Numerical Modeling for Tidal Hydrokinetic Turbine Siting

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NNMREC, a partnership between the University of Washington and Oregon State University and funded by the DOE, aims to connect research of renewable marine energy at universities with device developers and public interests. The stated areas of interest are [3]:

- Instrumentation for cost-effective characterization of sites and devices
- Optimization of arrays with respect to device orientation and placement
- Modeling of environmental effects of extraction for both near-field and far-field
- Improved reliability and survivability of devices through use of advanced composites

Goals

- Obtain high resolution 3D flow fields throughout the Admiralty Inlet Region
- Provide information to help in future device placement
- Interact with field experimentalists
- Provide flow information to turbine modelers
- Better understand the overall dynamics of the region, see [5] for an example of dynamics

Approach

- High resolution simulations of Admiralty Inlet using Regional Ocean Modeling System (ROMS) [4]
  - Hydrostatic
  - Terrain-following
  - Structured grid
  - Parallel
  - Large, active user base; local user group
  - One-way nesting successful for a passage in the Puget Sound
- Nest into simulations of Sutherland and MacCready in School of Oceanography

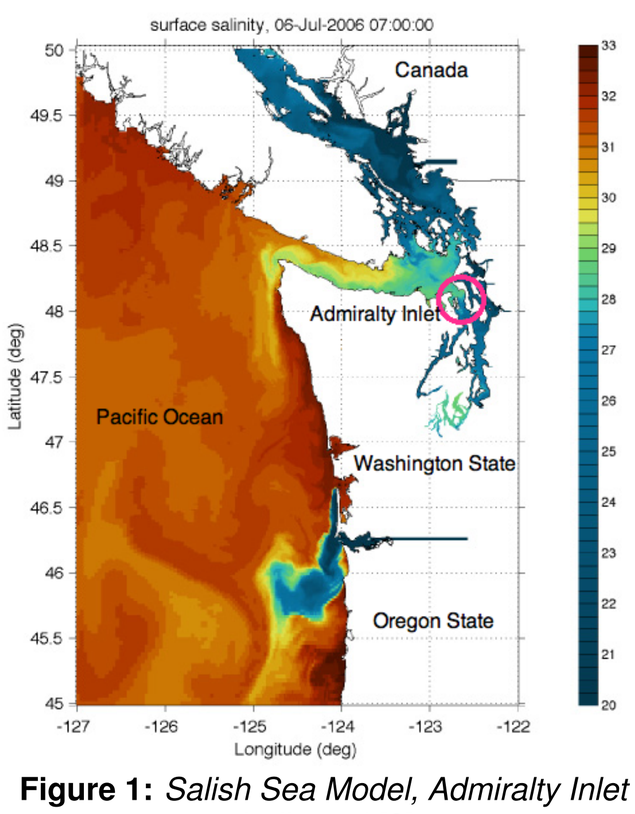

Figure 1: *Salish Sea Model, Admiralty Inlet Indicated [2]*

2D Idealized Simulations

- Simulate significant topographic effects of Admiralty Inlet in layers of complication
- 2D (x-z) flow with various bathymetry setups, density fields, and velocity forcing
- Dynamics of flow over sills
- Better understanding of ROMS and physics
- Build intuition for interpreting results

