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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Bromoform and dibromomethane in the tropics: a 3-D model study of chemistry and transport" *by* R. Hossaini et al.

R. Hossaini et al.

chm3rh@leeds.ac.uk

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Response to Referee 1:

We thank Referee 1 for his/her comments. The comments are repeated below (*in italics*) and our responses are given in **bold** text.

General remarks:

The paper is highly relevant for the justification of hitherto unexplained high Br_y concentrations modeled from BrO-remote sensing measurements. Because a too low Br_y concentration results from only using the long-lived gases (halons/CH_3Br). A theory under examination to close the gap is that very short-lives substances (VSLS)

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contribute to the amount of Br_y. There is one severe shortcoming of the paper in this respect: Authors use the TOMCAT simulation as their point of reference (base run) throughout the paper. However, they also state many times within the manuscript that the SLIMCAT runs are better correlated with the actual measurements of $CHBr_3$ and CH_2Br_2 from airplane campaigns in the higher troposphere/lower stratosphere region. Nevertheless, the SLIMCAT simulation is only used for sensitivity runs and resulting Br_y contribution of these gases is only reported for the TOMCAT base run. This is to my opinion not justified and needs very thorough consideration by the authors. If SLIMCAT simulations would be the base runs, amounts of $CHBr_3$ and CH_2Br_2 reaching the stratosphere would be much lower and discrepancy to the modeled Br_y from remote sensing would be larger. A suggestion would be that authors treat the SLIMCAT simulations equal to the TOMCAT simulations and give a range of Br_y contribution to the stratosphere from $CHBr_3$ and CH_2Br_2. However, then also SLIMCAT simulations should be made with different lifetimes. If model runs cannot be performed anymore it would maybe be a possibility to assume that the ratio between PGI and SGI does not change for the same lifetime in TOMCAT and SLIMCAT runs.

At present the SLIMCAT theta-level model does not include treatments of convection and turbulent mixing in the boundary layer. For this reason, the TOMCAT pressure-level model that does include parameterisations of these processes is taken as the base run. Comparison of modeled $CHBr_3$ and CH_2Br_2 with aircraft data does generally show SLIMCAT to perform better in the TTL and in particular for CH_2Br_2. This is due to the slower transport through the TTL from the theta level run where vertical transport rates are calculated from heating rates as opposed to from divergence of the analysed horizontal winds (as in TOMCAT). However, as stated in the manuscript, comparison of model with in-situ observations is not entirely conclusive and the aircraft data is sparse. An example would be the comparison of modeled $CHBr_3$ and CH_2Br_2 with data from the PRE-AVE campaign. In this case, it would appear the TOMCAT simulation

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performs better that of SLIMCAT in the TTL. The manuscript also points out that calculated residence times in the TTL from SLIMCAT seem more agreeable with other published values than that of TOMCAT. Considering these points we concur with the reviewer that the rationale behind presenting total Br reaching the stratosphere from $CHBr_3$ and CH_2Br_2 based solely on the TOMCAT runs needs revisions. However, the SLIMCAT run can still only be seen as a sensitivity test as it is not modeling all aspects of tropospheric tracer transport.

For the final ACP paper we will perform 3 additional SLIMCAT simulations with the same prescribed lifetimes of Br_y as that of TOMCAT sensitivity runs – S_{10}, S_{20} and S_{40} (10, 20 and 40 days). These runs will still require artificial mixing in the lower levels of the model to compensate for no treatment of convection and boundary layer mixing. This being the case, then the assumed removal of Br_y via washout, will be 'switched on' between $\sim$10 km to 17 km. We will then present a range of values of SGI, PGI and total Br reaching the stratosphere from $CHBr_3$ and CH_2Br_2 based on the theta-level model also.

Throughout the text we will modify the discussion so that although the TOMCAT run is still the standard 'base' case we also discuss the Br_y results from the SLIMCAT run.

Specific remarks

Abstract L. 8: vmr: specify before you use the abbreviation.

OK, we will make this change for the final ACP paper.

L. 15ff: For the reader not being precisely from the modeling community it is not easy to understand the p-levels and θ-levels. Please connect these nomenclatures with TOMCAT and SLIMCAT.

