Site Modeling for Tidal Turbines

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Outline

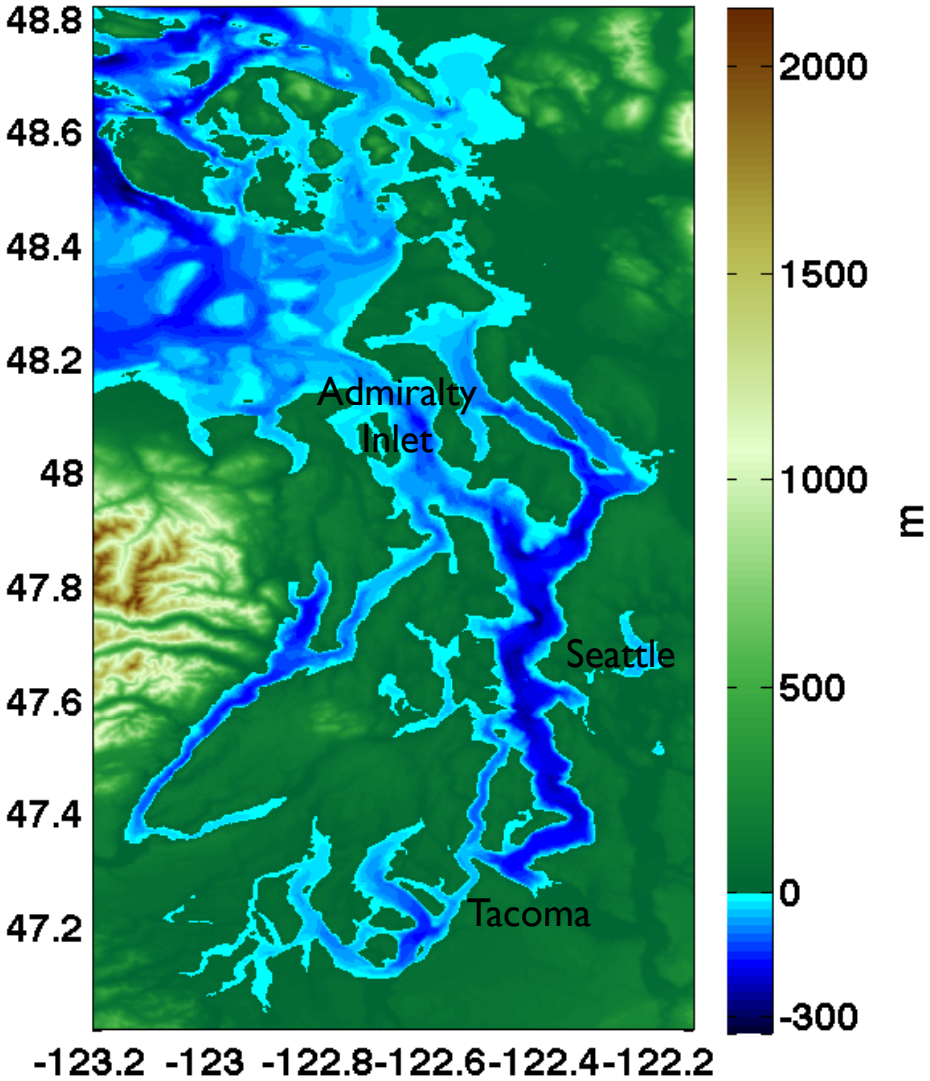
Considerations for Site Characterization

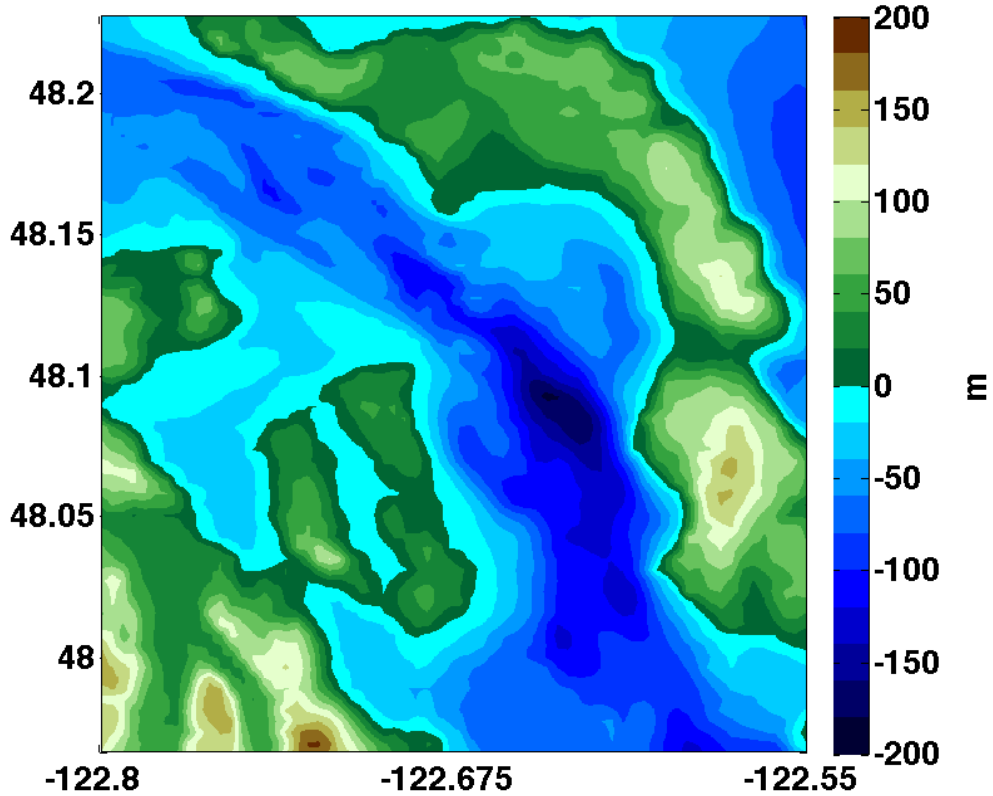
Use metrics as a tool; from European Marine Energy Council and contributed to by NNMREC researchers:

