Review of 'Technical note: the enhancement limit of coagulation scavenging of small charged particles'

General comments

In this study, the effect of particle charge on coagulation is studied theoretically. More specifically, it is shown that the enhancement of coagulation of charged particles has an upper limit of 2. The authors note that this effect should be considered, when studying atmospheric new particle formation involving ions.

The derivation of the coagulation enhancement limit seems sound, and the result can be useful when analyzing measurements or modelling new particle formation in the presence of charge. However, some references to previous research should be added, and some parts need to be clarified. Also, more discussion on the implications of the results is needed. I recommend the article for a publication after the authors have considered these revisions.

Specific comments

Line 5: In the abstract and conclusions it is mentioned that this effect is important when studying ion-induced new particle formation and ion-enhanced particle growth. However, these processes and their importance in the atmosphere (or in laboratory experiments) are not discussed elsewhere in the manuscript. In the introduction, the study is motivated more generally by the exponential dependence of particle survival probability on coagulation sink. Although this is true, if ions are generally unimportant in new particle formation, the enhancement of coagulation scavenging due to charge is also unimportant. Therefore, some discussion on particle formation and growth involving ions should be added to the introduction.

Line 14-15: In the statement "the role of charge has received less attention" it is not entirely clear if the authors are referring to the role of charge more generally or in some specific issue. Generally, the current knowledge of the effect of charge on coagulation should be clarified in the introduction. Now there are no references to articles on coagulation in the presence of charge, although relevant studies seem to exist (for example Ghosh et al. 2017 and references therein).

Line 32-33: A reference to a study showing the small charged fraction is needed.

Line 34-35: A reference is needed here (related to main charging mechanism).

Line 45: A reference is needed here (related to the charging state of sub-100 nm particles).

Line 39: Can you clarify how the fact that small particles are mobile is connected to the higher coagulation rate of small charged particles compared to small neutral particle?

Line 61-62: It is unclear to me how this limit also corresponds to the case where the presence of charge decreases collisions.

Line 63-64: Can you clarify why the first limit corresponds to the case where coagulation sink comprises of relatively small particles? Although it is shown in the next section, it is not clear here how this conclusion can be made.

Line 77-80: Can you clarify if the results from López-Yglesias and Flagan are based on some laboratory experiments? How do they correspond to other estimations for ion-aerosol attachment coefficients, for example those in Horrak et al. (2008)? And how does your extrapolation for neutral particles correspond to commonly used expressions for neutral particle collision rates?

Line 93-98: It would be good to add some discussion here on the conditions in which this limit of enhancement of coagulation is reached, and on possible practical applications where this result can be used. Finally, when discussing atmospheric implications of the result, the importance of ions in new particle formation could be clarified (see my first specific comment).

Technical comments

Eq. (1): All the symbols used in the equations should be explained, for example here it is unclear what the first symbol on the right-hand side refer to.

Line 34-42: It would be good to try to avoid using parenthesis excessively (here and elsewhere in the manuscript).

Line 46-48: Please clarify what different subscripts in collision coefficients etc. refer to.

Eq. (8): Here you could also clarify what subscript *i* and *j* refer to.

Line 80: You could start a new paragraph here before "In Figure 2,.."

Figure 1: Please refer in the figure caption to the article from where the coefficients are taken.

Line 85: There is a typo here (parametrizations).

Figure 3: Please explain in the figure caption what different lines refer to.

References

Ghosh, K., Tripathi, S. N., Joshi, M., Mayya, Y. S., Khan, A., & Sapra, B. K. (2017). Modeling studies on coagulation of charged particles and comparison with experiments. *Journal of Aerosol Science*, *105*, 35-47.

Horrak, U., Aalto, P. P., Salm, J., Komsaare, K., Tammet, H., Mäkelä, J. M., ... & Kulmala, M. (2008). Variation and balance of positive air ion concentrations in a boreal forest. *Atmos. Chem. Phys*., 8, 655–675,