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Spontaneous emission of gravity waves in idealized flows

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The coupling mechanisms between balanced motions and gravity waves have been an outstanding issue in research on the limitaions of balanced motions and on the sources of gravity waves for two decades. Some recent advances have come from the study of certain idealized flows simple enough for an explanation of the generation mechanism to be proposed. More precisely, simulations of idealized baroclinic life cycles have shown that waves generated by upper-level jets appeared in regions of strong strain and vertical shear. Simulations of dipoles have confirmed the importance of such regions (jet exit regions), but are simpler because the background flow is nearly stationary in the appropriate frame of reference (frame moving with the dipole).

The mechanism for the emission of inertia-gravity waves in the jet exit region of a dipole is explained using primitive equation simulations of a dipole and linear simulations of the evolution of perturbations to a balanced dipole. The background flow on which the linearization is made is crucial to determine the structure and characteristics of the emitted waves. The calculation of the forcing, coming from residual tendencies which appear when balanced fields are injected into the primitive equations, is crucial to determine the amplitude of the waves. Using the linear model and information coming only from the balanced dipole, we obtain an estimate of the emitted waves that compares well with those obtained in the full primitive equation simulations.

Based on the example of the dipole, diagnostics that give indications regarding the location and amplitude of spontaneously emitted waves are derived and tested in simulations of idealized baroclinic life cycles. Their use for applications and parameterizations is discussed.