High-resolution simulation of stratified flow and separation over an abrupt sill in a estuary

B. Wang[1], O.B. Fringer[2]

[1]Department of Civil and Environmental Engineering
Environmental Fluid Mechanics Laboratory
Stanford University
Stanford, California 94305
bingwang@stanford.edu

[2]Department of Civil and Environmental Engineering
Environmental Fluid Mechanics Laboratory
Stanford University
Stanford, California 94305
fringer@stanford.edu

Simulating the local flow field produced by an abrupt bathymetric feature or obstacle in an estuary is crucial to understanding the potential for erosion and deposition of sediments. While simulations are relatively straightforward to perform for small domains with idealized geometry and uniform ambient flows, they are much more difficult in realistic estuarine settings with complex bathymetry and strong tidal forcing. In this work, a high-resolution numerical model is developed to study the flow field around an abrupt sill in the Snohomish River estuary, WA, where energetic eddies are observed on the free surface in the wake of the sill. Because the flow and salinity fields are highly variable in time and space and wetting and drying occurs on nearby intertidal mudflats, it is impossible to provide the boundary conditions needed to simulate the sill as a small isolated system. Therefore, in our model, we employ an unstructured grid with resolution varying from 300 m offshore to 1 m around the sill, and aim to incorporate both the estuarine dynamics at the scale of tens of kilometers and the flow features in the vicinity of the sill at the scale of several meters. The predicted tidal flow and salinity dynamics and the eddies around the sill are consistent with field observations. Based on the model predictions, we discuss how the sill interacts with the tidal flow and salinity field at different stages of a tidal cycle.