Abstract View

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Weak Interactions of Equatorial Waves in a One-Layer Model. Part I: General Properties

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ABSTRACT

Dispersive equatorial waves are labeled by the zonal slowness s, the meridional quantum number n and the vertical separation constant c. The slowness (reciprocal of phase speed) is a variable more useful than the wavenumber to relate the interactions among equatorial waves. For instance, frequency is a simpler function of slowness than it is of wavenumber, and the four classes of equatorial waves are separated in s-space; *viz.*, Rossby (R): $sc \leq -2n - 1$, mixed Rossby-gravity (M): $sc < 1$, gravity (G): $-1 < sc < 1$, and Kelvin (K): $sc = 1$. Moreover, total energy and pseudo-momentum conservation require for the component with intermediate slowness of each triad to gain (loose) energy from (to) the other two. (If the triad is resonant, the wave with intermediate s must also have maximum absolute frequency.)

Nonlinear effects are parameterized by a single variable, the interaction coefficient &ggr; for each resonant triad (RT). The interaction and resonance conditions are reduced to finding the zeros of a polynomial of, at most, sixth degree is s; allowing for classification of all possible resonant triads: There are three types of RT for $n > 0$: *RRR*, *GGR*, and *GGG*; resonant triads with M ($n = 0$) and/or K ($n = -1$) components have the properties of one of these three classes, depending on the frequency of the wave(s) with $n < 1$ (namely, the M and K may be taken as an R for $\omega^2 \leq \beta c/2$ or as a G otherwise).

Non-local resonant triads in frequency space include: the packets of Rossby or inertia–gravity waves interacting with a long Rossby mode; short Rossby or inertia–gravity waves with different meridional quantum numbers interacting with a long Rossby or Kelvin mode (geostrophic flow); and the scattering of a short westward propagating inertia–gravity wave into a short eastward propagating inertia–gravity, mixed Rossby–gravity or Kelvin wave, by a short Rossby (or a mixed Rossby–gravity) wave with twice the wavenumber.

Unlike the problems of quasi-geostrophic flow at *midlatitude* and internal gravity waves in a vertical plane, there are resonant triads of equatorial waves with the same speed, which have a finite interaction coefficient.

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