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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of aerosols on the formation and development of radiation fog" *by* J. Rangognio et al.

Anonymous Referee #2

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Rev A MS# ap-2009-482 Authors: J. Rangognio et al Submitted to ACAPD open journal

Decision: This paper needs more work before it goes to the publications. Accepted with major improvements.

This manuscript focus on influence of aerosols on the fog formation and development of radiation fog. It uses a meso-scale model together with the ORILAM aerosol scheme coupled with a 2-moment microphysical cloud scheme. Activation scheme uses A&G (2004) which is developed for large scale cloud-climate interactions.

General comments: In general, it is an interesting manuscript to study radiation fog and aerosol effect for its formation and development. During my review I had several issues related un-explained scientific questions such as why Nd decreases while Na

increases after a critical Na number. They say that 1) aerosol number concentration was a key parameter for accurate prediction of microphysical parameters, and for its effect on vertical fog development and 2) fog life cycle is defined by ccn and its chemical properties. Unfortunately these points were not verified clearly with observations. There are significant differences exist in comparisons such Nd is 2 times more in the simulations compared to observations. Another issue is why the fog top height is different for various simulations if no moisture available e.g. subsaturation.

Method section is not given, in this section, they should explain how they proceed for the work Objectives are not clear. They have to have a paragraph clearly state the objectives of the work. Discussion section should also be given. There are many statements that no explanations are given (see below for details).

There is always a relationship between Na, its composition, and fog microphysics if there is enough moisture. If air is highly saturated, CCN will activate continuously without size or composition criteria. If not enough moisture exist, then fog droplets will not form after competing for vapor. In this respect if air doesn't have enough moisture, fog will not occur; doesn't matter if CCN exist or its composition has different species. Of course, you will have many small droplets if you increase Na but if radiative heating occurs, Nd (LWC) will decrease even if you increase Na. The effect of Na on Nd will be the function of heating/cooling processes. When it is cold early morning you will have more droplets but when sun comes out, droplets will evaporate, it doesn't matter if you increase the CCN or not. It depends on if you have enough cooling because of lifting or radiative cooling etc. If you have fixed CCN, activation will be function of cooling rate and availability of moisture.

Major/minor corrections:

Page 17965; Introduction: Line 1; First sentence: there is no relationship between this work and climate change, it should be taken out because it is nothing to do with this work.

ACPD

9, C6823–C6829, 2009

Line 5 “Vautard (2009) ..... reduction in low Vis contributed about 20% and 50% warming”. Vis can be due to rain , snow or fog, if snowing and vis increases, how this can be related to warming in Europe? Vis is related to precip and fog (or aerosols, RH etc.), if it increases, it means no precip. It doesn't means that heating caused it. Do you mean that when Vis increases clouds dissipates?? This is not correct.

Line 20; Nakanishi 2000; 3 stages and you do not study dissipation. Why not. Also how do you believe that TKE is used for 3 stages of fog? In radiation fog, you do not have TKE anyway, mainly driven by radiative cooling and settling of droplets.

Page 966; CNN activation by G&A is developed for climate studies. How this is applicable here, why this is acceptable? This is one major issue here.

Line 4; links microphysical aerosols to clouds????? This should be aerosols to cloud droplets.

Line 18; Please ref Gultepe et al (AMS Bulletin paper, 2009) who studies fog using various in-situ observations that include 3D wind, radiation, and microphysics.

Page 967; Fog formation is not only due to rad cooling, advection and turbulent/eddies may cause fog formation in the BL. Cooling at the top may not result in max size when droplets initially grow and they started to go down and collide with other particles, resulting higher LWC and size at low levels.

Line 8-9; microphysics affects indirectly fog life cyle through interactions of ..... This is true but an end result of net heating/cooling processes play a role for fog dissipation/formation.

Line 22; what are the complex processes????

Last paragraph: objectives are not clearly set up and given different locations. Should be organized properly.

Also, separate DISCUSSION section should be given and summarize uncertaini-

ACPD

9, C6823–C6829, 2009

ties/issues.

Page 968 CNRM/GAME is not defined, please check it.

Page 969 How accurate to use Kessler scheme and KK schemes for a radiation fog study?????? Did you discuss these?? I suggest that you should compare some of these parameterizations with observations such as droplet sedimentation.

Line 20; are these constant numbers are applicable for fog? They are mostly for clouds, is this right?

Page 971 Line 7; this sentence is not written correctly.

Page 972 Line 5; rising adiabatically, this is not the case for radiative fog. You do not have an updraft. Then how do you select these parameters?

Line 8; no verb in this sentence, and what and where a term is added?

Line 17; change it to: The ParisFOG. . .. .out over six months time period during. . .. . .

Page 17973 Line 4; only microphysical instruments will be given. . .. That is not true you provided other sensors/obs too.

Page 17974 Lines 1-3; is this sensors for only droplets or plus droplets and aerosols? Needs to be clarified. What threshold size issued for separation of droplets and aerosols.

