Interactive comment on
"Oceanic bromine emissions weighted by their ozone depletion potential"
by S. Tegtmeier et al.

Anonymous Referee #1

Tegtmeier et al presents a quantitative estimate of the ozone depletion potential (ODP)-weighted emission calculation for the most abundant very-short-lived brominated compound, CHBr3. They concluded that (i) presently, the ODP-weighted CHBr3 emissions amount to ~50% of ODP-weighted anthropogenic emissions of CFC-11, and (ii) the ODP -weighted CHBr3 emissions will increase by 31% by 2100 due to increases in surface emissions and convective activity. While I have reserved opinions on the importance of calculation of ODP for CHBr3, which is predominantly of natural oceanic origin, I agree that its ODP information may be of use to some extent and the manuscript should be published after addressing the following comments.

We thank Referee 1 for his/her valuable comments. Please find below our response (in italic) to the comments as well as the according changes to the manuscript.

1. Section 2.1, 2nd paragraph. It would be good to add brief details of how the bottom-up emissions were derived in Ziska et al. In particular, it will be useful to show what are the major drivers of the 30% increase in VSLS emissions, whether it is due to increased surface temperature, winds, salinity, etc.

We have added the following text to section 2.1:
'For the time period 2006-2100, the global monthly mean emissions are calculated based on the monthly mean meteorological input parameters from CESM1-CAM5 and fixed atmospheric and oceanic concentrations from Ziska et al. (2013) following the parameterization of air-sea gas exchange coefficient from Nightingale et al. (2000). … These derived changes of the future VSLS emissions are only driven by projected changes in the meteorological and marine surface parameters, in particular, the by changes in surface wind and sea surface temperature. The respective contributions of wind and temperature changes to the future emission increase can vary strongly depending on the oceanic region (Ziska et al., in prep).'.

Further details of the predicted future emissions and the driving forces will be provided and discussed in the manuscript from Ziska et al. (Future emissions of halocarbons based on CMIP 5 model output fields) which will be submitted to ACPD within the next weeks.

2. Section 2.3, 2nd paragraph. I do not agree with the authors "active chlorine from CFC-11 will be impacted by changes in the stratospheric circulation in the same way as active bromine from CHBr3". The residual circulation will probably be sped up differently in different places. Since the short-lived and long-lived gases are released at different altitudes, the impact of CFC-11 and CHBr3 will be different, which will consequently affect the ODP calculation. However, I do agree with the authors that the impact of a speed-up circulation on CHBr3 ODP is small, compared to the other factors. Therefore, I suggest cutting the discussion short and ending with simply stating that the impact of the stratospheric residence time on CHBr3 ODP is expected to be small.

We agree with the referee that our discussion of the impact of changes in the Brewer-Dobson-Circulation on the VSLS driven ozone loss is not correct and have shortened the text as suggested above.

3. Ziska et al. 2013 emissions are found to be low-biased in the extratropics according to Hossaini et al. (2013). Although this bias will have a small, possibly negligible, impact on ODP-weighted CHBr3 emissions due to very small ODP in the extratropics, it still worth a brief discussion on the impact of this caveat on ODP-weighted emission calculation for CHBr3.

We have added a short discussion of this point. In particular, we have added the following text to Section 3:
'The evaluation of various $CHBr_3$ emission inventories from Hossaini et al. (2013) shows that in the tropics the best agreement between model and observations is achieved using the bottom-up emissions from Ziska et al. (2013). In the extratropics, however, the $CHBr_3$ emissions from Ziska are found to result in too low atmospheric model concentrations diverging from observations by 40 to 60%. … The distribution of the ODP-weighted emissions demonstrates clearly that $CHBr_3$ emissions from the NH and Southern Hemisphere (SH) extratropics have negligible impact on stratospheric ozone chemistry. Thus, the fact that the emissions from Ziska et al. (2013) might be too low in the extratropics (Hossaini et al., 2013) does not impact our results.'.

4. P14657, 2nd paragraph. Is it possible to find more literature information on how much of the CHBr3 emissions are currently due to aqua-farming? How much are they expected to grow (in percentage) in the coming decades? As stated by the authors, when it comes to ODP, it is indeed the anthropogenic component we care about.

