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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling surface ozone during the 2003 heat wave in the UK" *by* M. Vieno et al.

Anonymous Referee #2

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General Comments

The paper describes the development and sensitivity of near surface ozone in the UK during the outstanding heat-wave in August 2003 using a regional chemistry transport model. A set of sensitivity experiments have been performed to analyse the impact of temperature, emissions, deposition and transport on the ozone concentrations over the south-west UK. The topic seems to be suited for ACP. This heat-wave episode has extensively been discussed with respect to climate change. Therefore, the paper could give some indications about air quality in a warmer climate and in addition on the impact of the uncertainties with respect to the poor knowledge about biogenic emissions. But there are some shortcomings in the manuscript.

In general:

- The results are discussed in chapter 4 and again in chapter 5. Maybe it is better to combine the chapters. - The authors should exploit their results more thoroughly at some points (see below) - The authors should be more specific in their conclusions. It is more a commonplace, that ozone is affected by meteorology, boundary conditions and chemistry (conclusions, p19524, line 10). It would be more interesting if there is anything to learn from the sensitivity studies with respect to ozone during heat waves or with respect to the expected effects of VOC or NOx emission reductions. - It is difficult to identify all the lines on the time-series plots with more than 3 lines (e.g. fig 7 – 11). The quality of these plots should be improved

Specific points

1) Chapter 4.1.1 and chapter 5: I don't agree with the authors that WRF simulates the temperature during the episode well enough. A fairly high correlation for the diurnal temperature cycle should be expected at least for fair weather conditions. The statements of the authors about the causes of the bias are not really convincing: Local effects seem not very likely in that magnitutde, when a similar bias appears for other sites (chapter 5, p19519, lines 6-7). Are there any indications about major flaws of the analysis during that period? And what would that mean to the reliability of the results presented? A cold bias of up to 5K surely has major consequences for the ozone budget. It will not only affect the chemical reaction rates and the biogenic emissions, as the authors present in their sensitivity study (fig. 7). In fact the too cold daily peak temperatures could be a major contributor to the isoprene deficit (fig. 10). The temperature bias will also strongly affect the boundary layer mixing by - increased stability during the night. - reduced boundary layer height including a too low downward mixing from the residual layer and the free troposphere - Maybe a to low convective activity in the model As the authors mention the sensitivity study with respect to a by 5K increased temperature in the EMEP model does not cover these more dynamical effects which have a major impact on the ozone budget in the PBL. The authors should comment on that. Would they still have reasonable agreement for ozone with correct temperature

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and dynamics (and correct isoprene and NOx)?

2) The issue of VOC vs. NOx limitation seems to play a major role with respect to the ozone sensitivity. It could help to put the findings in a more conclusive frame with respect to sensitivity and uncertainties.

3) Chapter 4.1.2 page 19516, line 3-4 and again chapter 5, p19524, line 7-9: "The August episode is not exceptional. . ." The episode is exceptional with respect to peak temperature, why not with ozone? What are possible reasons for such behavior? What is missing during the August episode or the other way round what are the conditions during other episodes that a similar level of ozone is reached although not always having such high temperatures?

4) The authors show, that advection has the largest impact on ozone over the UK. But they give too little information about the surrounding area. What is the coarse Domain extension and size? Are the major emission regions upwind well captured? From where is the advected ozone in the UK?

5) 4.1.2 Surface ozone: Does the model describe the annual cycle of ozone realistically? It seems as if the models underestimates the wintertime concentrations on many days and overestimates moderate summertime conditions.

6) Figure 3: Is there an explanation why the observed peak concentrations are highest at the intermediate site Writtle and the model shows an opposite behaviour comparing the 3 sites? What are the local characteristics of the Writtle site? The local conditions seem to be important as shown in chapter 5 (p19522, 1st paragraph).

7) Figure 4: Is there an explanation for the low slope in the linear regression? The model seems to underestimate most of the higher concentrations.

8) Chapter 4.2 first paragraph and figure 7 The authors should discuss the day-to-day variability of the temperature sensitivity

9) Chapter 4.2 3rd paragraph and figure 9: What is the effect of the +5K temperature

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experiment on the isoprene concentration? How much of the missing isoprene could be explained by the temperature bias?

10) Figure 11 and 12: the extremely high sensitivity of ozone to a reduction of NOx and the very low sensitivity to other parameters emissions are caused the NOx plume in the base case simulation on this day which destroys ozone practically completely. No such behaviour can be seen in the observations. I doubt that the sensitivities given for that day are reliable for the real situation on that day. To some degree this may also apply for other days with over- or underestimation of NOx.

11) Chapter 4.2, last paragraph, Table 1: What is your ordering criterion for the table? Why don't you make any use of the information presented there?

12) Chapter 5. p 19520, line 23 and figure 16: The fact that there is a vertical gradient in isoprene is not surprising. In addition, there are way too many lines do distinguish. If at all the plot is necessary, you should plot vertical for noon time. Which would at least give some idea about boundary layer height on the different days, which is a very important parameter with respect to chemistry an mixing, but completely missing in the paper.

Minor point

13) Abstract: I suggest using the word isoprene instead of C5H8 as in the rest of the paper. C5H8 could also belong to other chemical compounds.

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