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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Air-surface exchange measurements of gaseous elemental mercury over naturally enriched and background terrestrial landscapes in Australia" *by* G. C. Edwards and D. A. Howard

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Response to Anonymous Referee # 3

We are pleased by the positive review of our paper. We thank the anonymous reviewer for the insightful and helpful comments. We have undertaken to revise the manuscript to accommodate the reviewer's comments. We will briefly summarize those revisions below in the same order as the reviewer has commented.

In general we have provided more quantitative analyses, comparisons and discussion

as suggested. In particular, to facilitate further comparisons and parameterizations based on our measurements.

We have provided more information on the North American data set as suggested. We point out that there are very few data sets sufficiently large enough to show the relationship between mercury evasion from naturally enriched substrates and substrate concentration (Edwards et al., 2001; Gustin et al., 2000) and their dependence on temperature. We have published our North American data sets (Edwards et al., 2001, 2005; Schroeder et al., 2005) including our Nevada data. The Nevada data we collected was part of the Nevada STORMS experiment which has also been published along with the larger data sets collected during that experiment by Gustin et al., (1999a). Coincidently however, we have recently revisited our extensive North American data set to better address the generalization of these data in the context of climate change, mercury dry deposition, and scaling up issues. This paper is in preparation to be submitted soon.

Response to specific comments;

a) We have replaced the UNEP 2011 reference with Zhang et al. (2009, 2012). b) Revised to read "total burden to the atmosphere" c) Point taken and we have reworded this assertion. There is a substantial base of information on the unique aspects and diversity of the Australian climate, ecosystems, and native soils and vegetation to warrant investigation of the air-surface exchange of mercury. The pilot study data presented herein suggests it can be substantially different based on temperature regimes alone. Through our extended research we will be able to better quantify the differences. d) We have reworded this sentence to read ". . ...from similar studies carried out by the first author in North America." e) We have revised this paragraph to be more clear that we chose sites remote from the mining activity from 1914-1924 and that the sites chosen are undisturbed background and naturally enriched mercuriferous sites. f) We have added more detail on our method to the text. Our dynamic flux chamber method aligns with currently acceptable practices, the only unique aspect of which is the use of quartz glass to facilitate full transmission of UVB. g) We agree and have added text here to

be more quantitative with our comparison. Specifically Obrist (2012) found an average leaf litter THG concentration over 12 sites of 0.038 μg g-1 compared to our 0.041 μg g-1 and Graydon et al. (2008) found an average leaf litter THg over 5 sites in Canada of 0.041 μg g-1. h) In general, the purpose of this section is to summarize the flux magnitudes. We have revised the title to read "GEM flux magnitudes" and have added quantitative comparisons for our results from the papers cited with some discussion on the comparison. i) We have revised the description here to better explain our results. We have also revised Figure 4 to better illustrate the findings. Certainly soil temperature is a key correlate with respect to mercury evasion as the soil temperature plays a role in the in-soil processes that supply the GEM for evasion. The other processes that control the evasion are the diffusion through the quasi-laminar layer near the soil surface and the turbulent diffusion above that. These processes also are central to the sensible heating of the air. It is the latter we believe is responsible for the better correlation of the flux with air temperature. j) Again we have provided a more in-depth discussion in the revised paper. For these studies we only observed emission and deposition in the June background data and thus are unable to duplicate Xin and Gustin's (2007) laboratory studies for day and night exactly. To our knowledge this is the first full scale field study over bare soil reporting a mercury flux compensation point. Furthermore, our data taken in both light and dark conditions with variable climatic conditions showed a remarkable linear relationship and clear compensation point. Nonetheless, our data do lie in between Xin and Gustin's light and dark data and within the range of compensation points they reported. k) In Section 3.4 we have added a quantitative estimate based on the data of the error that would occur by using NA vs Australian data magnitude wise. The error estimated was 33%. We have added some text to discuss the implications of this difference.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 27927, 2012.