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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The influence of boreal forest fires on the global distribution of non-methane hydrocarbons" *by* A. C. Lewis et al.

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We thank the reviewer for their helpful suggestions and careful review. We have accepted and incorporated all of the minor typographic and editorial changes suggested by the reviewer into a revised version. We respond to the more substantial issues below highlighting how we have modified a manuscript for resubmission.

As suggested we have added some references and context to the earlier work on CO from biomass burning and the use of CO ratios to derive the emissions of other atmospheric trace gases released from biomass burning. This has been included in the introductory section.

We had limited our direct comparison of field data on biomass burning emissions of

hydrocarbons to CO with that of Simpson et al 2011, largely because this was a directly overlapping dataset in terms of chemical speciation and was from an almost identical geographic region. We have however extended our comparison of certain emissions ratios to other studies, using in particular the review of Andreae and Merlet which included data from burning in both extratropical and tropical regions.

The comparison highlights that for the species used in the modelling study in this paper there is very little difference between the ER from tropical forests and those of our boreal study. We have included additional text on this including: 'Using the summary values from Andreae and Merlet (2001) the ER of benzene in tropical forests is estimated at around 1.65 $\pm$ 0.10 ppt per ppb CO, as compared to our boreal ER of 1.40 $\pm$ 0.11. A similarly close agreement is found for ethene, propene and toluene – for example our boreal estimate for toluene is 0.69 $\pm$ 0.09 ppt per ppb CO, vs the tropical literature range of 0.73 $\pm$ 0.2. We consider therefore that the use of a single ER for all biomass burning emissions is sufficient to represent both regions in the model and that compared to uncertainty in the overall size of CO biomass burning emissions and anthropogenic benzene, this is likely to be a minor factor.

The reviewer raises the issue of smoldering fires a source to the atmosphere. It is clear that if our hydrocarbon ER was derived solely from near to source or fresh fire emissions then we would not capture this source in our data. However the scale of the aircraft observations, covering 28,000 km of sample tracks and from 500ft to 30000ft would suggest that all types of burning emissions are represented in our data. We do not observe any substantial deviation in hydrocarbon to CO slopes for biomass influenced air suggesting that the smoldering emission is captured in our ratio. There is a wider issue of whether smoldering CO is then captured appropriately by GFED3 but that is beyond this paper. The implication is that our estimates of influence may be under-estimates if the smoldering source of CO is not captured and is significant. We have added a comment on this in a revision.

We have taken the reviewers point regarding the title and have modified as suggested.

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This comment section also refers to the need to widen the literature in a number of areas, which we have done as outlined earlier.

P23440 L15-25. We have modified the text to highlight that our slopes obtained on a flight by flight basis are very close to that obtained using a composite of all data, suggesting over the range of ages observed in this study that there is no clear change in emission ratio with smoke age.

P23441, L9. We have highlighted further why we compare specifically to Simpson et al. given the similarities of the studies, but have also now compared selected data to other literature values.

P23441, P11-12. Propene values now compared also to Akagi et al. values.

P23442, P22. We have modified this section and made comments on impacts vs anthropogenic emissions more specific.

P23443, L20&25. We have now added text referring to the additional uncertainties that may arise from use of different fire inventories. We note: 'A comparison of global inventories by Stroppiana et al. (2010) would suggest that our biomass burning emission value of 350 Tg yr-1 is consistent with the NCAR (FINN) model but towards the lower end of the range given in this analysis, suggesting our hydrocarbons from biomass burning are conservatively estimated.'

P23444, L5-6. Now re-written to improve clarity.

P23445, L5-6. We have only a single background measurement station to use to constrain the benzene emissions and whilst we highlight the factors that would be needed to bring model and observation together, we do not feel that this provides sufficiently robust evidence to then proceed and use only this lower emissions value. We have clarified our reasoning in a number of places in the text. We use this lower value in a number of comparisons to highlight that our overall conclusions not generally affected even given a factor of three uncertainty in the biomass burning emissions.

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P23445, L12, We refer here to benzene emissions that have been fitted to observations for the 2010 annual cycle at Cape Verde. We have made this clearer the text and figure captions.

P23445, 17-21. Comparison made to the range seen in Sinha et al.

P23445, L19-20. Rewritten to improve clarity.

P23446, L5-11. We have added a substantial number of references to previous work in the paper and compare the values of ER used in this paper with literatures and reviews of literature. We don't feel that the findings of the paper would be enhanced in this particular section by further comparing the model against point literature values again, since the emphasis here is on what the model has told us about global distribution, rather than the paper acting as a review article.

P23447 L12. Clarified – see earlier comment – figure captures improved.

P23449, 10-11. Modified to reflect our inclusion of additional earlier work in the introductory and analysis section and comparison to other boreal and tropical burning ERs.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 23433, 2012.