The authors thank the editor for his helpful comments that improved the quality of the manuscript.

Comments from editor and answers from the authors

General comments

In general, in my opinion, the discussion of figures 9 and 10 and the conclusions section are the weakest points of the manuscript as of now. I suggest a rewrite of the relevant paragraphs, and provide further suggestions below.

Answer: The discussion of Figures 9 and 10 have been improved, including now arguments related to the physical consistency of the variables depicted.

Moreover, as underlined earlier by one of the reviewers, any conclusions referring to the computational cost have no support in the presented analysis. Please thus preferably cover computational cost in the analysis, or alternatively refrain from stating that the introduced approach offers improvement in this regard. Several mentions of the expensive look-up tables should best be replaced with a quantitative analysis of their cost, or removed.

Answer: The relevant parts of the manuscript have been changed to refrain from stating improvements about computational efficiency of the developed model or lookup tables.

As I have indicated in the very first message regarding this submission, I suggest mentioning the breakup process. It is listed as one of the missing mechanisms in the work of Clark (1976). Moreover, it is included in the Cohard & Pinty (2000) formulation (p. 1826 therein) to which the comparison is made, while it is not part of the Bott reference solution.

Answer: The objective of the research was to reproduce the behavior of the parameterization developed by Clark (1976) and Clark and Hall (1983) via a Machine Learning approach. Since the original parameterization does not include drop breakup in its formulation, it has been left out of the current implementation as well. However, the manuscript now includes mentions to this matter, and the inclusion of the breakup process has been included as one important recommendation for future versions of the model.

To fulfill the archival requirements of GMD, a persistent archive for the coad1d.f file is required (and corresponding change the code availability section). Personal university profile websites are not considered as permanent archives.

Answer: We have contacted Andreas Bott again, and with his permission we have stored the coad1d.f file in Zenodo. It now can be found at https://doi.org/10.5281/zenodo.5660185. The code availability section has been updated accordingly.

Specific comments

All specific comments have been addressed and fixed. Here we only mention those that require further explanation.

p3/l66: "is very expensive computationally" is too vague, and in fact misleading given that particle-based approaches are being introduced as less computationally expensive than the bin schemes covered in the preceding paragraph, please elaborate and refer to literature (perhaps Morrison et al. 2020: https://doi.org/10.1029/2019MS001689)

Answer: The Lagrangian particle-based is accurate, and represents well the stochastic nature of the collision-coalescence of drops, but it is also computationally expensive, as a large number of particles are needed in each grid cell, to be able to calculate accurate statistics (Morrison et al., 2020). The cost of these schemes could be reduced by using simple methods to treat droplet activation, such as the Twomey CNN activation (Grabowski et al., 2018; Twomey, 1959). However, even considering those simplifications, the cost of a Lagrangian particle-based scheme is 25% greater than bin microphysics, when considering a similar number of particles and bin variables per grid cell (Grabowski, 2020). This argument has been added to the introduction in order to elaborate on this topic.

p6/l154,156: bold notation for F

Answer: F from equations 13 and 14 are not the same vector F from eq 7. However, to gain in clarity, F from eqs 13 and 14 has been relabeled as B.

p7/l169: x_c seem undefined, wouldn't a reference to eq. (12) be enough anyway?

Answer: Absolutely true. Equation 16 has been removed from the manuscript, and replaced with a reference to eq. 12. Also, variable *x* has been replaced with *m* to make the notation consistent, and a definition of m_c has been added to the corresponding paragraph.

p7/l181: "and can be used with authorization of the author" is puzzling as the code is publicly accessible, please establish proper licensing and versioning terms with the author and cover it in the code availability section (not in the text as is done now)

Answer: The code have been versioned (v1.0.0) and licensed (GNU Affero General Public License v3.0 or later). It can now be found at https://doi.org/10.5281/zenodo.5660185. The code availability section has been updated accordingly.

p15/l302-303: this sentence seems unneeded given the "values require normalization" statement on page 12

Answer: This sentence was added in a previous review iteration because one of the referees mentioned that the axles did not match and that I should explain why. Since it is the result of previous reviews, we consider that it should not be changed in this iteration.

p18/Fig 7: y axis unit: "lnr-1" -> "ln(r/1 m)-1", right?

