

***Interactive comment on* “Evaluation of the parametrized transport of lead-210 in high-altitude European sites” by I. Dombrowski-Etchevers et al.**

Anonymous Referee #2

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The authors investigate the ability of the CTM MOCAGE to represent the distribution of lead-210, a decay product of Rn-222, in order to evaluate the transport and deposition processes of sub-micron aerosol in the model. This approach is well established. The authors further focus on high-altitude European sites by applying the zooming-option of their model and by comparing the model results to the CARBOSOL dataset. Furthermore they analyse in detail the effect of the 2003 European summer heat-wave on the lead-210 distribution.

Before the manuscript can be published in GMD, several major revisions should be considered in order to improve it and to increase its value also for other modellers. The specific recommendations are:

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1. The language needs to be polished considerably. I suggest to consult a native speaker. Constructions like “etc.” and “...” (e.g., page 249, line 6) should be avoided, since they leave unclear what is meant.
2. The study focuses on the evaluation of the CTM MOCAGE, thus for a GMD paper the name of the model should appear in the title. Furthermore, not only the transport plays a role, but also the deposition processes. Therefore, I suggest something like “Evaluation of transport and deposition of lead-210 in the CTM MOCAGE at high-altitude European sites”
3. The distribution of lead-210 does not only depend on the representation of transport in the model, but also in dry and wet deposition. This aspect and the uncertainties of these processes are not sufficiently evaluated / discussed in the study. The authors should consider to show flux maps of lead-210 (e.g., annual or seasonal averages) for dry and wet deposition and also compare to observational data and / or climatologies, as far as available. At least such flux maps can be used as reference for comparison to other models. Moreover, they will underline (or contradict?) the statement on page 256 (lines 9-11) and the conclusion on page 261 (lines 25-26).
4. Section 2.1 should be split into two subsections, one describing in more detail the **model** and one describing the specific **model setup** for this study, including the description of the radon emissions and a table with the performed model simulations in the different setups (resolutions, time span). The description of the radon source should also contain information about the treatment over ice- and snow-covered surfaces.

The model section, in particular, should contain brief summaries of the process parameterisations which are relevant for the lead-210 distribution (i.e., advection, convection, dry deposition, scavenging and wet-deposition) and not only the references to previous articles.

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Of particular interest for the model section is also a more detailed description of the “modular concept” mentioned on page 251, line 4. In how far is the fact that “washout processes are also directly implemented within the convection scheme” (page 252, line 1-2) in contradiction to this modular concept?

Furthermore, some further information about the technique behind the zooming option (e.g., how to deal with conservation laws at the zooming region boundaries, etc.), which is essential for the study are required for the reader who is not an expert in MOCAGE.

5. The abstract is somehow misleading, since it starts with issues on “climate modelling”, however the study is performed with a CTM without climate feedback. This needs to be reformulated.
6. Overall the analysis could be very much improved by making it more quantitative and less qualitative. This would also help other modellers to use the study as a reference to compare their own results to. Adequate means are
 - (a) Figures 1 and 3 are hard to read / interpret. Here it would be nice to show a more statistical analysis, e.g., by adding a table with the bias, standard deviation and correlation between model results and observations for the different time resolutions (monthly and weekly) and spatial model resolutions, the latter especially to underline the improvement with increasing model resolution. Instead of a table, the numbers could also be summarised in a Taylor diagram. The findings should be mentioned in the text.
 - (b) The statistics of figure 2 could (in addition) also be summarised in either a Taylor diagram, or the results from the station based regression analyses could be added to Table 1.
 - (c) Table 3: To be able to compare the numbers, both observed and simulated standard deviations should be added. Otherwise it is unclear in how far the differences are significant.

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- (d) For figure 6 and 7, the (absolute and relative) differences between model results and observations should be summarised in a table (or added to Table 3) to be able to compare the numbers.

In addition, these more specific comments should be addressed:

1. Abstract: I recommend to avoid the term “verification” and replace it by “evaluation”, since this kind of models cannot be verified, only falsified.
2. page 252, lines 26-28: Please be more specific about the “numerous factors” and the “possible” impact of the “current crudeness”. This is for GMD!
3. page 254, lines 15-17: Please explain, why the uncertainty of the radon emissions is lowest at tropical latitudes, or provide a reference for this statement.
4. page 256, lines 26-27: Please explain what you mean with “an inappropriate representation of the occurrence of frozen soil”.
5. page 257, line 20: Please explain, why the model “apparently cannot capture” the heat wave and / or the lead-210 distribution, although the CTM is forced with analysed meteorology.
6. I guess “Q1” to “Q4” in Figures 1 and 3 at the time axis abbreviate “quarter”. Better indicate the months.
7. Table 2: Please list also the geographic coordinates as in Table 1.
8. The axes of Figure 2 are unreadable, because the font is too small. What do the numbers in parentheses indicate? Add this information to the caption.
9. The quality of the panels in Figure 5 is poor, the numbers at the contour lines are hard to read.

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