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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global atmospheric budget of simple monocyclic aromatic compounds" *by* David Cabrera-Perez et al.

Anonymous Referee #2

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The paper "Global atmospheric budget of simple monocyclic aromatic compounds" presents a comprehensive study on the atmospheric budget of aromatics in the gas-phase. The authors described the implementation of aromatic compounds into the EMAC model in great details, in terms of their emissions, chemistry, and depositions. The paper also presented the validation of the simulation for aromatics using an ensemble of surface and aircraft observations. The paper is clearly written and easy to follow. The method is fully described. The conclusion is not surprising given our current understanding of the sources and sinks for these aromatic compounds. However, I do appreciate (and I think the community would too) the great effort the authors put into the implementation of these new species into models, and potentially the applications of such a model capability. Thus I think the paper could be published in the Atmospheric Chemistry and Physics (ACP), but it seems the manuscript as-is may suit

better for publication in the Geoscientific Model Development (GMD). The authors may consider the following suggestions to improve the quality of the paper:

1. The validation of the simulations has been focused on whether the model can reproduce the observed mixing ratios for aromatics. This is of course useful. A step forward for the validation is to test the model's capability for simulating the observed species: species ratios. For example, we have been using the benzene/toluene, or toluene/xylenes ratios as photochemical clocks to determine the age of air mass, because they are typically co-emitted from similar sources and they all have different photochemical lifetime. This could at least give some indications about how confidence the chemistry is in the model.

2. The speciation of xylenes and trimethylbenzenes, etc. The model lumps isomers and assumes equal proportions of single isomers. It is unclear how the rate coefficients are calculated for the lumped species. And, is it a good assumption to assume equal proportion of single isomers when we know some isomer dominates? Justification is needed here considering these species are typically more reactive than benzene and toluene thus are expected to have larger atmospheric impacts. Other two thoughts about the speciation: 1) how sensitive are observation techniques used in the validation to those isomers? 2) how do the emission inventories used here separate those isomers, and what are their assumptions when they lump species?

3. 'Anthropogenic emissions represent the largest source of aromatics' is not something really exciting, because this has been known for a long time. Can the authors provide more sectorial information about these anthropogenic emissions? For example, solvent usage has been considered as the largest source for toluene and (lumped) xylenes but not for benzene in the RETRO inventory. Can this work say something about the importance about the solvent usage? Another example, are emissions from vehicles still an important source for aromatics in urban and rural areas? Insights in such sectorial emissions could really improve the quality of the paper.

4. Can the authors say something quantitatively about the RCP emission inventory for benzene, toluene, and xylenes? Are they good? How good? Are there any regions that need to be improved based on the validation in the paper? What are the weaknesses of this emission inventory for aromatics?

5. Is it really necessary to simulate 666 reactions and 229 species in order to reach the conclusions of the paper? Do the authors have any recommendations for a simplified chemistry for model communities? What are the advantages of comprehensive descriptions about the chemical reactions? The authors need to expand the motivations about this.

6. Tables 1 and 2 in the supplement are not self-explanatory at all. They will need to be modified.

7. I suggest that the '2.3 Sinks ' should be renamed as '2.3 Scavenging and dry deposition', as '2.2 Chemistry' is considered a part of 'Sinks' too.

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