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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A synthesis of atmospheric mercury depletion event chemistry linking atmosphere, snow and water" *by* A. Steffen et al.

Anonymous Referee #2

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General comments:

This paper provides a review of the research on atmospheric mercury depletion events observed in polar regions and on their interaction with the polar environment. It tries quite successfully to bring together the findings of measurements in the atmosphere, snow, and water with model and laboratory studies. The review is generally well written and provides a useful overview of the state of research on the subject. Because of this, I believe that it is appropriate for publication in ACP.

To compile a paper from contributions by different authors poses always difficulties. I therefore recommend following modifications to make the paper more clear and to

harmonize it:

Page 10839, line 15: Are the authors really reviewing “the history of Hg in Polar Regions” or the research on Hg transport and fate there?

Page 10843, line 5: “This will be followed by sections outlining the underlying measurement techniques” – remove underlying

Page 10843, line 11: replace “a look into..” by “an outlook of”

Page 10844, line 13: The sentence starting with “This is the most stable form. . . ” is grammatically incorrect.

Page 10844, line 26: Several millions of inhabitants north of the polar circle are not exactly “few people”. The paragraph should also refer explicitly to the phenomenon called Arctic haze which was extensively studied in the 1980s (papers by Raatz et al.).

Page 10845, 2nd paragraph: Higher Hg levels in the upper layers of sediments are not specific to the Arctic but for the entire northern hemisphere. The second sentence thus needs rewording.

Page 10846, last paragraph: Low precipitation and consequently low wet deposition is also an important feature of the Arctic troposphere.

Page 10848, second and third paragraph: Other elements such as lead are also measured on aerosols without talking about “operationally defined measurements”. There may be measurement artifacts, but that is another matter. I disagree with the authors that the measurement of PHg is operationally defined. It is true the both RGM and PHg have short lifetime. But opposite to RGM, the lifetime of PHg is also well defined by the lifetime of the aerosols that carry mercury.

Page 10848, line 26: Should it not be “industrial activities since 1840’s”?

Page 10850, line 23: The “bioavailable” fraction of Hg should be defined.

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Page 10851, line 20: The methods reviewed in Section 3 were not designed specifically for the polar regions.

Page 10852, 2nd paragraph: What does it mean: "AFS instruments, which tend to require more facilities..." and "At times, this advantage is forsaken..." Reword or delete.

Page 10852, line 23: Enrichment of mercury by amalgamation was not invented by Fitzgerald and Gill, 1979. It was used already by Williston (JGR 73, 7051 (1968)) and much earlier by Stock and Stock and Cucuel (Naturwissenschaften 19, 499 (1931) and 22, 390 (1934)).

Page 10853, last paragraph: When writing about the sampling of RGM only methods that sample specifically RGM without PHg should be mentioned. The techniques by Brosset and by Stratton and Lindberg will collect PHg as well when used without filter. Filter has to be mentioned because it is an essential part of these techniques when RGM only has to be measured.

Page 10856, lines 14 and 15: "to measure air-snow GEM flux" and "air-snow RGM flux".

Page 10856, last paragraph: "Micromet", even if defined, sounds like laboratory jargon and thus should be avoided. The general characterization of the micrometeorological methods in the second paragraph applies to REA and MBR but not to eddy covariance method. The paragraph should be reworded.

Page 10857, line 9: "fast" is perhaps better than "instantaneous".

Page 10857, line 23-25: The limitation mentioned here applies also to MBR technique, since both techniques needs some time to collect mercury needed for accurate analysis. Even the eddy covariance technique does not provide instantaneous fluxes but fluxes integrated over a certain period. Please delete or reword.

Page 10858, 2nd paragraph: Chambers are essentially good for process studies but not

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for measurement of real fluxes because their application involves change of parameters governing the flux such as turbulence, radiation, temperature etc. The word “fetch” is used only in connection with micrometeorological techniques. Please reword.

