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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol-fog interaction and the transition to well-mixed radiation fog" *by* Ian Boutle et al.

Anonymous Referee #1

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Review of the paper entitled
"Aerosol-fog interaction and the transition to well-mixed radiation fog"

by Ian Boutle, Jeremy Price, Innocent Kudzotsa, Harri Kokkola and Sami Romakkaniemi

manuscript number ACP-2017-765

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Decision : This paper need more work before it goes to publication. Accepted with MAJOR improvements.

This paper addresses the difficult topic to evaluate the influence of aerosol for the numerical simulation of radiation fog. The results are based on one case observed at Cardington-UK during IOP1 of LANFEX field experiment and on one month of assimilation - forecast for February 2015. The subject of the manuscript is interesting as radiation fogs are not well known, but the actual scope of the manuscript is not so well defined. I have concerns about the methods used and I wonder about the value added by this study with respect to the existing bibliography.

Therefore I can not recommend publication of this paper without extensive and major revisions.

I would like to see the paper again once major modifications are done.

major remarks :

1. **Demonstrate the usefulness of using 3 types of models (LES - NWP - climate model)** :
   Previous studies on microphysical processes were done with NWP or 1D models or were the results of field experiments measurements. Please justify the use of LES to demonstrate the impact of aerosol on fog. What are the added values of LES study with respect to 1D model? This point is essential for the publication of this work.
   The impact of cloud droplet number with NWP should be evaluated in a statistical way : How has this modification improved the fog forecast? This evaluation could

be done with LANFEX data which provide many cases of "stably stratified fog" cases. Your conclusions are too speculative and need to be demonstrated.

2. **Validate the microphysical parameterization** :
   Your work is based on the use of a specific microphysical parametrization. In my opinion, the main characteristics of this parametrization should be detailed in the revised manuscript. Particularly, the dependence of activation parametrization with respect to radiative cooling and turbulent processes should be explained. This microphysical parametrization should also be validated for fog cases, with comparison with observations from LANFEX for example.

3. **Validate the numerical model used and particularly the frost-dew deposition** :
   The dew and frost deposition play a key role during the formation phase of fog and particularly in the transition to well-mixed radiation fog (eg Guedalia and Bergot 1994). Frost deposition could prevent the formation of dense fog despite radiative cooling. It is necessary to demonstrate that this process is correctly simulated. Otherwise, your modification may simply compensate the errors in the estimate of deposition by the model. It is also absolutely necessary to validate the model used for turbulent processes, radiation and soil-atmosphere exchanges.

4. **Contribution of this study with respect to bibliography** :
   Another shortcomings of the current manuscript is that it does not cite available literature. For example papers from Bott (1991) or Rangognio et al. (2009) have studied in detail the effect of aerosol on radiation fog. It needs to be shown what new results does this work provide compared to those already published. What are the differences in the model, observation and methods used? What are the differences in results found? You say in conclusions that "key factors affecting the development of well-mixed fog include :"
   "(i) the amount of time available for development before sunrise" : the point is

   well-known and has also be demonstrated by numerous studies. Please cite the current literature and please evaluate your contribution with respect to existing work.
   "(ii) the speed with which the fog layer can deepen , strongly governed by humidity profile" : please evaluate your contribution for this well-known result.
   "(iii) the amount of accumulation and coarse mode aerosol for activation" : this point is in contradiction with the LES study of Maronga and Bosveld (2017) on a Cabauw case which say in abstract that "the choice of droplet number concentration ... has a high impact on the liquid water content within the fog layer but a rather small effect on its life cycle". Please elaborate.