

1 General comments

Overall quality of the preprint

This manuscript comprehensively presents the implementation short-lived halogen (SLH) sources and very short-lived (VSL) halocarbons into CESM version 2.2.0. It furthermore highlights adaptation measures for widely used emission parameterization to new generations of coupled chemistry climate models. Comparisons are provided to both previously published CESM1 model integrations and a wide range of observations. Although targeted towards the CESM community, the manuscript provides profound insights that are valuable for other modeling groups, too.

All reviewer comments have been addressed satisfactorily, the overall quality of the manuscript has improved tremendously since its first submission. There are no further objections publishing it. Minor technical refinements as listed below may be applied before final publication.

2 Specific comments

Individual scientific questions/issues

- L189–191: SLH chemistry is also included in the standard chemistry mechanism used in ECHAM/MESSy Atmospheric Chemistry (EMAC) model [1].
- L1586–1589: *"The initial condition (ncdata) data has been replaced to ensure background SLH [...]"*. Here you describe the spin-up procedure for SLH. I might have overlooked it, but how did you initialize long-lived green house gases and ozone depleting substances?
- L1157/1289: Here and in other sections, the authors use two different tropopause definitions – the chemical tropopause compared with a threshold at 150 DU of ozone and the minimum lapse rate pressure. How does this affect the respective results?
- L1340–1349: In Fig. 18c), the differences between the nudged (CC-SLH [2 × 2–ndg]) and the free-running (CC-SLH [2 × 2–hst]) are quite substantial in the high latitudes ((60 – 90) °N/S). What are the reasons?
- L1494: *"CESM2-SLH Mendeley repository"*: You may want to include a link/url to said repository if possible.

3 Technical corrections

Purely technical corrections

- L74: Typo in punctuation: *e-g-*. → e.g.,
- L197: Wrong hyphens: *-including CESM1 and CESM2-* → – including CESM1 and CESM2 –
- L319: Presumably typos in *het_ss_3–5* (Table 1): CL_2 → Cl_2
- L452: *Here, we assumed identical accommodation coefficients and reaction yields for iodine than those used for the equivalent chlorinated and brominated reservoirs.* Grammar: *than* → as.
- L487: *IUPAC Atkinson et al. (2007, 2008).* Citation should be set in brackets here. → IUPAC (Atkinson et al., 2007; 2008).

- L522: [...] *transport and removal based on 3 (three) individual bins [...]*. Compliance with journal style: 3 (*three*) → three
- L690: 2015-2020. Wrong hyphen: - → –
- L862–863: 1.8-2.2 pptv + 2.5-3.0 = 4.3-5.2 pptv. Same as above. - → –
- L926: $I_y \rightarrow I_y$
- L1108: *in previous work (Fernandez et al., 2019, 2024)*. Grammar. Plural needed here: *work* → *works*
- L1237: *"The top-row show [...]"*. Grammar: *show* → *shows*
- L1340: *"Figures 18b and 18c shows [...]"*. Grammar: *shows* → *show*
- L1367: *"6 (six)"*. Compliance with journal style: 6 (*six*) → six
- L1367-1382: It might make sense to switch the order - first refer to Fig. 19 and afterwards to Fig. S7.
- L1396–1397: *"In this section we highlight the scientific relevance and limitations of including comprehensive halogen chemistry in CESM2-SLH in comparison with previous studies and other models, highlighting the main drivers [...]"*. Punctuation and style (word duplication). You may consider slightly rephrasing the sentence: In this section, we highlight [...], pointing out the main drivers that control [...].
- L1517: *"setup"* → set up
- L1516–1523: *"[...] this work provides a general but complete intercomparison of organic VSLS and inorganic halogen distributions obtained for the different experiments."* Duplicate of L1496–1498 (*"The current CESM2 [...] a complete set of CESM compsets."*) ? The authors should carefully assess Section 6 and could perhaps combine and condense the first paragraph and parts of the last paragraph to further reduce duplications.

3.1 Figures

- Figure 10: The dotted, light blue lines in subfigures (b, d, f) are barely visible.

References

- [1] Sinnhuber, B., and S. Meul (2015), Simulating the impact of emissions of brominated very short lived substances on past stratospheric ozone trends. *Geophys. Res. Lett.*, 42, 2449–2456. doi: 10.1002/2014GL062975.