Reply to reviewer comments:
Distinguishing the impacts of ozone and ozone depleting substances on the recent increase in Antarctic surface mass balance

Dear Dr. Savarino,

Thank you for considering this paper for publication in The Cryosphere. We have found the reviewer's comments insightful and helpful. Please find below a point-by-point reply (in black) to all the reviewers' comments (in blue).

Reviewer 1

Overview: This paper used specialized climate model simulations from CESM to analyze the relative contribution of ozone depleting substances, and stratospheric and tropospheric ozone (separately) on changes in Antarctic mass balance. The study clearly demonstrates and cleanly separates that the largest contributions come from stratospheric ozone in austral summer. This is accomplished through changes in the meridional moisture flux, strongly tied to barotropic instability (rather than baroclinicity) bringing more moisture to the Antarctic continent and increasing SMB. The paper is well-written, the figures are clear, and the results are fully justified by the analysis. I only offer one small potential minor revision to help place the paper in a broader context of the model reliability, which never really was addressed or referenced. It would be helpful to know that the values and changes of SMB are well within the known bounds of SMB from satellite observations (surface height estimates etc.) and other detailed models of SMB.

We thank the reviewer for the careful reading and very useful comments.

Minor revision suggestion: 1. There is never really a discussion on how well the models employed do at simulating observed Antarctic SMB from satellite measurements or in comparison to more sophisticated models of SMB. At the very least, the LENS simulations could be compared to this over a period of overlap.

Following the reviewer's comment we now discuss the ability of the CESM to capture the Antarctic SMB (lines 39-43). Previous studies have shown that the CESM captures the spatial patterns of climatological mean Antarctic SMB, and its variability, from ice-cores and reanalysis (Lenaerts et al., 2018). Furthermore, the CESM well captures the climate response in the Southern Hemisphere to ozone-depletion (England et al., 2016; Landrum et al., 2017). This provide us confidence in using the CESM to investigate SMB changes forced by different ozone related agents.

Specific technical edits: 2. Throughout: east Antarctica, west Antarctica, and Antarctic peninsula can all be capitalized since they refer to specific proper nouns / geographic regions: East Antarctica, West Antarctica, Antarctic Peninsula

We have capitalized all 'geographic regions' (lines 84-85).

3. Line 175 – change 'show' to 'shown'

Done (line 189).

4. Some of the nomenclature is a bit awkward, particularly in Fig. 8, why not just use derivatives instead of subscripts?

We would prefer to minimize the number of symbols on each figure, and to keep the current subscripts as 'derivatives'.

We would like to emphasize again our gratitude to the reviewer who pointed us in important directions that have significantly improved this manuscript.

Sincerely,

Rei Chemke, Michael Previdi, Mark England and Lorenzo Polvani

References

England, M. R., Polvani, L. M., Smith, K. L., Landrum, L., and Holland, M. M. (2016). Robust response of the Amundsen Sea Low to stratospheric ozone depletion. *Geophys. Res. Lett.*, 43(15):8207–8213.

Landrum, L. L., Holland, M. M., Raphael, M. N., and Polvani, L. M. (2017). Stratospheric Ozone Depletion: An Unlikely Driver of the Regional Trends in Antarctic Sea Ice in Austral Fall in the Late Twentieth Century. *Geophys. Res. Lett.*, 44(21):11,062–11,070.

Lenaerts, J. T. M., Fyke, J., and Medley, B. (2018). The Signature of Ozone Depletion in Recent Antarctic Precipitation Change: A Study With the Community Earth System Model. *Geophys. Res. Lett.*, 45(23):12,931–12,939.