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OK, we will do this.

L21: cold point tropopause.

OK.

L. 27ff: SGI specify before you use the abbreviation (SG-injection).

OK.

1. Introduction P. 16814 L. 3 . . .known. . . is possibly too strong. Scientific evidence is still too weak that it has been proven that this is true. So you could write . . .expected. . .? At the end of the sentence you could cite the WMO 2007 report.

OK, we will rewrite text and cite WMO (2007).

L. 6 substantial amounts of macroalgae?

OK, we will clarify text.

L10 Also here poorly understood is too hard a statement to my opinion. Possibly write:. . .is under discussion. here you could cite papers from Fueglistaler (Reviews of Geophysics, 47, 2008RG000267, 2009) and from Krueger (ACP, 8, 813–823, 2008).

OK, we will rewrite text and cite papers.

L. 13 pptv: mixing ratios are with v and sometimes without in the manuscript. I would omit and just write ppt.

In the ACP paper we will be consistent and write pptv throughout.

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L. 14 due to . . .

OK.

3.2 Simulations P 16821 L. 20 Please cite literature to justify your choice of 1.2 ppt

The use of a surface vmr of 1.2 pptv for $CHBr_3$ and CH_2Br_2 will be justified. We shall include a citation of Quack and Wallace (2003) who report background marine boundary layer $CHBr_3$ in the range 0.5-1.5 pptv. Similarly for CH_2Br_2, we shall include a citation of Butler et al. (2007), who report CH_2Br_2 in the range 0.6-1.3 pptv in the tropical marine boundary layer. We shall add further discussion on this issue for the final ACP paper.

P 16822 L. 6 σ-θ model = SLIMCAT.

OK.

P 16823 L. 18, explain UT.

OK.

P 16824 L. 9 above 350 K potential temperature?

OK, we will clarify this.

L14: LS, lower stratosphere (SL)?

OK.

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L. 28 explain WB-57, HCFC, HFC.

OK, we will explain WB-57 is an aircraft and spell out the tracer acronyms.

L. 29 a transfer time in the TTL of 3-4 months seems to be very large in comparison to number provided e.g. in the review of Fueglistaler (2008).

Yes. A transport time of 3-4 months within the 360-380K layer does seem large in comparison to the range quoted in WMO (2007) – i.e. 20-80 days. Possible reasons for this will be discussed and more details of the calculation will be included in the final ACP paper.

P 16824 L. 8: θ-coordinate model = SLIMCAT.

OK.

P 16826 . . .overestimation. . .

OK.

P 16831 L.1. Comment to the speculation about CH_2BrCl, $CHBr_2$,Cl and $CHBrCl_2$. Kerkweg et al., show data from the PEM Tropics B campaign, where concentrations near the tropopause region are possibly too low to contribute significantly to the stratospheric Br_y. CH_2ClBr: ~0.2-0.3 ppb $CHClBr_2$: ~0.1 ppb and $CHCl_2Br$: ~0.15 ppb.

OK, we will add this point in.

L. 3. . .although poorly quantified. . . should be . . .although not quantified. . .as Laube et al., provide no concentration for unidentified peaks within their chromatograms.

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OK, we will change this.

Fig.11 and 12: legend: Br_y instead of BR_y, include labels a-d into the figures.

OK.

References:

Butler, J.H., King, D.B., Lobert, J.M., Montzka, S.A., Yvon-Lewis, S.A., Hall, B.D., Warwick, N.J., Mondeel, D.J., Aydin, M., and Elkins, J.W.: Oceanic distributions and emissions of short-lived halocarbons, Global Biogeochem. Cycles, 21, GB1023, doi:10.1029/2006GB002732, 2007.

Quack, B. and Wallace, D. W. R.: Air-sea flux of bromoform: Controls, rates, and implications, Global Biogeochem. Cycles, 17(1), 1023, doi:10.1029/2002GB001890, 2003.

WMO (World Meteorological Organization), Scientific Assessment of Ozone Depletion: 2006, Global Ozone Research and Monitoring Project-Report No. 50, 572 pp., Geneva, Switzerland, 2007.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 16811, 2009.

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