

Interactive comment on “Polar processing in a split vortex: early winter Arctic ozone loss in 2012/13” by G. L. Manney et al.

Anonymous Referee #2

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Manney et al. present a study on the Arctic winter 2012/2013, a winter that was characterized by early winter polar processing and strong ozone loss resulting from the combination of unique dynamical conditions associated with a stratospheric warming in January 2013. Large ozone loss was observed during December and January, which was much larger than previously observed during these months. Nitric acid abundances were also among the lowest in the MLS record for the Arctic, indicating that the stratosphere has been denitrified. ClO enhancement during this winter was also much greater than in any other Arctic winter observed by MLS. This shows that this winter was indeed one of the unique winters during the past decade. This study is very interesting and deserves to be published in ACP. I only have the following suggestions for (minor) revisions which should be considered before publication:

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Specific comments:

Title: You mention ozone loss, but in fact many more processes than just ozone loss during this winter are analyzed (denitrification, chlorine activation etc.). So, I would suggest to change the title slightly to point this out more clearly.

Abstract: In my opinion, the abstract is too long and too detailed and could be shortened to make it more concise. It takes too long until the authors come to the point why their study is of importance. I wasn't aware that this winter was so special and was quite confused why this winter was analyzed until I reached the end of the abstract. I would suggest to move these sentences higher up, so that they occur rather at the begin of the abstract than at the end.

P4974, L6: Please give a temperature for the chlorine activation threshold.

P4974, L8: That would mean that the vortex was located quite far in the south. Can you be more precise? Where exactly was the vortex located. How far south did the vortex reach?

P4974, L9-10: In case of MLS first the long name is given and then the abbreviation. In case of CALIPSO it is vice versa. I would suggest to do this consistently throughout the paper, either first the abbreviation and then the long name or vice versa.

P4974, L21: Is 4 ppbv much? Does that mean it was a strong denitrification. I would suggest to point out more clearly what this means.

P4974, L1-26: As mentioned above, reading the first paragraph of the abstract without being aware how special this winter was, I did not understand it and was wondering why this study was performed. Of course, I realized that there must have

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been something special, but I wasn't sure what. The questions that came up in my mind was: What is so special with this winter? Was it the split, the unusual long exposure of the vortex to sunlight or the high chlorine activation?

P4974, L28: Please add the CALIPSO observation period.

P4975, L24-31: As mentioned above I would suggest to move these sentences up.

P4975, L26: I would appreciate if also other publications discussing Arctic ozone loss during the 2010/2011 winter would be cited, as e.g. the publications by Sinnhuber et al. (2011), Kuttipurath et al. (2012), Arnone et al. (2012), Hommel et al. (2014).

P4977, L24: Same comment as above; first the abbreviation or the long name?

P4978, L10-11: First the abbreviation and then the long name or vice versa as mentioned above.

P4978, L10: Is the usage of the abbreviation G591 for the GEOS data really necessary? I would suggest to just call it GEOS or GEOS-5 (or even GEOS-591 if you prefer to use the version number).

P4979, L1-2: The link to the web page could be given as footnote.

P4981, L16: see my comment on page/line P4978, L10.

P4982, L7: As mentioned in one of my previous comment other studies showing the severe ozone loss during the Arctic winter 2010/2011 deserve to be cited as well. Especially, it would be worth to mention the most recent ones as e.g. Hommel et

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al. (2014) since they usually cite all earlier papers dealing with this winter.

P4982, L28: The study by Achtert and Tesche (2014) published in JGR should be cited here as well.

P4983-4984: This may be a matter of taste, but I am not very fond of introducing and using too many abbreviations. I do not see any benefit of the abbreviations DMP and LTD, especially since e.g. DMP occurs in the text only twice and LTD only four times.

P4985, L14-15: "an animation covering....." I would suggest to put this sentence either in brackets or in a footnote.

P4989, L25 and P4990, L1: As stated above, I am not fond of too many abbreviations. Is the abbreviation VTC really necessary and useful?

Section 4: In this section the many different gases and chemical processes are discussed. Wouldn't it be possible to divide this section into subsections to make this section more clearly represented?

P4997, L22: What trajectory methods?

P4997, L25: What is the abbreviation "RT" standing for? Maybe you introduced it already somewhere in text earlier, but until I came to this paragraph I already have forgotten what it was standing for.

P5000, L17: The SSW is the cause for the vortex split. This should be clearly stated.

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P5000, L21: see my comment on page/line P4978, L10.

P5002, L17: Please add the MLS observation period considered in this study.

Technical corrections:

P4994, L 9 and 10: Add “N” so that it reads 60°N and 50°N, respectively.

Figure 12 caption: Shouldn't it rather read “for the other Arctic winters...” than “for the other years...”?

References:

Achtert, P., and M. Tesche (2014), Assessing lidar-based classification schemes for polar stratospheric clouds based on 16 years of measurements at Esrange, Sweden, *J. Geophys. Res. Atmos.*, 119, 1386–1405, doi:10.1002/2013JD020355.

Arnone, E., Castelli, E., Papandrea, E., Carlotti, M., and Dinelli, B. M.: Extreme ozone depletion in the 2010–2011 Arctic winter stratosphere as observed by MIPAS/ENVISAT using a 2-D tomographic approach, *Atmos. Chem. Phys.*, 12, 9149-9165, doi:10.5194/acp-12-9149-2012, 2012.

Hommel, R., Eichmann, K.-U., Aschmann, J., Bramstedt, K., Weber, M., von Savigny, C., Richter, A., Rozanov, A., Wittrock, F., Khosrawi, F., Bauer, R., and Burrows, J. P.: Chemical ozone loss and ozone mini-hole event during the Arctic winter 2010/2011 as observed by SCIAMACHY and GOME-2, *Atmos. Chem. Phys.*, 14, 3247-3276, doi:10.5194/acp-14-3247-2014, 2014.

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-

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12-7073-2012, 2012.

Sinnhuber, B.-M., G. Stiller, R. Ruhnke, T. von Clarmann, S. Kellmann, and J. Aschmann (2011), Arctic winter 2010/2011 at the brink of an ozone hole, *Geophys. Res. Lett.*, 38, L24814, doi:10.1029/2011GL049784.

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