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Kelvin waves in ECMWF analysis: normal-mode diagnostics

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Equatorial Kelvin waves show a large spread in spatial and temporal variability similar to their source of tropical convective forcing. Once decoupled from their source, Kelvin waves are modulated during their ascent by changes in the background wind and stability. In this presentation, we focus on the seasonal and interannual variability of Kelvin waves in relation with variability of (i) tropical convection and (ii) background zonal wind and static stability.

Global data is extracted from ECMWF operational analysis from January 2007 till May 2011 on 91 model levels (top level at 0.01 hPa) and $\sim$ 25 km horizontal resolution. Using three-dimensional orthogonal normal-mode expansions, we project input mass and wind data simultaneously onto balanced rotational modes and unbalanced inertia-gravity modes including Kelvin modes. Next, an inverse transformation of Kelvin modes to physical space is performed under the linearity assumption, allowing a study on the spatial and temporal variability of Kelvin wave zonal wind and temperature.

Results show an annual cycle in KW zonal wind in agreement with other studies. Minima resp. maxima in zonal wind amplitudes are found in the Indian ocean resp. Western Pacific and are most pronounced in the tropical tropopause at 150 hPa in January and 100 hPa in July. The annual cycle is enhanced (reduced) through interaction with a descending westerly QBO phase and enhanced (reduced) convective forcing. We also note a gradual eastward shift of KW zonal wind maxima till January 2010 in correspondence with an eastward shift of tropical convection.