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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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The manuscript studies the effects of individual meteorological parameters on PM2.5 concentrations over Europe, derives the sensitivity of PM2.5 to changes in each of the considered parameters and finally estimates the impacts of those meteorological parameters on future PM2.5 levels due to projected climate changes. The work has definitely a relevance to understanding how/why climate change may impact air quality, though the work does not offer any substantial novelty.

Some general comments:

(1) *As meteorological effects on PM2.5 are central in this work, the model's ability to reproduce observations in various meteorological conditions should be discussed in a*

more clear and transparent manner. I'd recommend to either make a summary about that in the end of Model evaluation part, or better to re-write the model evaluation, looking at each of the individual PM components and analyzing the model ability to accurately calculate it in different seasons. The bottom line is that Model Evaluation should be made shorter, more reader-friendly and should make a clear statement how good/bad the model performance is at variable meteorological conditions.

We have re-written the model evaluation section focusing on the model's performance under different meteorological conditions for each PM component following the reviewer's suggestion.

(2) *I'd recommend to shorten sections 5 through 9, especially with respect to the amount of numbers, as it is rather hard for a reader to consume all these quantitative information. It is shown in Figures anyway.*

We have reduced the amount of numbers trying to make these sections shorter and more reader-friendly as suggested by the reviewer.

(3) *Calculating the relative importance of meteorological parameters on PM2.5 (Section 10), the authors assume the same meteorological changes all over in Europe. As climate predictions indicate, there will be regional differences in the change of different meteorological parameters (for example, larger increase of winter temperatures in Northern Europe and smaller in Central/Southern Europe, whereas the opposite in summer). Those differences will overlay the differences in chemical regimes around Europe (thus different predominating PM components possessing different properties). Could the authors discuss on if/in which way these inhomogeneities may have significant effect on the main conclusions.*

This is a valid concern. That is why we use a range of values for the expected changes of each parameter (Table S1) and focus on the sensitivities. These sensitivities are expected to be more robust and be applicable to a zeroth order at least over the range

of expected changes. Given that, we do not expect that regional differences will significantly change our conclusions.

Other comments:

(4) *p. 10347 lines 9-10. Introduction: "Over past decades, increased levels of ... PM" - do the authors imply that PM levels have been increasing? Everywhere? - Then references should be made. Anyhow, PM is affecting both human health and climate even at average (background) levels.*

We have re-phrased this to avoid any misunderstanding. This sentence is now changed to: "Over the past decades, atmospheric particulate matter (PM) has received considerable attention due to its impact on human health, climate change, and visibility."

(5) *p. 10348, 10367: Better to refer to the latest IPCC report (2013).*

Done.

(6) *p. 10349, 4-5: "increasing mixing height in S-E Europe – above 100 m " - probably means "increase by more then 100 m"?*

Corrected.

(7) *p. 10355, 16-21: The authors explain the model over-prediction of PM1 nitrate and ammonium in Mace Head by the assumption on bulk equilibrium and shift to coarse mode. But would not this cause in less fine ammonium nitrate?*

The shift to coarse mode is what is probably occurring in the atmosphere under the presence of high levels of sea salt. This shift, however, is not well captured by the model, which predicts most of the nitrate at the fine mode. We have added a recent reference (Trump et al., 2014) that explores this issue in detail for Mace Head.

(8) *p. 10368, 9-11: "During all seasons, the increased volatilization of ammonium nitrate dominates, causing large decreases in PM2.5 with increasing temperature". However, it seems from the model evaluation tables S1 and S3 that modeled nitrate tends to be too sensitive to temperature. Could the authors comment on this.*

The sensitivities of ammonium nitrate to temperature in Table S1 are in the expected range based on the corresponding thermodynamics. Similar decreases of nitrate levels over the continental Europe, as temperature rises, was also shown by Aksoyoglu et al. (2011).

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