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Driving of the QBO by gravity waves and global-scale waves: a comparison between satellite data and reanalyses

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The quasi-biennial oscillation (QBO) is the dominant mode of atmospheric variability in the tropical stratosphere. It has effects on the weather and climate in the tropics and the extratropics. The QBO is a wave-driven circulation pattern of alternating easterly and westerly winds that propagate downward with time. Climate models have problems in simulating a realistic QBO because of problems in simulating the QBO wave driving in a realistic way. Both mesoscale gravity waves and global-scale tropical waves contribute to the wave driving of the QBO, but the relative contribution of the different wave types is not well known.

For the period 2018 until mid 2023 we estimate the QBO driving by gravity waves from the residual in the TEM momentum budget for three modern reanalyses (ERA5, MERRA2, and JRA55) and compare absolute values of the QBO gravity wave driving with estimates derived from temperature observations of the SABER satellite instrument. Qualitatively, good agreement is found, but MERRA2 gravity wave driving seems to be too strong in the upper stratosphere. Further, we derive the QBO eastward driving by global-scale Kelvin waves for the reanalyses and from SABER observations. The QBO eastward driving by Kelvin waves is similarly strong as the gravity wave eastward driving, and again good agreement is found between SABER and the reanalyses. In the reanalyses below 30km the total westward driving of the QBO by global-scale waves, however, seems to be weaker than the estimated gravity wave driving.