

Response to Review 2

(green: Responses; blue: Changes in the manuscript)

General Comments

- 1. There is some inconsistent use of defined acronyms throughout. In several cases, text alternates between using full text or previously defined acronyms. I recommend acronyms be used uniformly after definition.

Changed accordingly

- 2. There are several instances where parenthetical citations are provided where in-text citations should be used instead. Please carefully review citations and correct as needed. Some examples can be found at lines 91 & 222.

This was because the Bozem et al. paper wasn't published yet when we handed in the paper. In-text citation is now updated.

- 3. Figure labeling needs some improvement. Pressure axes in Figs. 3b, 4b, & 4g list no values, but they should. Not all colors utilized in Figs. 5b-d are defined - namely, what is the difference between light and dark blue? Also, it would be helpful in many instances if illustrations were added to tie into the discussion more. I found it hard to follow interpretations/arguments in some places.

The figures were updated

- 4. Were vertical velocities measured aboard the aircraft? If so, those would be a valuable addition to the analysis, particularly to support the arguments with respect to the role of gravity wave breaking. If not, it should be acknowledged somewhere that such measurements do not exist.

In the text, we added: 'However, it cannot be determined with certainty whether gravity wave breaking occurred, as additional information on the vertical structure (e.g., of Theta) or vertical wind speed measurements would be required, which were not available during this campaign.'

- 5. There is a third enhancement in H₂O (and attendant changes in other gases) at higher altitudes near 13:15 UTC which is not addressed in the manuscript. It should be acknowledged and an explanation of its possible (or known) source provided as it is clearly evident in Figure 3.

This increase occurs near the convective region but not within the area directly influenced by convection. Moreover, the transport from the convective systems is directed oppositely and therefore cannot explain the observed enhancement. We acknowledged this in the updated version:

‘At around 13:15 a second filament shows a strong H₂O increase, reaching up to ~30 ppmv at 345 K. This filament is located several hundred kilometres away from the overshoot and lies opposite to the direction of the overshoot’s forward transport. Back-trajectories indicate that the filament originated over the Atlantic and, prior to that, in polar regions. Thus, it is unlikely to have formed by convective injection from the observed overshoot; a more plausible explanation is alternative transport such as turbulence associated with a warm conveyor belt (WCB) uplift over the Atlantic or the influence of strong vertical wind shear near the jet.’

Specific Comments

- There are a few places where the H₂O acronym has an italicized "O". This should be fixed.

Corrected

- The "Homeyer & Bowman (2014)" reference is incorrect. It is missing many authors (should be Homeyer et al. 2014). See <http://dx.doi.org/10.1002/2014JD021485>.

Corrected

- Line 41: there is another limitation of the Ueyama et al. 2023 & Dauhut and Hohenegger (2022) studies not mentioned here - they primarily capture convection in the tropics, missing much (or nearly all) of the midlatitude overshooting.

Thank you for pointing that out. We acknowledge this in the updated text:

‘Concerning the convective impact on the global stratospheric H₂O_{gas} budget, the studies Ueyama et al. (2023) and Dahut et al. (2022) estimate it to be in the range of 10 %. However, this estimate is subject to considerable uncertainty, as these studies primarily account for tropical convection while largely neglecting extratropical events.’

- Line 48: unnecessary line break; merge with former paragraph.

Merged

- Lines 71-73: this sentence is unnecessary.

I am not sure which sentence you mean since there are several ones in Lines 71-73

- Line 107: revise "Additionally" to "In addition"

Changed accordingly

- Line 110: "he" should be "The"

Corrected

- Line 112: "arose" should be "resulting", and "temperature" should be "temperatures"

Corrected

- Line 128: "NASA'S" should be "NASA's"

Corrected

- Lines 133-134: both instances of "in XX hPa" should be "at XX hPa"

Corrected

- Line 141-142: This sentence can be more simply stated as "In this study, hourly ERA5 data are used at a longitude-latitude resolution of 0.25°."

Changed accordingly

- Line 144: please specify the method of interpolation. Linear in space and time??

Interpolation is linear for most variables, exponential in the vertical for water vapor (however, not used in this study)

- Lines 206-208: this sentence seems like too much of a detour and not very relevant to the focus of the analysis (certainly not beyond all that has already been said).

I do not fully agree, as we are also interested in the ice microphysics during convection, even though this aspect is not discussed in detail in the present study.

- Line 221: there are many more studies that can be cited here, especially some of the early modeling studies of Pao Wang and others.

The citation was added.

- Lines 265-267: the role of downward transport is also discussed and shown in a more appropriate analog of midlatitude overshooting simulations – <https://doi.org/10.1029/2022JD036713>.

The citation was added.

- Line 357: another worthwhile citation to bolster this argument would be the overshoot trajectory analyses of <https://doi.org/10.1029/2021JD034808>.

The citation was added.