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Stratospheric bimodality and the connection between the QBO and the NH winter vortex.

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The stratospheric Northern Hemisphere (NH) winter mean vortex alternates between a strong and a weak state which is manifested in a statistically significant bimodal distribution. In the end of the 1970s a regime change took place increasing the probability of the strong phase relative to the weak phase (Christiansen 2003).

In this paper we investigate the connection between the regime behavior of the vortex and the equatorial quasi-biennial oscillation (QBO) in three different data sets (NCEP, ERA40, and FUB reanalyses). The vortex is defined as the leading principal component of geopotential height at 20 hPa north of 20 N. The QBO is represented by the equatorial mean wind at 50 hPa. Although there are some differences between the data sets they agree regarding the general picture.

We find that stratospheric equatorial wind between 70 and 8 hPa shows a bimodal structure in the Northern Hemisphere winter. Such a bimodality is non-trivial as it requires an only weak variability in the amplitude. Unimodality is found above 8 hPa, where the semi-annual oscillation dominates. We find a strong coincidence between strong (weak) vortex winters and winter in the westerly (easterly) QBO regime.

We also find that the change of the vortex in the late 1970s can be related to a change in the QBO from a period with strong bimodality to a period with weak bimodality. Careful consideration of the statistical significance show that this change in the QBO can be random process simply related to the annual sampling of the QBO. Thus, no additional physical explanation of the regime behavior and regime change of thevortex may be necessary.

Finally, we consider previous findings of phase-locking between the QBO and the annual cycle and show that the phase-locking is related to the seasonal variations in the bimodality of the QBO.

Reference: Christiansen, B., Evidence for nonlinear climate change: Two stratospheric regimes and a regime shift. J. Climate, 16, 3681-3689, 2003.