Review of the paper "Uncertainty from choice of microphysics scheme in convection-permitting models significantly exceeds aerosol effects",
authored by Bethan White, Edward Gryspeerdt, Philip Stier, Hugh Morrison, Gregory Thompson, and Zak Kipling

This study is a revised version of the paper "Can models robustly represent aerosol–convection interactions if their cloud microphysics is uncertain?", authored by B. White, E. Gryspeerdt, P. Stier, H. Morrison, and G. Thompson. Two widely used bulk parameterization schemes referred to as "MORR" (Morrison and Milbrandt (2011) and "THOM" (Thompson et al. (2004, 2008)) were tested by simulations of three case studies with different type of convection: from shallow convection to a supercell storm. The simulations were performed at a priory given droplet concentrations of 100 cm-3, 250 cm-3 and 2500 cm-3.

A huge difference in cloud microphysical structure simulated by these two schemes is reported.

Both bulk schemes turned out to be insensitive to droplet concentration. So, the difference in results are related to the differences in the bulk-parameterization schemes.

The paper was improved in course of the revision. The overview of the state-of-the art bulk schemes includes now many necessary references.

In my view, the most interesting section in the revised paper is the analysis of the reasons of differences between the results obtained using these two. The authors stress a crucial role of representation of autoconversion process. The Thompson scheme uses one of versions the Berry and Reinhard (1974) autoconversion scheme. Gilmore and Straka (2008) (this study is referred now in the new article version) showed that the rates of autoconversion predicted by different versions of the Berry and Reinhard (1974) scheme differ by orders of magnitude. So, a justification of the choice of particular autoconversion scheme is required.

The Morrison scheme uses parameterization of autoconversion developed by Khairoutdinov and Kogan (2000) for drizzle formation in marine stratocumulus. Note that the mechanism of drizzle formation in Sc substantially differs from raindrop formation in Cu and, of course, in deep convective clouds. In this relation, Khairoutdinov and Kogan (2000) wrote in their article: 1) "The proposed bulk microphysical parameterization has been developed and tested for thermodynamic conditions typical for the midlatitude and extratropical stratocumulus layers formed over the areas of upwelling off the west coasts of continents; therefore, it may not be valid to extrapolate its use to other cloud types and conditions" and 2) "We have to emphasize that the proposed scheme is intended for LES of convective STBL with a spatial resolution of tens of meters. Such an LES resolves most eddies of turbulent flow and, consequently, spatial variation in supersaturation, water content, cloud condensation nuclei (CCN) count, drop concentration, etc. This auxiliary information enables one to add a level of complexity to the traditional bulk microphysics schemes by adding, for example, the explicit CCN–cloud drop concentration feedback, as done in this study. Therefore, the proposed scheme cannot be simply extrapolated for use in larger-scale models since the derived water conversion rates depend *nonlinearly* on local (eddy scale) cloud variables".

So, on one hand it is good that the important reason of the differences between results of the Thompson and of the Morrison schemes is found. On the other hand, a justification and reasoning of utilization of the Khairoutdinov and Kogan (2000) parameterization for conditions quite different from those in Sc are required.

3. The authors illustrate vertical profiles of mass contents of different hydrometeors averaged over the entire computational area. As a result, all information concerning the microphysical structure of clouds simulated by different schemes turns out to be lost, at least for specialists in cloud microphysics. It is necessary to present vertical profiles of maximum values of the mass contents. The profiles of cloud averaged values would be also useful. These figures should be accompanied by corresponding comments and analysis.

4. I still do not understand the reason of the existence of small cloud droplets near the surface (Fig. 6 and Fig. 7). If spontaneous breakup of raindrops is not included, the reasons of this very strange effect should be explained. What is relative humidity in the BL?

5. The section of Conclusions was improved, but still remains weak. The key finding as it is formulated in the paper is: "In the context of our finding, this strongly suggests that an accurate description of the autoconversion process in warm-rain regimes is fundamental not only to a realistic representation of cloud and precipitation, but also to its response to varying aerosol concentration".

This finding is not new and seems somehow trivial. It is not necessary to analyze in detail three case studies to conclude that the level of raindrop formation and the growth rate of raindrop mass are of crucial importance for warm and mixed-phase cloud microphysics. Actually, autoconversion rate determines the difference between cloud types: maritime vs. continental.

No solution or even suggestion concerning the ways to improve the representation of the autoconversion is proposed in the study. At the same time two moment bulk schemes allow calculation of the mean volume radius. Note that the mean volume radius is a very robust quantity, which vertical profile depends on droplet concentration, i.e on the CCN concentration. The mean volume (or effective) radius can be also calculated using adiabatic LWC and droplet concentration. It is also known that raindrop onset begins when the mean volume radius exceeds its a critical value of 13-14 um (Freud and Rosenfeld, 2012, Khain et al., 2013, Rosenfeld et al. 2014). This allows to calculate the height of the first raindrop formation quite accurately. Might be this condition can be used for testing and improvement of the schemes?

I also recommend to refer the recent studies by Igel and van den Heever (2016a,b, 2017), where different values of the shape parameters of Gamma distribution is considered and important reason of difference between the results of bulk schemes. Igel and van den Heever proposed the optimum shape parameter of gamma distribution at the stage of diffusion growth.

Of course, available bin microphysics models (WRF, SAM, parcel models with a very detailed description of raindrop formation) can be useful.

The discussion of the possible ways to improve the autoconversion schemes is desirable.

I recommend to accept the paper with *major revision*.

References:

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