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The role of asymmetric tidal mixing in the subtidal dynamics of narrow estuaries

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Observations of subtidal longitudinal flow in coastal plain estuaries often reveal seaward flow near the surface and landward flow near the bottom. Classical models explain this two-layer structure due to horizontal density gradients. However, also tides can contribute to the creation of significant subtidal currents through nonlinearities in advection terms, as well as through asymmetries in turbulent mixing, due to tidal straining of the density field.

In this contribution, the role of asymmetric tidal mixing in the generation of residual currents and in the net transport of salt is investigated using a series of experiments with a numerical model (ROMS) that simulate narrow estuaries under different tidal forcing and freshwater input conditions. It will be shown that the intensity and the vertical structure of the residual flow and the net salt transport due to asymmetric tidal mixing strongly depend on the stratification characteristics of estuaries (well-mixed, partially mixed, highly stratified). The changes in residual flow characteristics result from the influence of density stratification on the covariance of eddy viscosity and velocity shear that represents the driving force of asymmetric-tidal-mixing-induced flow in the tidally averaged momentum equation.