We have added a discussion of the current and potential future $CHBr_3$ emissions from farmed seaweeds: 'In particular, aqua-farming used, among other things, for food production and CO_2 sequestering has started to increase as an anthropogenic VSLS source. Leedham et al. (2013) estimated tropical halocarbon production from macroalgae in the Malaysian costal region and suggest that only 2% of the local $CHBr_3$ emissions originate from farmed seaweeds. However, based on recent production growth rates, the Malaysian seaweed aquaculture has been predicted to experience a 6-11 fold increase over the next years (Phang et al., 2010). More importantly, other countries such as Indonesia, Philippines and China are known to produce considerably more farmed seaweed than Malaysia (e.g., Tang et al., 2011), but their contribution to the total anthropogenic VSLS emissions has not yet been assessed. The ODP of $CHBr_3$ demonstrates the high sensitivity of the South-East Asia region to growing emissions. Globally the highest ODP values (Figure 1b) are found in the same region where we expect future anthropogenic $CHBr_3$ emissions to increase substantially. An assessment of current and future seaweed farming activities including information on farmed species, fresh or dry weight macro algal biomass and incubation derived halocarbon production values is required to estimates the net oceanic aquaculture VSLS production.'

Minor comments:

The usage of emission vs. emissions is not very accurate and consistent throughout the manuscript. In many places, they are misused. Please carefully read through the manuscript and correct.

We have corrected the use of emission vs. emissions.

P14644, L22-24: -> a future climate. However, at the same time, it is reduced by less ...

We have changed the text.

P14645, L12: Should cite Carpenter & Reimann et al. (2014) (Chapter 1 of WMO 2014) instead of Chapter 1 of WMO 2011.

We have changed the citation.

P14646, L17: and not the -> but not the

We have changed the text.

P14646, L21-24: Change "Despite, ..." to "The ODP is traditionally ... However, some recent studies ... "

We have changed the text.

P14646, L26: Add "the" before long-lived halocarbons

We have changed the text.

P14647, L16: inside -> insight

We have changed the text.

P14647, L24-25: "While we focus our analysis on one VSLS and introduce the method and application exemplary for CHBr3", I understand what you mean here, but should consider rephrase

We have changed the sentence to 'The method and application are introduced for $CHBr_3$, within a case-study framework and can be applied to all VSLS where emissions and ODP are available at a spatial resolution necessary to describe their variability.'

P14648, L7: introduce -> introduced

We have changed the text.

P14649, L4: -> than the other CHBr3 ...

We have changed the text.

P14649, L8 & L17 & P14661, L17: Should this be Ziska et al. 2013? If it is Ziska 2015, it was not mentioned in the references.

This citation refers to a manuscript from Ziska et al., in preparation for submission to ACPD within the next weeks. We have changed the reference to Ziska et al., in prep.

P14650, L5: time scales play -> time scale plays

We have changed the text.

P14651, L14: delete "the" before tropospheric

We have changed the text.

P14652, L4: extent -> extend
We have changed the text.

P14652, L17: residence -> residence time
We have changed the text.

P14653, L22: -> the beginning and end
We have changed the text.

P14655, L17-21: Change "The potentially damaging effect of CHBr3" to "The impact of CHBr3". Are these the column integrated ODPs at the corresponding grid-cells?

Since we describe here not the actual but only the potential impact (only the impact CHBr3 would have if it would be really emitted from this location) we decided to change the text to 'the potential impact of $CHBr_3$ on …'. The ODP of the air parcels is calculated following their path through the troposphere and stratosphere (in a Lagrangian sense) and is in this Figure displayed at the location of the emission of the air parcel.

P14655, L21: delete "the" before "surface"
We have changed the text to 'the ocean surface'.

P14657, L2: "the mostly small ODP" – consider rephrase
We have changed the text to 'the overall relatively small ODPs'.

P14658, L16: extent -> extend
We have changed the text.

P14658, L18: -> we first analyze
We have changed the text.

P14659, L1: within these two months -> for June and December
We have changed the text.

P14664, L10: given -> due to
We have changed the text.

P14667, L25: CHBr3 from the surface -> transport of CHBr3 from the surface
The text should read 'CHBr3 delivery from the surface …'

P14667, L29: und -> and
We have changed the text.

P14668, L3: not well enough understood yet -> not understood well enough yet
We have changed the text.

P14668, L8: add "," after fields; "in order to derived" -> to derive
We have changed the text.