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Slow Nonhydrostatic Flow and Balanced Energetics

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Gravity wave radiation by balanced flow evolution is currently the subject of considerable debate, with laboratory, numerical and theoretical examinations arguing the effect is anywhere from vanishingly weak to routine. Here a theoretical and numerical examination of balanced evolution characterized by O(1) aspect ratios is carried out, as such a parameter setting is typical of many laboratory settings. Accordingly, it is argued that the wave properties of the system are quite distinct from a system characterized by small aspect ratio. In particular, the fluid exhibits superinertial and subinertial linear wave modes characterized by vertical shear in layers of constant density. The restoring force on the flow comes from a combination of Coriolis acceleration and pressure gradients, so the oscillations are not strictly inertial. The flows are 'slow', yet nonhydrostatic effects are leading order. The predicted long time behavior of the system departs markedly from that of the hydrostatic one in that exchanges between balanced and unbalanced flows appear at leading order and importantly involve the nonhydrostatic effects. Numerical experimentation supports the basic results of the analytic development and yields evolution broadly consistent with the laboratory.