The Effect of Bottom – Generated Tidal Mixing on Tidally Pulsed River Plumes

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Abstract:

The mixing of river plumes into the coastal ocean influences the fate of river-borne tracers over the inner-shelf, though the relative importance of mixing mechanisms under different environmental conditions is not fully understood. In particular, the contribution to plume mixing from bottom generated shear stresses, referred to as tidal mixing, is rarely considered important relative to frontal and stratified shear (interfacial) mixing in surface advected plumes. The effect of different mixing mechanisms is investigated numerically on an idealized, tidally pulsed river plume with varying river discharge and tidal amplitudes. Frontal, interfacial, and tidal mixing are quantified via a mixing energy budget to compare the relative importance of each to the overall buoyancy flux over one tide. Results indicate that tidal mixing dominates the energy budget when the tidal mixing power exceeds that of the input buoyancy flux. This occurs when the non-dimensional number, $Ri_E R_0^{-1}$ (the estuarine Richardson number divided by the mouth Rossby number), is generally less than 1. Tidal mixing accounts for between 60% and 90% of the net mixing when $Ri_E R_0^{-1} < 1$, with the largest contributions during large tides and low discharge. Interfacial mixing varies from 10% to 90% of total mixing and dominates the budget for high discharge events with relatively weaker tides ($Ri_E R_0^{-1} > 1$). Frontal mixing is always less than 10% of total mixing and never dominates the budget. This work is the first to show tidal mixing as an important mixing mechanism in surface advected river plumes.