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Frontal instability and the radiation of inertia gravity waves

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In this experimental study we consider the instability of a density front in a differentially rotating two–layer fluid. Within the rotating frame the upper layer is accelerated by the differential rotation of a lid at the surface. In contrast to former comparable experiments of this type, we consider miscible fluids in a relatively wide annular tank. Velocity and dye measurements (PIV and LIF) allow for the measurements of the velocity and density fields. In the parameter space set by rotational Froude number and dissipation (i.e. ratio of spin-down time to disk rotation time), different flow regimes are observed, ranging from axisymmetric to irregular baroclinic instable flows. The different regimes more or less adjoin those found for immiscible fluids by Williams et al. (J. Fluid Mech. 2005).
In the present experiments, we find a new type of instability that is due to the resonant interaction between Kelvin and Rossby waves (first studied Sakai,
J. Fluid Mech 1989) and compare our experimental results with the analytical results obtained on an annular domain by Gula, Zeitlin and Plougonven (2009).
Further, observations in the unstable flow regimes suggest 'spontaneous emission' of inertia gravity waves. The origin of these waves is discussed in the light of Kelvin-Helmholtz instability Hölmböe instability, and geostrophic adjustment waves.