Answer: As the mass density function g is defined in function of $\ln r$, the plots are in units of $\ln r$ too. An example of this units ($\ln r^{-1}$) being used in previous literature can be found at Berry (1967).

p20/Fig 8: y unit wrong? if it is a number density, then the x axis unit should be featured for the area-under-the-curve to sum up to N in cm-3

Answer: The units for number concentration DSD are *number of drops per unit volume* (cm^{-3}) in the radius range $(r, r + dr)$. To calculate the concentration probability density function, lognormal distributions need to be integrated over radius (Pruppacher and Klett, 2010)

$$N_i = \int_{r_{i-1}}^{r_i} f(r_i) dr$$

with *f(r)* being the lognormal probability density function as defined in eq. 2 of the manuscript:

$$f(r) = \frac{N}{\sqrt{2\pi}\sigma r} e^{[-(ln\, r-\mu)^2/(2\sigma^2)]}$$

Of course, during the course of the calculations all units must the homogeneous (*cm*). The *x* axis in Fig. 8 is depicted in μm for clarity, to avoid the space-consuming scientific notation needed to express it in *cm*.

p22/l434: which observations? give reference, elaborate

Answer: Barros et al. (2008) found the same behavior while revisiting the validity of the experimental results obtained by Low and List (1982), excluding drop breakup. This piece of information has been added to the manuscript to provide clarity.

References

Barros, A. P., Prat, O. P., Shrestha, P., Testik, F. Y. and Bliven, L. F.: Revisiting Low and List (1982): Evaluation of raindrop collision parameterizations using laboratory observations and modeling, J. Atmos. Sci., 65(9), 2983–2993, doi:10.1175/2008JAS2630.1, 2008.

Berry, E. X.: Cloud droplet growth by collection, J. Atmos. Sci., 24(6), 688–701, doi:10.1175/1520-0469(1967)024<0688:CDGBC>2.0.CO;2, 1967.

Clark, T. L.: Use of log-normal distributions for numerical calculations of condensation and collection, J. Atmos. Sci., 33(5), 810–821, doi:10.1175/1520-0469(1976)033<0810:UOLNDF>2.0.CO;2, 1976.

Clark, T. L. and Hall, W. D.: A cloud physical parameterization method using movable basis functions: Stochastic coalescence parcel calculations, J. Atmos. Sci., 40(7), 1709–1728, doi:10.1175/1520-0469(1983)040<1709:ACPPMU>2.0.CO;2, 1983.

Grabowski, W. W.: Comparison of Eulerian bin and Lagrangian particle-based schemes in simulations of Pi Chamber dynamics and microphysics, J. Atmos. Sci., 77(3), 1151–1165, doi:10.1175/JAS-D-19-0216.1, 2020.

Grabowski, W. W., Dziekan, P. and Pawlowska, H.: Lagrangian condensation microphysics with Twomey CCN activation, Geosci. Model Dev., 11(1), 103–120, doi:10.5194/gmd-11-103-2018, 2018.

Low, T. B. and List, R.: Collision, coalescence and breakup of raindrops. Part I: Experimentally established coalescence efficiencies and fragment size distributions in breakup, J. Atmos. Sci., 39(7), 1591–1606, doi:10.1175/1520-0469(1982)039<1591:CCABOR>2.0.CO;2, 1982.

Morrison, H., Lier-Walqui, M., Fridlind, A. M., Grabowski, W. W., Harrington, J. Y., Hoose, C., Korolev, A., Kumjian, M. R., Milbrandt, J. A., Pawlowska, H., Posselt, D. J., Prat, O. P., Reimel, K. J., Shima, S., Diedenhoven, B. and Xue, L.: Confronting the challenge of modeling cloud and precipitation microphysics, J. Adv. Model. Earth Syst., 12(8), e2019MS001689, doi:10.1029/2019MS001689, 2020.

Pruppacher, H. R. and Klett, J. D.: Microphysics of clouds and precipitation, Springer Netherlands, Dordrecht., 2010.

Twomey, S.: The nuclei of natural cloud formation part II: The supersaturation in natural clouds and the variation of cloud droplet concentration, Geofis. Pura e Appl., 43(1), 243–249, doi:10.1007/BF01993560, 1959.