

Towards a seamlessly diagnosable expression for the energy flux associated with both equatorial and mid-latitude waves

*Hidenori AIKI^{1,2}, Richard J Greatbatch^{3,4}, Martin Claus³

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. Application Laboratory, Japan Agency for Marine-Earth Science and Technology, 3. GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, 4. University of Kiel

For mid-latitude Rossby waves (RWs) in the atmosphere, the expression for the energy flux for use in a model diagnosis, and without relying on a Fourier analysis or a ray theory, has previously been derived using quasi-geostrophic equations and is singular at the equator. By investigating the analytical solution of both equatorial and mid-latitude waves, the authors derive an exact universal expression for the energy flux which is able to indicate the direction of the group velocity at all latitudes for linear shallow water waves. This is achieved by introducing a streamfunction as given by the inversion equation of Ertel's potential vorticity, a new and novel aspect when considering the energy flux. For ease of diagnosis from a model, an approximate version of the universal expression is explored and illustrated for a forced/dissipative equatorial basin mode simulated by a single-layer oceanic model that includes both mid-latitude RWs and equatorial waves. Equatorial Kelvin Waves (KWs) propagate eastward along the equator, are partially redirected poleward at the eastern boundary of the basin as coastal KWs, followed by the shedding of mid-latitude RWs that propagate westward into the basin interior. The connection of the equatorial and coastal waveguides has been successfully illustrated by the approximate expression of the group-velocity-based energy flux of the present study, which will allow for tropical-extratropical interactions in oceanic and atmospheric model outputs to be diagnosed in terms of an energy cycle in a future study.

Keywords: group velocity, model diagnosis, tropical-extratropical interactions

