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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Formation and transport of photooxidants over Europe during the July 2006 heat wave – observations and GEM-AQ model simulations" *by* J. Struzewska and J. W. Kaminski

J. Struzewska and J. W. Kaminski

Received and published: 9 October 2007

Reply to the Anonymous Referee #1

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1. Section 1, p.1, right-hand column, middle: "The increasing frequency... ": the sentence appears before the actual demonstration that the frequency has, in fact, increased. This leaves the reader confused. Putting it at the end of the same para would make more sense.

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Reply:

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We believe that increasing frequency of heat waves in Europe is a well known fact which does not need to be proven. The sentence mentioned by the reviewer begins the article, and introduces further literature review. Also, it is followed with reference to Shar at al., 2004 paper which has been quoted in the recent IPCC report.

However, we will rewrite this paragraph to avoid any confusions.

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2. "Warm air flowing ..." The sentence seems to be directly contradicting the Figure 1. With all my attempts, I could not find the hot air moving from Scandinavia towards the south (which sounds a bit peculiar by itself). Figure 1. Legend is missing. What wind? What temperature (2m, I guess?)? Wind scale? ...

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Reply:

The purpose of including Figure 1 was to demonstrate the development of the synoptic situation during the analyzed period. Of course, the figure does not show the complex 3D structure of air masses advection described in the sentence mentioned by the reviewer: "Warm air [from over North Africa] flowing on the western edge of the high pressure cell [established over Ukraine] turned to the south over Scandinavia, towards the Baltic Sea and Central European countries". The description of heat the 2006 wave case is based on daily reports from weather service as well as the analysis of available surface weather maps undertaken by authors, and hence contains much more information than could be derived from Figure.1.

The meteorological fields shown on Figure 1 are taken from the Canadian Meteorological Centre analysis. The following fields were used: surface temperature (at sigma = 1), sea level pressure and wind (given in knots) near the top of the boundary layer (sigma = 0.842).

Since the paper deals with air quality issues in the synoptic context rather than with

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the development of the heat wave phenomenon, we consider removing Figure 1 and keeping only the description of meteorological situation.

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3. Figure 2 does not seem to be necessary.

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Reply:

Global models are not commonly used in regional air quality applications. Figure 2 represents the setup of the global variable resolution grid used in this study and demonstrates the spatial extent of the high resolution (˜15 km) core sub domain. At the same time the figure shows the location on the computational equator and the poles. The reader can appreciate that the entire European continent, North Africa and a large part of the Atlantic Ocean are within the uniform resolution sub domain of the global grid. Thus, it is our position that Figure 2 is necessary.

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4. The chemical scheme outline is entirely non-informative. At the very least the main groups of species considered must be named. A proper reference would be very good here. This would also partly eliminate the ambiguity about VOC disaggregation, which is mentioned but left unexplained.

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Reply:

The gas-phase chemistry mechanism currently used in the GEM-AQ model is based on a modification of version two of the Acid Deposition and Oxidants Model (ADOM) (Venkatram et al., 1988), derived from the condensed mechanism of Lurmann et al. (1986). The ADOM-II mechanism comprises 47 species, 98 chemical reactions and 16 photolysis reactions. In order to account for background tropospheric chemistry, 4

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species (CH3 OOH, CH3OH, CH3O2 and CH3CO3H) and 22 reactions were added. All species are solved using a mass-conserving implicit time stepping discretization, with the solution obtained using Newton's method. A comprehensive description of the GEM-AQ model is given in Kaminski et al., 2007 (GEM-AQ, an on-line global multiscale chemical weather system: model description and evaluation of gas phase chemistry processes. J. W. Kaminski, L. Neary, J. Struzewska, J. C. McConnell, A. Lupu, J. Jarosz, K. Toyota, S. L. Gong, J. Cote , X. Liu, K. Chance, and A. Richter. Accepted for publication in ACPD, October 2007).

We will include these references in the final version of the paper.

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5. Model evaluation. I appreciated very much the multi-dimensional evaluation: meteorology, surface concentrations, and vertical profiles. However, the authors seemingly missed a very interesting item: the model shows 2-3 times too slow wind speed and still is nearly perfect with chemical species! The only explanation I can imagine is that the episode was not sensitive to the transport, all the stuff was produced locally. But was that really so? Or, the model is "right for wrong reason"? Again, I appreciate very much the honest demonstration of all the results but the striking difference between the supposedly strongly linked parameters really deserves discussion.

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Reply:

This remark is difficult to understand - plausibly the reviewer commented on the first version of the manuscript where plots showing vertical profiles of meteorological parameters were generated for wrong periods. This was corrected before the official, on-line, release of the manuscript.

As mentioned in section 4.3, vertical profiles of meteorological parameters were shown for July 5th and 12th (although we did get better agreement for other days) to interpret

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vertical ozone distribution available for days shown.

The ozone concentrations measured in Legionowo were not "nearly perfect" for these days and the discrepancies between modeled and measured values were explained as follows:

"On 5 July the model overestimates ozone partial pressure below 800 hPa of about 1mPa. This corresponds to 10 ppb near the surface, which agrees with analysis of surface measurements for the Legionowo station for that day. [...] The modeled ABL being too shallow is a plausible reason for the ozone overestimation within ABL for that day. The effect of accumulation was enhanced by the underestimated wind speed."

[...]

"On 12 July the model underestimated the ozone partial pressure within the boundary layer (below 700 hPa) by 1mPa (˜10 ppb). [...] On 12 July the modelled temperature in the boundary layer was underestimated, and the temperature profile indicates a stable condition below 950 hPa. [...] Temperatures that were too low, weak vertical mixing and overestimated wind speed resulted in ozone underestimation within the boundary layer."

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6. Conclusions are much too long and repetitive. Cutting them by half would only improve the paper.

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Reply:

The Conclusions section itself is not "repetitive". However, some information presented in the Conclusions is a summary of previous sections. As the paper is relatively long - such a summary of the meteorological context, modelling tools, evaluation methods, and the list of analyzed indices can help the reader to follow the main conclusions.

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The impact of the 2006 heat wave on photochemical pollution is summarized with respect to geographical location. Moreover, the authors tried to identify mechanisms leading to elevated ozone levels. Such analysis was not provided in previous sections where the detailed description of the results was given.

However, the authors will follow the reviewer's suggestion and will make an attempt to shorten and clarify this section.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 10467, 2007.