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Stability of submesoscale wake vortices in a rotating and stratified shallow-water layer: laboratory experiments.

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Laboratory experiments were performed on the Coriolis rotating platform to study the three-dimensional instabilities of intense wake vortices. A linear salt stratification was set in the upper layer, which mimics the oceanic thermocline, on the top of a thick barotropic layer, which resembles a deep-ocean condition. In order to reproduce the dynamic of a surface current interacting with an isolated and steep island (or archipelago), obstacles were towed only in the upper layer. Several vortices with different size and intensities were generated in the shallow surface layer, considering several stratification profiles. We focus here on the generation of submesoscale eddies (i.e. radius smaller than the local deformation radius). This experiment is the first laboratory study, run at large Reynolds (Re=3000-50000), which explored the impact of the thermocline stratification on the stability of intense shallow-water anticyclones. It is well known that inertial and/or elliptical instabilities may strongly destabilize intense anticyclonic eddies, if the vorticity in the vortex core is negative enough (ξ/f<-1), where ξ is the relative vorticity and f the Coriolis parameter. However, we found that several anticyclones remain stable even for intense negative vorticity values i.e. up to (ξ/f=-3.5), in strong stratification conditions (i.e. large burger number). Linear stability analysis of shallow-water vortices, suggests that the growth of three-dimensional perturbations, is mainly controlled by: the Burger number, the Rossby number, and the Ekman number. Both laboratory and theoretical studies confirm a large stability region for the submesoscale anticyclonic vortices, particularly when the Rossby and the Burger numbers are large.