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Comment

## ***Interactive comment on “A method to represent ozone response to large changes in precursor emissions using high-order sensitivity analysis in photochemical models” by G. Yarwood et al.***

**G. Yarwood et al.**

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Received and published: 19 July 2013

We thank the reviewer for helpful comments that will improve the paper. Below are specific comments from reviewer #2 and our responses.

MAJOR COMMENTS: 1. The authors present this methodology as capable of predicting ozone concentrations at any combination of NO<sub>x</sub> and VOC emissions, yet their evaluation is limited to 3 cases in which VOC and NO<sub>x</sub> are modified by the same percentages (i.e. 25% NO<sub>x</sub>, 25% VOC). Since the method is developed based on two model simulations in which NO<sub>x</sub> and VOC emissions are scaled equally, equal percentage NO<sub>x</sub> and VOC emissions changes should be the most likely for the methodology to

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Discussion Paper



properly replicate. In order for the authors to make the claim that their methodology can really replicate any combination of NO<sub>x</sub> and VOC emissions, they must present evaluation of some “corner cases”. For instance, the authors should test additional brute force simulations with NO<sub>x</sub> only and VOC only emissions changes and also unequal changes in NO<sub>x</sub> and VOC (i.e. 25% VOC, 75% NO<sub>x</sub>; 75% VOC, 25% NO<sub>x</sub> etc).

Response: Our tables in the manuscript and supplement include 25/100% NO<sub>x</sub>/VOC case. The original text was not very clear on this point and we will improve the way that we describe the 25/100% NO<sub>x</sub>/VOC case to make clear that we have evaluated an “off-diagonal” case.

2. The choice of transition points in Equation 3c seems somewhat arbitrary. The authors state that they were based on results of performance tests but give no details and do not quantify these tests. Would the authors get better performance if they used 10% and 50% as their transition points instead of 15% and 25%? 10% and 50% seem like more natural choices. Were these tested? Was there some quantification method used to choose the specific transition points of 15% and 25% over other possible choices?

Response: We agree that the transition points in equation 3c are a choice to be made in implementing the method. In the text, we explain how brute force results were used to constrain the choice. We have added a statement emphasizing that the transition points in equation 3c are a choice that can be refined using brute force results in the region of the transition.

3. The authors should discuss in the text that the ozone estimates at varying NO<sub>x</sub> and VOC emissions levels are only valid for modeled time period. For instance, the authors modeled the year of 2006 so their results are not necessarily applicable to meteorology conditions that occurred in other years or that might occur in the future.

Response: We will add caveats that model results are subject to uncertainties and that extrapolating model results from one year to another requires assumptions that go beyond the scope of this work.

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4. This technique, like most HDDM applications, is simply a way to recreate model predictions under a range of emissions conditions without rerunning the modeling system for every potential emissions level. It should be acknowledged in the text that the model itself has errors and unless the base conditions (100% NO<sub>x</sub> and 100% VOC) are explicitly evaluated against ambient data, the results are completely within the “model world” and may or may not accurately reflect how actual concentrations would respond.

Response: We will add caveats that model results are subject to uncertainties and that extrapolating model results from one year to another requires assumptions that go beyond the scope of this work.

5. This technique is evaluated for 22 cities, but no information is given for how cities were delineated. Are results based on model predictions for all grid cells within the city limits, all grid cells within the MSA, or by some other method? Please provide some description or map showing how the grid cells representing each city were delineated.

Response: We will expand the description of how the evaluation for 22 cities was performed.

MINOR COMMENTS: 1. Page 2590, line 10: References should be made to the actual articles which document the creation of the emissions (Pouliot et al) and meteorology (Vautard et al) inputs. \*George Pouliot, Thomas Pierce, Hugo Denier van der Gon, Martijn Schaap, Michael Moran, Uarporn Nopmongkol, Comparing emission inventories and model-ready emission datasets between Europe and North America for the AQMEII project, Atmospheric Environment, Volume 53, June 2012, Pages 4-14, ISSN 1352-2310, 10.1016/j.atmosenv.2011.12.041. (<http://www.sciencedirect.com/science/article/pii/S1352231011013288>) \*Robert Vautard, Michael D. Moran, Efisio Solazzo, Robert C. Gilliam, Volker Matthias, Roberto Bianconi, Charles Chemel, Joana Ferreira, Beate Geyer, Ayoe B. Hansen, Amela Jericevic, Marje Prank, Arjo Segers, Jeremy D. Silver, Johannes Werhahn, Ralf Wolke, S.T. Rao, Stefano Galmarini, Evaluation of the

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meteorological forcing used for the Air Quality Model Evaluation International Initiative (AQMEII) air quality simulations, Atmospheric Environment, Volume 53, June 2012, Pages 15-37, ISSN 1352-2310, 10.1016/j.atmosenv.2011.10.065. (<http://www.sciencedirect.com/science/article/pii/S1352231011011605>)

Response: We will add these references.

2. Page 2592, line 6: The first ME should be MB. The associated equation should be changed accordingly.

Response: We will correct this error.

3. Figures 5-8: Increase the font size on these figures, the axes and regression line equations are unreadable at the current size.

Response: We will improve these figures as suggested.

4. Figure 6: Subplots b) and d) are unnecessary for this figure since they duplicate exactly Figure 5b and 5d.

Response: For clarity we wish to keep subplots b) and d) in Figure 6.

5. Figure 8: Subplots b) and d) are unnecessary for this figure since they duplicate exactly Figure 7b and 7d.

Response: For clarity we wish to keep subplots b) and d) in Figure 8.

6. Tables S1 and S2: Consider bringing these into the main paper.

Response: We wish to retain the use of supplementary material to separate lengthy tables and figures from the manuscript, for clarity.

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Interactive comment on Geosci. Model Dev. Discuss., 6, 2585, 2013.

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