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Atmospheric Chemistry and Physics Discussions

Interactive comment on "How sensitive is the recovery of stratospheric ozone to changes in concentrations of very short lived bromocarbons?" *by* X. Yang et al.

Anonymous Referee #2

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This study investigates the sensitivity of stratospheric ozone to bromine from very short lived source gases (VSLS) under different levels of the stratospheric chlorine and bromine loading. It is based on a set of idealized time slice calculations with a chemistry climate model to represent possible future bromine and chlorine levels. This study addresses an important topic and should be published in ACP after consideration of the following, mostly minor, points. The manuscript is generally well written and I have only a few suggestions for improving the language.

General comments

1. There are previous studies that have investigated the impact of additional bromine from VSLS on stratospheric ozone that need to be cited here. Salawitch et al., GRL, 2005 (doi:10.1029/2004GL021504) have investigated the impact of VSLS on past ozone trends and Feng et al., ACP, 2007 (www.atmos-chem-phys.net/7/2357/2007/) have give the calculated change in mid-latitude total ozone for an increase of VSLS of 5ppt that can be directly compared to the current study.

2. Salawitch et al. (2005) and Sinnhuber et al. (2009) have noted that the impact of VSLS on stratospheric ozone is particularly strong in the presence of enhanced aerosol loading. This study uses year 2000 conditions, that may represent a grand minimum in the stratospheric aerosol loading (e.g. Solomon et al., Science, 2011). I would recommend to include at least a discussion or caveat, how the aerosol loading may effect the results of this study.

3. As the authors rightly say, we have very little understanding at present if or how the emission of VSLS may change in the coming decades. In this respect the finding of a 7 year delay in the recovery of the ozone hole for a 5ppt increase in bromine from VSLS has to be treated just as a sensitivity calculation. However, the chemistry climate models reported in WMO (2011) when following the REF-B2 specifications did not consider bromine from VSLS. So you could probably make the much stronger statement here, that considering VSLS with a likely present day contribution of about 5ppt will lead to a delay of the projected ozone hole recovery by about 7 years relative to previous estimates.

4. The results show the largest impact in the SH high latitude lowermost stratosphere, likely related to the Antarctic ozone hole. But why are Figs. 1 to 3 restricted to annual means only? If possible it may be worth showing also October for SH and March for NH in Figs. 1 and 2, or showing the total ozone changes in Fig. 3 as a function of latitude and season.

Specific comments

p.9730, l.2: "like bromocarbons": the bromine containing VSLS are all bromocarbons, so the phrase should be changed accordingly

p.9730, l.20: "inorganic chlorine is the dominant halogen compound". What do you mean here? Ozone loss is dominated by chlorine? What about mixed bromine/chlorine cycles, how to attribute these? Bromine increases the importance of chlorine, but without chlorine, bromine is less effective...

p.9730, l.21: "recovery of anthropogenic chlorine". I suggest to better say "decrease of anthropogenic chlorine"

p.9731, l.25: I find it slightly odd to call the remaining 80% the "remainder".

p.9731, l.27: Reference for pre-industrial VSLS contribution?

p.9732, l.17: natural halogens will not respond to the Montreal Protocol. Better say "... may change in the future".

p.9732, l.22: I could not find a statement on a possible increase of 2-3ppt of bromine in Hossaini et al. (2012). They do show a change in source gas injection of about 1ppt of bromine for RCP 8.5. However, Hossaini et al. (2012) do not consider changes in product gas injection, which may counteract the increase in source gas injection (e.g., see the recent paper by Liang et al., ACP, 2014, doi:10.5194/acp-14-5781-2014).

p.9732, l.25: Strictly speaking, the value of 60 is valid for global mean total ozone. In the lower stratosphere the efficiency of bromine relative to chlorine is even larger than the factor 60 (see Sinnhuber et al., 2009).

p.9733, l.4: sentence hard to read. please rephrase.

p.9735, l.23: Near the tropical tropopause the ozone response to VSLS seems to be largely independent of the chlorine loading, which makes sense as inorganic chlorine is very low there. This impact on tropical ozone may be worth discussing in a bit more detail. Can you put these 2-4% changes due to VSLS into context of other projected

changes? I.e., do VSLS play an important role for tropical ozone, or is this of minor importance?

p.9738, l.15: Again, the changes in the tropics are smaller than in the extra tropics, but that does not mean they are not important. In particular as they are largely independent of the chlorine loading.

Fig.1: The label "Bry=23ppt" etc. is unclear. As I understand this represents the difference between Bry=28ppt and Bry=23ppt, right?

Fig.2: (a) Is this annual mean? (b) Why is Bry different for different chlorine levels? Was local Bry used in these plots?

Fig.3: I understand this figure has been constructed by averaging the simulations with different bromine loading. Can you give a measure for the coherence between the simulations, e.g. by including error bars of the standard deviation or similar? Where are changes between high chlorine and low chlorine (red and black lines) significant?

Technical corrections

p.9730, l.18: "apre" -> "a pre"

p.9732, l.12: "Tegtemier" -> "Tegtmeier"

p.9733, l.26: "stratospheric polar clouds" -> "polar stratospheric clouds"

p.9736, l.21: "black" -> "blue"

p.9737, l.9: "where" -> "we"

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 9729, 2014.