

Response to Anonymous Referee #2

The revised manuscript is significantly improved by the following:

- 1) simulations with gravitational settling have been included, thereby showing a preliminary view of the problem in a closer context to cloud physics.
- 2) A more thorough discussion and interpretation of the theory is included, significantly improving the clarity of the discussion.
- 3) The main manuscript has been carefully proofread, thereby reducing the number of distracting typos.

I recommend acceptance after dealing with a few additional corrections and clarifications.

>> We thank the referee for these positive remarks.

Note: line numbers refer to the “track-changes” version of the paper submitted with the revision.

Title: It started as “Nontrivial relations” and now it is “Intricate relations”... Not sure I’m a fan of either one because they are so vague. But they’re not wrong, so it’s the authors’ call.

>> After much deliberations, we decide to keep the title unchanged.

Abstract: The abstract is thoroughly rewritten and is technically acceptable, but it must have missed the grammar check. Please correct throughout.

>> We have corrected the grammatical errors found.

Line 40: “dual” is confusing... do you mean “pair” or “two”?

>> we have revised it to “two”.

Page 2, footnote 1: I am confused by the statement “without that condition, MRV is always zero in turbulence.” A similar statement was made in the response to my review. My understanding is that inertial particles in the $St < 1$ regime have a mean-inward drift velocity. Perhaps I am missing something here. The point is probably sufficiently subtle that it should be clarified in the main text rather than briefly mentioned in a footnote.

>> We thank the referee for raising this point. While revising this, we found that we had mistakenly considered (Sundaram & Collins, 1997) as a study of (non-colliding) ghost particles. In fact, it was a study on particle subjected to hard-sphere collisions. Thus, there should be no conditioning in the MRV they used. Also, the footnote is now unnecessary and will be deleted.

>> Besides this, the referee may have confused particles’ mean relative velocity (MRV) with the so called “mean-inward drift velocity” which is related to the mean drift-flux (Eqn. 5 in the manuscript). We note that the latter results from correlation of turbulent fluctuations and should be interpreted as an additional mean inward velocity. In a system of ghost particles, MRV is zero, but under the separation paradigm, MRV conditioned on negative

velocities could be used to estimate collision rate. We have added a brief discussion of this at the end of Section 3.

Line 142: Correct “we shall we”.

>> Corrected.

Lines 151-152: Why is this statement in quotation marks? Is it from another source? If yes, please clarify the source. If not, I’d recommend dropping the quotes to minimize confusion.

>> Corrected.

Line 155: I don’t know what it means that the mean relative velocity “must be predominantly negative”. It’s either negative or not. Or do you mean over most of the range of scales r , or most of the Stokes number range, or something else? Also, how does this relate to the point made above regarding footnote 1 on page 2?

>> We have removed “predominantly” to avoid confusion. We have also removed “footnote 1 on page 2”.

Page 13 and Figure 3: This is the most significant improvement to the paper and I applaud the authors for putting in the work to make these additional simulations to explore the effect of gravitational settling. As I expected, for the range of settling numbers up to order unity, there is no fundamental change in the behavior of the system. This greatly increases the relevance of the work to the cloud physics community. It might be worth noting that the range of Stokes numbers and settling parameters explored are very well aligned with measured values in natural clouds (e.g., Siebert et al. “Towards understanding the role of turbulence on droplets in clouds: In situ and laboratory measurements” Atmospheric Research, 2010).

>> The suggested reference has been added.

Line 297: Here “significant” might be an overstatement. I would say “from negligible to order 10%” or “from negligible to significant, but not dominant”.

>> This change is now adopted.

Lines 304-308: The added discussion of hydrodynamic interactions and the reference to the recent work of Yavuz et al. 2018 is appreciated. Note that another paper just came out dealing with the same topic, so it may be worth citing: Bragg et al. “Hydrodynamic interactions and extreme particle clustering in turbulence” Journal of Fluid Mechanics, 2022.

>> The suggested reference has been added.

Line 317: Correct “This is could be”.

>> Corrected.