

EGU22-8251

<https://doi.org/10.5194/egusphere-egu22-8251>

EGU General Assembly 2022

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



Zonal wavenumber spectra of the vertical velocity and horizontal wind divergence associated with the Rossby and non-Rossby waves in the tropics

Valentino Neduhal¹, Nedjeljka Žagar¹, and Žiga Zaplotnik²

¹Meteorological Institute, University of Hamburg, Hamburg, Germany

²Faculty of Mathematics and Physics, University of Ljubljana, Ljubljana, Slovenia

In contrast to the kinetic energy spectrum of the horizontal motions, the spectrum of kinetic energy of vertical motions (vertical kinetic energy spectrum) is poorly known because the vertical velocity is not an observed quantity of the global observing system. The vertical kinetic energy spectra can be simulated by non-hydrostatic models but are difficult to validate. Furthermore, contributions to the vertical kinetic energy spectrum from the Rossby and gravity waves have traditionally been treated separately using the quasi-geostrophic omega equations and the polarization relations for the stratified Boussinesq fluid, respectively. This approach is difficult to apply in the tropics, where the Rossby and gravity wave regimes are nonseparable and the frequency gap between the Rossby and gravity waves, present in the extra-tropics, is filled with the Kelvin and mixed Rossby-gravity waves.

We apply a unified framework for the derivation of vertical velocities of the Rossby and inertia-gravity waves and associated kinetic energy spectra using the eigensolutions of the linearized primitive equations. It can be considered applicable to the hydrostatic atmosphere with horizontal scales up to around 10 km. The derivation involves the analytical evaluation of divergence of the horizontal wind associated with the Rossby and inertia-gravity modes. The new framework is applied to the ECMWF analysis in August 2016 and August 2018. Latitude and altitude dependence of the horizontal wind divergence and vertical kinetic energy spectra within the tropics are discussed and compared with observations over the tropical Atlantic. In particular, we discuss the slope of the vertical kinetic energy spectra for the two dynamical regimes.