



The Holton-Tan relationship in the CMIP5 and CCMVal2 models

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The motivation for this study is the observation that the stratospheric Northern Hemisphere 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). Christiansen (2010) found a strong coincidence between strong (weak) vortex winters and the westerly (easterly) QBO phase.

In this paper we investigate the connection between the QBO and the NH vortex - the Holton-Tan relationship - in historical CMIP5 and CCMVal2 experiments. The CMIP5 archive contains both models with and without a spontaneously generated QBO. Additionally, the CCMVal2 archive includes models with prescribed QBOs.

We find that models with prescribed or spontaneously generated QBOs do show realistic bimodal behavior of the QBO and that the strength of the variability of the vortex in the models is realistic. However, we also find that the Holton-Tan relationship is generally weaker in the models than in the reanalysis but that it in general has the right sign.

In a long (1000 years) pre-industrial control run (MPI-ESM-MR) the winter QBO shows considerable low-frequency variability. Furthermore, the correlation between the QBO and the vortex calculated from different 50 years periods shows large differences ranging from weakly negative values to 0.45. This might indicate that the observed strong Holton-Tan relationship is a chance occurrence particular to the recent period.