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The quasi-biennial oscillation in a global warming climate

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The effects of anticipated 21st century global climate change on the stratospheric quasi-biennial oscillation (QBO) has been studied using a high-resolution version of the MIROC atmospheric GCM. This version of the model is notable for being able to simulate a fairly realistic QBO for present day conditions including only explicitly-resolved nonstationary waves. We ran a long control integration of the model with observed climatological sea-surface temperatures (SSTs) appropriate for the late 20th century, and then another integration with increased atmospheric CO2 concentration and SSTs incremented by the projected 21st century warming in a multi-model ensemble of coupled ocean-atmosphere runs that were forced by the SRES A1B scenario of future atmospheric composition. In the experiment for late 21st century conditions the QBO period becomes longer and QBO amplitude weaker than in the late 20th century simulation. The downward penetration of the QBO into the lowermost stratosphere is also curtailed in the late 21st century run. These changes are driven by a significant (30-40 %) increase of the mean upwelling in the equatorial stratosphere, and the effect of this enhanced mean circulation overwhelms counteracting influences from strengthened wave fluxes in the warmer climate. The momentum fluxes associated with waves propagating upward into the equatorial stratosphere do strengthen overall by about 10-15% in the warm simulation, but the increases are almost entirely in zonal phase speed ranges which have little effect on the stratospheric QBO, but which would be expected to have important influences in the mesosphere and lower thermosphere.

Keywords: QBO, gravity wave, global warming