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Atmospheric Chemistry and Physics Discussions

Interactive comment on "3-D evaluation of tropospheric ozone simulations by an ensemble of regional Chemistry Transport Model" *by* D. Zyryanov et al.

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We thank the reviewer for his fruitful remarks. In general the recommendations and modifications proposed by the reviewer #1 have been updated in the text. In particular, new sensitivity tests have been conducted, and results are integrated into the paper. In the following, we specifically answer points of the review #1 that need some more explanations.

Page 28,808, line 4: Please provide more details on the "unsatisfying results". Could they also have been caused by the low model top used by CAMx (300 mb)?

In this case the problem was coming from an interpolation problem between CAMx

ozone fields and MOZART's ones for upper levels. For this reason, values up to 6 km height were not considered for this model. The sentence has been removed and only the altitude of the top of this model is mentioned for sake of clarity.

Page 28,809, lines 1-23: could lightning NOx also play a role in this underprediction? How was it handled by the regional CTMs?

It is true that lightning NOx (and also NOx emitted by aircraft) could play a role in ozone budget in the upper troposphere. Allen et al. (2010), or Monks et al., 2009 and reference therein, mention that the summer midlatitude NOx budget is greatly influenced by lightning NOx. As a consequence a non negligible part of the ozone budget above 400hPa can be influenced by this type of emissions (up to 10 to 20% i). These aspects are not taken into account in the RCTM. Nevertheless global CTM's do represent these emissions. Thus there is an indirect representation of these emissions in RCTMs by boundary conditions. Nevertheless, the representation of lightning NOx in the CTM is still highly uncertain due to a poor knowledge of the production process itself but also du to a poor knowledge of deep convection to which lightning are related to. Authors propose to mention these aspects in the model description section:

"Moreover, altitude emissions, i.e lightning NOx emissions and aircraft emissions are taken into account in IFS-MOZART (Horowitz et al, 2003) following the parameterization proposed by Price et al (1997) for lightning NOx and the work of Friedl (1997) for aircraft emissions. RCTM do not directly represent these altitude emissions but use boundary conditions from the MOZART-IFS model."

Moreover we have added a sentence in the result section to mention (section 4.1) these aspects, i.e the potential impact on results of these processes and the way they are taken into account in models:

"On the other hand, altitude emissions produced either by lightning or aircraft could explain a part of model error. The regional models of this study do not represent these emissions; they are only taken into account in IFS-MOZART and it is also well-

known that these processes are still not well characterised. Nevertheless, Due to the low residence time of air masses in the free troposphere within the model domain (of the order of several days) and small ozone production rates there, lightning NOx and aircraft emission over Europe are not expected to significantly impact European free tropospheric ozone levels"

Page 28,811, lines 2-4: I am not sure I follow the argument about the increased variability. Could you please elaborate and define variability in this context?

This sentence expresses that fact that in the upper troposphere the standard deviation of observed ozone concentrations is larger than in the lower part of the troposphere where it represents 54% of mean concentrations instead of 25% and 26% for FT and PBL (cf table 3). Ozone concentrations themselves are higher. This induces higher RMSE even at constant or increasing correlation. The sentence in the text has been changed to:

"RMSE increases with altitude despite a slight increase in correlation (Figure 3). This could be explained by larger ozone concentrations and in particular larger ozone variability (1 σ standard variation) in observed and simulated time series observed at these altitudes (cf standard deviation in table 3). Larger variability generally favours correlation if basic processes are well taken into account, here in particular variations of the tropopause height, but also increases RMSE if such processes are not perfectly taken into account."

Page 28,815, line 24-26: does the statement "which makes it necessary to dispose of simulations also above 6 km" refer to all models or only CAMx?

Yes it refers to all models. The new sentence is now:

"Inspection of the averaging kernels shows that ozone values above 6 km height contribute to the retrieved 0–6 km columns, which makes it necessary to dispose of simulations with model top above 6 km."

Page 28,819, lines 26-29: Please elaborate.

The text has been clarified to:

"In conclusion, the comparison between models and IASI shows that models qualitatively reproduce the observed lower tropospheric continental scale N/NW-S/SE gradient. Also the temporal variability of the columns at large geographical scales (1500 – 2000 km) is well reproduced (correlations between IASI and the model's median in the range 0.63-0.74). These correlation coefficients are larger than those obtained from the comparison between simulations and in situ ozone profiles in the free troposphere. This is consistent with the fact that for these comparisons point measurements are used (with respect to spatial averages for the case of IASI observations)."

Page 28,840, Figure 2: use decimal points rather than commas on the x-axis Pages 28,844 – 28,845, Figures 6a-b. Please modify the labels from "summer.2008" to "Summer 2008" or something similar. Page 28,448, Figure 9: The figure lacks a color scale and the labels are not readable.

Figures will be updated accordingly to reviewer's remarks.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 28797, 2011.