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Interactive comment

Interactive comment on "Delivery of halogenated very short-lived substances from the West Indian Ocean to the stratosphere during Asian summer monsoon" *by* Alina Fiehn et al.

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We would like to thank Reviewer 2 for the suggestions to further improve the manuscript. Below you find our answers to your specific points. The reviewer's comment is marked with 'RC:' and is written in quotes, our answer in normal font.

RC: "Overall I think this is a good paper and should be published in ACP. There is considerable interest in short-lived halocarbon emissions and the cruise presented here provides important additional information. The stratospheric input is quantified and presented with a range of model-based metrics which allow comparison with other studies. The uncertainties/limitations of the modeling are described."

We thank the reviewer for this very positive review.

Answers to the specific comments of the reviewer:

RC: “Line 130: The word ‘project’ is not correct here. (Also line 466).”

In line 130, we changed ‘project’ to ‘model’. In line 466, ‘projected’ was changed to ‘determined’.

RC: “Line 136: ‘..during the Asian summer monsoon season’? (Missing words?)”

The term summer monsoon already includes one season. We thus think that the word “season” is not necessary in the manuscript.

RC: “Line 193: Do you mean 154 samples every 3 hours, or 154 overall which are spaced about every 3 hours?”

We mean 154 overall samples spaced about every 3 hours. We added “overall” and “spaced about” to the sentence.

RC: “Line 257: ‘July 2000-2015’. Should be rewritten to clarify it is for July during those years.”

Done.

RC: “Line 283: Can you show these differences with respect to the ECWMF winds somehow?”

Figure 1a shows the ECMWF monthly mean winds as black arrows and the in situ ship measurements as blue arrows. Thus, we think differences are directly visible in the figure. See also our answer to your next comment.

RC: “Can you add the time varying ECMWF winds in Figure 2, if there is a discrepancy to discuss?”

The comparison of time varying ERA-Interim winds and in situ ship winds can be found in Fig. S1 in the supporting material. In line 285, we added the sentence: “Surface winds from in situ ship measurements, radiosondes, and time varying ERA-Interim data show good agreement (Fig. S1).”

RC: “Line 291: Give the lifetime of butane so the reader can judge what this is testing.”

The atmospheric lifetime of butane is estimated to 2.5 days considering the reaction with OH and ozone (Finlayson-Pitts and Pitts, 2000). We added to line 291: “(lifetime 2.5 days (Finlayson-Pitts and Pitts, 2000))”.

RC: “Line 301: Change ‘lower’ to ‘smaller’. (There are many other places where I would suggest changing higher to larger, when higher can be confused with meaning higher altitude).”

Yes, we agree with the reviewer and changed the words “lower” and “higher” in several places in Sect. 3.2 and 3.3 to “smaller” and “larger”, respectively.

RC: “Section 3.3.: This section compares the emission values between the cruises, but I think it is missing an overall synthesis or discussion about what these differences tell us about the different regimes or techniques. I would suggest adding a paragraph after line 389.”

We added the following paragraph at line 389: “In general, the emissions measured during the OASIS cruise in the subtropical and tropical West Indian Ocean were as large or larger than in other tropical open ocean cruises or studies. Especially CH2Br2 emissions during the OASIS cruise were larger than any previous emission estimates. The West Indian Ocean seems to be a region with significant contribution to the global open ocean VSLS emissions, especially in boreal summer when wind speeds are high because of the southwest monsoon circulation.”

RC: “Line 398: It would be interesting to see some plot of the vertical distribution of tracers in the different transport regimes.”

We show the vertical distribution of bromoform from the OASIS cruise for the four transport regimes averaged over the time of the model calculation in the below Fig. R1.

These profiles confirm that the bromoform emissions in the Westerlies and Transitions regime stay mostly below 5 km height, while in the Monsoon Circulation and Local Convection regimes bromoform is more uniformly distributed in the troposphere. We added this figure to the supporting material and explanatory text in line 404: "The different uplift heights are reflected in the vertical distribution of bromoform in each transport regime (Fig. S2)."

