

## GENERAL COMMENTS

This manuscript presents the ozone loss and an ozone mini-hole-like event in the Arctic winter 2010/2011 and compare with the ozone loss occurred in previous Arctic winters, the winter 2009/2010 in particular. The authors use several satellite and ground measurements for their study. The content of the manuscript is suitable to publish in ACP. However, the manuscript needs a careful revision before it can be accepted.

## MAJOR COMMENTS

Most of your discussion is based on the Arctic winters 2010/2011 and 2009/2010. Therefore, the broad title on the comparison is not appropriate. You can use something like "Chemical ozone loss and ozone mini-hole event during the Arctic winter 2010/2011". You also need to clearly state the focus of this study; Arctic ozone loss or the ozone mini-hole event? You could dedicate two separate sections for these (e.g. Introduction, data and method, Arctic ozone loss in 2011, Ozone mini-hole event in January 2011, and conclusions) instead of the subsections (e.g. Section 3.8).

Since this is a scientific manuscript, you could avoid the history of satellite launching or preparation things. In addition, there are several publications on SCIAMACHY and GOME observations. Therefore, Sections 2 and 3 can be cut short substantially with relevant validation references and by removing the figures 3 and 4. Describe only what it matters here (your data processing for this study). The figures 3 and 4 do not give any additional information about the chemical ozone loss. Furthermore, it is strange to describe the meteorological situation of the winters with ozone maps (instead of temperature or potential vorticity maps). On the other hand, Hurwitz et al. (2011) and Kuttippurath et al. (2012) have given detailed descriptions of the dynamics of these winters. You need to cite these publications here.

Section 3.5.1: This section explains that there are large differences between modeled and measured trace gases presented in the manuscript. The differences are not well explained too. Although the link between these trace gases and ozone loss is well known, the link is missing in the text. Since you can explain the ozone loss process and its relation to the species with measurements, you do not need this section at all, as it raises more questions.

Section 3.7: Compare the timing and extent of chlorine activation with other published results for this winter.

Section 3.8: In this section you state that (a) the size of OMH was atypically large, (b) its direction was opposite to what was observed previously, (c) was not associated with large tropopause elevations, (d) and its life cycle was unusually large (more than 10 days or so). In addition, at some places you use "OMH-like situation" (e.g. page 16632, 16633), but in other places, including conclusions, you use OMH (e.g. page 16636). In general, all these statements are strong enough to refute the event to be called an OMH. Therefore, please make your arguments stronger to establish the low ozone episode was an OMH (if this is your point).

Page 16600, lines 1, 2: There are two significant publications on ozone loss in 2010. They should be cited and discussed (Kuttippurath et al. 2010, Wohltmann et al. 2013).

Wohltmann, I., Wegner, T., Müller, R., Lehmann, R., Rex, M., Manney, G. L., Santee, M. L., Bernath, P., Sumińska-Ebersoldt, O., Stroh, F., von Hobe, M., Volk, C. M., Hösen, E., Ravegnani, F., Ulanovsky, A., and Yushkov, V.: Uncertainties in modelling heterogeneous chemistry and Arctic ozone depletion in the winter 2009/2010, *Atmos. Chem. Phys.*, 13, 3909-3929, doi:10.5194/acp-13-3909-2013, 2013.

Kuttippurath, J., Godin-Beekmann, S., Lefèvre, F., and Goutail, F.: Spatial, temporal, and vertical variability of polar stratospheric ozone loss in the Arctic winters 2004/2005–2009/2010, *Atmos. Chem. Phys.*, 10, 9915-9930, doi:10.5194/acp-10-9915-2010, 2010.

Page 16608, line 11: Any reason for selecting this particular value as vortex edge?

Page 16610, line 9: Area weighted average: the area of each grid box divides the ozone values here?

Page 16610, line 22: I do not see thirty years of data here. It is only for the period 1995–2011.

Page 16611, lines 7–9: If you would like to discuss the large variability of Arctic ozone loss, then there are better examples (instead of 2009/2010) such as winters 1998/1999, 2000/2001, 2001/2002, 2003/2004, and 2005/2006. Perhaps, you wanted to discuss the most recent winters?

Page 16615, lines 19–24: This has already been demonstrated for a range of Arctic winters in Kuttippurath et al. (2010).

Page 16616, para1: Compare your ozone loss estimates with other published results for this winter (2010/2011). Your comparison is not complete here, as there are also other published studies for this winter.

