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Island wake dynamics: various parameters and regimes of asymmetry

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Island wakes in the open sea are regions of strong eddy activity at meso or sub-meso scales. Various asymmetry of theses eddies were studied by means of laboratory experiments and numerical simulations. Unlike the classical two-dimensional wake, where the Reynolds number controls the vortex street, the wake of isolated oceanic island or archipelago is controlled by at least three dimensionless parameters. These include the Rossby number, the Burger number and the Ekman number. At large scale, for small Burger number, the linear stability analysis of frontal wake flows explains the preferred formation of anticyclonic vortices in the lee of large islands. Once they are formed, theses large-scale anticyclones tend to be more stable and robust to external strain perturbations than their cyclonic counterparts. Hence, if the island or the archipelago is large enough (larger than the deformation radius) we could expect the predominance of large anticyclones in the oceanic wake. Moreover, in such case, a transition from absolute to convective instability was also found for rotating shallow-water wakes. The patterns of the convectively unstable wake strongly differ from the standard two-dimensional Karman street and the vortices are shed at an higher frequency (i.e. larger Strouhal). At smaller scales, for large Burger number, the Rossby and the Ekman number control the dynamics. Recent experimental and numerical results have shown that an island wake flow may exhibit a transient and three-dimensional instability in the region of intense anticyclonic vorticity (finite Rossby). This instability is a branch of the inertial (or centrifugal) instability in the framework of rotating, stratified shallow-water flows. The stabilizing impact of the thermocline stratification will be taken into account in the Burger number. Hence, theses various regimes of asymmetry will be presented in the Rossby-Burger phase space diagram.