

Review for the manuscript submitted to ACP: Modelling the European wind-blow dust emissions and their impact on PM concentrations

General comments

Dear editor and authors,

The manuscript attempts to quantify the wind-blow dust (WDB) emissions over Europe and their effect on PM_{2.5} and PM₁₀ concentration by conducting simulation using CAMx coupled offline to WRF. The experiments span for a decade and are conducted with and without the WDB emissions over Europe. Additional experiments are conducted considering either ISORROPIA or EQSAM for secondary inorganic aerosol. The PM_{2.5} and PM₁₀ are evaluated using stations from the AIRBASE network.

Overall, the manuscript is well written, the results in most cases are presented clearly and the topic is very relevant to ACP scope. However, based on the evaluation with AIRBASE, the addition WDB emissions over Europe and the produced PM deteriorates the performance of the model. In all cases the correlation drops with an increase of RMSE. Bias is rarely getting better, mainly over stations/seasons where PM were strongly underestimated in the noWDB experiments. As discussed in conclusions previous studies showed that the WDB emissions over Europe were by an order lower (Korcz et al., 2008) and the produced PM half (Vautard et al., 2005) of what is estimated by the current study. Considering the above I think it would be very beneficial to provide an uncertainty estimate for your WDB emissions over Europe that take into account (i) the overestimated wind and (ii) the combination of low LAI over urban grid boxes that can potentially be a false dust source. Further I have included some specific comments that can improve quality and readability of the manuscript as well as some technical corrections.

Specific Comments

- L126-127: Since there is a new reanalysis dataset (ERA-5) from the same source, do you think you would get different results if you used it to drive your model? Especially when considering that wind was overestimated in your simulations and that caused problems with the WDB emissions over Europe.
- Figure 2: “gs⁻¹” probably corresponds to “gram * second⁻¹” right? Or is it something else? Also it would be better to show these emission fluxes in km⁻¹ instead of gridbox⁻¹.
- L229-234: It is very valuable that you explain this clearly, though it unveils a potential bug for emissions over urban centers in Europe. To sum up your point, urban grid boxes at 9 x 9 km resolution in most cases are partially (<50%) characterized as only urban, while the rest is considered crop land with quite low leaf area index and thus potential dust sources. Would it be possible to fix that by setting the urban cover to 100% for grid boxes that are clearly cities or weight the LAI depending on the percentage of grid box characterized as crop land?
- L261 and Figure 7: Not in all stations see “Kralupy nad Vitavou”? The annual cycle of the measurements is very different in that case. Do we know why?

- L287-288: This could be easily checked by concentrating on these high peak days and evaluating the surface wind (average and max) with stations as well as checking if the wind-blown dust emissions are high?
- L305-308: Is this description better fitted in the Methods? Also note that RMSE is extra sensitive in outliers since the differences between the simulated and the observed values are squared.
- L319-321: Which means that the WBD emission scheme over Europe makes the model weaker in terms of PM_{2.5} and PM₁₀, especially for correlations which in some cases it drops from 0.6 to 0.1 when WBD are considered. What is the main cause for that? I think you should propose potential causes for these results and discuss what can be improved in the current European WBD emissions set up in the model.
- L348: It would be a good addition at this point to explain why is that the case.
- L395-396: Since the WDB emissions over Europe is even smaller that you have estimated, there effect on PM is even smaller. Wouldn't that mean that your estimates are close to what has been reported before by Korcz et al. (2008) and Vautard et al. (2005)?

Technical Corrections

L19: "crustal" to "crystal"? If this right check it through out the text, e.g. L193, L197 etc.

L194: "surface temperature;" to "surface temperature,"?

L202: Could you rephrase please? "(only anthropogenic aerosol source and anthropogenic- and MEGAN-based gas-phase emissions)". E.g. "(including anthropogenic aerosol emissions as well as anthropogenic and biogenic gas-phase emissions)"