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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Linking climate and air quality over Europe: effects of meteorology on $PM_{2.5}$ concentrations" *by* A. G. Megaritis et al.

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This is a useful paper providing a detailed analysis of the effect of meteorological parameter changes, linked to climate change, on various processes affecting aerosol concentrations. While several studies have already been performed in this field, this paper specifically attempts as much as possible separating different effects. This allows making evident the many competing effects acting. In a concluding section, the impact of different parameter changes on PM2.5 levels are compared and relate to a climate change scenario. The paper should be published in ACP after having taken into account groups of remarks.

Major comments:

(1) *Section 3, Base case simulations and model evaluation: A discussion should be added on how well processes are represented in the model in order to be confident about the calculated sensitivities with respect to meteorological parameters. The comparison with observations can only give part of the answer. A dynamical model evaluation (i.e. evaluating the model capacity to simulate sensitivities) is difficult and out of the scope of the study. Instead, the confidence in the simulated model sensitivities should be simulated based on our physical understanding. It would be helpful to add a table regrouping the various figures given in this section.*

We have re-written the model evaluation part focusing more on the links between model performance and meteorology. We have also added a paragraph in Section 4 discussing the various processes simulated in the model which are targeted by the specific sensitivity runs as suggested by the reviewer. In Table S1 (column 4) we summarize/regroup results from Figures 2 through 8. We think that adding an extra table with more or less the same information would be redundant.

(2) *Section 10, Relative importance of meteorological parameters. It is not clear to me, how figures 9 and 10 are constructed. It seems to me that figure 9 summarizes results with respect to the previously applied changes in parameters.*

That is correct. In Figure 9 we summarize results of all the sensitivity tests that have been presented in detail as maps in Figures 1-8. Fig. 9 shows the sensitivity distribution of average PM2.5 to a change (increase) of each one of the meteorological parameters on a percent basis. This is no clarified in the text.

(3) *Figure 10 apparently extrapolates these changes to future climate projections. But how is this done?*

That is correct. In Figure 10 we show the expected concentration change (in μg m^{-3}) calculated based on the PM2.5 sensitivity and the expected change of each of the parameters shown in Table S1. For example the predicted sensitivity (simulation-average) of PM2.5 to the overall temperature change for the summer period is -23 ng m^{-3} K^{-1} (Table S1, column 4). According to the different IPCC (2007) scenarios, the average temperature in Europe is expected to increase over the next century from 1 to 5.5 K (Table S1, column 2). If we multiply this range with the average PM2.5 sensitivity (-23 ng m^{-3} K^{-1}) we get an expected concentration change of -23 to -128 ng m^{-3} (Table S1, column 5). If we do the same for the numbers representing the 10th and 90th percentile (Table S1, column 4, numbers in parentheses) we get the range of expected concentration change (Table S1, column 5, numbers in parentheses). This range of values (-0.8 μg m-3 to 0.37 μg m^{-3}) is depicted in Fig. 10 for the temperature change during summer (red bar in first column). This is now explained in the revised text.

(4) *I doubt a little bit that it is possible to conclude on a 10 percent change in wind speed due to future climate scenario. It should be explained that these values are very crude choices.*

As explained now in the text, projections for wind speed in Europe vary significantly with space. Here we use a projected change from -10 to 10 percent which is based on the IPCC SRES A2 scenario.

(5) *Does the error bar in the figures 9 and 10 represent the spatial differences to a uniform parameter change or also include the response to variability of a parameter change itself?*

Each bar in Fig. 9 shows the range due to the spatial variability. The results in Figure 9 are normalized so if the response remains close to linear they should be useful for a range of parameters. The results in Fig. 10 though include both the variability in space and the variability in the parameter change itself. We have added text clarifying this

important point.

(6) *Is there a need of linear extrapolation, in order to extrapolate from a 10 percent to a 40 percent change in precipitation intensity? If so, the uncertainty in this procedure should be stated, for instance a saturation of wet deposition with respect to further increase in strong precipitation is expected.*

Yes these estimates are based on a linear extrapolation. This assumption is explained in the text. We have added some text to discuss the corresponding uncertainty in the revised manuscript.

(7) *Temperature induced PM2.5 concentration changes are strongest with respect to those due to other parameters in figure 9, but weakest in figure 10. Is this simply due to the reference (i.e. relative vs. absolute changes)?*

This is not only due to the different units of the y-axis of these figures but also due to the expected future change of each parameter in Figure 10. For example the expected change in precipitation (on a percent basis) is much larger than that of temperature.

(8) *Technical correction: Page 10364 line 19: due mainly to changes "in" sulfate and sodium chloride.*

Done.

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