Page 10860, line 13: “elution” instead of “elusion”?

Page 10861, line 15: “Few measurements of.... have been collected” sounds a little bit strange.

Page 10862, last paragraph: “The reactions between Hg(0) and.....but may occur faster in the aqueous phase”. This statement is not correct for three reasons. Firstly, the reaction partners are mostly not dissolved O_3 and Cl_2 but ions formed during their solution. Secondly, the individual reactions might be faster but they are limited only to the aqueous phase which represents only a small fraction of the air. Thirdly, the transport to the droplets and the dissolution of the gases are both kinetic processes and as such reduce the rate of the overall chemical reaction. Please make this paragraph more clear.

Page 10870, last 5 lines: “....RGM present in the air is adsorbed on aerosol but at higher levels....”. “The same hypothesis was also used by....”

Page 10871, line 18: Reword the sentence starting with “Results from a study....”

Page 10872, line 8: “lack of knowledge of Hg speciation..” instead of “lack of speciation of Hg”.

Page 10872, line 21: “estimated” instead of “demonstrated”

Page 10874, line 22: “targeted and comparison studies” sounds strange, please reword.

Page 10877, 1^{st} line: “.. more efficient scavenging of Hg resulting from AMDE..”

Page 10877, line 10: Should it not be 25 km as mentioned further below?

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Page 10880, 1st line: “Modeling of mercury in the Arctic region”

I would change the sequence of the chapters 5.1 and 5.2 because at the beginning is the transport of mercury to the Arctic. Only mercury that has been imported to the Arctic can be processed.

Page 10881, line 5: High concentrations in air or snow?

Page 10883, line 10: What does “dominantly” in brackets refer to? Please reword.

Page 10883, line 13: “The that main transport. . . .” Delete “that”

Page 10883, line 16: replace “Polar Region” by “Arctic”

Page 10883, line 22: Do really models provide “a critical understanding”? Please be more critical.

Page 10884, line 12: “the reduction of emissions”

Page 10885, line 11: “GEM emissions” instead of “GEM fluxes”. The entire paragraph should clearly distinguish between emission and deposition, the word “flux” is meaningless in the context of this paragraph.

Page 10885, line 23: “have indicated that. . . ”

Page 10886, 1st paragraph: This paragraph needs rewording to shorten it and improve its clarity. E,g “snow emitted GEM with a rate of 0 – 50 ng/m^3. . . ”. Also more specific “emission” or “deposition” should be used instead of “flux”.

Page 10886, line 21: “This is surprising . . . ” does not refer to Fig. 6 but to the first sentence of the paragraph. Please correct.

Page 10896, line 8: RGM associated with aerosols is no more RGM but PHg. Please reword.

Page 10897, 3rd paragraph: Little is said in many words. One sentence would do.

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References need generally a homogenization. The titles are sometimes written with all word with capital letters, the journals are sometimes abbreviated sometimes not. Please use consistently the ACP reference format.

Page 10900, line 15: $^{200}HgCl_2$

Page 10902, line 29: “pf”?

Page 10903, line 29: “transport”

Page 10906, line 13-19: The erratum should follow the paper reference.

Page 10911, line 32: (HOCl/OCl^-)?

Page 10913, line 4: Tellus

Page 10914, line 25: Hg^0

Page 10914, line 32: O_3, Hg^0

Page 10916, line 6: Hg^{+1}

Page 10918, Sommar et al. 2004 and 2007: Would not be the final version sufficient?

Page 10919, Sumner et al 2005: The title of the book is missing.

Page 10920, line 8: Subscripts!

Page 10921, line 3: experimental

Table 2: The table is confusing for two reasons. The entries in column “analytical method” are not in the line pertinent to column “analyte”. The references are not given specifically for the appropriate line. Please correct even at a cost of the larger length.

Table 4: The unit “Torr” is not in use any more.

Fig. 5: Text inserted into the figure is garbled.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 10837, 2007.