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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global atmospheric model for mercury including oxidation by bromine atoms" *by* C. D. Holmes et al.

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Please find our responses to the reviewer's comments below in bold.

This manuscript is focused to evaluate the role of bromine chemistry in the global mercury cycle and how it inïňĆuences the atmospheric mercury transport and removal processes, and ultimately how modeled concentrations of Hg(0), Hg(II) and Hg(p) compare with observations. Major known bromine chemical reactions with Hg have been introduced in GEOSS-Chem model and comparison of results obtained by adopting (Hg+Br) and (Hg+OH/O3) mechanisms have been provided. One of the goal is to deïňĄne which of these mechanisms is more likely to occur. The authors conclude that the bromine oxidation pathway results to produce a better agreement with the observations, though signiïňĄcant uncertainty still remain. In summary the paper is well writ-

ten and quite innovative from technical point of view. The approach used and the Br chemistry adopted is well known in the literature, results are well discussed though not always the authors give credit to previous published work on the subject, especially that related to mercury emissions from anthropogenic and natural sources as pointed out below.

Mercury emissions from anthropogenic and natural sources used in this work are primarily based on Selin et al.(2008) in which Hg emissions were increased to match observations. In this MS has been used 300 Mg yr-1 as global Hg emission from biomass burning based on a Hg/CO ratio of 100 nmol mol-1. I am quite surprised that the authors have not considered the work published by Friedly et al. 2009 (Environ. Sci. Technol. 43, 3507–3513) which provides a very interesting assessment of mercury emissions from biomass burning by season and by region. In Friedly et al. 2009, mercury emissions from biomass burning is estimated to be 675 +/- 240 Mg/year as an average for the period of 1997-2006, and a discussion of inter-annual variability by region/forest type region is also provided. One of the outcome of Friedli et al. (2009) was that during the (1997-2006) period, the largest mercury emissions are from tropical and boreal Asia, followed by Africa and South America. It is important to keep in mind that one of the outcome was that these emissions do not coincide with the largest carbon biomass burning emissions, which originate from Africa, because frequently burning grasslands in Africa and Australia, and agricultural waste burning globally, contribute relatively little to the mercury budget. I believe the authors should consider the estimate provided in Friedli et al. 2009, otherwise should discuss why they do not agree with the estimates provided in this earlier work.

We have added a discussion of the biomass burning analysis by Friedli et al. (2009) to section 2.1:

"Biomass burning emits 300 Mg a$-$1 following the distribution of biomass burning CO, using a new Hg/CO emission ratio of 100 nmol mol$-$1 derived in Section 3.5. Friedli et al. (2009) estimate larger biomass burning emissions of 675 $\pm$ 240

Mg a−1 based on satellite-derived fire area and biome-specific emission factors, but our results here are not sensitive to this difference because this is less than 10

We also cite the literature review of plume enhancement factors in section 3.5:

"Weiss-Penzias et al. (2007) and Finley et al. (2009) found similar Hg/CO enhancements (136 ± 60 nmol mol−1) in the Pacific Northwest during summers 2004-5, and Talbot and Mao (2009) found 60 nmol mol−1 during summer ARCTAS flights, which are similar to ratios of 70-240 nmol mol−1 observed worldwide (Ebinghaus et al., 2007; Friedli et al., 2009)."

As general comment, I noticed that the reference Selin et al. (2008) is used as overarching reference instead of referring to the original work from which the estimate has been derived from - i.e. for the mercury emissions from artisanal gold and mercury mining, I would suggest to use the original reference which is the work by Telmer et al. and Veiga et al. (e.g., Chapter 6 in "Mercury fate and transport in the global atmosphere, edited by Pirrone and Mason, published by Springer in 2009). Telmer et al. estimated mercury emissions from ASGM of 400 Mg yr-1 to which 50Mg yr-1 has to be added from mercury mining that brings the total amount to 450 Mg yr-1.

We share the reviewer's concern for citing original work, and have reexamined each citation of Selin et al. (2008). These are mainly used to compare our results to the earlier GEOS-Chem model described by Selin et al. In the particular case of artisanal mining, the emissions used in this work and Selin et al. (2008) are not based on the work of Telmer and Veiga (2009) but we now cite their work in section 2.1: "In addition, Hg0 emissions from artisanal gold mining total 450 Mg a−1 (Hylander and Meili, 2005; Selin et al., 2008), which is very close to the independent estimate of 400 Mg a−1 by Telmer and Veiga (2008)."

There are few references that need to be updated, reported now as ACPD, that have been published already in ACP.

We updated references to papers wherever possible.

Overall, I suggest to accept the MS for publication as soon as the above criticisms have been addressed in appropriate manner.

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