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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of fluctuations and correlations in droplet growth by collision-coalescence revisited. Part II: Observational evidence of gel formation in warm clouds" *by* Lester Alfonso et al.

Anonymous Referee #1

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General comments:

This manuscript is a sequel of "The impact of fluctuations and correlations in droplet growth by collision–coalescence revisited – Part 1: Numerical calculation of post-gel droplet size distribution" (https://doi.org/10.5194/acp-17-6895-2017). It aims to provide an observational evidence of "gel formation" in warm clouds. By analysing the droplet size distribution of the largest droplet from the observational data, the authors showed that the distribution of the mass of the largest droplet is a mixture of a Gaussian and a Gumbel distributions. In general, the idea and the corresponding analysis are original

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Discussion paper

in the sense that observational evidence was provided to support the “lucky droplet model”. However, the authors didn’t address the previous works on this topic. The state-of-art development on this topic is far beyond what is described in the current manuscript. I would support the publication of this manuscript if the following comments are carefully addressed.

Specific comments:

1. They are several studies that have already addressed the lucky droplet model for the collision-coalescence process of cloud droplets. I would suggest the authors cite those papers and address how the current manuscript advances the study compared with the earlier works. This can help place the current manuscript in a more general context and exhibit the novelty of the present study. Telford (1955) [1] may be the first to propose the lucky droplet model for the collision-coalescence process of cloud droplets. Kostinski and Shaw (2005) [2] developed the model of lucky droplet, which was further investigated using large deviation theory by Wilkinson (2016) [3]. The numerical work of Dziekan P, Pawlowska H. (2017) [4] supports the model of Kostinski and Shaw (2005) [2]. I suggest the authors to explicitly explain the main differences between the current study and those works mentioned above in the introduction and results.

2. Many papers have studied the the collision-coalescence problem, which should be also addressed in the introduction. A good summary is given by Grabowski and Wang (2013) [5]. The work (summarized in Grabowski and Wang (2013) [5]) by the group of Wang should be addressed. Several stochastic models by Pinsky et al (2004, 2007, 2008) [8]-[10], Mehlig et al (2007) [6], and Wilkinson et al (2006) [7] should be cited. Recent numerical work by Onishi and Seifert (2016) [11], Li et al (2017) [12], Li et al (2018) [13], and Chen et al. (2018) [14].

I would suggest the authors compare the Monte-Carlo method used in Shima et al. 2009 [15], Li et al (2017) [12] and Li et al (2018) [13].

3. For the fitted distribution in Fig.1, 5, and 7, could the authors have more samples to get better statistics?

4. A question related to question 3.: on Line 239, the authors used 200 droplets of 10um, and 50 droplets of 12.6 um for the Monte Carlo simulation. Is it statistically convergent? Can the authors provide a statistically convergent study (similar to the one in Li et al (2017) [12])?

5. L65: please provide reference for the use of “gel formation” in “percolation theory” and “nuclear physics” respectively.

6. L80: ”average number of droplets”. Do you mean “droplet (particle) number density” ? I would suggest the author use the commonly accepted terminology in both cloud physics and statistical mechanics for readability.

7. L81: I don’t quite understand “the time rate of change of...”. Could you please rephrase the sentence for readability?

8. Eq.3, where is “\tau” defined?

9. I don’t understand how Eq.4 is obtained. What is T_gel? What is the physics of this time scale?

10. For the discussion of the Smoluchowski equation in section 2.1, please compare the argument by Pumir, A., and M. Wilkinson, 2016 [16]. http://soft-matter.seas.harvard.edu/index.php/Sol-Gel_Transition

11. L110: please provide reference after “experimentally”.

12. L111: please provide reference after “percolation”.

13. Eq. 5a and 5b, please compare them with Kostinski and Shaw (2005) [2] and Wilkinson (2016) [3].

14. L133: “We must emphasize that phase transitions cannot take place in a fi-

nite system. For this type of systems, the notion of pseudo-critical region is introduced.". Please provide more physical explanation and references for the statement and "pseudo-critical region".

15. L154: What is "product kernel"? If it is widely used, please provide several references. What are the assumptions for the kernel, linear drag, gravity only? Could you please explain why you choose this kernel?

16. L164: Could you please explain what kinds of "Monte Carlo algorithm" you used? Is it comparable to Shima et al. 2009 [15], Li et al (2017) [12] and Li et al (2018) [13]? I understand you focus on the collision-coalescence process of cloud droplets. Could you please also provide the equations you solved numerically? Also, can you explain the difference of your "Monte Carlo algorithm" with those of Shima et al. 2009 [15], Li et al (2017) [12] and Li et al (2018) [13].

17. L167: Can you give a physical explanation about why you choose "C=5,49*10ˆ(10) cmˆ3sˆ{-1}"?

18. L173: Could you please explain more about the "mixing fraction", like mixing fraction of which quantity and the corresponding physical picture or intuition?

19. L250-259: Could you please describe in more details about the measurement, like where the cloud droplets are from, warm clouds? What are the measuring environmentally conditions, like the temperature, water vapor mixing ratio? What is the spatial and time resolution of the FM-120? Can you measure the time evolution of droplet size distribution?

20. L260: Please provide reference for "The block maxima (BM) approach in extreme value theory (EVT) was applied" and compare with the large deviation theory/method described in Wilkinson 16 [3].

Technical corrections:

21. L271-272: Please rephrase the sentence "The sample size...of data" to improve

the readability. The “which clause” is not encouraged in scientific writing.

22. L318: Did you mean “entire dataset”?

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