

Interactive comment on “Early unusual ozone loss during the Arctic winter 2002/2003 compare dto other winters” by F. Goutail et al.

Anonymous Referee #1

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General Comments

This paper describes the calculation of chemical ozone loss in the Arctic winter 2002–03, based on SAOZ measurements and 3-D CTM calculations. The main subject is the description of the very early ozone loss in 2002–03 derived using measurements and 3-D CTM calculations on the one hand, and on the other hand, from 3-D CTM calculations. Further, a comparison of ozone loss in 11 winters in given.

Chemical ozone loss in winter 2002–03 was already discussed in literature using different measurements, methods and model analysis. Thus, a publication of results of SAOZ measurements is in time as well as a summary over the 11 years. However, a comparison with results using different measurements and methods would be interest-

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ing.

In Section 5, Fig. 4 is discussed. SAOZ results are shown as well as REPROBUS and SLIMCAT results. I would suggest to interchange Section 5 and 6. Then, the authors would finish the discussion of the winter 2002–03 and afterwards compare with the results of other winters and additionally, with different measurement results.

The paper is well written. In some paragraphs it is too short, see specific comments. In general the discussion of the uncertainty of results is missing as well as the comparison with different published results. After an enhancement of the paper concerning the comments, it can be recommended for publication in ACP.

Specific Comments

The abstract could do with some more specific information. It should be mentioned that the authors use the REPROBUS model for the eleven years, and that SLIMCAT and REPROBUS results are compared for the winter 2002–03. Further, it should be clearly stated, that ozone loss is estimated inside the poleward boundary of the polar vortex and that it is an average over 7 stations. Uncertainty ranges of the results are missing. Could the authors emphasis more clearly, why ozone loss is unusual in this winter.

Section 3: Page 5022, line 16. 'the edge of the vortex', How is the edge defined?

Page 5023, line 13-16: 'Consistently with the meteorology, the loss started very early (Fig 2, bottom), during December, a 10 % total column ozone reduction' The scatter of ozone loss within one station and within all stations considered are quite large (up to 15 % at the beginning of January for Sodankyla, and at the beginning of February for Thule). How is this possible? At the beginning of December 2002, ozone loss of up to 5 % is obvious, considering Sodankyla (Fig.2, bottom panel, red open circles), at a time when no ozone loss should have been occurred (as shown in Fig.6). Is

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there maybe an offset that wrongly increases accumulated ozone loss? Further, at the beginning of January 2003, a decrease of the 10-day average measured total ozone reduction (increase of the black line from -12 percent to -10 percent) is obvious in Fig.2 bottom panel. In considering accumulated ozone loss, what does this decrease mean? Looking at Fig.2 bottom panel, it is hardly possible to derive the exact time, at which time 10 percent ozone loss were reached using these results, owing to the strong scatter. Would an average of less days change the results? The uncertainty of the total column ozone reduction and of the average rate per day should be added.

Section 5.

‘While during most of the winters, the loss begins in January or eventually in mid-December like in 1995/96, in 2002/2003, it started very early in December in coincidence with very low stratospheric temperatures.’

This paragraph could be enhanced with regard to the following issues. What about 1997–98 and 2003/2004? In these years, ozone loss starts very early, derived by SAOZ/REPROBUS (Fig 4). Further, in 1994/95 temperatures are very low in December as well, and in 1999/2000 in the second half of December. However, with SAOZ much less ozone loss is calculated.

Next paragraph: The comparison between SAOZ/REPROBUS results and model results should be extended to all winters considered. Here, only 1994/1995 and 1995/1996 are discussed.

Why is ozone loss in 1994/1995 and 1995/1996 still not reproduced by REPROBUS and SLIMCAT although ‘improvements have evidently been made in the two 3-D CTMs’? By the way, in 1994/1995, strongest ozone loss was calculated in this study, however other published results do not agree with this result.

The range of uncertainty of all winters should be added.

Section 6.1: First paragraph. In Fig.5, at the beginning of December, an offset of about

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3 percent ozone loss is obvious (all symbols scatter below zero). This may influence the result.

Third paragraph: '..., but HCl was completely depleted', at which altitude?

Fig. 6: In December 25, ozone depletion occurs at the vortex boundary of 5-10 % in 475 K and less in 550 K. It would be interesting to calculate an entire vortex average, that is certainly less than 5 % in 475 K and much less than 5 % in 550 K. Would this mean that the results of this study depend on the location of measurement stations?

Section 6.2 last paragraph:

In Appendix A and B, two models are described in detail, but during the discussion of different results, I cannot find a reference concerning the difference between these models. Which differences can be seen in the results? Some more discussion about this issue should be added in this section and in Section 5.

Conclusions: 'An unusually early ozone loss was observed in 2002/2003, at least one month earlier than during any of the previous eleven winters'

It is not 'at least' one month earlier (see 1997–98 and 2003/2004).

last sentence: There is not indication that ozone loss has taken place without illumination of the vortex in this paper. What is meant by 'low sun?'.

Minor comments

Section 6.2 'At the end of the winter, the cumulative losses 20 %.' In Fig.7 it seems to be 19 %.

Fig. 5.: error bar is missing

Fig. 6.: scales of the figure cannot be read at all

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