

## ***Interactive comment on “Modelling of mercury with the Danish Eulerian Hemispheric Model” by J. H. Christensen et al.***

### **Anonymous Referee #1**

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#### General Comments:

The manuscript describes a mercury atmospheric transport model and some results obtained by the model. Significant part of the text is devoted to an attempt to simulate Arctic mercury depletion phenomenon, which can be responsible for elevated concentrations of mercury in Arctic ecosystems. Mapping of deposition fields over the Northern Hemisphere and particularly over the Arctic is extremely important for assessment of environmental pollution by persistent toxic pollutants like mercury. Creation of mercury monitoring network of more or less high density is absolutely unreal on global scale (or even in the Arctic). Hence, the only way to obtain the information is usage of reliable mathematical models.

Unfortunately, a reader can get no idea about reliability of the model described. The

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mercury model description is very curtailed. No attempts are made to explain choice of the modeling parameters. No information is given about verification of the mercury model.

The paper focuses on the problem of mercury pollution in the Arctic. It would be better to reflect this interest to the Arctic in the paper title.

It is difficult to read the text. Only one example - let us look at the first three phrases of the second paragraph of the Introduction. 1. "The Model (DEHM) is a well-tested model". 2. "The purpose of the model is". 3. "The model is based on the DEHM". Can a reader understand what model is described?

Taking into account importance of the problem touched upon, the paper should be published. However, serious improvements should be done both in manner of text writing and (much more important!) in demonstration of reliability of the mercury model.

Specific comments:

Page 3529, lines 12-14. It is possible to assume that the authors do not consider both re-emission and natural emission of mercury. For a hemispheric model the boundary conditions are realized on the Equator only (1.5 ng/m<sup>3</sup>). Atmospheric exchange through the Equator is slow. Only anthropogenic emissions and weak atmospheric transport through the Equator can not provide maintenance of more or less stable mercury concentration on the level of 1.5 ng/m<sup>3</sup> in the Northern Hemisphere. So, the model must reveal permanent long-term decline of the background mercury concentration.

Page 3529, lines 16-17. There is scientific information that mercury chemistry can involve radicals, chlorine and other reactants (e.g., Shia et al, 1999). What reason is to ignore such reactions?

Page 3529, line 19. As I understand the model starts to take into account the depletion (fast oxidation) at the moment of "polar sunrise". What is the moment of "polar sunrise"? Appearance of a small piece of the sun over the horizon for few minutes after

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the polar night? Appearance of the full disk of the sun over the horizon? Sunrise in the Arctic is very slow process. By the way, ¿Polar sunrise? or ¿Polar Sunrise?

Page 3529, lines 19-20. Fast oxidation of Hg(0) to HgO. Why HgO? Is there any theoretical or empirical evidence? Any reference?

Page 3529, line 22. The depletion can be realized only ¿over sea ice?. What information on sea ice was used in the model?

Page 3529, lines 21-22. Additional oxidation rate. Additional to what rate?

Page 3529, line 22. Extremely important!!! What is a reason to choose the additional rate equal to 0.25 1/hr? Any theoretical consideration? Any reference? It would be possible to obtain much more intensive mercury deposition fluxes in the Arctic if one assumes the rate which is 10 times higher. The value used must be explained.

Page 3529, lines 22. Temperature of depletion termination is assumed to be 4°C. Why? Is it momentary value? Is it daily mean temperature? It is extremely important parameter, which determines the total value of mercury deposition over the Arctic. Any scientific support must be done for choice of this value.

Page 3530, line 15. Effect of the depletion is very pronounced in the region of Hudson Bay. However, on the level of 60 degree latitude there is no ¿Polar Night?. So, there is no ¿Polar Sunrise? there. How could the model simulate the strong effect of the depletion here? At Barrow the model predict the beginning of the depletion by the end of February ¿ the beginning of March (Fig. 8). However, the sun appears on this latitude in the middle of January. Again, the question arises ¿ what does it mean ¿ ¿Polar Sunrise?

My best wishes to the author team and my assurance that the paper will be improved and published.

Reference: Shia R.-L., Seigneur Ch., Pai P., Ko M., and Sze N.D., 1999. Global simulation of atmospheric mercury concentrations and deposition fluxes. J.G.R., 104, D19,

23747-23760.

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**ACPD**

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S1420

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