Page 16620, line 4: What is the reason to compare it only to this particular study here? This is not mentioned/justified here. Please note that there are many published works dealing with modeling of ozone loss for the winters 2005 and 2011.

Page 16620, lines 8-14: What about the dynamics/radiation scheme in the model? You mean the chlorine activation in the model is not comparable to measurements? A recent study by Wohltmann et al. (2013) state that the maximum difference of simulated ozone loss from various scenarios, including the differences in PSC and denitrification schemes, is about 10%. It is worth mentioning here if the differences are also within the same range.

Page 16620, lines 15-18: Does that mean model dynamics has no role if the LINOZ is used in the model?

Page 16620, lines 19-21: How does the chemistry affect your tracer simulations?

Page 16621: lines 13–14: Yes, due to the major warming.

Page 16623, line 1: Put “e.g.” before the citations.

Page 16623, line 6: There is only one final warming, not “a” final warming, but “the final warming”.

Page 16623, line 20: Not in “some winters”, but in cold winters.

Page 16623, line 22: “end of the observations”? State the precise time period.

Page 16625, lines 20—21: Arctic ozone hole? I thought it showed only signs of an ozone hole, not a well-defined one as in the case of the Antarctic ozone hole.

Page 16625, line 23: Hurwitz et al. (2011) discussed dynamics, not chemical ozone loss. Also, there are some other studies that discussed ozone loss in 2010/2011.

Page 16633, last paragraph before conclusions: These statements are too general. Please write something from your study here.

Page 16634, lines 18—20: Since you haven’t shown this (contribution of the chemical cycle to the ozone loss) in this manuscript, you need to cite appropriate references here.

Figure 2: What lines are min, mean, and max? Please make a good figure legend here to differentiate the lines.

Figure 3: I do not find any reason to include this figure, as it gives no additional information. If you are discussing dynamics, you could refer Hurwitz et al. (2011) and Kuttippurath et al. (2012).

Kuttippurath, J., Godin-Beekmann, S., Lefèvre, F., Nikulin, G., Santee, M. L., and Froidevaux, L.: Record-breaking ozone loss in the Arctic winter 2010/2011: comparison with 1996/1997, *Atmos. Chem. Phys.*, 12, 7073–7085, doi:10.5194/acp-12-7073-2012, 2012.

Figure 5: There was no well-defined vortex from March onwards in 2009/2010 (due to the major warming in early February). So you need to cut the data afterwards in March.

Figure 6: Please put the same scale/colorbar for comparison with Figures 5 and 8.

Figure 7: All dots are of the same size in these plots!

Figure 8: Please see the comment for Figure 5, and also use the same colorbar/scale for each plot as in Figure 5.

Figures 9, 10: Select the winters you would like to discuss and show plots for those winters only. It is slightly disturbing to have different winters for different plots.

## TECHNICAL CORRECTIONS

Please proof-read the manuscript before you submit as there are several corrections. I list some of them here.

Page 16599, line 13: Delete “see for example” and then write “e.g.”

Page 16608, line 12: Full stop after 80 N.

Page 16608, line 16: Better to use “similar conditions” instead of “equal conditions”.

Page 16608, line 23: Delete “slightly” (5—15% is mentioned and is not a “slight” increase).

Page 16609, line 8: Sander et al. 2006, not JPL/NASA.

Page 16609, line 16: “start in”

Page 16609, line 17: “to estimate the ozone loss”

Page 16614, line 6: Please re-write the sentence.

Page 16614, line 21: “a strong vortex less air from”?

Page 16618, line 9: “per second larger”

Page 16620, line 2: “slight underestimation”

Page 16620, lines 2-3: “modeled ozone loss” or “simulated ozone loss”, not “modeled induced ozone loss”.

Page 16621: lines 10-11: “total supply of PSCs”?

Page 16622, lines 10, 16: “information” not “informations”

Page 16623, line 1: (e.g. Manney et al., 2011, ...) as there are many analyses available for this winter.

Page 16625, lines 13—14, Use “prolonged” or a similar word, not “long-lasting”.

Page 16626, line 8, “dissipated” is better than “dissolved”

Page 16626, line 9: Delete “the” before 6 February.

Page 16629, line 1: vortex “slides”?

Page 16630, line 6: “it” did?

Page 16630, line 12: “onwards”

Page 16630, line 16”: “never slide”

Page 16632, lines 15, 19: delete “perfectly”

Page 16645, line 26: the year should be 2011.