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Geoscientific Model Development Discussions

Interactive comment on "GEM-MACH-PAH (rev2488): a new high-resolution chemical transport model for North American PAHs and benzene" *by* Cynthia H. Whaley et al.

Cynthia H. Whaley et al.

cynthia.whaley@canada.ca

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Italic font is quote from referee.
Responses start with [CW]

General comment: The present manuscript describes the improvements in PAH modelling in North America. The results with an analysis and discussion of the biases are lengthy and clearly presented. The strength and remaining limitations of the modelling system are put in evidence.

[CW] Thank you for your review of our paper. Below we will address your comments.

Major comment: Possible reasons like the missing reaction with NO3 radicals are given for the high BaP model bias. I would like to see a discussion of what the recent results of Mu et al. 2018(DOI:10.1126/sciadv.aap7314), if implemented in GEM-MACH-PAH, would change the predictions for BaP. The reduced OA diffusivity would increase BaP lifetime especially in winter. On the other hand the ROI temperature-dependent reaction of BaP is predicted to be the major cause of changes compared to the Kwamena's parameterization.

[CW] Thank you for pointing us to this recent paper by Mu et al. As noted in the original manuscript (p8, line 257), we chose the Kwamena approach since the BaP-O3 scheme from that work were mid-range of the three available in the literature (including Pöschl and Kahan as well), while that described in Mu et al presents a fourth option, potentially worth considering for low temperature conditions (e.g., in Arctic or global simulations). We have added the following discussion to our revised paper:

"Additionally, Mu et al (2018) suggest that the heterogeneous BaP-O_3 reaction should be temperature-, humidity-, and organic aerosol phase state-dependent (none of which are taken into account in the Kwamena scheme used in our work). However, it has been shown that the Kwamena scheme and the Mu scheme produce similar results in mid-latitudes (where our study is located) (Mu et al, 2018). Spring/summertime BaP would be minimally affected, as outdoor temperatures at that time of year resemble the room temperature laboratory conditions that the Kwamena scheme was based on. Additionally, our positive model bias would likely increase in the fall-wintertime, when low temperatures and humidity would increase BaP lifetime in the Mu scheme."

Furthermore, we expect the relative change in results to be small with respect to the impact of emissions uncertainties.

Minor comments: In a few instances references to figure panels a), b) and c) are given although no trace of it can be found on figure 6 and 7, for example.

[CW] Thank you for catching those errors. In our revised manuscript, we have clarified

all figures so that (a), (b), (c), etc are included and consistent with the text and captions (Figs, 2, 6, 7, and 11 updated).

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