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Interactive comment on “Bromine partitioning in the tropical tropopause layer: implications for stratospheric injection” by R. P. Fernandez et al.

Anonymous Referee #1

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1 General remarks

Fernandez et al. present a modelling study about the partitioning of inorganic bromine in the tropical tropopause layer. Using global and box simulations, they investigate the source and product gas injection of bromine, in particular from VLSL. Special emphasis is exerted on the role of heterogeneous reactions, which are crucial for understanding bromine chemistry in the TTL. The study is well written and yields interesting results, for example the existence of a “tropical ring of inorganic bromine” in the TTL region. I recommend the manuscript for publication in ACP after addressing the following (mostly minor) comments.

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2 Specific comments

- Section 2: The authors state that the global simulations were conducted for repeated 2000 conditions, whereas the the input data was from a previous CAM-Chem run. I was just wondering if this previous run reproduced the exceptional La Niña event during 2000. If that is the case, this would possibly affect your results from your “CTM-like” run as the atmospheric conditions were not quite exemplarily during this year.
- Section 2.1.4: I share the previous referee’s concern of omitting ice uptake of HBr and HOBr, which are major nighttime reservoirs. The study by Aschmann et al. (2011) found no significant impact of HBr uptake, as stated in this section, however, this omission casts some doubt on the extraordinary high values of convectively transported Br_y (see point below).
- Heterogeneous reactions on ice, Table S1: I was surprised that the reaction of $BrONO_2 + HBr$ has not been included. It links two major nighttime reservoirs with $\gamma=0.3$ (Sander et al., 2011). Is there a specific reason to leave it out?
- Br_2 : With a single exception on p. 17873, l. 26 the nighttime abundance of Br_2 is mentioned nowhere. As many heterogeneous reactions lead to the production of Br_2 I assume that this species has to be a major “reservoir” during nighttime. I think it would be illustrative to include it in the discussion of (nighttime) Br_y partitioning and add it to Figs. 1 and 11, as the abundance of Br_2 is a direct indicator of the effectiveness of heterogeneous reactions.
- Convective transport of Br_y : The amount of PG_{VSL} given in this study is largely dependent on convectively transported Br_y released from sea salt aerosols from the MBL to the free troposphere or even higher (Sect. 3.2 and 3.5). Given that sea salt aerosols are apparently a major source of Br_y even in the TTL (which is in contradiction with the results of Yang et al., 2005), there is little information

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given about the treatment of sea salt aerosols in the model. Furthermore, I'm puzzled by the effectiveness of convective transport of Br_y in the model. In Sect. 3.2 it is stated that the Br_y mixing ratio in the TTL may reach up to 3 pptv during vigorous convection events, roughly half of the Br_y mixing ratios at the surface. Firstly, according to Roms and Kuang (2010) only about 30% of air detraining in the TTL is actually from the boundary layer, the rest is entrained further upwards. Secondly, I'm surprised that such a large fraction of potentially soluble Br_y "survives" the convective uplift, even when considering heterogeneous recycling. As stated by the previous referee this in contradiction with the recent study by Liang et al. (2014).

3 Technical remarks

- p. 17858, l. 2: switch "degradation" and "inorganic".
- p. 17873, l. 26: "..., being HOBr the dominant...". Some words are missing here.

4 References

- Roms, D. M., and Z. M. Kuang (2010), Do Undiluted Convective Plumes Exist in the Upper Tropical Troposphere?, *Journal of the Atmospheric Sciences*, 67(2), 2, 468-484, doi:410.1175/2009jas3184.1171.
- Liang, Q., Atlas, E., Blake, D., Dorf, M., Pfeilsticker, K., and Schauffler, S.: Convective transport of very short lived bromocarbons to the stratosphere, *Atmos. Chem. Phys.*, 14, 5781-5792, doi:10.5194/acp-14-5781-2014, 2014.

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