Investigation of the climatology and long-term variations of the stratospheric Kelvin waves using ERA-Interim

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In this study, we proposed a new aspect, based on the temporal evolution of the stratospheric zonal wind, investigating the properties of Kelvin waves during different temporal stages of quasi-biennial oscillation (QBO) in the stratosphere. 16 cycles of the stratospheric QBO were found during the period of 1979–2018 using the zonal wind profiles over the equatorial region (±10˚), which was retrieved from ERA-Interim, a long-term reanalysis dataset produced by the European Centre for Medium-Range Weather Forecasts (ECMWF). The duration of each QBO cycle varies from 23 to 42 months among the 16 cycles, and this variability causing the investigations regarding Kelvin waves and QBO are unexpectedly arduous. Therefore, we tried to standardize the elapsed time during each QBO cycle to 0–1, to study the climatological connections between the QBO phase and the amplitudes of wavenumber 1 as well as wavenumber 2 Kelvin waves. Another reanalyzed atmospheric parameter of temperature were retrieved from the same ERA-Interim dataset, and the Kelvin wave amplitudes at 6–24 days periods were analyzed using the method of two-dimensional fast Fourier transform (2D-FFT). The results of the present study show the dominant wave period varies from shorter to longer periods as the time elapses in a QBO cycle. Fast Kelvin waves are more evident in the upper stratosphere, but slow Kelvin waves are further apparent in the lower stratosphere. Besides, we also found the Kelvin wave activities have significantly increased in the 21st century. The present study is the first attempt to investigate the long-term (40 years) morphology of Kelvin waves using the ERA-Interim reanalysis dataset. Conclusions regarding the climatological variations of Kelvin waves lend us further understanding of the Wave-mean flow interactions in the stratosphere over the equatorial region.

Keywords: Atmospheric Kelvin waves, Quasi-biennial oscillation, Wave-mean flow interactions, ERA-Interim

