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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Chemical ozone loss in Arctic and Antarctic polar winter/spring season derived from SCIAMACHY limb measurements 2002–2009" *by* T. Sonkaew et al.

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Chemical ozone loss in the polar vortex in both hemispheres is derived based on SCIAMACHY satellite data using the vortex average approach. This paper investigates 7 winters between 2002 and 2009. Results from the vortex average approach in this study are compared to results form other studies for the Arctic winter 2005. The paper as currently presented leaves many open questions with regard to the performance of the method, as well as the purpose of some analysis of this study. Therefore I recommend a major revision of this paper before it should be considered for the publication in ACP.

1. The Method: It is not clear from this paper how ozone loss derived here is reasonable in comparison to results from other studies in Arctic and Antarctica. All we learned is that the method results in reasonable ozone loss values in March 2005.

2. Various references to other studies are missing.

3. Scientific purpose of the results shown in Figures13 and 14 is not clear.

Specific Comments:

Introduction:

Line 9: Processes that cause in Arctic and Antarctic ozone loss are for the most part understood, but there are still uncertainties that need to be investigated. For example models are not able to reproduce chemical ozone depletion (see SPARC 2010, Chapter 6 and references therein).

Line 13: Antarctic ozone loss was shown to cover a range of 350-600 K, as for example discussed in Tilmes et al., 2006 (JGR)).

Line 19. There are certainly more studies that could be added, see WMO 2006, Chapter 4.1.2.2 and references therein.

Section 2.1: Is SCIAMACHY ozone evaluated against other independent observations? Explain the vertical coverage of the instrument here and why ozone loss is only derived between 450 and 600K and not further down.

Section 3:

The area of the polar vortex is often defined using equivalent latitudes, as for example described in Mueller et al., 2008, and references therein. Consider plotting Figures 1 and 2 with regard to equivalent latitudes and discuss how your definition compared to the one given in Mueller et al., 2008. Figure 4 could be also plotted with regard to equivalent latitudes.

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Section 4:

Page 6564: The calculation of the ozone changes due to vertical transport is the main factor that controls the amount of ozone loss in this study. Therefore it is very important to understand whether this calculation is valid. To prove this, you might want to consider looking at a long-lived tracer in the lower stratosphere (like N2O) and apply your method. If your radiative heating calculation is correct, the derived change of N2O should be in agreement with the observed. In this way, you might be able to estimate the uncertainty of this calculation.

Figure 3: Instead of the error bars, shading might help to illustrate the uncertainty of the distribution

Page 6565: line 4: change 'seasons' to 'years'

Line 11: what does 'first spike' mean?

Describe how you determine the standard deviations in Figure 3, a and b, and what they mean. Also, the lines in panel b are hard to read. Consider limiting y-axis range.

Page 6566: Line 6ff. This comment goes back to the early comment about the performance of the method to derive chemical ozone loss. The resulting chemical loss is very variable and Figure 3,d. Vortex average ozone loss is expected to not decrease during the ozone loss season, because there is no production expected and vortex internal mixing process are not significant. What causes this variability? Are there problems in deriving the amount of decent of the vortex?

Further, to derive the ozone loss, how do you justify that a linear fit is reasonable over three months? Ozone loss rates accelerate with increasing sunlight spring. Ozone loss rates can be for example given for single months.

Line 20. How do you justify the large ozone loss values in 2009? Did the polar vortex move towards low latitudes receiving more sunlight in early winter? This is however not very obvious from Figure 1, bottom panel. Are there other studies showing this? It is

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not enough for ozone depletion to have cold conditions in early winter, you also need some sunlight to start the catalytic cycles.

Line 25: please add at the 475 K potential temperature level.

Page 6566: How do your results compare to earlier studies for other years than 2005 (for example studies mentioned in the WMO report, as well as Kuttippurath et al., 2010, Harris et al., 2010, Tilmes et al., 2004 for the first two years considered).

Page 6567: Line2-8: Winters with high ozone loss 05,07, and 08, and not consecutive years.... It is not clear what the authors mean here.

Section 4.2: Can you add a comparison of your results to early studies? Antarctic ozone loss was comprehensively discussed for the winter 2003 in Tilmes et al., 2006, using ILAS satellite observations. Huck et al, 2006, performed a multi-year analysis of ozone loss over Antarctica. There are other studies as well.

Section 5: As mentioned above, add comparisons looking at other winters in Arctic and Antarctica as well.

Figure 7, and corresponding text as well as Figure 13 and 14 and the Discussion:

The authors calculate the O3 mass loss and the daily mean of the vortex volume. These two measures do not correlate very well, considering both Arctic and Antarctica. What is the point the authors trying to make here? Also, in Figure 13, a relationship between PSC occurrence rate for February and ozone loss seems not to make much sense, since ozone loss till April is accumulated over the entire winter. Do you suggest, that only the PSC occurrence in February matters for the chemical ozone loss in the entire winter? How do you justify this? There are many studies showing significant ozone loss in the early winter (in January).

Rex et al., 2006, Harris et al., 2010, discuss the relationship between O3loss and the volume, where PSC potentially exists. Also, Tilmes et al, 2006b, introduced a correlation between O3loss to a PSC formation potential (however only till 2005), which

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describes the fraction of the vortex that is potentially covered. There, also the volume of the vortex for different winters was calculated.

The authors might consider correlating the PSC occurrence rate in this paper for the entire season, with the PSC volume derived in the studies mentioned above.

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