The importance of the QBO meridional circulation for modulating the polar vortex in climate models

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The Quasi Biennial Oscillation (QBO) is known to influence the strength of the northern hemisphere stratospheric polar vortex in winter. While there is still some debate around the specific QBO-to-polar vortex teleconnection mechanism, the ability of the QBO to modulate planetary wave propagation is likely to be an important factor. Holton and Tan (1980) propose that movement of the zero-wind line southward during the westerly phase of the QBO increases wave propagation towards the equator away from the polar vortex, hence strengthening the vortex, while Garfinkel et al. (2012) demonstrate that circulation changes associated with the QBO-generated secondary residual meridional circulation play a more important role for the propagation of planetary waves, and thus for the vortex, than the movement of the zero-wind line. The QBO effect on the polar vortex is usually weaker in models than in observations. We hypothesize that the weak model response is related to biases in the simulated secondary meridional circulation, which is usually too narrow in the models. We use long, pre-industrial runs from several climate models with internally generated QBOs, and artificially remove biases by sub-selecting years with more realistically looking QBO meridional circulation. We show that the polar vortex response to the QBO phase strengthens in this sub-set of years, thus providing support for the primary role of the QBO meridional circulation in modulating the vortex response.

Key words: QBO, Polar Vortex, Meridional Circulation, Model Biases

References

Holton, J. R., and Tan, H. C. 1980: The influence of the equatorial quasi-biennial oscillation on the global circulation at 50 mb. *Journal of the Atmospheric Sciences*, **37**, 2200-2208.

Garfinkel, C.I., Shaw, T.A., Hartmann, D.L. and Waugh, D.W., 2012: Does the Holton–Tan mechanism explain how the quasi-biennial oscillation modulates the Arctic polar vortex?. *Journal of the Atmospheric Sciences*, **69**, 1713-1733.