

# Rossby wave interaction connecting the tropics and midlatitudes: a new asymptotic theory and solitary waves

Joseph A. Biello with A.J. Majda

## Abstract

Equatorial baroclinic Rossby waves are equatorially trapped and can respond to equatorial diabatic heating. Equatorial barotropic Rossby waves have a significant projection and midlatitudes. Both of these families of Rossby waves are weakly dispersive in the limit of long zonal wavelength and their wave speeds allow for resonant interactions on intraseasonal timescales. We have developed simplified asymptotic equations for the nonlinear interaction of long wavelength equatorial Rossby waves and barotropic Rossby waves with a significant midlatitude projection in the presence of suitable horizontally and vertically sheared zonal mean flows. The simplified equations allow for nonlinear energy exchange between the barotropic Rossby waves and the baroclinic equatorial waves for non-zero zonal mean vertical shear through wave-wave interactions. Idealized examples in the model demonstrate that midlatitude Rossby wave trains in a baroclinic mean shear can transfer their energy to localized equatorially trapped baroclinic Rossby waves through a nonlinear “westerly wind burst” mechanism. Conversely, equatorially trapped baroclinic Rossby wave trains in the idealized model can transfer substantial energy to the midlatitude barotropic Rossby waves. From the viewpoint of applied mathematics, the asymptotic equations derived here have several novel features. In particular, they admit analytic solitary wave solutions which correspond to interesting localized vortical flows in the equatorial troposphere.