

Interactive comment on “Biomass burning at Cape Grim: exploring photochemistry using multi-scale modelling” by Sarah J. Lawson et al.

Anonymous Referee #1

Received and published: 10 January 2017

This paper presents several sensitivity studies of high resolution chemical transport modeling (CTM) to reproduce biomass burning (BB) plume strikes observed at Cape Grim. Two meteorological models are used to explore the sensitivity of model predictions to meteorological inputs, while three sets of emission factors are used to explore the model sensitivity to adjustments to the modified combustion efficiency (MCE) of the fires. These results are compared to observations and used to estimate the impact of biomass burning on the enhancement of O₃ observed at Cape Grim during both events.

In general, this is a well-written paper on an important topic, the impacts of biomass burning on surface O₃ concentrations, using an interesting dataset from Cape Grim. The methods generally appear to be reasonable and the evidence presented supports the conclusions. The model sensitivity studies presented help to illustrate that the ob-

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served O₃ peaks were generally due to anthropogenic pollution, rather than biomass burning emissions. However, in a few places the methods are not adequately explained, and I have some questions and concerns about the modeling studies. Thus I recommend publication after revision to address my comments as detailed below.

Major Comments:

P6, L14-16: We need more details on the measurements in the text, such as a reference for the measurement method, the measurement frequency and averaging, the precision and accuracy, any known biases or other interferences, etc.

P7, L20-21: At this horizontal scale, you are going to start to resolve some of the eddies in the boundary layer, which may cause problems if your meteorological model assumes that all turbulent eddies are sub-grid scale as part of its boundary layer parameterization. How did you avoid these issues in your models?

P8, L24: You don't define how you arrived at the "base" emissions shown in Figure 2, or why the total emissions (integral under the curves) is not the same in the base and the FDI-scaled emissions. We need more detail on what you are doing to calculate the emissions.

P8, L29-30: I assume you are using the temperate forest MCE range because savannas generally have a high MCE in these EF databases. However, this is seemingly inconsistent with using savanna EFs for most species. How do you reconcile this?

P13, L15-17: You need to make clear that this inconsistency between the best MCE values to use for CO and BC is due to errors in your assumed relationships of the emission factors of the two pollutants with MCE, rather than that you are suggesting that the fire had multiple MCEs or that the value is highly uncertain.

P19, L6: You don't discuss how you estimated the background concentration, and thus the excess concentration, of O₃. Since your results may be very sensitive to the choice of background, it's important to be clear on how you calculated it.

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Minor Comments:

P1, L25-29: The first sentence here on the previous work seems out of place in the abstract, and the second sentence is true, but not really a conclusion of this study. Thus I recommend cutting both sentences.

P2, L7-11: This summary paragraph is not really necessary to include in the abstract, so I recommend cutting it.

P2, L21: "impacts of BB plumes from a fire" – BB plumes are from fires by definition, correct? Also, you need to specify the impacts, e.g. impacts on human health, air quality, climate.

P7, L20: Were both models run at this resolution? If so, please correct that.

P13, L24-26: This is only true for CO, not BC, right? So I think you need to make that clear.

P14, L29-30: This is only true for BB2, right? If so, make that explicit.

P15, L11-22: I'd suggest cutting both of these paragraphs. The first just repeats statements you have already made, and thus belongs in the conclusions. The second is true, but except for the first sentence referring to the previous work, it is obvious and not really related to the study presented in this paper.

P17, L4: Make clear again that this additional modeled peak was not observed.

P17, L22-23: Need a reference for this work.

P17, L22-29: This paragraph sounds like it would fit better in the introduction rather than in the results section.

P19, L15-18 and P21, L18: Please also give the change in absolute units (ppbv).

P20, L3: Please make clear that this is a photochemical age, not the actual age of the air mass.

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Figure 1 caption: Since you use two models, saying "the model" is ambiguous.

Figure 5: I'd suggest increasing the font size of all the text in this plot. It is difficult to read right now.

Figure 6c: I'd suggest adding vertical lines or bands showing the four modeled O3 peaks on this figure, so we can see how the peaks are affected by the presented differences.

Typos:

P1, L23: I think "non-methane organic compound" is the more common phrase, so I'd suggest using this here and again at P2, L17.

P1, L23-24: I think you need commas before "which in turn" and after "ratio"

P3, L25-28 and elsewhere: you need to use a consistent format for these lists of a), b), c) etc. Sometimes you separate them with commas, elsewhere with semi-colons, or here with nothing.

P4, L8: "monthly" is repeated.

P4, L28 and elsewhere: The formatting of the references in the text is inconsistent with ACP style. Please double-check them all to save the copy-editor some time.

P5, L24: Need a space between "20" and "km"

P8, L15-16: You should introduce the abbreviation FDI here along with the reference, rather than down at L22.

P9, L31: I suggest cutting "within the computational time step loop."

P9, L33: "momentum", not "moment"

P10, L20: "summarizes the main findings"

P10, L22: "from 23 February 2006,"

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P10, L24: "Before investigating the impact"

P11, L15: "(5 hours actual)" is redundant and should be cut.

P12, L7: "and a more concentrated plume."

P12, L16: Need commas before and after "respectively"

P13, L4: Cut "Method"

P13, L13 and elsewhere: I'd suggest adding an equals sign here, to give "(MCE = 0.89)" and do the same consistently through the paper.

P14, L25: Add units to the NO and NO₂ mixing ratios.

P17, L1: "The modeled concentrations are very similar"

P18, L11-12: The statement in parentheses is redundant, so I'd suggest cutting it, and then combining L13-14 with this paragraph.

P20, L21: I'd make this Section 4.

P20, L30 and 31: You are missing a "the" at the beginning of each line.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-932, 2016.