

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-150

Anonymous Referee #1

Referee comment on "Interannual variability of winds in the Antarctic mesosphere and lower thermosphere over Rothera (67°S, 68°W) in radar observations and WACCM-X" by Phoebe E. Noble et al., Atmos. Chem. Phys. Discuss.,
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Comments on the ACP manuscript 'Interannual variability of winds in the Antarctic mesosphere and lower thermosphere over Rothera (67°S, 68°W) in radar observations and WACCM-X' by Noble et al.

Journal driven questions:

Does the paper address relevant scientific questions within the scope of ACP? Yes

Does the paper present novel concepts, ideas, tools, or data? Yes

Are substantial conclusions reached? Yes

Are the scientific methods and assumptions valid and clearly outlined? Mostly - see below

Are the results sufficient to support the interpretations and conclusions? Mostly - see below

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Mostly - see below

Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Mostly - see below

Does the title clearly reflect the contents of the paper? The title does not reference consideration of linkages to climatological indices. But then, the title is already long enough.

Does the abstract provide a concise and complete summary? Yes

Is the overall presentation well structured and clear? Yes

Is the language fluent and precise? Mostly.

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Mostly

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? No

Are the number and quality of references appropriate? Yes.

Is the amount and quality of supplementary material appropriate? None is supplied. That is appropriate.

This paper describes the annual cycle of winds above Rothera station as measured by a meteor radar and as modelled by WACCM-X. The results of a regression analysis with a number of climatological indices are also described. Comparisons are made to other analyses and conclusions are drawn. The paper represents a useful contribution to our understanding of the polar MLT region and our ability to model it and warrants publication after the consideration of the points described below.

Some aspects of the analysis method are novel but their rationale are not fully described.

The authors often use the median to describe the data. At line 102, they say this removes tides and planetary waves but do not say why this is so. Such wave phenomena can lead to velocity distributions that have strange shapes. The authors' use of the median and the interdecile range to describe the data gets around this. In their comparisons with other results, though, they need to make sure the reader is cognizant of the use of different statistical measures.

In the abstract and the conclusions, the authors propose that a bias exists in WACCM zonal winds due to missing eastward momentum forcing. This conclusion can be supported on the time scale of a single time step (because on that scale, the model is using the forcing to define a grid point's next velocity value). But on longer time scales, the dynamical equations include the influence of other forcings such as the Coriolis effect. If balanced flow was assumed, the zonal wind bias would be due to incorrect meridional forcing. The authors need to consider their proposal here more carefully.

In the introduction, the authors introduce WACCM-X. A short description needs to be included here (Line 63).

The authors note that QBO10 and QBO30 are 'orthogonal' near line 134. They should provide an explanation of what they mean by this.

Near line 136, the authors say that the influence of the SAM is important for Antarctic winds. How do they know this is true or that the SAM does not influence non-Antarctic winds. Please rephrase.

In the discussion of multicollinearity in section 3.1.1, VIFs are introduced without a reference. It is also not clear what R is (it too needs a reference). An example on which dependent and independent variables contributed to the calculation of a VIF would perhaps clarify this section.

The authors should note the presence of the following two Antarctic observation and analysis papers in the context of both trends and linkages to climatological indices:

French W.J.R., Mulligan F.J., Klekociuk A.R.(2020) Analysis of 24 years of mesopause region OH rotational temperature observations at Davis, Antarctica – Part 1: long-term trends, *Atmospheric Chemistry and Physics* 6379--6394; doi:10.5194/acp-20-6379-2020

French W.J.R., Klekociuk A.R., Mulligan F.J. (2020) Analysis of 24 years of mesopause region OH rotational temperature observations at Davis, Antarctica – Part 2: Evidence of a quasi-quadrennial oscillation (QO) in the polar mesosphere, *Atmospheric Chemistry and*

Physics 8691–8708; doi:10.5194/acp-20-8691-2020, 2020.;

The discussion of gravity wave tendencies in section 6 and near line 434 should include consideration of the relationship between GW tendency and the background wind. Wave breaking is affected by background wind conditions so a discussion of GW tendency needs to consider the existing relationships between climatological factors and the winds discussed earlier in the paper. The plot title on Fig 8a should include a word or symbol that denotes tendency. (It is misleading when read by itself as it is.)

Specific comments:

Near line 292 (first paragraph of section 5.2), the zonal 95-100km ENSO significant zone (fig 6c) seems to extend into June.

Near line 349 – The authors should note that the 10 deg latitude difference between Scott Base and Rothera could affect comparisons.

Sentence starting L 443. At what height does the effect on GW forcing seen by Li et al (2016) occur?

L35 'constrain' to 'constraining'

L64 move parenthesis after '1992' to after '(2009)'

L94 Suggest delete 'In this section we discuss'

L130 Suggest small 's' on 'Solar' and follow by a comma

L 182 replace 'to test' with 'which'

L212 Start a new sentence after 'Figure 3'

L282 Delete last 's' in 'westwards'

L293 delete 'a' before 'south'

L294 '... WACCM-X in either component'? This is now what I see. Please check wording.

L333 Do you mean QBO30 in this line?

L391 insert 'by' after 'paper'

L406 Suggest replace 'Although' with 'However'

L466 replace 'affects' with 'effects'

L473 End sentence after 'all heights'