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Kelvin wave propagation and climatology in the tropical tropopause layer

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Kelvin waves are large-scale convectively coupled waves in the tropics, and can propagate through the tropical tropopause layer (TTL) and into the stratosphere. In the TTL they have been linked to vertical mixing and cirrus formation. We have developed a new method to identify and track individual waves across multiple levels, and we apply this method to ECMWF ERA Interim reanalysis temperature data. We first filter the data using correlation with a template wave in place of the spectral filter often used in previous work, and find this new filter gives enhanced performance when looking at zonally asymmetric features in Kelvin wave activity. The waves are then tracked by connecting local maxima in the filtered data both horizontally and vertically taking into account the typical propagation characteristics of the waves. A statistical picture of Kelvin wave propagation, and in particular the paths waves take through the TTL, can be built up from these tracks. Unlike previous work, this method can robustly detect low amplitude Kelvin waves, allowing the decoupling of wave activity and wave propagation, giving a different and more accurate picture of propagation than that from looking at Kelvin wave activity alone.

The background winds have the largest influence on wave propagation, and we show that the large seasonal cycle in tropical winds causes a seasonal cycle of Kelvin wave propagation and of stratospheric Kelvin waves. Very different pathways for vertical wave propagation exist in different seasons. ENSO also significantly alters the winds in the tropics, and in particular modifies the Walker circulation, which causes a large change in Kelvin wave propagation. To understand these climatological results, we also present a climatology of Kelvin wave forcing using brightness temperature as a measure of convective activity, and find our results for TTL Kelvin wave propagation to be consistent with changes in tropospheric convective forcing.