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Interactive comment on "The Role of the Size Distribution Shape in Determining Differences between Condensation Rates in Bin and Bulk Microphysics Schemes" *by* A. L. Igel and S. C. van den Heever

Anonymous Referee #2

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Review of "The role of the size distribution shape in determining differences between condensation rates in bin and bulk microphysics schemes"

In this manuscript the authors argue that the shape parameter of bulk distributions is important in models to properly understand cloud properties as well and process rates. The problem is that the shape parameter is highly variable. They argue that the shape parameter accounts for much of the difference in condensation rates between bin an bulk models. Overall the manuscript needs more clarification of the results and better explanation of the impacts of the results.

Major comments: Condensation and evaporation will affect the dynamics of the simulation so why not use a kinematic framework similar to that used by Morrison and Grabowski, 2007 where microphysics does not feedback into the dynamics? Have variables such as updraft speed checked for the simulations to ensure that the dynamics are in fact similar between the two models?

More explanation needs to be given in the discussion especially in explaining how condensation and evaporation work in both bin and bulk models and why the difference in results (Fig. 5) between condensation and evaporation. In general the conclusions are confusing (especially point 1 and 2) and need to be rewritten.

Only one value of the shape parameter was used for the bulk model. Do different values of the shape parameter provide better or worse comparison to bin condensation rates? Does using a variable shape parameter as described in Fig. 1 lead to better results compared with bin?

Minor comments:

Line 27: suggest adding bulk model references

Line 28: should be "mass mixing ratio" and "total number mixing ratio"

Line 29: remove "typically"

Line 31: what mixing ratio? Mass mixing ratio?

Line 37: remove "simulations with"

Line 42: remove "both liquid- and ice-phase"

Line 46: what do you mean by value? There is value in how computationally cheap bulk models are.

Line 66: explain why the third function is in total disagreement. What assumptions lead to this disagreement.

Line 79: suggest new word choice for "disagreement"

Line 91: explain the liquid implementation here, get rid of the appendix and get rid of the ice implementation discussion.

Line 96: Walko (2000a) or Walko (2000b)?

Line 96: Eq. 6 is not in Walko 2000

Eq. 2: What are the units of G? Is r_c a mixing ratio or mass concentration?

Line 113: The ventilation coefficients could be set to 1 in both models to see their impact.

Line 129: what model time period are the results from? And how long does it take for the clouds to spin up?

Line 133: suggest "homogeneously in the horizontal direction."

Line 141: define relative humidity

Line 169: suggest "in order to better compare..."

Line 173: do you mean S-ND bins or bin-model bins

Line 200: why does the RDB scheme predict higher condensation rates for low integrated diameter values? I suggest showing some bin and bulk distributions to explain the discussion from lines 199-203

Line 210: can you explain what it is about evaporation versus condensation that leads to the better evaporation rate comparison between the two schemes? How does the bin distribution change during evaporation versus condensation?

Line 221: suggest "larger shape parameter"

Line 232: why use the first 15 bins? What are the other bins used for and how many bins are there?

Fig. 4: suggest doing fits of the data points for better analysis

Line 262: The 1600 simulations cover a larger area in integrated diameter space but not supersaturation space. This should be pointed out.

Line 268: suggest changing the word "startling"

Line 298: The rates are similar, but there is a lot more spread in the data. Statistics on the data would help here.

Line 300: What are you using to base the fact that a gamma distribution is a good assumption for cloud droplets? Is it because the bulk model with an assumed gamma distribution predicts condensation rates fairly well compared to a bin model? If so this should be explained.

Conclusion point 2: Just state the most important variables that determine differences between bin and bulk condensation rates. Don't worry about stating what is not important (f and G) unless it is surprising.

Conclusion point 4: There are other reason to use sub-stepping in bin models. Suggest removing point 4.

Line 318: condensation rates become less important when riming rates are large. Also ventilation can be large for hail. This may not matter or be relevant for certain other hydrometeor types.

Table 1: G_RDB should read "Terms to account..." This term also accounts for vapor diffusion.

r_c should be mass mixing ratio

saturation ratio should be defined

Fig. 5 suggest putting a line through condensation rate ratio = 1

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