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Atmospheric Chemistry and Physics Discussions

Interactive comment on "How important is biomass burning in Canada to mercury contamination?" *by* Annemarie Fraser et al.

Anonymous Referee #1

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This paper seeks to improve estimates of biomass burning emissions and investigates the impact of these emissions on Canadian mercury contamination by combining air quality modelling, observations from a network of atmospheric mercury concentration monitoring sites between 2010 and 2015, and Bayesian inversion techniques. The research questions are relevant to the ACP community, and this work uses appropriate methods to provide new and valuable insight into the importance of biomass burning as a source of emissions in Canada and the spatial distribution of its impact. I would recommend publication in ACP after minor revisions to: further clarify terminology, description of methods, and figures; and deepen the discussion to further highlight how this study contributes to our understanding of mercury from biomass burning more broadly.

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Discussion paper

1. “Biomass burning” as a term can be a little ambiguous, and in different communities is used to encompass some or all of: wildfires, crop residue burning, planned burning, and biofuel burning for heat and electricity generation. My impression is that in this study (given the data inputs), biomass burning is used to refer to the first three. It might be useful to spell this out explicitly early on in the paper to avoid any confusion.

2. (I’ve grouped a couple of related comments into this point — apologies if it is a little sprawling.) In the Abstract, the inversion is largely presented as a means to an ends, though in the results and discussion, the authors touch on several points that emerged from the inversion process that, to me, were also major contributions of the study that merited mention in the Abstract. Further elaboration on these points might be interesting to those studying mercury and biomass burning more generally. Some examples:

20-28 p.9: “This is an indication of a break down in one or more of our initial assumptions: the FINN calculation of burned biomass has uncertainties in magnitude or in location, the emission factors are not constant in space-time but are functions of fire type and other factors such as atmospheric deposition, or the six vegetation types do not accurately represent the variation in mercury emissions by species. . . Peat is much more 25 prevalent in the Northwest Territories than in BC (Tarnocai et al., 2011), the discrepancy in improvement between the years is perhaps an indication that peatland should be considered in defining the vegetation types; this is currently difficult due to sparseness of measurements of Hg from biomass burning plumes.”

6-11, p.15: “Our synthesis inversion study could be improved upon by implementing a more detailed optimization scheme, for example by considering more vegetation/land-use types such as peatland into consideration when assigning vegetation types and by accounting for spatial distribution of atmospheric deposition. Comprehensive measurements of mercury species in biomass burning emission plumes for different land-use types, and a suitable network of air concentration measurements of mercury including speciation would help in constraining the estimates of the Hg emissions from biomass

burning and the resulting deposition."

Related to the above, could the authors elaborate a little further on this point of what we would need to better constrain biomass burning emissions using top down measurements? It certainly seems like GEM:PBM emissions ratio would be a useful parameter to conduct a synthesis inversion on, but that the speciated measurements are lacking. Could wet deposition measurements be helpful in this regard or are they unable to capture evidence of the plumes?

A brief summary of how factors like fire type, temperature etc. are thought to affect biomass burning emissions and how the different emissions inventories treat these issues might be helpful earlier in the manuscript as well. Is there a non-FINN alternative that better captures the factors that are relevant for North American biomass burning emissions?

3. L20, p.1: The phrase "the range" is used here and elsewhere in the manuscript, which I think may be a little misleading, as it suggests to me "the full range" and I'm not sure that the scenarios considered do represent the full range of potential emissions. As the authors note, there are other sources of uncertainty not considered, and also structural uncertainties in emissions calculation methods between inventories (e.g., FINN, GFED). Using the phrase "a range" might be more accurate.

4. L17-20, p.2: It might be worthwhile to flag here, or in the following sentence, that emissions from soils and oceans can be secondary emissions of originally anthropogenically emitted mercury.

5. L17, p.4: Should there be another study listed here, in addition to the Cole et al. 2014?

6. Section 4: I found it somewhat difficult to understand the fire events ID process, especially when looking at Figure 2. Is the same criteria used to determine whether there's a peak in the observed data?

7. L25-35, p.8: I found this discussion of the range of reported estimates of EFs (from which the priors were derived) quite helpful. I wonder whether some of this info could be included in Table 2?

8. Figure 1 caption: It reads “Location of all of the Canadian stations and the American stations where fire plumes were observed. Filled symbols indicate stations at which a fire plume was observed, and these stations are labelled with the site names given in Table 1.” What do the open circles mean?

9. Figure 2 caption (and others): “The model concentrations have been corrected for the bias between the model and the observations.” Was this bias correction discussed in the manuscript?

10. Figure 4 caption: It might be helpful for the reader to use the full names of the vegetation types here rather than the codes, either in the figure itself or to list them in the caption.

11. Figure 7 caption: This is mentioned in the text, but it would be useful to include in the caption also which of the three emissions scenarios this is for.

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