RC: "Line 413: I don't understand the definition of transit half-life. It might be the use of 'has reached 17km.' All entrained tracer reaches 17km? It seems like Figure 5 would help but that comes later. For Figure 5 can you add a symbol on the blue line at the half-life value? (If I have understood correctly)."

We used the term "entrained tracer" as a synonym for "has reached 17 km". We changed the explanation to: "...transit half-life, which is the time after which half of the total amount of entrained tracers have been entrained above 17 km altitude." We also added a half-life marker in Fig. 5.

RC: "Line 416: Table 4: Please check all the values in Table 4. I tried to check my understanding of Transport Efficiency by dividing entrainment by emission. E.g. for $CHBr_3$ cruise mean: 5.5/430 = 1.28%. Not 1.38. I tried other values and there seemed to be differences (23.6/430 = 5.49% and not 6.38%). What is wrong? Also, it would help if the text used the same precision as the table (e.g. line 419 say 1.38% and not 1.3%, or is it 1.28%?)."

Thanks for checking Table 4 carefully! Your understanding of the transport efficiency is correct. There were slips in Table 4, because of a former version of the manuscript. We recalculated transport efficiencies, corrected the tables and adjusted the precision in the table and Sect. 3.4.

RC: "Figure 5: What are the units of the left-hand y axis?"

The unit on this axis is number. We added the unit to the y-axis description of Fig. 5.

References:

Finlayson-Pitts, B., and Pitts, J.: Chemistry of the upper and lower atmosphere: Theory, experiments and applications, Academic, US, 2000.

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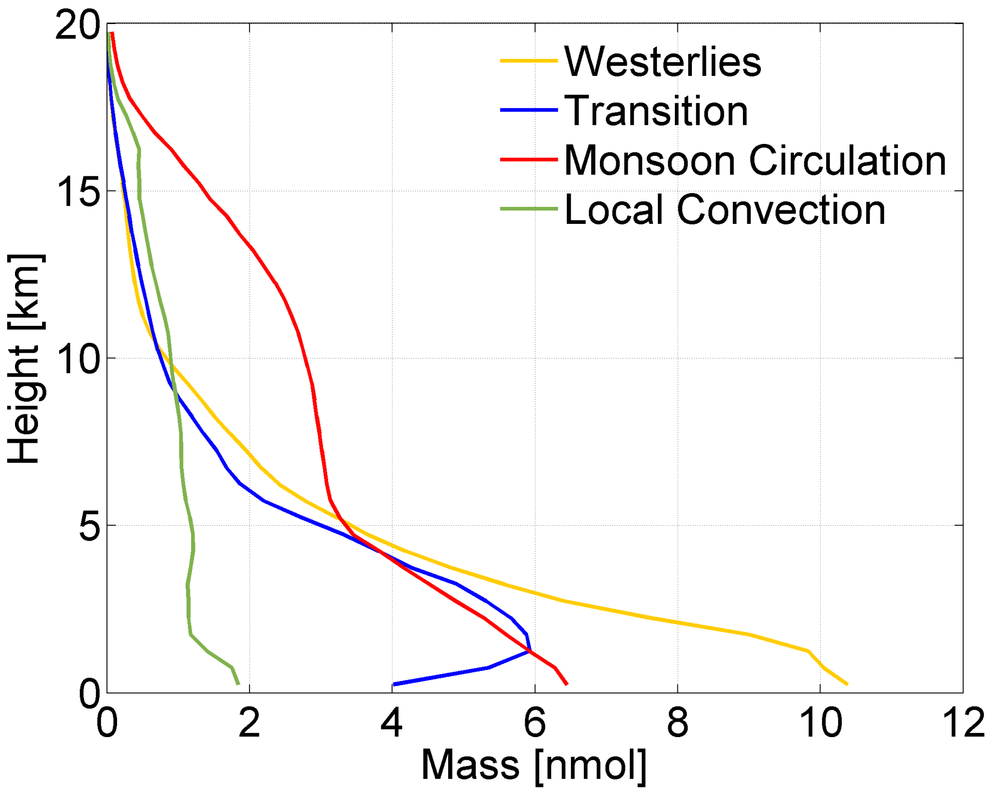

Fig. 1. Time-averaged vertical distribution of bromoform in the four transport regimes (Figure 3b).

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Discussion paper