Authors' Response to Minor and Technical Revisions

on the Manuscript "Cleo: The Numerical Methods of a New Superdroplet Model including a Droplet Breakup Algorithm (v0.52.0)" by Clara J.A. Bayley et al. (2026)

Title	Cleo: The Numerical Methods of a New Superdroplet Model including a Droplet Breakup Algorithm (v0.52.0)
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MS No.	egusphere-2025-4399
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Thank you to both Emily de Jong and anonymous referee #2 for reviewing our manuscript and the changes we have made since its initial submission. We greatly appreciate their feedback, also in this round of minor and technical revisions, and in the following we seek to address each of the remaining revision requests they have made. Additionally, we have moved the figures which were at the end of the manuscript to be "in-place" instead (Figures 7 to 13 and Table B1 and B2) and corrected our equation referencing by using the "eqref" instead of "ref" LaTeX command.

Please note the updates to the dataset for this paper (https://doi.org/doi:10.17617/3.SDN0NX) is currently viewable from this link whilst it awaits publishing:
https://edmond.mpg.de/previewurl.xhtml?token=6ed04ec0-fd10-4ce4-a508-09280f4f2a14.

Minor Comments from Emily de Jong

In the following the referee's suggestions include reference line numbers which refer to the track changes article version from the previous revised manuscript. Our responses to these suggestions however, include the line numbers of the updated manuscript.

1. *L163: PySDM needs some citation or explanation at this first appearance*

   We now cite Bartman et al. (2022b) and de Jong et al. (2023b) at the first mention of PySDM, L156-157 now reads "However, this means that unlike for example PySDM **(Bartman et al., 2022b; de Jong et al., 2023b)**, Cleo ...".

2. *L171 mentions that "Cleo's current representation of aerosols is crude" – can you elaborate on how Cleo represents aerosols? Is it simply through mass of solute species, or only a single species?*

   We now clarify that Cleo represents the mass of a single solute species. L165-167 now reads "Cleo's current representation of aerosols is **relatively crude because it models the mass of only one solute species according to Shima et al. (2009)**, unlike some SDMs which have since incorporated multiple aerosols and aerosol chemistry (Jaruga and Pawlowska, 2018; Bartman et al., 2022b).".

3. *L290-291: I'm glad that the suggestion to further verify the breakup algorithm pointed to a resolvable issue with the random number rescaling. However, although the presented results now use a 2nd random number to determine the collision outcome, they still reference the possibility of rescaling instead. If possible, please include the details of this rescaling alternative, since it is apparently not straightforward (perhaps in Appendix A). The intent here to avoid having future studies fall into the same trap that this implementation initially did.*

   We have not included a formulation for how to rescale the random number because we are still working to understand how to correct our formulation for cases when the superdroplet collision probability (p_{α}) is greater than 1.0 (which is the condition under which the rescaling in our original manuscript failed). At the moment Cleo therefore leaves open the option to rescale the random number but doesn't provide a formulation itself (the user must provide one), and that is what we want to convey in this manuscript. To make that clearer we've amended the relevant sentence (L227-229) "In general however, the outcome of a collision in Cleo does not need to depend on a second random number, it can instead be calculated from the superdroplet attributes or by rescaling the original random number **given the user provides a formula to do so**.".

4. *Figure 9: Perhaps clarify in the caption which kernel or test case is explored in each panel.*

We have re-worded the caption of Figure 9 to make this more clear. It now reads "The evolution of the droplet mass density distribution under the tests of the SDM collision algorithm as in Shima et al. (2009, Sec. 5.1.4, Figure 2). The line-style indicates the collision kernel; the line-width indicates the number of superdroplets, n_s; the colour indicates the time. Panel a) shows the mass density distribution when using the Golovin kernel for collision-coalescence, as well as its analytical solution (solid grey). Panels b) and c) show the tests using the hydrodynamic kernel for collision-coalescence as in Shima et al. (2009), and, additionally, the same tests using the hydrodynamic kernel but when breakup and rebound are also accounted for, using Cleo's extended treatment of collisions with parametrisations based on Testik (2009), Straub et al. (2010), and Schlottke et al. (2010), (see main text, Section 3).".

5. *Table B1: consider clarifying which process or equation a few of the coefficients correspond to. E.g. ventilation for alpha and betas; Marshall Palmer size distribution for the "mp" subscripts;*

   We have now added equation references to all the notation in Tables B1 and B2 for which we think it makes sense to do so (16 references added in total), including for the alphas and betas mentioned by the reviewer. For the constants listed which relate to the Marshall Palmer distribution we have added "constant in exponential droplet size distribution (Marshall and Palmer, 1948);".

Typographic Comments from Emily de Jong

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- *L1: Consider using parentheses instead: "Eulerian (bulk and bin)"*

  To aid readability we have opted to remove the commas and the word "conventional" instead so that L1 now reads "The numerical methods of Eulerian bulk and bin models ...".

- *L204: make this a complete phrase "Section 3.1, whereas if. . . "*

  To correct this have replaced "whereas" with "in contrast", L197-198 now reads "In contrast, if a collision occurs in the extended algorithm, the last step of the original collision-coalescence algorithm is modified as shown in Figure 2b".

- *L288: "PySDM" (capitalized, or be consistent with lowercase "p" throughout)*

  We have corrected L280 to "PySDM", and likewise we use "PySDM" throughout the rest of the manuscript.

- *L444: "was" should be "were"*

  Corrected to "were" on L432.

- *Figure 13 caption needs an "and": "Solid lines are the mean" AND "the shading is. . . ."*

  Thank you for noticing this, we've now inserted the missing "and" in the Figure 13 caption.

Technical Corrections from Anonymous Referee #2

The referee commented:

I do wish to clarify my point regarding "log standard deviation" confusion, believing that this can cause confusion in cloud/aerosol science regarding the terminology. My comment should have been clarifying if the value of 1.4 was log standard deviation (ln(sigma)) as is currently stated or if it was really geometric standard deviation (which would be exp(sigma)). I apologize for somehow omitting the key word of geometric. The implication of what this 1.4 value is takes this from a broad distribution to a narrow distribution. Looking in your codebase, I'm at least led to believe that it is geometric standard deviation, with some yaml inputs containing comments as such. I believe that between the reference paper (and their provided code/inputs), this manuscript, the Cleo code base and my comments highlights how easily confusion in terminology can occur, which allows these possible parameter interpretation errors to propagate.

I apologise that we did not understand this point in the previous revision but thank you for taking the time to explain it again so that we do now. Indeed the "geometric standard deviation" instead of "log standard deviation" is meant here and I have corrected L484 accordingly.