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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "An algorithm for the numerical solution of the multivariate master equation for stochastic coalescence" *by* L. Alfonso

Anonymous Referee #2

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The paper deals with the problem of impact of internal fluctuations on growth of droplets due to collision-coalescence. It is a matter of broad interest, since stochastic effects are one of the possible explanations of how droplets cross the size-gap (Kostinski et al., Bull. Amer. Meteor. Soc. 86, 235–244, 2005).

In order to rigorously account for fluctuations, the author uses master equation. A method to solve master equation for any type of collision kernel is presented. It is based on the idea of reducing dimensionality of the problem by considering only states that can be reached from given initial conditions. Since this state space grows rapidly with number of initial droplets, the method is applicable only to very small volumes

(<50 droplets). Results of the developed method are compared with more widely used stochastic coalescence equation, which does not account for fluctuations.

The author claims that the major advantage of his method is that it is the first one to account for correlations in probabilities of system states (paragraphs near the end of Sec. 1). However, a numerical method developed by Gillespie (Gillespie D. T., J. Atmos. Sci. 32 (10), 1977-1989, 1975), contrary to what the author suggests, also accurately reproduces master equation. In Gillespie's method, the master equation is not solved directly, but a single stochastic trajectory following this equation is obtained. Temporal evolution of probability distributions of different states can be obtained by averaging over many runs. Seeßelberg proposed a variation of Gillespie's method in which droplet mass is discretized into bins, which makes the algorithm applicable to significantly larger systems than the one proposed in the discussed paper (Seeßelberg et al., Atmospheric Research 40(1), 33-48, 1996).

In my opinion a comparison of results and efficiency with Gillespie's method is necessary. The author should clearly outline what are the advantages of his method over the Gillespie's one and in which situations should it be used.

Other thing that would be beneficial is a short discussion of how do results presented in the paper actually relate to cloud development. From Figs. 6, 7 and 9 one can conclude that fluctuations and correlations tend to delay formation of large droplets in small volumes (in comparison with the deterministic equation). However, this results can not be extrapolated to larger systems. Such a small volume would not remain undisturbed for time of the order of 1000s. Does the author expect that fluctuations in small volumes can have significant impact on development of clouds?

Minor comments:

- In Section 2, l. 14 author writes that to solve master equation directly, arrays of the size of 3 x 10ˆ20 elements would have to be used, where does this number come from?

- In the Abstract it should be more clearly stated that the kinetic collection equation and Smoluchowski coagulation equation are different names for the same equation.

Technical comments:

- Wang (2006) – reference not present in bibliography.

- Sec. 2.2, l. 10 “will increased” should be “will increase”.

- Sec. 1, l. 12 “infinite large”should be “infinitely large”.

- Labels in Figs. 5, 6 and 9 are unintelligible.

- In Figs. 6(c) and 7(a) there are too many labels on the ordinate.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 12213, 2015.