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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol dynamics and dispersion of radioactive particles" *by* Pontus von Schoenberg et al.

Anonymous Referee #1

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General Comments

In this paper, the authors describe work examining how the consideration of full aerosol dynamics and complex cloud modelling impacts on the prediction of air concentrations of Caesium-137 when compared to the simple scavenging schemes used in Lagrangian particle dispersion models. Their results show that the use of complex cloud modelling results in increased loss of caesium-137 from the atmosphere when compared to simpler cloud schemes. They also show that in most cases other aerosol dynamical processes have a much smaller impact on the air concentration of caesium-137 but in a few cases the impact is much greater.

The aim of this paper is demonstrating the advantages of including advanced aerosol physics in Lagrangian dispersion model. Therefore, I think it would be helpful if the

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Discussion paper

authors could comment in the discussion on the likely impact of their results if, for example, more complex cloud physics had been used in modelling the Caesium-137 from Fukushima. A number of papers have shown that, at longer range, the air concentration of Caesium-137 from Fukushima is underestimated by Lagrangian models. As the results here show that advanced cloud physics will increase the amount of Caesium-137 lost from the atmosphere it would appear that including advanced cloud physics in a model to simulate Fukushima would result in a greater underestimate of the Caesium-137.

It would aid my understanding of the results if some of the descriptions in the introduction (and method) were made more specific. For example, I would like to see a clearer description of the processes the authors are considering to be advanced aerosol processes and the processes the authors consider as advanced cloud physics. Not all radiological dispersion modellers are familiar with the naming convention for different particle sizes so a list of these would be helpful. Finally, there are a number of locations were information is presented in and order which to me is not intuitive. For example, the paragraph at line 50 introduces aerosol particles yet their physical properties are described in the previous paragraph. Also, the second paragraph of the discussion provides an overview of the different aerosol processes which would have been useful to read in the introduction.

More generally, the method is clearly laid out and the results section is easy to follow. I have a few more specific comments (see below) but I would recommend this paper is published subject to minor revisions.

Specific Comments

The authors used a Lagrangian trajectory model to obtain the path of the air masses through the atmosphere and then a box model to model changes in the properties of the air mass. Since the size of the particles are only considered in the box model and not the trajectory model, I think this means that gravitational settling can only be

considered as a loss process. Many Lagrangian models take gravitational settling into account as a vertical velocity allowing particles to move downwards through different flow fields. Would the authors be able to comment if or how gravitational settling is taken into account and the impact of this assumption?

The end of the paragraph between lines 80 and 86 seems to suggest that Eulerian models are not used in emergency preparedness. I know several centres that do use Eulerian models in emergency preparedness, but I believe that like the Lagrangian emergency models they do not use complex aerosol dynamics. Would the authors be able to rephrase the end of this paragraph to reflect this?

On lines 129-131 the authors describe calculating trajectories using HYSPLIT. Could the authors comment on whether the trajectories were based on mean winds and turbulence or just mean winds?

In Figure 2 for the station at Zeppelin there appears to be a big difference in the initial number size distribution between the winter and summer months. Is this difference expected and if so, what is the cause?

On line 225-226 the authors note that "the effect of ice components in clouds is neglected . . .". Are the authors able to provide an estimate of how much this will overestimate the scavenging efficiency?

Lines 300-302. The authors describe a rapid decrease in the total particle number concentration in the first hours of the simulation. I am not sure I can see this in figure 3 and I am wondering if it occurs so early that it merges into the left-hand x-axis. If this is the case would the authors be able to note this in the text.

Figure 4: The colours in the caption for this figure do not match the colours in the legend although the colours in the legend fit with what is described in the text. I would recommend moving to the colours described in the caption as it is usual to associate warmer colours with the summer months. The authors could also consider making

some of the lines dashed as it is difficult to uniquely pick out 12 different colours.

Line 351: I think this paragraph would benefit from an introductory sentence or two explaining why precipitation is being considered.

Minor Corrections

The following are suggestion for small modifications to improve the readability of the manuscript.

Line 28: Replace “have currently” with “currently have”

Line 33: I think this should be “radiological species” not “radiological spices”

Line 57: Replace “determine also composition” with “determine the composition”

Line 66: Replace “dispersion models for these purposes” with “dispersion models for emergencies”

Line 76: Replace “simulations as both dry and wet” with “simulations of both dry and wet”.

Line 81: Remove “that” after reference

Line 158: Add a space after “7178”

Line 179: Replace “external mixture” with “externally mixed” to match “internally mixed” on the previous line

Line 283: Remove “and” after “The outcome”

Line 304/5: Replace “decreases the total particle number concentration” with “the total particle number concentration decreases”

Line 313: Replace “Table 1” with “Table 2”

Line 314: Replace “each of the three stations” with “one of the three stations”

Line 318: Add a bracket after “ALL PROC”

Figure 5: Would benefit from being larger.

Line 359: Remove “the remaining”

Figure 6: As the lines are only constructed from a small number of points, I think it would be helpful to mark those points along the lines.

Page 16: Consider replacing “annual variability” with “monthly variability” or “intra-annual variability”. To me, “annual variability” suggests the variation between years not months.

Line 395: Consider starting a new paragraph with the sentence that begins “Figure 7”

Line 401/2: I don’t think the lack of December data needs repeating again here.

Line 403: I think this should be “individual order” rather than “individual relation”. “Relation” would imply that the gaps between the lines don’t change and they do.

Lines 417-420: I’m struggling to read this sentence and would recommend splitting it into two sentences.

Line 445: Replace “and” at the beginning of the line with “during”.

Line 446: For emphasis I would suggests starting a new sentence when describing the impact on the deposition field.

Figure 8: I would find it helpful if you could include a sentence in the figure caption highlighting the different x-axis scales.

Line 467: Replace “appearance” with “characteristics

Line 476: Replace “It determines” with “They determine”

Line 485: Replace “slightly” with “slight”

Line 516/517: Replace “where the median” with “the median” and remove “for the” at

the beginning of line 517.

Line 546: Think this should be “>100nm” rather than “<100nm”

Line 559: There is a “t” missing in “precipitation”.

Paragraph beginning line 565: There are some brackets missing in this paragraph

Line 603: Remove “there” after “LPDM”

Line 618: Remove repeated “the” and replace “wary” with “vary”.

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