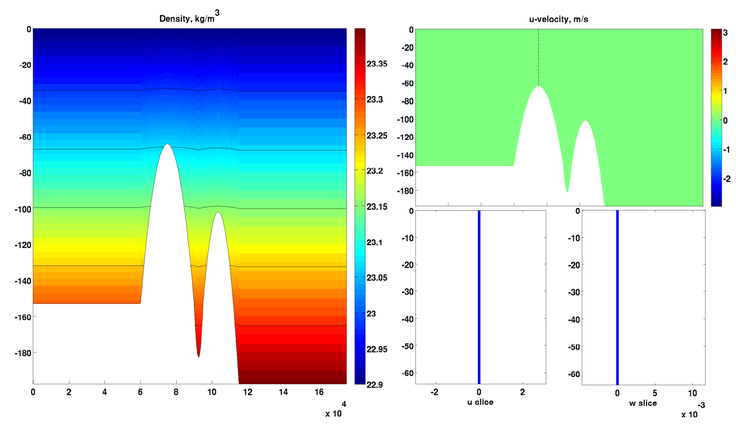

Figure 2: *Sample Linear Density Initialization*

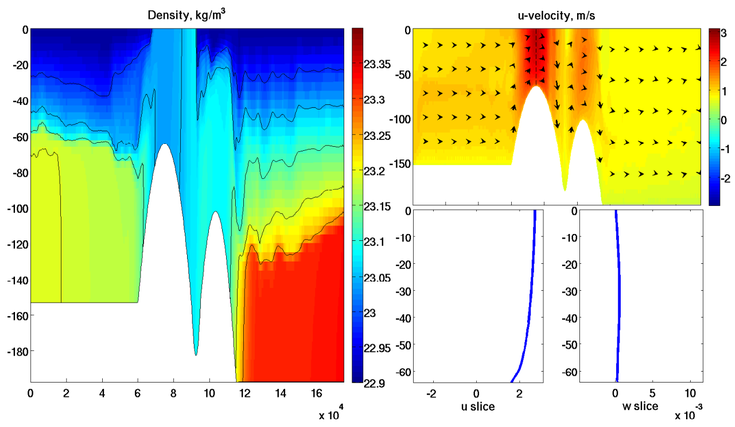

Figure 3: *Sample Results: Density, Velocity, and Slices from Top of First Sill*

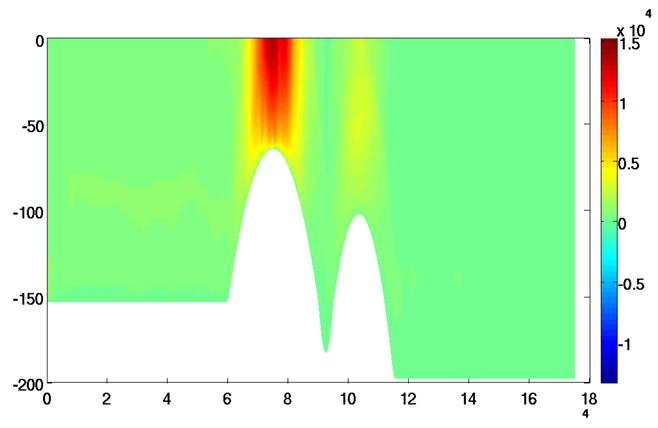

Figure 4: *Sample Results: Kinetic Power Density, W/m^2*

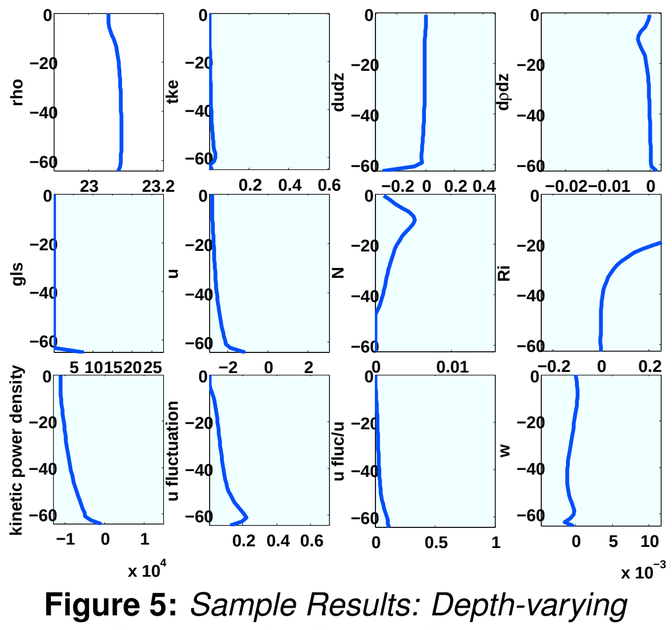

Figure 5: *Sample Results: Depth-varying Properties for Turbine Placement*

Flow Characterization

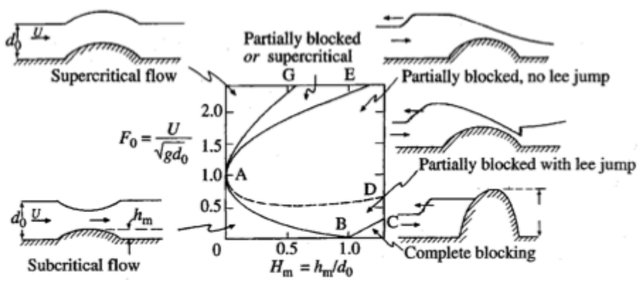

Figure 6: *Possible Flow Regimes [1]*

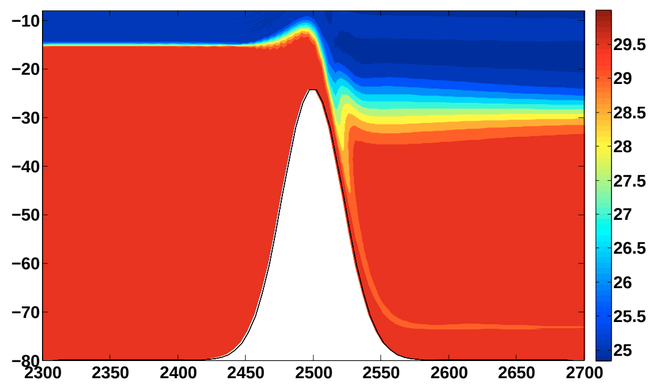

Figure 7: *Two-Layer Flow: Partially Blocked with Lee Jump, Shown in Density Field*

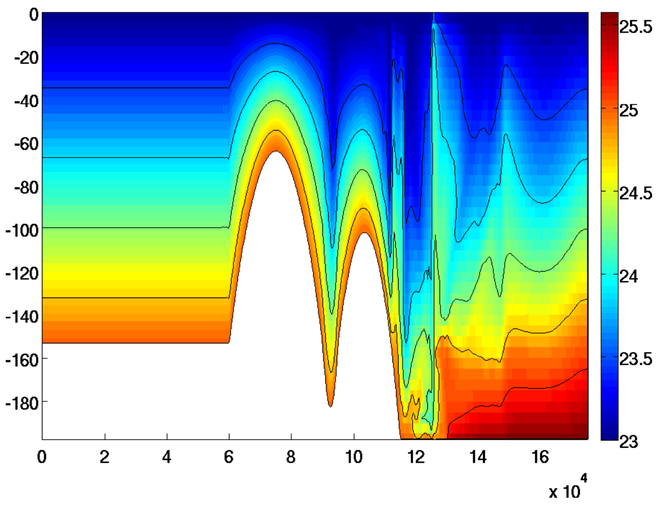

Figure 8: *Continuously Stratified Flow: Supercritical, Shown in Density Field*

Future Work

- More complex idealized flows
- Then move to 3D, realistic, nested Admiralty Inlet simulation
- Characterize flow fields for turbine siting
- Interact with other research areas

References

[1] P. G. Baines. *Topographic Effects in Stratified Flows*. Cambridge Univesity Press, 1995.

[2] Modeling the Salish Sea. http://faculty.washington.edu/dsuth/MoSSea/index.html.

[3] Northwest National Marine Renewable Energy Center: University of Washington branch. http://depts.washington.edu/nnmrec/.

[4] Regional Ocean Modeling System. http://myroms/org.

[5] H. Seim. *Observations and Energetics of an Evolving Shear Instability in Admiralty Inlet*. PhD thesis, University of Washington, 1993.