Geosci. Model Dev. Discuss., 7, C1047–C1053, 2014
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Geoscientific Model Development Discussions
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Interactive comment on "MATCH–SALSA – Multi-scale Atmospheric Transport and CHemistry model coupled to the SALSA aerosol microphysics model – Part 1: Model description and evaluation" *by* C. Andersson et al.

Anonymous Referee #2

Received and published: 5 July 2014

ÂňÂňÂňÂňThe article describes the implementation of the sectional aerosol dynamics model SALSA in the regional chemical transport model MATCH. The coupled model, MATCH-SALSA, is then evaluated against particle number and mass concentration measurements from several ground stations located across Europe. The technical descriptions of the processes included in the model are detailed and well written. The evaluation of the model is thorough and key issues with the current model set-up are identified. The study is well within the scope of GMD and I recommend publication in GMD once the following comments and concerns have been addressed.

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General comments

1. Articles in GMD are required to represent a sufficiently substantial advance in modelling science; therefore the authors need to a better job of communicating the importance of this model and how it will extend/advance previous modelling work. For instance, what are existing regional/global sectional models lacking compared to MATCH-SALSA and what are the major benefits of using this model over the others available? At the very least, it would be good to get an idea of how the model set-up and performance (against observations) of MATCH-SALSA compare to other similar models (particularly the PMCAMx-UF model, which is also a regional sectional model focussed on the European domain). The authors have communicated the technical aspects of the model well, but discussion of how MATCH-SALSA fits in with and compares to existing aerosol models is lacking.

2. The Introduction (Section 1) needs some further attention in terms of the number of citations and the quality of the written language. In comparison with the rest of the article, this section is not particularly well written and steps should be taken to make improvements. I have given some specific comments and technical corrections below for more guidance.

3. I strongly agree with Referee 1's comment regarding the layout and order of Sections 4 and 5. When reading through the article I made several comments regarding the lack of reasons given for the model discrepancies (particularly in Section 4.3.1), but realised when reading on to Section 5 that some of these discrepancies were discussed later in the article. To improve the readability of the article I would also suggest moving the discussion of model discrepancies into the relevant sub sections in Section 4 (or at the very least, add comments at appropriate points in the text to state that the model discrepancies are discussed further in Section 5).

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4. Throughout the article there are numerous references to the supplementary material (report). The supplementary report is extensive and is an important accompaniment to the article. However, to aid the reader and prevent the need to go back and forth between the documents I suggest including some of the sections/tables/figures in the main paper.

Specific comments

1. Abstract: The sentence on L12-13 “Elemental and organic carbon concentrations are underestimated at many of the sites.” contradicts sentence before. I suggest that you alter or combine the sentences on L11-13 e.g. “On the other hand the model performs well for inorganic particle mass (including secondary inorganic mass), but elemental and organic carbon concentrations are underestimated at many of the sites.”

2. Section 1, P3268, L16 L19: Please provide some references of previous studies that have used/described/developed bulk and modal models. See for example the models compared (and corresponding references) in Mann et al. (2014).

3. Section 2.3, P3274, L24 – P3275, L6: The text describes that MATCH-SALSA can be coupled to an online cloud activation model. I assume this coupled model is only used for quantifying cloud drop number concentration and is not used in this study? Please clarify this.

4. Section 3, P3276, L1: Are the vertical levels in the model terrain following? Please state this in the text.

5. Section 3, P3277, L1: Please include reference(s) after “95–100% in European scale models”.

6. Section 3 (general): How are oxidants treated in the model? Are they online or specified from offline fields?

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7. Section 4 (general): What model level is used to compare with observations? Is the model output interpolated to the location of the ground station? Please give details.

8. Section 4.2.2, P3279, L4-6: Firstly, is the correlation coefficient quoted here r or r^2? If these values are not squared, they indicate particularly low correlations between the model and observations. How do these values compare to other models (including ECHAM5-HAM-SALSA) that have been evaluated against observations from the same ground stations (e.g. Spracklen et al., 2006, 2010; Fountoukis et al, 2011; Reddington et al., 2011; Bergman et al., 2012)? In particular with regards to the comments on model resolution, do the global models (with grid sizes on the order of 200 km x 200 km over Europe) show weaker correlation with these observations relative to MACTH-SALSA? Please add some discussion on this.

9. Section 4.2.4, P3280, L12-14: Again, can these results be compared to any of the modelling studies listed in the comments above? How does the performance of MATCH-SALSA at simulating nucleation events compare to e.g. the performance of the GLOMAP model (presumably on a coarser grid) at Hyytiala in Spracklen et al. (2006), which captures nucleation events relatively well?

10. Section 4.2.4, P3280, L14: The size of the grid cell is quoted here to be $2x10^3$ km^2, but in the description of the model set-up the spatial resolution of the model over Europe is quoted to be 44 km. Please clarify/explain this.

11. Section 4.3.1, P3281, L23: The bias is defined in the supplementary report, but should be defined in the main text (or at the very least the reader should be directed to the supplementary material for the definition).

12. Section 6 (Conclusions), P3286, L17-18: "The model peak PNC occurs at the same or smaller particle size as the observed peak." To be clearer that this

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sentence refers to the particle size distribution I suggest changing the sentence to the following: “The model peak in the particle number size distribution occurs at the same or smaller particle size as the observed peak.”

Technical corrections

1. Section 1, P3268, L1: “Especially” should be changed to “In particular,”.
2. Section 1, P3268, L2: Change “. . .importance for the health impacts..” to “. . .importance for impacts on human health. . .”.
3. Section 1, P3268, L5-7: Sentence does not read well. I suggest changing it to the following: “As the dynamics of these ultrafine particles are particularly sensitive to the various aerosol microphysical processes, they need to be considered in as high detail as possible in order to describe PNC accurately (e.g. Adams and Seinfeld, 2002).”
4. Section 4.2.2, P3279, L2: “is general” should be “in general”.
5. Section 4.2.4, P3280, L9: “Especially” should be changed to “In particular,”.
6. Figure 6 Figure 9: Please increase the text size of the legends to make them more visible.

References

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