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Seasonal Variations of the Quasi Biennial Oscillation in the MPI Earth System Model

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We investigate seasonal modulations of the quasi-biennial oscillation (QBO) of the tropical stratosphere using the Max Planck Institute Earth System Model. We analyze the QBO in a 500 year simulation for pre-industrial boundary conditions of 1850. The atmospheric model is truncated at wave number 63, which makes the parametrization of non-stationary gravity waves necessary. In the vertical direction the atmosphere is resolved in 95 levels up to 0.01 hPa.

The simulated QBO shows a realistic period, variance, amplitude and vertical extend. We find that the seasonal distribution of the onset of QBO westerly jets is almost exclusively determined by westerly jets of the semi-annual oscillation (SAO) at 5hPa, where both oscillations overlap. Hence, phase alignment of the westerly jets occurs in spring and fall. Also QBO easterly jets are influenced by easterly branches of the SAO, but the seasonal clustering at 5hPa in winter and summer is less exclusive. We further discuss how the QBO jets initiated in spring or fall differ in their following downward propagation through the upper stratosphere. Here, differences can be related to the seasonal stalling of the easterly jets in the lower stratosphere between 30 and 50 hPa. In the middle stratosphere between 15 and 30hPa, seasonal variations of the wave forcing and the equatorial upwelling lead to strong variations of the propagation rates of the QBO jets.

Because both subsets of jets, initiated either in spring or fall, show coherent downward propagation characteristics, the seasonal clustering of the westerly jets extends through the whole stratosphere, but shifts to later months with increasing pressure.