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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Source-receptor relationships for speciated atmospheric mercury at the remote experimental lakes area, Northwestern Ontario, Canada" *by* I. Cheng et al.

Anonymous Referee #1

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General Comments

This study presents a very thorough analysis of the sources impacting a remote continental site using a combination of source-receptor methods. The authors provide a valuable, well-researched summary of the methods applied to investigate source-receptor relationships of Hg. Overall, this is a high-quality piece of work that deserves publication as it furthers our knowledge of sources impacting remote mid-latitude sites. However, the following point needs to be considered by the authors before publication:

In a number places, the authors attribute a correlation between elevated RGM and O3 to photochemical production. This may not always be the case, especially when

elevated RGM and O3 are correlated with low RH. Elevated RGM, O3, and low RH are thought to be a signature of free tropospheric air (e.g. Weiss-Penzias et al., 2009, JGR) and this explanation needs to included. Based on 7Be and Hg simulations, Amos et al. (2011, ACPD) suggests that springtime RGM at ELA is influence by free tropospheric air.

Lastly, a minor comment on the style of the paper. There are a number of very long sentences and paragraphs that I suggest the authors break up to improve the readability of the text. These are pointed out in the Specific Comments.

Specific Comments

Page 31433, Title: Should "experimental lakes area" be capitalized? It is referred to as the "Experimental Lakes Area" in other publications (e.g. Graydon et al., 2008, ES&T). It's also capitalized in the first sentence of your abstract.

Page 31434, line 12-13: I suggest, ". . . like ELA. . ." instead of ". . .like the ELA".

Page 31435, lines 2-7: Consider breaking "Source-based methods require. . ." into two sentences for clarity.

Page 31436, line 4: "Combination" should be changed to "combinations". Also consider creating a new paragraph break at "Combinations of the. . .".

Page 31438, lines 1-2: Are the major ions associated with total particulate matter, or just fine particulate matter?

Page 31438, section 2.2: It would be appropriate to include your study period (May 2005 – December 2006) here.

Page 31439, line 2: Consider adding a new paragraph break at "Although the accuracy. . .".

Page 31439, line 7: replace "Furthermore to the issue are uncertainties. . ." with "Furthermore there are uncertainties. . ."

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Page 31440, line 5: How is "seasonal" defined here? Monthly averages? Three-months averages (e.g. DJJ, MAM, JJA, SON)? Please be clear.

Page 31440, line 24: What qualifies as a "high" factor loading? Can you be more quantitative?

Page 31441, line 3: StatSoft (2011) doesn't seem like the most appropriate reference to cite for the definition of K-means and hierarchical cluster analysis. I suggest citing work from the statistics literature (or a textbook) instead.

Sections 2.4.2-2.4.4: The authors provide a very clear, concise summary of how each methods works, but what is lack from these sections is why are the authors using these methods. I suggest adding 1-2 brief sentences to each section communicating to the reader why the authors are using the methods described.

Pages 31442-31444: The paragraph that begins on page 31442 line 24 and ends on page 31444 line 5 is very long and difficult to follow. I suggest breaking it up into three separate paragraphs about GEM, RGM, and PHg.

Page 31443 line 1: Low RH and high O3 suggests may be a signature of free tropospheric air. This could be important to consider, in addition to soil emissions and coal combustion.

Page 31446, lines 19-20: Change "the lack of correlation" to "a lack of correlation".

Page 31447, line 15: Poissant et al. (2005) should also be referenced.

Page 31449, lines 7-11: I strongly suggest removing, "Recent studies in marine environments... far away from polar regions." Discussing marine environments and high Arctic sites seems irrelevant and you dismiss the mechanisms happening at these sites anyways. These three sentences distract from the main message of the paragraph.

Page 31449, lines 20-21: "There is also a strong influence on this factor by temper-

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ature, which enhances the surface emission process." Which surface emission processes are the authors referring to here? Temperature is related to the emission of Hg(0) from surface soils (e.g Poissant and Casimir, 1998), but I am not aware of any studies showing a relationship between temperature and surface emissions of PHg. If the authors are aware of such studies, they should cite them.

Page 31449, lines 25-26: It is not clear why a five-cluster solution was chosen over four- and six-cluster solutions.

Page 31451, line 31451: What is "fairly high"? Please provide the percentage.

Page 31452, lines 25-26: The discussion of marine environments does not seem relevant at ELA, which is in the middle of the North American continent. It would be more appropriate to cite studies showing that Hg(0) oxidation by halogens is possible on a global scale and not just in marine environments (e.g. Seigneur and Lohman, 2008; Holmes et al., 2010).

Page 31456, lines 18-21: "That is, the transport of industrial/combustion emissions was often occurring simultaneously with photochemi20 cal production of RGM or crustal/soil emissions, suggesting this type of Hg source was well-represented in the data." This sentence is confusing.

Page 31456, line 29: Consider changing "... halogen species as they are also important..." to "...halogen species since they may also be important..."

Page 31457, lines1-2: Other oxidants (e.g. Br) have also been shown to be potentially important on a global scale (e.g. Holmes et al., 2010).

Page 31457, line 6: Consider adding a brief summary the strengths and weaknesses of the methods you've used here.

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