# A baroclinic model of the Columbia river-to-ocean continuum

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The Columbia River estuary is characterized by high river discharges and strong tides which generates generating high velocity flows and sharp density gradients. Its dynamics strongly affect the coastal ocean circulation. Numerically modelling this region requires the model to be multiscale, but also not too diffusive to correctly represent the plume propagation and the salinity intrusion in the estuary.

To model this ROFI, we use and develop SLIM 3D, a finite element model that solves the Boussinesq hydrostatic equations on unstructured grids with a P1DG scheme. The grid is vertically extruded on a constant number of "sigma-z" levels, where the resolution is focused in the near-surface region.

The bathymetry of the estuary alternates between deep narrow channels and shallow areas. In order to keep its relevant features, we developed an iterative smoothing procedure to satisfy the Haney criterion elementwise, and hence limiting the diffusion to an unresolved scale.

In this work, we analyze the ability of SLIM 3D to reproduce the main features of the Columbia River-to-ocean continuum. In particular, we emphasize on the tidal variations of the salinity intrusion, as well as on the plume characteristics, the latter being strongly impacted by the wind stress. We compare the results with in-situ data on the shelf and at multiple locations in the estuary.

A fair comparison is also performed with another unstructured grid model, SELFE, that has been extensively used in that region. Both models are compared on idealized testcases and on the Columbia River ROFI benchmark. Our simulations confirm the tendency of SELFE to be quite diffusive, resulting in overly smoothed density gradients when compared to observations, where SLIM 3D seems to reproduce sharper fronts.

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