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Mixing induced in a dense current flowing down a sloping bottom in a rotating fluid

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A density driven current was generated in the laboratory by releasing dense fluid over a sloping bottom in a rotating freshwater system. The behavior of the dense fluid descending the slope has been investigated by systematically varying four parameters: the rotation rate, the bottom slope, the flow rate of the dense fluid, and the density of the dense fluid. Over a wide range of parameter values, the following four flow types were found: laminar, wave, turbulent and eddy regime. All of the experiments revealed that increasing the slope angle and the density of the dense fluid allowed the flow to evolve from the laminar, to the wave, to the turbulent regime. Furthermore, increasing rotation rate induced the formation of eddies. For values of the Froude number greater than one the wave regime was observed in which wave-like disturbances appeared on the interface between the dense and fresh fluids. For values of the Froude number less than one, the laminar regime occurred in which the dense current had a constant thickness behind the head. The amount of mixing between the dense and the ambient fluids was measured and its dependence on the Froude number and on the distance downslope was determined for increasing values of the Reynolds number. Mixing increased significantly when passing from the laminar to the wave regime; i.e. with increasing Froude number. We believe that mixing between the dense salty water and the lighter fresh water was caused by breaking waves. In particular, for some parameter values the waves grew to such large amplitudes that they were observed to break in a three-dimensional fashion, possibly increasing the amount of mixing. We quantified the amount of mixing observed and estimated the value of the entrainment velocity at the interface between the dense fluid and the fresh overlying fluid. The results have been compared with previous laboratory experiments which presented the classic turbulent entrainment behavior and observational estimates of the Mediter-

ranean and Denmark Strait overflow. The agreement between the observations and the laboratory experiments was encouraging and indicated that the waves observed in the present experiments may be a possible candidate for the mixing observed during oceanic overflows.