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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improved simulation of tropospheric ozone by a global-multi-regional two-way coupling model system" *by* Y.-Y. Yan et al.

Anonymous Referee #1

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General Comments

This paper examines the impact on global model simulations of tropospheric ozone of including three higher resolution nested regions which feed back to the global model. The benefits of the coupled system are assessed by comparison with atmospheric measurements and are shown to reduce biases in the stand-alone global model. The paper is well written, with the methods and results clearly presented and explained. The model evaluation against available tropospheric measurements is also thorough.

My main concern is that the results obtained from this one study with one model, GEOS-chem, may not be sufficiently general or provide sufficient scientific insight for publication in ACP and that GMD might be a more appropriate journal for what is prin-

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cipally a model validation paper. It is not surprising that changing the resolution of a model changes the results, nor that a higher resolution, albeit not for the full model domain, leads to a better simulation. The authors make frequent references to 'non-linear chemistry' as an explanation for the differences, but I'm not convinced that the actual chemical mechanisms are fully elucidated. Interpretation of the results is also hampered by having the emissions and STE also change within the nested regions so that ascribing changes in the simulated ozone to a particular cause becomes difficult. Nevertheless, I do consider the study merits publication in either ACP or GMD.

Specific Comments

P.25792, L.10

It could be noted that 0.667x0.5 is still a relatively coarse resolution compared with many regional CTMs (which still struggle to match point measurements near emission sources).

P.25792, L.10

It might be helpful to include a global map with the three nested regions indicated.

P.25793, L.19

Has it been tested whether it is appropriate to change the model's horizontal resolution while retaining the same vertical resolution?

P.25796, L.8

Why are the isoprene emissions higher at higher resolution? How does the land cover change?

P.25796, L.22

Did you check that afternoon ozone is close to the max 8h average in both model and measurements? It would be be reassuring to know that the simulated diurnal cycle is

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somewhat realistic.

Section 3.3

I appreciate the authors are being careful, but I found the detailed discussion of the two TCO products a little distracting from the main modelling results and suggest it might be shortened a little.

P.25799, L.8

'The two way coupling.. (Yan 2014)' Does this statement apply only to CO? Otherwise it appears to preempt the results about to be presented and discussed.

P.25800, L.12

'... indicates a significant effect of model resolution' Or of changed emissions?

P.25800, L.13-21

All the differences discussed are quite small, in line with what might be expected from any minor change to the model configuration. How significant do the authors consider them?

P.25801, L.25

Add brief comment on why it is okay to do this analysis while the model is still spinning up.

P.25802, L.7 to P.25803, L.8

I didn't find Figures 2 and 3 and the associated discussion particular enlightening. Is there more to say than that the higher resolution model shows more detail and more urban rural contrast?

P.25802, L.25

'...reflecting the resolution dependent non-linear chemistry', Expand and give a more

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detailed explanation.

P.25803, L.8

'...the amount of ozone produced is affected by model resolution'. Again, expand

Section 4.4

This section is somewhat perfunctory. Contrasting chemical and non-chemical impacts of changing resolution merits a little more discussion.

Section 5.1

My understanding is that the ozone within the nesting domain is being compared with the measurements after being re-gridded back onto the coarser global domain? So Figures 5 and 7 are comparing point measurements with the model ozone 'averaged' over a 2.5x2 degree grid cell. This could be mentioned. Is it worth looking at the bias of the model ozone on the original high resolution nested grid? The biases versus the EMEP measurements could be compared with the biases between those measurements and the EMEP/MSC-W model regional CTM reported in the annual EMEP Status Reports (www.emep.int/mscw/mscw_publications.html).

P.25809, L.7

I'm not convinced that it has been fully demonstrated that the model improvements are driven by better representation of chemistry rather than by changes in emissions or STE. If the DSMACC simulations are a key element in this argument why relegate them to an appendix? The broad conclusion that small scale processes are important for global chemistry and higher resolution gives a better simulation is somewhat general, and adding more specific details to the conclusions would be beneficial.

Technical Comments

P.25791, L.12 destructed -> destroyed

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P.25791, L.23 its nonlinear -> their nonlinear

P.25793, L.8 upon -> over

P.25796, L.24 ozone are sampled -> ozone is sampled

P.25797, L.5 of polluted environment -> of the polluted environment

P.25797, L.6 aircrafts -> aircraft

P.25797, L.23 ozone are sampled -> ozone is sampled

P.25798, L.21 TCO are calculated -> TCO is calculated

P.25800, L.26 by global model -> by the global model

Table 2 Is 'Fos' in row 5 a typo?

Figure 9 caption Frankfort -> Frankfurt

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 25789, 2015.