

Interactive comment on “PSCs initiated by mountain waves in a global chemistry-climate model: A missing piece in fully modelling polar stratospheric ozone depletion” by Andrew Orr et al.

Andrew Orr et al.

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Author Comment

Reviewer #2

We are grateful for the Reviewers insightful comments and that they are happy to recommend its publication after we have addressed their minor comments, which we have answered below.

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(1) Comment - Line 31, and at other locations throughout the manuscript: You use the phrase 'ice frost point is rarely exceeded' here. But really, you mean that temperatures rarely fall below the ice frost point temperature (without the additional wave-induced cooling phase). I suggest you rewrite these phrases throughout the manuscript to make this clear, and avoid the phrase 'rarely exceeded'.

Reply: This suggestion has been followed. The text 'the ice frost point is rarely exceeded above the Antarctic Peninsula' has been revised to 'the temperature rarely falls below the ice frost point temperature above the Antarctic Peninsula'. A similar correction was made a further four times at other locations throughout the manuscript.

(2) Comment - Line 222: Comments that the lowest temperatures (around -6K) are 'perhaps the region of the distribution that is critical for decreasing below the threshold for PSC formation'. This would probably only be true early in the season and at the end, when synoptically the temperatures are warm. On the other hand, in mid-winter, you would be more likely to only need a small negative perturbation to form (ice) PSC. Relatedly, Figures 2 & 3 indicate that very few waves have large negative perturbations, but that is not of course saying these large amplitudes are unimportant especially at season start and end – perhaps this point could be made too.

Reply: These suggestions have been followed. The sentence on line 222 has been modified to state '... showing a lower bound of around -6 K, which is perhaps the region of the distribution that is critical for decreasing temperatures below the threshold for PSC formation (particularly during early winter and early spring).' We have also added an additional sentence to cover the Reviewer's second point: 'Both Figs. 2 and 3 suggest that Antarctic Peninsula mountain waves with relatively large amplitudes of 5-10 K are uncommon (although it is noted that Eckermann et al. (2009) observed waves in this region with an amplitude of around 10 K for a particular case study).'

(3) Comment - Line 225: Comparison of parameterised perturbation and Rothera perturbations. A clear agreement. However, all observations are only seeing part of

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the wave spectrum, and in particular radiosondes are preferentially observing inertia-gravity waves. Moffat-Griffin et al. (JGR 2011, doi 10.1029/2010JD015349) concluded that winter & spring radiosonde observations of stratospheric waves at Rothera may also be in part due to non-orographic sources (e.g. vortex edge). You mention in the text that AIRS includes orographic & non-orographic wave sources. It seems to me that you should note that the Rothera radiosondes likely do so too.

Reply: This suggestion has been followed. An additional sentence has been included which says: 'Note that the radiosonde results may also include contributions from non-orographic sources, such as from waves generated by the edge of the polar stratospheric vortex (Moffat-Griffin et al., 2011).'

(4) Comment - Line 232: A 'hot-spot' within the Antarctic Peninsula 'hot-spot'?

Reply: This sentence has been revised by removing the section 'as well as a hot-spot of mountain wave activity (Hoffmann et al. 2013)'

(5) Comment - Line 245: You write that the lower bound of the T-Tice distribution is around 0K in the control case, but it seems about -2K or even -3K to me (black line in Figure 5b). Please check. Maybe a better way (more quantitative way) of comparing is to say at what temperature the e.g. 1% limit is at?

Reply: This change has been made, and the sentence now states that the difference is from -2 to -3 K.

(6) Comment - Line 332: See comment from line 222 above.

Reply: This suggestion has been followed. As with the reply to the comment on line 222 above, this sentence has been modified to include the phrase '(particularly during early winter and early spring)'

Technical Comments:

(7) Comment - Lines 26 & 27: I don't think 'AIRS-observations' and 'radiosonde-

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observations' need hyphens.

Reply: This change has been made.

(8) Comment - Line 69: 'typically have horizontal wavelengths'

Reply: This change has been made.

(9) Comment - Line 112 & following: Subscript the '3' and '2' in HNO₃, H₂O

Reply: These changes have been made.

(10) Comment - Line 136: suggest rewording to 'at pressure heights around 850 hPa'

Reply: This change has been made.

(11) Comment - Line 139: I think the reference for ERA5 is Hersbach et al, QJRM 2020, doi:10.1002/qj.3803

Reply: This change has been made.

(12) Comment - Line 139 & 140: You use 'shown' and 'not shown' in the same sentence, please reword

Reply: This suggestion has been followed. This sentence has been reworded to 'To test this here, the 30-year mean wind at 850 hPa for austral winter (June-July-August) from the control experiment was computed and found to be in excellent agreement with the climatological mean from the reanalysis-product ERA5 (i.e. the fifth-generation reanalysis product from ECMWF, Hersbach et al., 2020) over the 1979 to 2019 period (not shown).'

(13) Comment - Line 236: Sentence seems incomplete.

Reply: This suggestion has been followed. The sentence has been revised to 'By contrast, the AIRS-observed values show the peak source region to be more over the northern section of the Antarctic Peninsula. Note that the AIRS-observed values also show some contributions from over the sea surrounding the Peninsula, which

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as discussed earlier is a possible reason for some of the disagreement between the distributions of parametrised and AIRS-observed cooling-phase in Fig. 2.'

(14) Comment - Line 272 'high-altitude', not 'high-elevation'

Reply: This change has been made.

(15) Comment - Line 340. Phrase 'only during October (and to a lesser degree September)' doesn't make sense. Reword

Reply: This suggestion has been followed and the sentence rewritten and simplified.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-560>, 2020.

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