

Interactive comment on “Sensitivity of PM_{2.5} to climate in the Eastern U.S.: a modeling case study” by J. P. Dawson et al.

Anonymous Referee #2

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This work uses the PMCAMx chemical transport model to investigate the sensitivity of PM_{2.5} to perturbations in a number of meteorological parameters. It provides very helpful information for understanding climate-induced changes in PM air quality. The manuscript can be accepted for publication after addressing the following comments.

Major concern:

This work is based on the sensitivity studies with one meteorological parameter changed at a time, but in reality all the meteorological variables are closely related to each other. For example, changes in temperature will lead to changes in water vapor content, wind, convection, precipitation, etc. The authors should be cautious with drawing conclusions such as “PM_{2.5} concentrations had a rather small response to

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temperature changes in summer (-16 ngm-3K-1 on average), Ě” in the conclusion section. This way of performing sensitivity study should be stated clearly in the abstract and in conclusions to avoid confusion. For the same reason, I don't think it is appropriate to conclude in the abstract that “it may be valid to represent a combined change in many meteorological variables as the sum of individual meteorological changes” and suggest that “ a simple 25% adjustment may be sufficient to compensate for the differences between the combined-change simulation and the summed individual sensitivities.” Although mathematically combined changes are somehow close to the sum of individual changes, the physical and chemical reasons underlying this conclusion are not clear at all. In terms of magnitude, 25% difference is not a small amount. Also, why combined change is always smaller than the sum of individual changes? Can this additivity be applied to each aerosol species?

Specific comments:

Second paragraph on page 6490: Additional studies that examined the effect of climate change on ozone should be cited: Johnson et al. (2001), Brasseur et al. (1998, 2006), Unger et al. (2006), Liao et al. (2006), Muraraki and Hess (2006), and Steiner et al. (2006). Additional references on the effect of climate change on aerosols: Unger et al. (2006) and Liao et al. (2006).

Line 10 on Page 6492: Simulation period of about a week seems a little too short to me. Predicted aerosol distributions and concentrations and default weather system can have large influence on your results. Why not doing the simulation for the whole month of July or January?

Page 6492: Why does the model have 14 vertical layers in July and 16 layers in January? Since the sensitivity to mixing height was investigated by changing mixing height by one model layer, how does this difference in vertical layers influence results from the sensitivity study?

Line 5 on Page 6492: Is SOA from isoprene included in the SOA scheme?

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Lines 18-19 on Page 6492: Biogenic emissions were assumed not to change with perturbations in meteorology in this work. Because biogenic emissions increase with temperature, SOA is underestimated in the simulation examining the sensitivity of July PM_{2.5} to temperature. A test with biogenic emission increasing by 25% in your sensitivity run might help you to know the bias caused by your assumption.

Top of Page 6494: It is described that “Average concentration was 40 $\mu\text{g m}^{-3}$ in the New York area, due largely to primary organics. In July, the highest average concentrations (up to 44 $\mu\text{g m}^{-3}$) were in the Midwest, especially the Chicago area; this was largely due to high sulfate concentrations.” Are these predictions representative of the conditions in the eastern US? Should the highest PM_{2.5} concentrations be located over eastern US in summer?

Figure 2: Why isn't BC shown? How did you calculate PM_{2.5} mass based on predicted ions, SOA and POA?

Section 3.1: Why sulfate increases with temperature in summer but is insensitive to temperature in winter (Figure 3)? Give quantitatively how sulfate production (gas-phase and aqueous-phase) changes with temperature in January and July.

Figure 3: why did the authors select different temperature perturbations for January and July? A perturbation of +1.5 K is shown for July but not for January.

Section 3.2: The effect of changing wind speed is expected to have different effects over different areas; over an area with a convergence of mass fluxes, increasing wind speed would increase aerosol concentrations, while over an area with a divergence of mass fluxes, increasing wind speed would reduce aerosol concentrations. Why increased wind speed generally leads to reductions in PM concentrations in this work?

Page 6497: Is SOA as sensitive to water vapor as nitrate aerosol?

Table 2: What do you mean by expected changes in meteorological fields? Model predictions? It says in the table caption that “(Major sensitivities in bold)” but no bold

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letters are found in the table.

Figure 10: How are non-sulfate aerosols influenced by changing cloudy areas?

Sections 3.7 and 3.8: Sensitivity of PM concentrations to precipitation rate (or to precipitation area) relies on the locations with precipitation. Small change in precipitation over heavily polluted area would have a large effect on PM_{2.5} concentrations. Sentences such as “É, with the strongest effect in areas receiving light to moderate rainfall and in their downwind areas.” (Lines 20-21 on Page 6501) are correct only when examining percentage changes in concentrations. Please clarify in the text.

Lines 2-4 on Page 6501: It is stated that “Since convective storms tend to be short-lived, changes in precipitation rate help them more fully wash out aerosols”. What fractions of aerosol mass are washed out by convective and large-scale precipitation, respectively, over the eastern US in January and July in the base case?

Figure 13: What are the data points?

Lines 7-9 on Page 6502: See my major comments.

Section 5: Describe in the text how you calculated sensitivity mean and predicted effect mean in Table 5.

Conclusions: Since this study is based on a regional simulation over eastern US for a short time period, conclusions drawn from this study may depend on predicted aerosols and default weather system in the model. This should be mentioned in the conclusion section.

References:

Brasseur, G. P., J. T. Kiehl, J.-F. Müller, T. Schneider, C. Granier, X. Tie, and D. Hauglustaine, Past and future changes in global tropospheric ozone: Impact on radiative forcing, *Geophys. Res. Lett.*, 25, 3807-3810, 1998.

Brasseur, G. P., M. Schultz, C. Granier, M. Saunois, T. Diehl, M. Botzet, E. Roeckner,

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and S. Walters, Impact of climate change on the future chemical composition of the global troposphere, *J. Clim.*, 19 (16): 3932-3951, 2006.

Johnson, C. E., D. S. Stevenson, W. J. Collins, and R. G. Derwent, Role of climate feedback on methane and ozone studied with a coupled Ocean-Atmosphere-Chemistry model, *Geophys. Res. Lett.*, 28(9), 1723-1726, 2001.

Liao, H., W.-T. Chen, and J. H. Seinfeld, Role of climate change in global predictions of future tropospheric ozone and aerosols, *J. Geophys. Res.*, 111, D12304, doi:10.1029/2005JD006852, 2006.

Murazaki, K., and P. Hess, How does climate change contribute to surface ozone change over the United States?, *J. Geophys. Res.*, 111, D05301, doi:10.1029/2005JD005873, 2006.

Steiner, A. L., S. Tonse, R. C. Cohen, A. H. Goldstein, and R. A. Harley, Influence of future climate and emissions on regional air quality in California, *J. Geophys. Res.*, 111, D18303, doi:10.1029/2005JD006935, 2006.

Unger, N., D. T. Shindell, D. M. Koch, M. Amann, J. Cofala, and D. G. Streets, Influences of man-made emissions and climate changes on tropospheric ozone, methane, and sulfate at 2030 from a broad range of possible futures, *J. Geophys. Res.*, 111, D12313, doi:10.1029/2005JD006518, 2006.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 7, 6487, 2007.

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