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Interactions between almost unstable baroclinic waves and the tropical convection in aquaplanet simulations

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Simulations performed with the ECHAM5 GCM and the boundary conditions provided in the control simulation of the aquaplanet intercomparison project feature a strong and persistent wavenumber 5 signature. Such a mode peaks around 30 degrees, has a preferential symmetric component between the two hemispheres, and a weak baroclinic zonal tilt. Moreover, a phase lock with the tropical convection is observed. Previous works, mainly based on models without an explicit convection, called for an inverse energy cascade as the process that feeds energy in a wave 5 Rossby wave whose phase propagation is slowed down by the interaction with the high frequency. The theory is here expanded by taking into consideration the interaction with the tropical convection and the baroclinicity of the system.

Spectra of the meridional wind velocity shows that the wave 5 component is part of a well defined dispersion relation ranging from wave number 3 to 7 with westward group velocity. A decrease in the mid-tropospheric temperature gradient displaces the components toward a more eastward propagation, and leads to the subsequent stabilization of wavenumber 6 and 7. The analysis of the cospectra of VT and WT shows how the stabilised quasi-stationary component is a marginally stable wave, transporting but only partially converting energy. These results are interpreted in agreement with the Green's model of baroclinic instability, and the Hoskins and Karoly ray propagation's theory. Moreover, the stationary, marginally stable baroclinic wave can resonate with the tropical convection, thus becoming itself a tropical-extratropical coupled unstable wave. The dynamic of the process of interaction is discussed and its overall feedback on the energetic of the systems is evaluated.