Review of
Bridging the condensation-collision size gap: a direct numerical simulation of continuous droplet growth in turbulent cloud
submitted to ACP by Chen, Yau, Bartello and Xue

SUMMARY: This manuscript discusses results from Direct Numerical Simulations at low resolution ($N^3 = 64^3$) of turbulent cloud environment: the flow is seeded with point-like droplets, and both condensational and collisional growth are studied. The authors consider three flow situations: 1) droplets settling in still air, ii) droplets moving in a flow characterised by a low value of the kinetic energy dissipation rate ϵ_0, and iii) droplets moving in a flow characterised by a higher value of the turbulent kinetic energy dissipation rate $10\,\epsilon_0$. To quantify the effects of turbulence on the droplet growth, the size distribution (SD) obtained in the different runs (7 in total) is examined and compared.
The main finding of the paper is to show that, starting from the same initial condition for the droplets, the SD exhibits a larger broadening when both condensational and collisional effects are implemented (see below).
In a previous paper (Ref.[1]), the authors used DNS to study turbulence effects on collisions efficiency and broadening of SD in a similar set up. In particular, by considering droplets in the range of radii $r <= 70\mu m$, they found that broadening is more important when turbulence is stronger.

Present work, as the authors clearly state, is a sequel of Ref.[1]. Unfortunately, it is much less convincing. As I explain below, I have some major concerns about the results and find the paper lacking a well tought physical analysis.
Here below I report major comments only.

MAJOR COMMENTS:
1) DNS are performed at what is at present considered a low resolution. With $N^3 = 64^3$ grid points, the Eulerian flow is only weakly turbulent. Varying the value of ϵ does not modify the flow regime from weakly to strongly turbulent (in practice, the Reynolds number stays unchanged), but it impacts all statistics whose prefactors depend on the kinetic energy dissipation rate. In literature, recent studies consider resolutions at $N^3 = 256^3$, at least.
A low resolution set up could be however acceptable if more emphasis were

given to a deep and well-tought analysis of the numerical results. This is not the case of the present paper.

2) In Appendix B, it is stated that droplets dynamics is described by eq. (B10) for $r < 40\mu m$. In this case, the still-fluid terminal velocity is $V_T = g\tau_p = kr^2$. For larger particles, it is unclear if eq. (B10) is still used or not.
How is the droplets dynamics described when $r > 40\mu m$? Is non-linear drag used or what?
Moreover, it is stated that if the radius $r \geq 40\mu m$, the adopted the still-fluid terminal velocity becomes $V_T' = k_2 r$. This means that at $r = 40\mu m$, the function describing V_T not only changes its dependency on r, from quadratic to linear, but that there is also a jump in the value: if I am not wrong at $40\mu m$, we have $V_T = 0.19 m/s$ and $V_T' = 0.32 m/s$....
Either I have not well understod, or there is a problem with this description.
Finally, at radii as big as $60 - 100\mu m$, the particle Reynolds number is no longer small, so that I am afraid that the calculation of the disturbance flow in terms of a linear Stokes eq. is no longer valid.
All the big droplets description should be reconsidered and better discussed.

3) The way collisions are treated in the DNS is not described. How are collisions described when one or both droplets have radii larger than 40 micron?

4) A critical issue of this work is the number of simulated droplets, which is initially equal to $80/cm^3$ for a volume of $(10cm)^3$. Since this is not high, I have some troubles with the statistical meaning of the results.
In Figure 1, SD is shown in the range of values 10^2 down to 10^{-4}. However below 10^{-3}, the signal is very noisy, and possibly statistically not relevant. This applies also to all discussion about the size of the largest droplet in the domain: if I have one of such large droplets, its measure is zero. So either the authors are willing to perform many of these simulations to increase the statistical accuracy, or they should limit their discussion e.g. of data in Fig 1. to $dN/dr > 10^{-3}$.

5) Comments in the Results and discussion section are very qualitative. Knowing that “droplets larger than $35\mu m$ (over $0.001 cm^{-3}$) can be seen as early as 3.5 minutes in the condensation-collision experiment, but 6 minutes in the collision-only run” might be mentioned, but a physical analysis of the

results is lacking.
Moreover as I said weak and strong turbulence cases differ in the prefactors, not in the amplitude of the inertial range (which is almost absent in DNS at 64^3), so authors should explore what really causes the observed SD.
Did they measured some conditional statistics to better assess what modifies the droplets collision rates when condensational growth is present? Is there a role of large velocity differences between similar size droplets? I would guess that the so-called sling effect is stronger if r/R approaches 1, and weaker for different size droplets.

6) From literature, including Chen et al. 2016, it is known that turbulence enhancement on collision rate is most significant in similar-sized droplets: what the present work add to this known observation?

7) Also, I think that the purely gravitational case can be omitted.

FINAL ADVICE: I acknowledge that the authors have introduced the "first DNS approach to explicitly study the continuous droplet growth by condensation and collisions inside an adiabatic ascending cloud parcel", but it seems that much of the new physics we can learn of has not been presented here. On the basis of the above considerations, I have to say that in the present form the manuscript is not suitable for publication on ACPL.

References

[1] Chen, S., Yau, M. K., and Bartello, P., J. Atmos. Sci., https://doi.org/10.1175/JAS-D-17-0123.1, 2018.