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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Cloud-droplet growth due to supersaturation fluctuations in stratiform clouds" *by* Xiang-Yu Li et al.

Anonymous Referee #2

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"Cloud-droplet growth due to supersaturation fluctuations in stratiform clouds"

by Xiang-Yu Li, Gunilla Svensson, Axel Brandenburg, and Nils E. L. Haugen

The focus of this paper is the influence of supersaturation fluctuations on droplet condensation growth, which has become an active area of research in recent years. To have the stratiform clouds as a motivation, authors have studied this effect in the absence of the mean updraft velocity. In this study, the conservation of momentum and scalar (temperature and water vapor) equations are solved using the direct numerical simulation (DNS) in a rectangular domain and the random velocity forcing drives the turbulence. Here, the Eulerian scalar and momentum field is coupled with the Lagrangian droplet dynamics using the superparticle method. Additionally, the physics of droplet activation and droplet collision-coalescence process were ignored. All droplets

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Discussion paper

were considered at an initial size of 10 um and the starting supersaturation in the domain was 2%. Authors have examined cases of different Taylor Reynolds number (Re_λ) and mean kinetic energy dissipation rate (ϵ).

In general, the approach here is very much similar to that of Sardina et al. (2015), Siewert at al. (2017) and others. The only significant difference is the treatment of supersaturation field; in the current case, it is obtained by solving temperature and water vapor conservation equations contrary to the assumption of supersaturation field as a passive scalar in previous studies. Moreover, the authors compared the results with the stochastic formulation of Sardina et al. (2015) and other numerical-simulation studies. The results are consistent with the other studies, the droplet size dispersion (σ_A) growth is proportional to $t^{1/2}$. Similarly, the broadening in droplet size distribution is shown to be nearly independent of ϵ (a slight decrease), however, it increases with increase in Re_λ consistent with the conclusions of Sardina et al. (2015).

Review points:

- The authors should be clear about the novelty. The main significant differences between current simulation and previous are the treatment of supersaturation field and the feedback due to condensation. Although, authors also acknowledge that the treatment of supersaturation as a passive scalar is sufficient. Furthermore, they explicitly showed that the results are independent to the dissipation rate (ϵ) which was not clearly presented in the other studies. Please update abstract, intro and conclusions to make clear.

- Claimed relevance is to stratocumulus clouds, but entrainment of unsaturated air and possible secondary activation is know to strongly change droplet size distribution in that system. How does absence of entrainment limit the results presented? What changes can be expected when entrainment and activation are included? These limitations should be discussed.

- Page-6, Line 16: It should be supersaturation instead of saturation.

- Page-7, Line 7: Fix the typo

- The assumption used to get the eq. 20 is not required to derive the equation for σA growth.

- The phase relaxation time might be changing with time due to the mean radius growth (specifically, at the starting since there is a starting supersaturation around 2%). It might cause some deviation in the result (σ_A vs t) from the $t^{1/2}$ relation. Authors should discuss this effect along with the discussion of figure 4.

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