**Atmospheric
Chemistry
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Discussions**

Interactive
Comment

Interactive comment on "Technical Note: A diagnostic for ozone contributions of various NO$_x$ emissions in multi-decadal chemistry-climate model simulations" *by* V. Grewe

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The Referee #2 recommended to substantailly improve the manuscript and to include more information. However, from the detailed comments it turned out that most of the information is already given in the text, but unfortunately not described clearly enough. I hope that my answers, given below and included in the manuscript will make the it better readable.

Detailed Comments:

- The used model E39/C has 12 tracers, which are transported for chemistry. The diagnostics includes addional 17 tracer, which increases the CPU time by approximately 35%. The inclusion of two further species, e.g. HNO3, N2O5, would give a total increase of 70% in CPU Time, since they have to be introduced for each source. The

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numbers are given now in the text.

- Probably there is no clear optimal delta for all emission sources. Lightning in the tropics is the most important source and it is determining the NOx concentration. A 10% change in the emission will significantly change the background chemistry, whereas a 10% change of the aircraft emissions changes the background to a smaller extend. The 5% approach minimises also the non-linearities resulting from the combination of the different chemical lifetimes of NOx and ozone and the effects during long-range transport (see introduction). Those effects can not occur in air pollution modelling.

- The Referee is totally right, and I rephrased the regarding sentences. The box model study is not and can not be a proof of the validity of the approach, because then the whole chemistry has to be included and a large parameter range has to be analysed. It is more thought to motivate the approach and convince the reader that it is a possible way and to make clear the meaning of the simplification. As a motivation it should be presented before introducing the approach. To make the ms more readable I added some more words in the Methodology paragraph, to clarify this point. However, I also included some more results for a variety of parameters (see AC to 1st Referee).

- I agree with the Referee that the nomenclature is somehow difficult. My intention was to minimise the indices. Therefore I chose x,X,Y instead of NOx O3, ... I don't think that a substitution will increase the readable, but the idea of a table for an overview of the meaning of the indices is excellent.

- Agreed, the box model is no proof for the correctness of the methodology. This was not the intention. Otherwise the error analysis is not needed.

- The meaning of reasonable means that the NH aircraft induced ozone changes are around 2.5% (Grewe et al., 2002a, simulation LIG) and around 60% (Grewe et al., 2002b) in the tropics for lightning. The diagnostics gives also 2.5% and 40%-50% for the aircraft and lightning ozone contributions. In the case of lightning emissions the 60% value is considerably higher than the respective value of the diagnostic (40.50%),

which also may result from the different approaches, more important is that the pattern of the contributions are very similar.

- I see the point: I introduced a somehow more detailed discussion in the introduction to clarify the numerical problems in the beginning. The smaller the delta for the emissions the more numerical problems occur in the calculation of the ozone perturbation. The non-linear effects can be smaller but then they are amplified by multiplying with the inverse of delta. I agree that there is no perfect test method to validate the diagnostic against. Therefore the conclusion was that none of the both methods is superior. But since both give similar results they have at least the same quality. I tried to clarify this more in the text.

- Fa in the SH: Ozone has a large contribution from lightning, which is transported on a long way. Lightning NOx is converted to HNO3 on that way and washed out, but ozone not. This leads to non-linearites in the NOx and O3 estimates for 'true' ozone.

- Yes the Referee understood it correctly. The different position of the indices has different meanings, which were explained in detail in the text. The additional table should now better clarify it.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 327, 2004.

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