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Interactive comment on "Experimental study of the aerosol impact on fog microphysics" *by* Marie Mazoyer et al.

Anonymous Referee #2

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In the study microphysical properties of 23 fog events has been reported. The main finding is that the droplet number concentration is lower than expected and the dependence on aerosol concentration can not be observed. I think the data provided can give a valuable contribution as there isn't too many similar datasets available. However, the analysis is quite limited in some parts and the conclusions does not really reflect the data. There is much more potential and room for improvements. Also the manuscript does not include findings from any article published after 2015. Since then there has been several modelling studies with varying amount of details in representation of aerosol-fog interaction. The findings from the presented manuscript must reflect findings from recent literature before it can be accepted for publication. Thus I recommend major revisions.

1) It is acknowledged that the used SMPS does not give information on the aerosol particles with diameter larger than 496nm. Why don't you use data PALAS-WELAS to get an estimate on the particle concentration larger than that? Based on Figure 7 there is quite nice overlap and agreement between the instruments after hygroscopic growth in ambient conditions is accounted for.

2) The number of fog droplets is compared to both CCN at 0.1% supersaturation and N_200, which both are on average clearly higher than the observed droplet concentration. Without further analysis it is quite strongly said that the droplet concentration does not depend on aerosol. As the aerosol is measured up to 496nm and PALAS-WELAS instrument could be used for larger particles, it would be quite straightforward to analyze if the shape of aerosol size distribution is affecting the observed droplet concentration. Now it can be only concluded that N_200 and CCN(0.1%) are not good proxies for fog droplet concentration in polluted conditions.

3) The results presented are mainly for the first hour into the fog lifecycle although data would provide a nice possibility to analyze the whole lifecycle. Is there some reason except the comparison to pre-fog aerosol? Is the first hour somehow relevant for the whole cycle? For example in Figure 5, why does PALAS-WELAS see such a strong increase in the concentration whereas FOG-monitor values are quite constant in the morning just before fog dissipation? Is this the situation in all observations?

4) In the end it is discussed that the droplet concentration in radiation fog is subject to a pronounced decrease in the droplet concentration while stratus lowering cases are not. This is quite obvious as in the beginning of radiation fog formation the whole fog layer is cooling (higher supersaturation maintained) and there is lots of aerosol particles present. While fog matures and grows in height, available particles are consumed within the fog and cooling is more efficient at the top of fog. See e.g . Boutle et al. (2018) or Tonttila et al. (2017). I do not see any point in the comparison to cumulus clouds where dynamics is totally different.

5) The big question is what is the relevant droplet concentration for numerical weather prediction and climate modelling purposes? Is it really the number of droplets actually activated or some other value accounting also the biggest hydrated aerosols? I would like to see some discussion on that.

6) It is concluded that the activated fraction mainly depends on the aerosol size. I do not agree on this statement. In Figures 9 and 10 I only see that the critical size for activation and fraction of activated particles anti-correlate, but this does not say anything on the mechanism driving this relationship. Not the size of aerosol particles at least. Instead Figure 10a gives some indication that particle chemistry might have some role in activated fraction. To really make any conclusions about the effect of size or chemistry, the information of aerosol size distribution above 200nm should be used. This is available, so I don't see any reason why not to use it.

7) Visibilities and LWC values are discussed but not shown. Comparison between visibility and droplet concentration could give some idea how relevant is the role of activated droplets when compared to hydrated aerosols in different cases. Even more if visibility at both measurement altitudes is given.

8) Figure 4 does not give support for understanding the method for iterating critical size and supersaturation. Please try to improve it.

References:

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