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Cross-shelf transport and dispersion due to baroclinic instabilities

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The dominant forcing mechanisms for the circulation in the northwestern Gulf of Mexico are largely determined by location relative to the shelf break. On the inner shelf, the flow is mostly controlled by the wind and on the outer shelf is affected by the mesoscale loop-current eddies. However, in the summer, baroclinic instabilities can develop along the boundary of the mid-shelf river plume front, leading to large eddies ($\sim$50 km length scale) that can reach across the entire shelf and strongly affect the local flow field. These instabilities advect fresher water toward the shelf edge and pull denser water back toward the coast. The details of how the flow crosses between these two regimes is of interest because it controls the flux of river-borne biogeochemical properties to the deep ocean, as well as for the potential onshore transport of oil from offshore spills.

We approach this problem using a high resolution numerical model of the Texas-Louisiana shelf run using the Regional Ocean Modeling System (ROMS) and a Lagrangian particle tracking model (TRACMASS). By initializing drifters at the sources of fresh water (the Atchafalaya and Mississippi rivers) in the numerical model, we are able to explicitly track its trajectory through the numerical domain in time. These trajectories can then be used to characterize the cross-shelf transport and lateral dispersion due to the instabilities caused by the presence of the fresher water. We expect the transport and dispersion to be enhanced when compared with these quantities at other times of the year when the instabilities are not present, as well as with other regions of the shelf break that are farther from the plume edge area.

Additionally, an idealized numerical model of a shelf break with both horizontal and vertical density gradients has been run through relevant parameter spaces to examine the range of baroclinic instabilities. Drifters are run in these simulations for comparison of transport and dispersion with that seen in the realistic model.