Page 17976 Section 4 should be “1D simulations” a) sensitivity tests for aerosol properties 1) for aerosol concentration 2) for aerosol median diameter 3) . . .. b) case study for radiation fog 1. model configuration 2. . . ..

Page 977 Line 28-29; When Na increases the Smax decreases, Rcrit increases. I do not see why Na increases and Smax decreases. Do you mean aerosols absorbs more vapor that causes Smax decreases. . ... This needs to be clarified.

ACPD

9, C6823–C6829, 2009

Page 982 Line 1; why CCN decreases when Na increases? This doesn't make sense. A ratio between CCN/Na can be a constant for certain airmass. If the aerosols becomes wet, this is another issue. Un-activated fog doesn't make sense. Fog defined as activated droplets. If not activated, it is not fog. Wet aerosols but not fog. Fog happens at ~100% RHw. If it is about 90%, it is just haze/mist.

Page 979 Lines 23-25; for polluted airmass, Smax becomes smaller e.g. 0.03% compared to 0.3 % for a clean airmass for a fixed diameter. If you do not fix critical diameter, when Smax decreases you should have larger critical size, in this case your Nd should be smaller. This is opposite what you are saying. In other words, if you fixed Smax, you will have more Nd in polluted airmass. This needs to be explained little more.

Page 983 Line 25; I think there is 3K diff between model and obs, this is a huge diff. This is not a good result (Fig. 7).

Why not show a plot for T and Td from observations? (Fig. 7).

Fig. 8; diff in IR down is about 20 Wm-2, not 5 wm-2. This is a huge diff and suggests that simulations are not very good for fog formation. Needs more clarification.

Fig. 9; There is no relationship between Nds from model and observations!!!!! Difference is almost 2 times, this makes a huge difference in Vis and fog coverage.

Fig. 10; how come you see larger LWC (box d, Na=12000) than box b (Na=1000)???? It is very clear that you make an assumption here, what is it. Usually, Na increases LWC decreases. Same for Na=5000 cm-3. You need to explain this in a better way.

Fig. 11; if the S is constant in vertical (or saturated air), cloud top should be same for all cases. How do you explain this that fog top height is different for all cases randomly???

Same for fog base height? Why there is no net heating/cooling at the base, no fog!!!!!!!

Page 984 Line 13; where is the fig for well simulated LWC?????

Page 985 Lines 5 -15; there is no gravity waves in rad fog conditions, where is this

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9, C6823–C6829, 2009

coming from???

If you cannot measure it how do you know your theoretical values are correct?

Page 986 Please compare your model results with a parameterization given by Gultepe et al in JAM AMS. Vis is function of LWC and Nd, and can be compared easily. You can find settling rate parameterization in that paper to validate your results.

Line 8; what do you mean realistic behaviour? This doesn't make sense. Line 21; evolution of cloud droplet number concentration ..... versus time is shown in Fig. 10.

Line 18; it is not complete senstence number concentration of what?

Line 22; not clear sentence, needs to be rewritten.

Page 987; Line 1; at 0600 UTC ..... Why greater development occurs at 180 m than this of 150 m. You have many small aerosols at 180 m than this of at 150 m???

Line 13; The number of aerosols directly affects the S, this is not true. CCN affects the super saturation. If the aerosols not activated, nothing happens to S.

Line 18; lwc is condensed; this doesn't make sense, it is already condensed.

Why cooling rates are at different levels, fog type should be same for all conditions, unless there is an updraft?

Page 988 Line 8; how come you can have high LWP when it is polluted? Also in line 13.

Fig 10, 11, and 12 should be discussed orderly.

Page 989 8700 cm-3 and 8300 cm-3 difference is very small, why you make this analysis here?

Line 3; 3 chemical compositions??? What are they?

Page 990 Line 8-10; why this happens, why LWP becomes difference for these cases?

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9, C6823–C6829, 2009

Section 6 Line 25; doesn't make sense. ". . ...are the budgets of these two processes."

Line 23; radiative cooling is the main source of condensed water and aerosols. . .. . . How come rad cooling affects the aerosols. It affects S but not directly aerosols. You need to modify the sentence.

You need a discussion sections, currently, it is all over.

Page 991 Line 18; growth kinetics such as . . .. . . should be given here.

Line 25; aerosol number concentration limits the increase of S. . ..., I think Na doesn't affect S but CCN does. If aerosols are not CCN and not activated, doesn't matter how many aerosols you have. You mean CCN affects S.

Conclusions should be summarized in a better way other than mixing everything together. For example, it may be itemized.

Table 5; Line 1 and 2; why you have same rad cooling when Nd is 2 times more.

Table 1; provide size limit for each mode.

Fig. 9: why Nd is so different for model and observations? Why this happens? Vis can be 100% different for this. Can you plot Vis here from the model and observations (such as using Gultepe al parameterization).

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 17963, 2009.