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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Attribution of ground-level ozone to anthropogenic and natural sources of NO_x and reactive carbon in a global chemical transport model" *by* Tim Butler et al.

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Butler et al. present an analysis of modelled surface ozone concentrations with respect to the chemical production via either NOx or VOCs. The paper is well written and offers important insights in the relation between regional emissions and ozone surface mixing ratios. However, I think some more comments on

- Interpretation of the diagnostics and

- Uncertainties

should be given.

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Interpretation:

a) Loss processes

As far as I understood the ozone production terms are taken into account in the tagging scheme for ozone. How is the ozone destruction treated? Increase in the NOx emissions and hence NOx concentrations affect not only ozone production, but also the lifetime of ozone (e.g. Stevenson et al. 2006). Hence also the individual sources contribute differently to the ozone destruction. How would your results change, if you take this effect into account?

b) Ambiguity

While the separation of the ozone production wrt NOx and VOC is very helpful in understanding the driving mechanisms, it may also appear as ambiguous. E.g. Figure 4 indicates that European ozone is largely dominated by NOx from ozone (top) or methane (bottom). That sounds like a contradiction. Shouldn't it be in the end one ozone bar having all contributions included, instead of two (top and bottom figure)? I think it would be helpful to add some discussions here.

Uncertainty:

a) Resolution:

The plume processes for ships are mentioned, which I think is an important process to be considered. But what is about model resolution in general? Does this affect city or harbour plumes as well?

b) Quality of emission data

How sensitive are the results to uncertainties from emission data. Biogenic emissions, etc. ?

Minor Comments:

page 2 / line 53/54 Dahlmann et al. calculated explicitly the ozone production efficiency and showed that lightning and aviation NOx emissions are most efficient, in case you want to quantify the number of ozone molecules per emitted NOx.

page 4 / line 108 Grewe (2013) provided a theoretical framework for taking into account these competing effects and compared that in a simple framework in Grewe et al (2010) and in a chemistry-climate model in Grewe et al. (2017). Please rephrase that this is NOT common to all tagging schemes.

line 115: There is also a nice table in recently published work by Mertens et al. (2020) (https://doi.org/10.5194/acp-20-7843-2020) discussing in detail the characteristics of these two methods, which might be helpful here.

line 115: Perhaps you want to adapt the naming consistently throughout the manuscript? contribution/share for tagging approaches changes/impact for perturbation? E.g. line 56 Hoor et al used perturbation approaches. The wording "contribution" in this respect might be misguiding.

line 126: This statement might be misunderstood. The Butler et al tagging scheme is the only one, which separately analyses attribution of tropospheric ozone to its NOx and reactive carbon precursors, whereas the Grewe et al scheme is the only, which analysis attribution of tropospheric ozone to both together, NOx and reactive carbon precursors, taking competing effects into account.

line 159: Is there any reason why the spin-up differs?

line 233: also Dahlmann et al. 2011.

line 401: Please elaborate a little bit more on this comparison in terms of quantitative values. I guess we should expect a difference in the strength of the contribution vs perturbation? If so, can that be explained by the difference in the method?

line 550: RF and human health effects are not calculated. Please re-phrase that this is a potential important impact based on literature and not your findings.

Figure 4: Please adapt the text in the figure to explicitly state that surface ozone is presented. Caption: Please include some more details, e.g. "Source-receptor relationships between annual averaged surface ozone volume mixing ratio and NOx and VOC emission type and region.", in order to clarify that with region the NOx emission and not the ozone production is meant.

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