Authors' Response to Anonymous Referee #2 Interactive comment on "Three-dimensional model evaluation of the Ozone Depletion Potentials for n-propyl bromide, trichloroethylene and perchloroethylene"

We thank Referee #2 for consideration of our article. Regarding the concerns presented (shown in italics):

1. On page 17891-17892, the authors mention that results from an earlier study (Wuebbles et al., 2001) suggests about half of the bromine from nPB enters the stratosphere in the form of inorganic bromine (Bry), with direct transport of nPB and transport of BrAc accounts for the 33% and 19%, respectively. Thus the troposphere-to-stratosphere transport of Bry plays the most important role in understanding how nPB impacts stratospheric bromine and ozone. In section 2, the authors explain how degradation of nPB is treated in the model (nPB+OH -> BrAc), however I couldn't find any further explanation on how BrAc is converted to Bry subsequently. Also Bry is highly soluble. Recent modeling works suggest that Bry has a lifetime of ~10-15 days against wet deposition (e.g. Warwick et al., 2006; Hossaini et al., 2010; Liang et al. 2010) and about 30% Bry produced in the troposphere are removed by wet scavenging before entering the stratosphere (Liang et al. 2010). How is wet deposition of Bry treated in MOZART-3? How is the lifetime and washout efficiency of Bry against wet scavenging in MOZART-3 compared to these studies?

We have a sentence in the existing manuscript (p. 17895, lines 20-21) regarding BrAc photolysis in accord to Burkholder et al. (2002), which immediately ejects Br atom. While BrAc could also react with OH or potentially be soluble in cloud and rain water, the BrAc lifetime against photolysis is too short for either loss process to be significant when little BrAc is produced at night.

The Br_y species HBr, HOBr, and $BrONO_2$ are removed by wet deposition in MOZART-3, as described in the supplemental material of Kinnison et al. (2007), with an effective rate constant identical to that for HNO_3. Unfortunately, we did not save wet deposition removal rates for these species to the output files at the time MOZART-3 was run (several years ago), so we are unable to compare to the more recent Br_y wet deposition studies cited by the referee.

2. Section 3. How do the authors decide on the magnitude of emission fluxes used for nPB (2.48 Tg/yr), PCE (3.91 Tg/yr) and TCE (51.7 Tg/yr)? Why not choose an emission flux rate that corresponds to the current emission strength or a flux rate that will yield ~1% reduction in ozone (which seems to be a more conventional choice)? I understand ODP is in general independent of the choice of the emission strength, but it would be good to explain the rationale of the choice of these emission rates and also to clarify in the text that the magnitude of emission fluxes has little impact on the calculated ODP.

The primary purpose in our selection of emission fluxes was to obtain a global column O_3

change reasonably close to that created by the CFC-11 perturbation we used (surface mixing ratio increased by 80 ppt from the reference MOZART-3 run), which was -0.587%. We are changing the statements in the Methodology and Results sections of the revised manuscript to make our selection of emissions magnitude for this ODP study clearer to readers.

The current emissions rates for TCE and PCE, or even the (higher) 1999 emissions of RCEI which we cited, would not have caused large enough O_3 column perturbations in MOZART-3 to be numerically useful to calculate ODP.

And with regard to the minor comments (again repeated in italics):

Page 17890, line 18-19: It would be helpful to add the chemical formula for TCE (C2HCl3) and PCE (C2Cl4) here in the parentheses.

Agreed; we have introduced these chemical formulas at the definitions of the abbreviations (first sentence of the Introduction section) in the revised manuscript.

Page 17897, line 19-20, "and the resulting change in the distribution of tropospheric and stratospheric O3 as scaled to 1% decrease in global O3 burden". I don't understand what you mean by "scaled to 1% decrease in global O3 burden". Please clarify.

That clause is admittedly too brief; we are expanding it to

> ... and the resulting change in the distribution of tropospheric and stratospheric O_3. In the parts of Fig. 1, the values obtained from MOZART-3 are divided by 0.214% global O_3 burden decrease resulting from this nPB emissions scenario. In further figures, the values presented are likewise scaled by the percent global O_3 burden decrease appropriate to the compound and emissions scenario.

in the revised manuscript.

Page 17898, line 1-2: "the minimum Bry perturbation in the tropics suggests that much of the Bry crosses north of 20N". Convective lofting through the tropical tropopause layer has long been suggested to be the most important pathway of air entering the stratosphere (e.g. Sinnhuber and Folkins, 2006; Fueglistaler et al., 2009). Your result seems to contradict the above suggested pathway. What's the explanation? If much of the cross-tropopause transport of nPB and its degradation products do occur north of 20N, what are the transport mechanisms? In addition, is Bry subject to washout in the model? If so, could this minimum Bry perturbation in the tropics simply reflect more efficient washout in deep convective up-lofting in the tropics?

For nPB, transport through the TTL is less important than for long-lived source gases because nPB does not reach the base of the TTL in quantity (Fig. 1a). The transport of Br_y from nPB into the stratosphere in MOZART-3 then occurs through isentropic extra-tropical cross-tropopause transport, resulting in the higher values of stratospheric Br_y increase for northern than for

southern latitudes that is shown in Fig. 1c. This corresponds well to the long recognized mechanisms previously discussed by Holton and others.

MOZART-3 wet deposition removes HBr, HOBr, and $BrONO_2$ among the Br_y species as mentioned above, and the tropical local minimum of Br_y perturbation and further decreases toward zero of Br_y perturbation in the Southern troposphere (Fig. 1c) are due to that washout. We will note the Br_y and Cl_y species subject to washout in the Methodology section of the revised manuscript.

Page 17899, line 11-13: I would suggest moving this sentence to somewhere in the first paragraph in Introduction.

We agree, and this change is being applied to the revised manuscript with appropriate modifications to the second sentence in the existing Results paragraph.