Turbulence effects on warm rain formation in precipitating shallow convection revisited, by Axel Seifert and Ryo Onishi

In this paper, the authors followed the previous work of Seifeit et al. (2010) to study the effect of turbulence on the evolution of warm rain in precipitating shallow convection. Their main purpose is to compare two alternative formulations of turbulent collision kernel, Ayala-Wang and Onishi. The reference case of purely gravitational collection is also considered. They first developed an approximate autoconversion parameterization based on the turbulent collision kernels. The main conclusion is that the results of precipitation rate, characteristic rain development times, etc., depend on the kernel, calling for further investigation of turbulent kernel formulation. This conclusion is reached based on a large set of LES runs which considered different initial droplet number density, shape (mean size), and LES grid resolution.

The paper is interesting and may be published. However, some clarifications need to be made in order to provide a more complete and fair picture in the context of the complex problem of rain initiation.

1. The starting point of the paper is the introduction of two collection kernels. Fig. 1 shows how the Reynolds number affects the change of kernel in each case. For most regions, the Ayala-Wang kernel seems to have a more stronger Reynolds number effect. Is there any region in Fig. 1 f) showing a stronger dependence compared to Fig. 1 c). If so, can the reason be provided?

2. The paper relies heavily on the contents in other papers including basic definitions. For example, the precise definitions of autoconversion, accretion, and selfcollection are not given. It would be useful to provide definitions of such.

3. Furthermore, regarding the enhancement of accretion and selfcollision k_{rr}, I assume this factor is used in determining the mean size of rain drops. Can an equation like Eq. (8) be provided to show how k_{rr} is actually incorporated in the moment methods.

4. One of the observations is that the Ayala-Wang kernel lead to faster autoconversion and Onishi's leads to faster accretion. The faster autoconversion is due to stronger Re dependence. Can the reason for faster accretion for the Onishi's kernel be provided? This could be discussed in terms of aspects related to the point 1 above.

5. The study uses a single mass ($2.6 \times 10^{-10} kg$ or about 40 μm in radius) as the dividing size between cloud droplets and rain drops. I wonder how this choice affects the conclusions of the paper. Can the authors study other dividing size such as 25 μm or 35 μm as the dividing size? This is important since a very rough moment method is used in the LES.

6. The formulation involves a shape parameter ν (Eq. 7). I assume A and B are related to L_c and $\overline{x}_c$. It is not clear if ν is kept as a constant during the LES simulation and how ν is determined. Can this be clarified?

7. In the model equation (10), a single exponent p is used for the whole range of Re. In reality, the collection kernel (specifically the RDF) first increases with Re, then saturates or decreases slowly with Re. The question is then how valid a single exponent in representing the effect of flow Re.

8. Another observation is that the Ayala-Wang kernel leads to shallow inversion height. However, in Wyszogrodzki et al. (2013) and Grabowski et al. (2015, Atmos. Chem. Phys., 15: 913-926) based on the spectral bin method, it is shown the dynamic effect of faster droplet growth is a deep cloud top. I wonder if these two are contradictory, and if the reason for this contradiction is due to their use of the moment method. Clearly, the strong sensitivity of the collision kernel with droplet size and shape of droplet size distribution requires a more accurate representation than the two-moment method. The authors should clarify the various errors associated with the moment method, and potential effect on the conclusions of the paper.