Equilibration of symmetric instability and inertial oscillations at an idealised submesoscale front

AARON WIENKERS, DAMTP, University of Cambridge, LEIF THOMAS, Stanford University, JOHN TAYLOR, DAMTP, University of Cambridge — Submesoscale fronts with large lateral buoyancy gradients and $O(1)$ Rossby numbers are common in the upper ocean. These fronts are associated with large vertical transport and are hotspots for biological activity. Submesoscale fronts are susceptible to symmetric instability (SI) — a form of stratified inertial instability which can occur when the potential vorticity is of the opposite sign to the Coriolis parameter. Growing SI modes eventually break down through a secondary shear instability, leading to 3D turbulence and vertically mixing the geostrophic momentum. Once out of thermal wind balance, the front undergoes inertial oscillations which can drive further small-scale turbulence.

Here, we consider the idealised problem of a balanced front with uniform horizontal buoyancy gradient and bounded by flat no-stress horizontal surfaces. We study the equilibration of this unstable front using a linear stability analysis and 3D numerical simulations. We find drastically different behavior emerging at late times. While weak fronts develop frontlets and excite subinertial oscillations, stronger fronts produce bore-like gravity currents. We describe the details of these energy pathways as the front evolves toward the final adjusted state in terms of the dimensionless front strength.

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