *by* J. Tonttila et al.

Anonymous Referee #2

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This manuscript is an extension of the work by Tontilla et al. (2013, T2013 hereafter). It investigates the impact that subgrid variability in cloud microphysics processes (activation and autoconversion) have on the cloud aerosol indirect effect. The main finding is that the magnitude of the aerosol indirect effect is reduced by 18% when the subgrid variability is taken into account for both activation and autoconversion. Overall, the manuscript is clear and well written. The topic is very relevant to ACP, but a number of revisions should be made before publication.

1. The authors should clarify how the model configurations REF, ACT, ACACT differ from the configurations REF, SUBW, SUBWRT, W_ADJ1, W_ADJ2 in T2013.

2. There is no mention of retuning for radiation balance. If REF is in radiation balance, then ACACT must not be. I would suggest to add a retuned version of ACACT to the comparison. In T2013, the retuning involved adjusting the autoconversion scaling factor. There is ample evidence in the literature that altering autoconversion can have a large impact the magnitude of the indirect effect, so this should be discussed and investigated.

3. Panels in Figures 2, 3, and 4 are very small and difficult to read. In the difference panels, most regions are probably not statistically significantly different from one configuration to another. Maybe it would be better to plot zonal averages and then highlight which regions of the zonal averages are statistically significant.

4. West et al. (2014, doi:10.5194/acp-14-6369-2014) found a strong relationship between the variance of the subgrid vertical velocity distribution and the magnitude of the indirect effect.

5. P15525, lines 1-6: this is an incomplete description of the state-of-the-art. A very large number of climate models do not use a single effective vertical velocity for activation, but rather explicitly integrate over a vertical velocity distribution. This was first proposed in 1997 and has been adopted in many contemporary climate models (see for example dois: 10.1029/97JD00703, 10.1029/96JD03087, 10.1029/2005JD006300, 10.1175/2010JCLI3945.1). ACT follows the same basic idea.

6. P15526, lines 16-17. Even if one were to assume that all the TKE was confined to vertical motions (which is physically impossible), the upper bound on the proportionality coefficient would be 1.41 (sqrt(2)). Is the 1.68 value simply treated as a tuning parameter?

7. P15526: choosing sigma to be the same as the single effective velocity in REF almost automatically guarantees that CDNC will be smaller with subgrid variability than without, since the majority of sample points will have velocities smaller than the effective velocity.

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8. Section 2: mention the number of sub-columns and the additional associated cost compared to REF.

9. Table 2: add CERES-EBAF observation for SWCRE and LWCRE. Also add net TOA radiation values.

10. In T2013, Sect 6, there is a brief discussion about an imposed minimum cloud drop number of 40 cm-3 in ECHAM5.5. If this minimum value is still being imposed, it would be relevant to discuss it in the present manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 15523, 2014.