

Interactive comment on “The January 2006 low ozone event over the UK” by M. Keil et al.

M. Keil et al.

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Referee 1

The authors would like to thank the referee for the thorough assessment of this paper. As a consequence many improvements have been made to a revised version of this paper.

General comments

This paper presents a case study of the low-ozone event over the UK and investigates it from a number of perspectives. The scope and boundaries of this paper were not adequately presented to readers, particularly in the introduction to the paper. As a result criticism has been made, quite rightly, that there is an apparent weakness in the chemical analysis in this case-study. However, we would like to point out that a full chemical analysis was not within the scope of this paper and we were approaching this study from a meteorological and dynamical view point (this issue is discussed at

length in the response to reviewer 3). In order to correct this we have re-written and re-structured the introduction to this paper. In addition, significant adjustments have been made to the sections on NAMEIII and the conclusions to reflect the scope of the paper and to aid clarity.

There were potentially additional features within the NAMEIII system that could add to a chemical study of this event, such as producing temperature records for the thousands of back trajectories that were released. However, as NAMEIII was being run for the very first time for stratospheric purposes we primarily relied on the results from the core functionality of the system which was to produce air history maps which complemented our other dynamical analyses contained within the paper. Further comments on the use of the NAMEIII system are made below in response to specific points.

The clarity and brevity of this paper have been improved. Many of the changes have been outlined below in the specific points. The description of the ozone mini-hole process has been improved and further links with the whole troposphere, rather than just the UTLS region, have been made. As a consequence of the changes this paper has become a more focused case study which highlights the important role of the dynamics of the situation and illustrates how an atmospheric dispersion model, which usually focuses on the troposphere, can be applied to the stratosphere.

Response to the remarks

The results from the Koch et al. (2005) paper are summarised in the restructured Introduction section.

Specific comments

p8459, I3-4: - We have changed the text to "This would suggest there is also a tropospheric mechanism for the ozone minima."

-, I12: - This has been modified

p8460, I13: - This has been corrected

-, I14:- The text here has been changed to clarify what the aim of the paper is, and what the NAME III model is used to do.

p8461, I8 (and I10): The text has been modified slightly to make this more definitive.

-, I10:- The Dobson instrument has been used largely unchanged since the 1940s or early 1950s, so the 1980 reference quoted is still valid. The reference for the Brewer instrument is more recent because the instrument is more modern than the Dobson.

-, I24:- the text has been altered to clarify this sentence.

- References to Fig.1 have been changed in the text to Fig. 1 (upper panel and Fig. 1 (lower panel) for additional clarity.

p8462, I9:- Done.

-, I13 (and I20-22):- These two paragraphs made been modified and the discussion made clearer. More reference to the values of total ozone in Fig. 2 has been made when defining the "low ozone area".

-, I17:- We used geopotential height at 46 hPa and Ertel's potential vorticity at 520 K. This has been added to the text.

-, I20-22:- see response for I13, above.

p8463, I12-13:- Done. The discussion in this paragraph has also been shortened somewhat.

-, I17-22:- We have supplied more details about the ozone column calculations.

p8464, I4-6:- Agreed. The text in the first 2 paragraphs of Section 3 has been rearranged to aid the clarity of the discussion.

-,I19:- The threshold has been added to the text.

-,I21-22:- Details on the upper PSC altitude detected by Sciamachy are given by von Savigny et al (2005). Unfortunately, no data for January are shown in this paper, but the

paper does show that the upper PSC altitude drops from around 23 to 15 km between July and September, and that this altitude is well correlated with the lower stratospheric temperature minimum.

-, I29:- This sentence has now been deleted and the structure of this paragraph changed slightly in order to improve the discussion.

-, I29 and p8465, I3:- The sentence on I29 has now been deleted anyway (see comment above). We take the referee's point regarding the text on p8465, I3, but we believe our expression is concise and easily understandable to the reader.

Fig 5:- This is good idea but not possible within the time available. The figures on the web site are readily accessible and so it is easy for the reader to quickly download the PSC maps to compare with Figure 5.

p8465, I18:- Agreed. We have deleted "possible" from the text.

-, I23, -, I29, p8466, I1: We have corrected the reference to Fig. 6, and added the references to Figs 2 and 6, as requested.

p8467, I19:- No. The text in this section has been changed to clarify the explanation.

-, I23-24:- We have deleted this text, since it is unclear and unnecessary.

-, I28:- The text has been modified to explain how the time-integrated air concentration is calculated.

Estimating the amount of ozone at the receptor, as the referee suggests, is in principle possible, but this approach would introduce potential errors, which would be hard to quantify. These include: errors in the initialisation of the particles and errors due to the absence of ozone chemical changes, since the NAME model does not include any representation of ozone chemistry. Therefore, it may be possible to estimate ozone amounts using the NAME model in future studies, but the complexity of the task means that it is beyond the scope of the current study.

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p8468, l1: "ring" has been changed to "area".

-, l6-7:- No, we mean air that has passed through the 15-30 km layer on its way to the receptor. The text has been altered to clarify this point.

-, l8-12:- The text has been made clearer, both in this paragraph and adjacent ones.

-, l13:- Again, the text has been changed to clarify what we mean.

-, l15-16:- We agree - Figure 9 shows that the trajectories follow the jetstream, as the referee states. We have altered the text to clarify our point - namely that close to the receptor the trajectories follow an anticyclonic path.

-, l19:- Again, the text has been changed to clarify our point.

-, l25:- This has been addressed by removing "UTLS" from the text.

p8469, l14:- "within" has been changed to "beneath"

p8470, l6-7:- We think that this sentence aids the clarity of the paper and so it is unaltered.

-, l9-10:- Given that thousands of particles are calculated here, this is a large task. It could be possible, but we believe it is outside the scope of this paper.

-, l14:- Yes. We agree. Here, we are saying that the path the particles take close to the receptor is anticyclonic. This point has already been clarified via our response to comments at p8469, l15-16 and p8469, l19.

-, l16:- Here, we are talking only about the "synoptic-scale" ozone reductions. These are discussed in Section 2, in our examination of total ozone patterns in Figure 2. These are separate from the larger scale ozone reduction (also discussed in Section 2 and elsewhere), which is related to stratospheric ozone depletion.

-, l18:- Agreed. "UTLS" has been removed from the text.

-, l19-29:- We feel that this paragraph connects the study to the wider issue of why

low ozone events over Europe can be important to the general public and not just to scientists. Therefore we have left it in.

Fig 3:- We are happy to leave the description of the figure in the caption.

Fig 5:- No. See previous comment.

Fig 7:- The text has been altered in section 4 to clarify what is shown in Figures 7-10. This clarifies that Figures 8-10 are not merely subsets of Figure 7 and that we do not mean 5-30 km.

Figs 8-10:- we have changed "originating" to "originating from or passing through"

Fig 10:- The changed projection is the best way of showing the results we wish to discuss. A combined Fig 10 and 9 would look a mess.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 8457, 2006.

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