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Geoscientific Model Development Discussions

Interactive comment on "TOAST 1.0: Tropospheric Ozone Attribution of Sources with Tagging for CESM 1.2.2" *by* Tim Butler et al.

Anonymous Referee #2

Received and published: 20 April 2018

Manuscript Summary

The manuscript presents a well written summary of the implementation of a tracer tagging system within the Community Earth System Model that is able to identify and track the sources of tropospheric ozone. Separate tagging schemes are available for NOx and VOC precursor emissions which avoids some of the pit falls from previous schemes. An example of the using the tagging scheme is presented and highlights the ability of the scheme to identify the contribution of different of sources to ozone formation. I found the paper well written and suitably detailed and think would make a valuable contribution to future source-receptor studies. I would recommend publication once the following comments have been addressed.

General Comments

1. On a number of occasions, in the introduction and conclusions, the manuscript mentions that tagging methods are complimentary to perturbation (sensitivity) methodologies for analysing source-receptor relationships. Perhaps the author would like to comment further in the conclusion sections on how might this be achieved and what particular aspects of the two different methods are complimentary or comparable.

2. As expected the manuscript focussed on the reactions involved in the production of ozone. However, there is not much mention made about termination/loss reactions and how these interact with the tagging scheme. It is mentioned in Section 3 (e.g. Section 3.2.1 P9) but it would be good to mention this a bit more and perhaps provide an example reaction of how tagging is treated in these reactions (or refer to the supplementary).

3. Is there a clearer way of labelling the tagged tracers to make then more identifiable with their source? For example the Ox tagged tracers have the suffix '_X_TAG' whereas the NOy tagged tracers are labelled as '_TAG'. Could the NOy tagged tracers not be labelled as '_Y_TAG' or '_N_TAG' to clearly identify their source?

4. Throughout section 5 there are numerous times when winter is mentioned in isolation (e.g. P12 Line 31). Please could the author check in the results section that reference is made to northern hemisphere winter or just the individual month to avoid confusion.

5. Throughout section 5 there are numerous references to results in March/April or Spring. However, no such results are presented in the manuscript. I found it very frustrating for the manuscript to be talking about results which I could not see. Therefore I would like to see the results presented for this season in order to be able to confirm any assertions made in the manuscript.

6. Key on Figure 5 and 6 are quite small. These figures could be enlarged for the final version or the keys made larger to make sure that they are clear and legible.

Minor Comments

Section 1. P1, Line 16 – 'as well as an contributor' should be changed to 'as well as a contributor'.

Section 2. P5. Lines 22-25 and Lines 1 to 4 on P6. – Perhaps this whole paragraph would be better placed as the introduction to the methods section since it is highlighting the improvements from the scheme developed here.

Section 3. P6 Line 7 – 'and arbitrary list of tags to be applied' replaced with 'an arbitrary list of tags to be applied'.

Section 3. P6 Line 15 – Is it possible here or in the supplementary to supply a list of possible tags that could be applied and also list what emission files are required to be provided for each tag. Tags are mentioned in Section 4 but perhaps could be brought forward to here as well.

Section 3.1.1. P7 and 8 – I found the description of how to avoiding over-representing the influence from local NOx sources using the separate tagged tracers a little bit confusing at times. Could this mechanism possibly be represented schematically to help the user in tracking the different pathways that the tagged tracers follow?

Section 3.1.2. P8 Lines 11 to 12 – Are these manual reactions separate to the automatically determined ones and could they be separately flagged in the supplementary material?

Section 3.1.2 P9 Lines 1 to 2 – How much does letting the Ox tag be inherited from NO2 sources impact on the tagging scheme (related to point 2 above).

Section 4. P12 Line 21 – 'win' should be 'in'

Section 4. P12 Line 21 and 24– Final year of the simulation is mentioned whereas it would be nice to state actual year of the simulation in which results can be obtained (i.e. 4th year).

Section 4. P12 Lines 23 to 24 – Is there a reason that using the tagged chemical mechanism generates different results to the original mechanism, particularly in the free troposphere?

Section 5. P12 Line 30 – I don't think that the gradient really reverses that much for ozone from anthropogenic sources, changes are more subtle.

Section 5. P14. Lines 2 to 4 – Is this sentence talking about O3 only from the VOC tagging? I think it this needs to be clarified in the sentence.

Section 5. P15 Line 1 – I found the colours on these Figures quite hard to determine actual concentrations from. The blues seem to cover the range of between 8 and 20 ppb making it hard to identify precisely the contribution from methane. Would using a different colour scale (or different increments) provide better results?

Section 5. P 15 Line 3 – Is the influence of the stratosphere stronger in winter, looks like just a shift in hemispheres.

Section 5. P 15 Line 4 – August is mentioned but no results shown to verify (See point 5 above).

Section 5. P 16 Lines 6 to 9 – In one sentence mention is made of an upper bound on the stratospheric contribution whilst later on it is referred to as a lower bound. Please could the author clarify if this is correct.

Section 5. P 19 Line 17 to 18 – Could you provide numbers to verify that the stratospheric contribution is lower in the VOC tagging than for NOx tagging.

Section 5. P19 Lines 25 to 29 – Mention is made here of the limitations in the stratospheric chemistry within the model. I think it would be useful to briefly mention if anticipated future improvements to stratospheric chemistry are likely to increase or reduce the stratospheric contribution to tropospheric ozone.

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