Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric new particle formation: real and apparent growth of neutral and charged particles" *by* J. Leppä et al.

J. Leppä et al.

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We would like to thank the referee for the constructive comments to our manuscript. Below are our answers to the comments. Major additions to the text are also quoted here.

Anonymous Referee #1

General Comments: The paper is generally well-written and solid. It is a useful contribution to the literature and should be published with only minor revisions.

Specific Comments: The major problem I have is with the generalization of Section 2.1.3 on self-coagulation. The authors derive results for a monodisperse distribution, which to me means essentially a single size bin. For these conditions the derivations

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follow to obtain equations (6), (8), and (9). That is, N is the total number concentration and V(tot) is the total volume concentration. However, when the distribution is generalized to spread over multiple size bins, N consists of particles from all these bins. They state in Section 3.3.3 that "the particle concentration in the mode decreases". It seems the authors are trying to have it both ways. Does Equation (9) generalize to a mode that consists of many bins? How does that follow from the assumptions necessary for Equations (5) and (6)?

By self-coagulation we mean coagulation of particles with other particles in the same population, a definition quite often used in the literature. This definition was added to Section 2.1.1 to avoid misunderstandings.

The monodisperse assumption was made when deriving Eqs. 8 and 9 to simplify the analytical calculations. Even though Eqs. 8 and 9 are exactly true only in the monodisperse case, they can be used to estimate the growth rate due to self-coagulation for a mode containing a wider range of particle sizes. The accuracy of the estimation decreases as the width of the mode increases, but as we have shown in Section 3.2, Eqs. 8 and 9 are capable of giving accurate estimations on the growth rate of a nucleation mode due to self-coagulation in atmospheric conditions. A sentence was added to Section 3.2 to clarify this result. Mathematically, Equation 9 does not generalize to a mode that consists of many bins, but the growth rate due to self-coagulation can be approximated by assuming that all the particles in the mode have the same size. The following paragraph clarifying this issue was added to the end of the Section 2.1.3:

"Eqs. 8 and 9 are exact only for a monodisperse distribution. However, they can be used to estimate the growth rate due to self-coagulation even if the growing mode consists of particles with varying sizes, but the accuracy of the equations decrease as the width of the mode increases. In Section 3.2 we will show that Eqs. 8 and 9 can be used to determine the growth rate due to self-coagulation of a nucleation mode in atmospherically relevant conditions."

Technical Corrections: p. 2079, line 17: "improper understanding on the vapors partic-ipating into these processes" is awkward. I suggest something like "incomplete knowl-edge of the vapors that participate in these processes".

The wording "improper understanding on" was changed to "incomplete knowledge of".

p. 2080, lines 15-16: Reword to read "and how can these problems be dealt with?

The part was reworded according to suggestion by the referee.

p. 2080, line 17: Add a "?" after "sizes".

Added.

p. 2083, line 24: What value is used for "r", and why?

For "r" we have used the value corresponding to a sulfuric acid molecule, as sulfuric acid is expected to play an important role in the first steps of growth of atmospheric aerosol particles. This is now mentioned in the end of the Section 2.1.2.

The Eq. 4 has been originally derived in a framework in which $1/(4\pi\varepsilon 0)$ is set to unity. To avoid misunderstandings, we changed the Eq. 4 in a way that all the quantities are given in SI units. The revised version of the end of the Section 2.1.2 is now the following:

"Here e is the elementary charge (1.60×10-19 C), dp is the particle diameter in meters, $\varepsilon 0$ is the vacuum permittivity (8.85×10-12 F m-1) and γ = 1/kT, where T is the temper-ature in Kelvins and k is the Boltzmann constant (1.38×10-23 J K-1). A polar molecule can formally be described as a compound having a negative and positive charge set a part by a fixed distance. This distance, given in meters, is denoted by r in Eq. 4 and a value corresponding to sulfuric acid molecule was used in this study."

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