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Internal waves in Columbia River estuary

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Internal waves (IWs) as found in and near the Columbia River are long believed to play a prominent role in small-scale mixing and have important implications for coastal ecosystem (Pan et al. 2007). While some IWs are generated by the interaction between the tides and the shelf (Moum et al. 2003), or by the decelerating plume front (Stashchuk and Vlasenko, 2009), here we examine IWs generated in the north channel of the estuary at certain tidal phases. The generation mechanism is hypothesized to be the flow of flooding stratified fluid over sharp bathymetric transitions. Evidence of the IWs include persistent occurrence of rough surface “patches” as captured by SAR imagery, and small-scale features observed with two REMUS-100 autonomous underwater vehicles and a shipboard echo-sounder.

Here, the focus is on a phased modeling study designed to better understand and characterize the generation mechanism of the estuarine IWs. We start with vertically resolved, essentially 2D baroclinic simulations of circulation in a schematic channel-like domain with variable bathymetry, with tides and oceanic salinity forced at the ocean boundary, and freshwater discharge at the river boundary. We then extend the modeling effort to realistic 3D domain, bathymetry and boundary forcing, as found in the Columbia River estuary, where model results can be qualitatively compared against field observations. In both domains, results from hydrostatic and non-hydrostatic simulations are inter-compared, with differences interpreted towards identification of generation mechanisms and of persistent features that can be the target of further observational studies. Hydrostatic simulations are conducted with an established 3D numerical model (SELFE, Zhang and Baptista 2008), which skill has been extensively assessed against Columbia River data from the SATURN observation network (http://www.stccmop.org/datamart/observation_network). Non-hydrostatic simulations constitute the first application of a new, yet unpublished, version of SELFE.

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