Review of the paper entitled
"Large-eddy simulation of radiation fog with comprehensive two-moment bulk microphysics: impact of different aerosol activation and condensation parameterizations"

by Johannes Schwenkel and Bjorn Maronga

RC1: This paper addresses the difficult topic to evaluate the influence of cloud microphysical parameterizations on large-eddy simulation of radiation fog. The results are based on one case of deep fog observed at Cabauw (Netherlands). The subject of the manuscript is interesting as radiation fogs are not well known, and particularly the influence of microphysical processes on the fog life cycle. However, I think that some revisions will be helpful to make this paper clearest.

Author's answer: First of all, we would like to thank the reviewer for the detailed and constructive feedback. In particular, the suggestions on the visibility and time marks of the fog cycle were added and are now discussed in the revised manuscript. Furthermore, the other points of criticism regarding the aerosol concentration and the difference between shallow fog and deep fog were taken into account and the manuscript was adapted accordingly. With the help of these comments, it was possible to contribute to a significant improvement in the work and to clarify the research.

RC1: **1. clarify the effect of microphysical parameterizations on the fog life cycle :**
Following Fig. 8, the microphysical parameterizations used do not modify the fog onset, the time when fog becomes optically thick, the lifting time of fog and the time when fog is completely dissipated. However, it is very difficult to evaluate precisely these parameters from Fig. 8. I think that a table summarizing these 4 times, crucial in the fog life cycle (onset, transition into optically thick fog, lifting time and complete dissipation), would be helpful to evaluate the impact of the parameterizations used. Could you please add this table and discuss the impact of microphysical parameterizations on these parameters? Please elaborate.
Author's answer: We agree with this objection that a table is the method of choice for displaying these parameters. In the revised manuscript the table is provided in section 4.3 and discussed in the following.
Modification(p19, l1): The effect of the different activation schemes on the time of the fog life cycle is summarized in Tab. 2. The largest differences occur for simulation N2EXP in comparison to N1EXP and N3EXP. The onset is delayed by 25 min, while the maximum liquid water mixing ratio is reached 45 min earlier, than in the other cases. Also lifting and dissipation are affected and occurred15 min and 40 min (with respect to simulation N3EXP) earlier. This is due to a lesser absolute liquid water mixing ratio which is more easily evaporated by the incoming solar radiation. Therefore, it can be concluded that the use of different activation schemes (if they change the droplet number concentration) has an effect on the time marks on the life cycle, even though the general shape stays untouched

RC1: **2. effect of microphysical parameterizations on visibility at ground level :**
Your simulations demonstrate that the microphysical parameterizations mainly impact the microphysical properties of the fog layer (liquid water mixing ratio and LWP). These parameters (ql and nc) have a significant impact on the diagnosed visibility. Could you please discuss the impact of the microphysical parameterizations used on the diagnosed visibility at ground level? Is this impact significant? Or is this impact of the same magnitude than uncertainties due to visibility diag-nostic? Please elaborate.
Author's answer: This is a good suggestion, since the visibility was a measured quantity during CESAR. We have added time series of the simulated and measured visibility (even though it was not our aim to represent a specific fog case as close as possible to observations) in the revised version.

Modification(p2, l2): In Fig. 9 the simulated visibility for the cases N1-N3 in 2 m height as well as the observed value is shown. For the simulation the visibility is calculated by

$vis=1002/(n_c \rho q_l)^{0.6473}$,

following Gultepe et al. (2006). Here, n_c and q_l must be given in units of cm^{-3} and gm^{-3}, respectively. Hence, the visibility is significantly affected by the droplet number concentration and the liquid water content. As one can see all simulations reproduce the general trend of the visibility quite well. During the onset of the fog all simulation tend to underestimate the visibility. In the mature phase Simulation N2 exhibit the largest values to the observed visibility, but matches best during the lifting phase. However, it should be mentioned that it was not our goal to mimic one particular fog case.

RC1: **3. effect of aerosol :**

Your tests are done for a background aerosol concentration of 842cm−3 and for a given aerosol chemical composition. What is the impact of this hypothesis on your results? Are your results also valid in a highly polluted atmosphere (e.g. observation made during WIFEX), or in an atmosphere with low aerosol concentration? Please elaborate.

Author's answer: It is true, that our simulations shows results for only one aerosol environment. However, these are well-known and frequently investigated conditions. Furthermore, in many of the observed radiation fog events the underlying conditions are similar the chosen aerosol conditions of this study.

Of course, changed aerosol conditions would change the absolute numbers of the errors done with the investigated microphysical parametrizations. However, the qualitative findings will be untouched. The reason why we have not conducted simulations for only quantifying the difference for different aerosol environments is then based on the needed computational resources which are tremendous (54h on 3072 computer cores).

However, we agree that these findings with their concrete numbers are limited to cases with continental aerosol conditions. Due to that we have adapted the manuscript to clarify that it's based on continental aerosol conditions.

Modification(different passages): [..] continental aerosol conditions [..]

RC1: 4. **shallow fog / deep fog**

Are your findings also true for shallow fog (with thermal inversion at ground level)? The dynamical processes between shallow and deep (mature) fog are strongly different. And consequently, the impact of microphysical parameterizations could be very different during the fog life cycle (due to difference in supersaturation magnitude). Could you please clarify the sensitivity of microphysical parameterizations depending on the fog type (ie shallow vs deep fog)?

Author's answer: This is an interesting objection. However, in current research the focus is more on deep fog events, as these affect our everyday life much more (e.g. dangers for air and car traffic). Moreover, even though the dynamics of shallow fog compared to a deep fog event might be different, it was not our aim to derive universally valid statements for the entire parameter space (as for different aerosol conditions).

Unfortunately, as stated in the previous comment this is with a high-resolved (isotropic grid-spacing of 1m) LES not possible where one simulation requires many computer resources (as mentioned above).

Form the fundamental research point of view, different microphysical parameterizations might also affect shallow fog since the crucial parameter is the supersaturation.

But we agree, to clarify that our statements are especially valid for a deep fog case under typical continental aerosol conditions, and according to that we had adapted our manuscript.

Modification(at different passages): [..] deep [..]

RC1: 5. Stolaki et al. (2015) use 1D model. She does not use 2D LES. Please modify (p2 l2).

Author's answer: This is right. It is corrected in the revised revision.

Modification(p2, l2): [..] while using the one-dimensional mode of the MESO-NH model [..]

RC1: 6. Figure 6b, 6c, 6d, 9c and 10c are very hard to read (too many curves on the same plot). Could you please try to improve these figures?
Author's answer: As also the other reviewer criticized the figures. We modified them, as we separate them to more individual plots.
Modification(Fig 6,9,10): We modified the figures 6,9 10.