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Inertial instability in island wakes

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Submesoscale and intense vortices are often encountered in the wakes of isolated islands. However, unlike the standard two-dimensional Kármán street, the oceanic vortex streets are affected by the earth's rotation and the vertical stratification of the thermocline. Inertial instability, which is a centrifugal instability mechanism in the presence of the Coriolis force, is a destructive mechanism that acts selectively on anticyclones with strong vorticities. Here we present preliminary results suggesting that this instability may be an additional, and somewhat overlooked, mechanism for three-dimensional mixing in island wakes, supplying nutrient-rich waters from the base of the photic zone, and creating localized blooms. In contrast, the stratification has a stabilizing effect, which limits the mixing, and may lead to stable anticyclones with finite relative vorticity.

We use linear stability analysis to define the dynamical parameters that govern the stability, and find the parameters, which are both insensitive to different vorticity profiles and are relatively easy to estimate from laboratory experiments and oceanic in situ measurements. We map this parameter space, and corroborate our findings with large-scale laboratory experiments studies, performed at the LEGI-Coriolis platform. Finally, we compare our calculations with some published oceanic island wake case studies.