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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Decadal regional air quality simulations over Europe in present climate: near surface ozone sensitivity to external meteorological forcing" *by* E. Katragkou et al.

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We would like to thank Reviewer #2 for the detailed and constructive comments.

Our response follows:

COMMENT: However, although rather extensively and systematically discussed this sensitivity, the authors do not examine at all the importance of chemical boundary conditions. Because of the relatively low upper boundary of the air quality regional model (about 6.5km), it is expected that the ozone simulations will be significantly affected by the imposed boundary conditions. In page 10679, line 25, it is mentioned that 'top and lateral boundary conditions were kept constant to a clean atmosphere'.

This sentence needs to be clarified: Do the authors mean that they used the same boundaries for all months and years of the decanal simulations? (Of which chemical compounds?) These conditions will definitely affect the chemical compounds that are subject to long range transport like for instance carbon monoxide, the reactive nitrogen family and ozone If these conditions were kept constant, it is somehow expected that small changes in near surface ozone will be calculated. Changing meteorology on global scale will modify oxidant fields on global scale and thus their long range transport terms, including stratospheric influx to the troposphere. These 'chemical weather' changes at all boundaries need to be accounted when constraining the regional air quality model. Unfortunately, the authors restrict their analysis to the meteorology impacts – totally decoupled from the chemical changes on larger scales than that studied. They conclude that changes in meteorology and regional biogenic emissions that are meteorology driven result in changes in near surface ozone by about 5 ppbv. This result needs to be complemented by the evaluation of its robustness to the large scale chemical weather changes at least by performing shorter term (for instance one year) simulations and applying a proper 'chemical forcing' to the boundaries.

RESPONSE: Chemical boundary conditions play an important role on air quality simulations. Top and lateral boundaries were kept constant with no seasonal variation and annual variability, identical for both decadal simulations in the set up of this study. There are a few of limitations to be noted with respect the chemical boundaries of the air quality simulations. This assumption implies that important processes such as stratosphere-troposphere exchange and intercontinental transport of pollutants are not taken into consideration. It is known from global studies (Stevenson et al., 2006) that stratospheric flux to the troposphere is an important contribution to the global ozone budget and that in future projections upper tropospheric ozone will rise, especially in the Northern Hemisphere, which is related to an increased influx from the stratosphere. However in these global studies the effect of stratospheric influx to the surface ozone (the focus of this study) is rather small. As far as it concerns the effect of intercontinental transport of pollution towards Europe, Li et al. (2002) showed that the effects

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of North America and Asia anthropogenic emissions on European surface ozone is in average over summer 1997 around 2-3 ppbv for the largest part of Europe. This is rather small compared to the effect of the European emissions on European surface ozone which is more than 20 ppbv. Naturally, the evaluation of the modeling system reveals disagreement of model results with observations in areas which are close to boundaries. In order to address the comment of the referee, we performed two sensitivity studies: in the first we increased O3 top boundary by 20% and in the second we increased O3 lateral boundaries by 5%. The changes in surface ozone were found to be less than 5%. In a new paragraph entitled "Sensitivity to chemical boundary conditions" we discuss more in detail the role of chemical boundaries in our modeling system and the limitations from our modeling set-up.

COMMENT: Most figure and Table captions need to be rephrased to clarify to which level they refer. Is it model surface level values? or integrated values?

RESPONSE: We deal only with surface values. All our captions are changed correspondingly.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 10675, 2009.

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