Comments on “Theoretical investigation of mixing in warm clouds – Part 2: Homogeneous mixing”

The significant contribution in this paper is the development of analytical results for the time evolution of a droplet size distribution for both monodisperse and polydisperse droplets in the limit of homogeneous mixing. The novelty in this, as far as I am aware, is that previous work has focused on the final stage of the distribution, such as commonly portrayed in the mixing diagram. Although it is idealized work, the non-dimensional equations and parameters in Equations 16 to 19 provide nice insight into cloud response to mixing. In particular, the finding that polydisperse droplet populations can show signatures typically interpreted as due to inhomogeneous mixing is insightful.

General criticisms:

1. The introduction should provide better and clearer motivation for why a study of the time evolution of the droplet size distribution is of interest. This would be more valuable than additional discussion of general mixing concepts that already are covered in part 1. Also, as with part 1, the link between this paper and the other two parts needs to be clearly defined. What are the assumptions and limitations, and what is the area of application for the present work, especially relevant to the other two parts? With regards to the connection to other work, is Figure 1 in this part 2 really necessary, given that a similar version already is at the foundation of part 1 (part 1 Figure 1)? Finally, it is absolutely necessary that the notation between the three papers should be uniform. This currently adds a lot of confusion in trying to understand the results of part 2 in the context of the results obtained in part 1.
2. Overall I would say that, while I view this as insightful work, there is a general need throughout the paper to discuss more about the physical interpretation rather than just writing down equations. For example, Eq. 23 is too complicated.

Specific comments

1. S is supersaturation in Part 2 and 3, but it is saturation ratio in Part 1 and most textbooks. Choose one symbol and be consistent in all parts.
2. Liquid water content and liquid water mixing ratio are different. In the text, q is liquid water mixing ratio, but the authors sometimes refer to it as LWC. For example, section 3.2 “Time evolution of supersaturation and LWC”, section 4.3 “Evolution of LWC and supersaturation”. The authors need to check the whole text and make it consistent.
3. Page 30279, line 14: missing space between “parameter” and “gamma”.
4. Equation 22 on page 30280: should have a “~” over “t” for “S(t)”.
5. Page 30288, line 20-22: I don’t understand “the concept of homogeneous mixing, according to which the mean and effective radii do not change.” Please clarify.

6. Appendix B: Equation number in the text (for example page 30298 Line 15) should be “BX” not “AX”
7. Figure 3 caption: should be “LWC=0.29g/m3” not q
8. Figure 6b: should be normalized liquid water mixing ratio not LWC
9. Figure 7a: x axis should be 0, 5 10 15?
10. Figure 7 caption: also q should be LWC.