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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Identification of potential regional sources of atmospheric total gaseous mercury in Windsor, Ontario, Canada using hybrid receptor modeling" *by* X. Xu and U. S. Akhtar

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Response to reviewers' comments on "Identification of potential regional sources of atmospheric total gaseous mercury in Windsor, Ontario, Canada using hybrid receptor modeling" by X. Xu and U. S. Akhtar

The authors are gratified by the reviewers' recognition of the value of our study. We also thank the reviewers for their constructive comments and suggestions.

We agree with the reviewers that the manuscript could be strengthened. Specifically, the Method Section could be further clarified. For example, the use of hourly Hg concentrations to be in sync with hourly meteorological data; the justification of using Wind-

sor Airport meteorological data since Windsor is on a flat terrain with a few high rise buildings; reporting the time periods when Hg concentrations were missing or deemed invalid; and explaining more rigorously the reason of running one trajectory per day.

About the starting height of 500 m, as one reviewer pointed out, it is often chosen because it represents a midpoint of well-mixed, convective boundary layer. We believe that 500 m is the best choice given that the height of boundary layer changes significantly with season and time of day. Therefore, a midpoint is most representative of a 72-h trajectory instead of a height that is best suited for the start time.

When the Potential Source Contribution Function (PSCF) criteria values were considered, we decided to use the average mainly because of the relatively small sample size (N=293 days in year 2007). Should a high value such as the 85th percentile be used, there would be only a few days in some seasons; which makes the resulting source regions most sensitive to a particular day or two. In other words, the uncertainty could be large. We appreciate that the reviewer pointed out the need for more explanation.

Literature search has been conducted to back up the claim of higher load of coal fired power generation in summer. Similarly, technical reports will be used to support winter low ozone concentrations in the region. Furthermore, Hg sources in Windsor and Detroit will be considered in the analysis. A weaker deposition to vegetations in an urban setting will also be considered in the seasonal analysis.

We thank the reviewer for pointing out the influence of temperature and pressure on the volume of air. Calculation will be conducted using meteorological data to quantify the effects on Hg concentrations.

PSCF is one of receptor modeling tools. In comparison with back-trajectory only approach, the PSCF method also takes into consideration the receptor concentrations. Furthermore, in this study we used Hg air emission inventories in US and Canada to verify the potential source regions identified by the PSCF. As pointed out by the second reviewer, this method would not allow the consideration of air mass concen-

trations before the 72-hour journey to the receptor, nor the Hg emissions along the air mass pathway. The quantitative assessment of source-receptor relationships and the inclusion of air mass concentrations beyond the 72-hour time frame is best suited to a transport-chemistry model such as Community Multiscale Air Quality (CMQA) model (Byun and Ching, 1999). Sophisticated transport-chemistry models like CMAQ integrate emissions, transport, chemical reactions, as well as dry and wet depositions in a gridded system, therefore the modeling results are considered more reliable than receptor models. On the other hand, transport-chemistry models are much more expensive to implement. In an application of CMAQ for example, air mass concentrations beyond the 72-hour time frame or some geological locations would be presented as boundary conditions. Those concentrations vary with day of year, time of day and elevation above ground. Normally, a simulation of a larger domain is required to specify such concentrations. In the case of Hg, emission inventories outside of US and Canada (e.g. re-emission of Hg from the ocean surfaces and man-made emissions in Asia) have a large uncertainty which would likely cause biases in the inflow Hg concentrations to North America.

Other receptor models such as the Positive Matrix Factorization or PMF (Paatero and Tapper, 1994) are available. There are also source-receptor models, for instance the Chemical Mass Balance or CMB (Watson, 1984). The basic assumption is that the source profiles are known and unchanged between the sources and receptor. These receptor and source-receptor models all require ambient concentrations of a large number of compounds which are costly to obtain. Another limitation of these models is that the absolute or percentage contractions, by emission sectors such as on-road vehicles and coal fired power plants, at the receptors are estimated, but not the geological region of the sources. In short, we believe that PSCF is a suitable approach for some applications when the use of comprehensive models is prohibited due to limited resources. We agree with the reviewer it is necessary to state in the manuscript the need to verify the PSCF modeling results with that of other receptor models and transport-chemistry models.

We will also amend some Tables and Figures (Table 1, Fig. 2, Fig. 4b), revise the abstract, and edit other sections following the reviewers' suggestions.

References

Byun, D. W., and Ching, J. K. S. Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMQA) Modeling System. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, 1999, (peer reviewed).

Paatero, P., and Tapper, U. 1994. Positive matrix factorization - A nonnegative factor model with optimal utilization of error-estimates of data values. Environmetrics, 5, 111-126.

Watson, J. G. 1984. Overview of receptor model principles. Journal of the Air Pollution Control Association, 34, 619-623.

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