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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Charging and coagulation of radioactive and nonradioactive particles in the atmosphere" *by* Y.-H. Kim et al.

Anonymous Referee #2

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In this work authors proposed three approaches for the description of charging and coagulation of radioactive and nonradioactive particles in atmosphere. The work is based on recent theoretical developments by Kim et al. (2014, 2015) in which, it was found that, electrostatic interactions caused by radioactivity can significantly modify the particle charge distribution. In the present work, mutual effects of charging and coagulation were examined. The applicability and accuracy of the new approaches depends on several factors, such as the size of particles and the initial conditions, while the computational cost may differ by $\sim 2-3$ orders of magnitude from each other. The proposed approaches can be employed in various studies, such as, the influence of radionuclides on electrification phenomena in atmosphere.

Overall, I believe that the present work is of a good quality and it is suitable for pub-

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lication. Apart few minor points described below, the manuscript is well written and reasoned. The analysis of the results is very detailed, while the limitations, accuracy, and the range of applicability of each approach has been carefully examined. Comparison of theoretical predictions with experimental results seems to validate the presented approaches.

As a general comment, throughout text and in figures, particle sizes are expressed sometimes in micrometers (μm) and some other times in nanometers (nm). For the readability of the paper, I believe that authors should decide to use consistently only one of the two units.

Specific points

- Symbol n_k first appearing in Eq.-7 has not been defined. Is it obtained from the decay rates $n_{k,j}$ which was defined before? The same for symbols $\beta^+_{k,J}$ and $\beta^-_{k,J}$ in the same equation, which are different from $\beta^+_{k,j}$ and $\beta^-_{k,j}$ appearing before.
- In Eq.-10 in the definition of the time-evolution of particles, the symbol $n(x, j)$ was picked to denote the number densities of particles. This may be confusing since the same symbol n has been used before to denote number concentration of charges. Using instead symbol N similar to Eq.-11 may be more clear.
- In Eq.-11, the property distribution factor $\eta_{l,m}$ has not been described. Also, it may be confusing that the same symbol was used before for the decay rate of the radioactive particles.
- Page 23805, Line 22-23: Equation numbers (in parentheses) used for each method seems to be redundant at this place since they have given in the previous paragraph just above.
- Page 23808, Line 22: No units are given for the diffusion charging rate.

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- For the case of charging and coagulation kinetics of non radiative particles, approach 1 was evaluated using the approximate analytical solutions suggested by Alonso (1999) (paragraph 3.2.1). I believe that the authors should shortly describe the previous approach and how it differs from the present one. At this end, it should become transparent the novelty of the present approach. Moreover, it should be clarified, why the results of the present approach are compared to the approximate analytical solution and not to the corresponding numerical solution of the rigorous population balance equations given by Alonso.

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