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On the coalescence of anticyclones in stratified rotating flows

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Oceanic meso-scale lenticular vortices play an important role in the redistribution of heat, salt and momentum in oceans and thus contribute to the climate equilibrium on Earth. These vortices are governed by geostrophic and hydrostatic balances between pressure gradients, Coriolis and buoyancy forces from where they get their shape and aspect ratio [1,2]. This equilibrium leads to quasi-2D balanced motions in which energy is prevented to feed small scales by the conservation of potential vorticity. Understanding the way energy escapes from this mesoscopic turbulence to feed the smallest oceanic scales where dissipation occurs, is the subject of an intense research. Among several different routes to dissipation, the emission of internal gravity waves has been evoked to be a possible conveyor of energy redistribution [3]. On another hand, vortex pairing events are often observed in oceans [4] where they participate to the complex dynamics of the mesoscopic turbulence in the oceans. The aim of the present study is to describe and parametrize the merging of two lenticular anticyclones by means of stratified flow experiments performed on a rotating table. For this purpose, we generate pairs of anticyclonic vortices by the gentle injection of a small volume of water inside a continuously stably stratified rotating layer in the same way that Griffiths & Hopfinger [5] did thirty years ago for a two layer system. Aside from describing the different regimes that lead or not to the coalescence of the pairs, in particular the determination of the critical initial separation distance [6] (to our knowledge this problem has never been revisited experimentally in the case of a continuously stratified layer), the final goal of this research will be to quantify the amount of the ageostrophic energy loss when two lenticular vortices are coalescing. Indeed, during the transient time of their merging, the dipolar unbalanced structure that forms may radiate away internal gravity waves that will dissipate the excess of energy of the pair compared to the final balanced single anticyclone.

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