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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Turbulence effects on warm rain formation in precipitating shallow convection revisited" *by* Axel Seifert and Ryo Onishi

Anonymous Referee #1

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Review of "Turbulence effects on warm rain formation in precipitating shallow convection revisited" by Seifert and Onishi

Recommendation: minor revision

This manuscript, in essence a follow-up to Seifert et al. (QJ, 2010), compares results of LES simulations of shallow precipitating convection focusing on the effects of two collision kernels that include effects of small-scale turbulence, the Ayala-Wang kernel and the Onishi kernel. This is a well-written paper than can be published as is, but I have several specific comments that the authors might consider to further improve their presentation.

Specific comments (the first two more serious):

1. The logic (the same as applied in Seifert et al. 2010) is to derive the autoconversion and accretion enhancements for the 2-moment scheme of Seifert and Beheng, and then to use the modified 2-moment scheme in LES simulations. I feel this is a justifiable methodology (especially considering the expense of the bin scheme), but I feel the 1D kinematic model of Seifert and Stevens might not be sufficient to validate the 2-moment implementation. To me, the key difference between bin and 2-moment scheme is the representation of droplet sedimentation (mass/number weighted in the 2-moment scheme and different for every bin in the bin scheme). Thus, the surface rainfall (e.g., Fig. 4 in the current manuscript) may agree well in the 1D test, but may differ more significantly in a test where horizontal variability is included, for instance, in a 2D kinematic test. Overall, I feel the difference in the sedimentation between bulk and bin schemes deserves a closer look, not necessary in the context of the current paper, but in a more general study. I would like to see this aspect at least to be recognized in the current draft.

2. The fact that differences in the cloud microphysics (i.e., rain formation in the current study) may affect cloud dynamics is obvious. However, this aspect is not even mentioned in the current manuscript except for (relatively obscure and not discussed) references to the inversion height shown in Fig. 6. I think some discussion of the feedback from the microphysics to the cloud field dynamics (e.g., deepening of the cloud field that is an unfortunate feature of the RICO setup) should be added to the manuscript. Overall, separation of purely microphysical effects from the impact on cloud dynamics is difficult, but needs to be done to fully understand the impacts. Again, I feel just mentioning this issue and leaving it for a future study (perhaps applying the "piggybacking" method that Grabowski used in his studies published in JAS in 2014 and 2015) would be sufficient. A hint of the dynamic feedback can perhaps be shown by adding the inversion height to time evolutions shown in Fig. 5.

3. P. 3, paragraph starting at l. 30. The way enhancements are shown in Fig. 1 does

not allow seeing the enhancement for droplets of equal (or very close) size. Can you show the enhancement for equal-size droplets for the two formulations? How important are such collisions for the acceleration of rain formation?

4. P. 4, the end of section 4. I think you can explicitly say when discussing Fig. 4 that the differences are about 10-20% max, a relatively small difference considering differences seen in cloud field simulations.

5. P. 7, discussion around l. 29. I think the discussion has to do with the undesirable aspect of the RICO case, namely, the deepening of the cloud field. Perhaps this should be openly stated (I think it is not obvious to someone not familiar with the RICO case). My suggestion at the end of 2 above would also help to make this obvious.

6. P. 8, text between l. 10 and 15. I feel more explanation is needed here. What is sigma_x (mean standard deviation from the time average?). What is the "lag-1 auto-correlation"? How many samples are there in the 6-hour time series? This method of assessing statistical significance is different from the Student t-test statistic, correct?

7. P. 10, l. 30. Here is an example of the microphysics-dynamics feedback that is important in this problem, yet it is really not discussed in the current draft.

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