- Quantification of resource
  - Mean speed
  - Mean kinetic power density
  - Turbine operation time
  - Power available given turbine properties
- Qualification of resource
  - Bidirectionality
  - Power bias
- Turbine survivability and efficiency
  - Vertical velocity
  - Shear
  - Turbulence

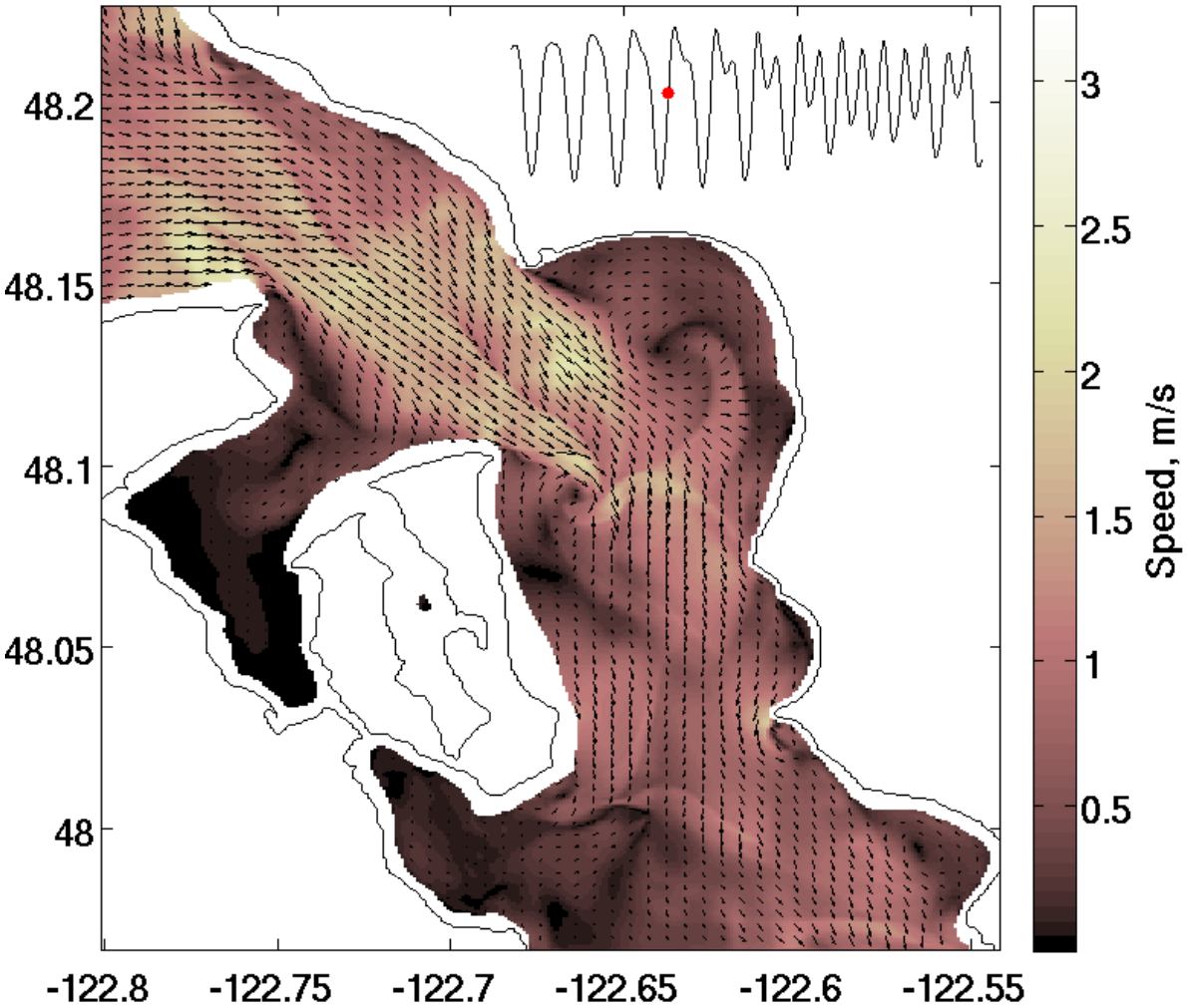
$\Rightarrow$ We want to know where these occur and why

Puget Sound Map and Admiralty Inlet Domain





Simulation Sample and Parameters



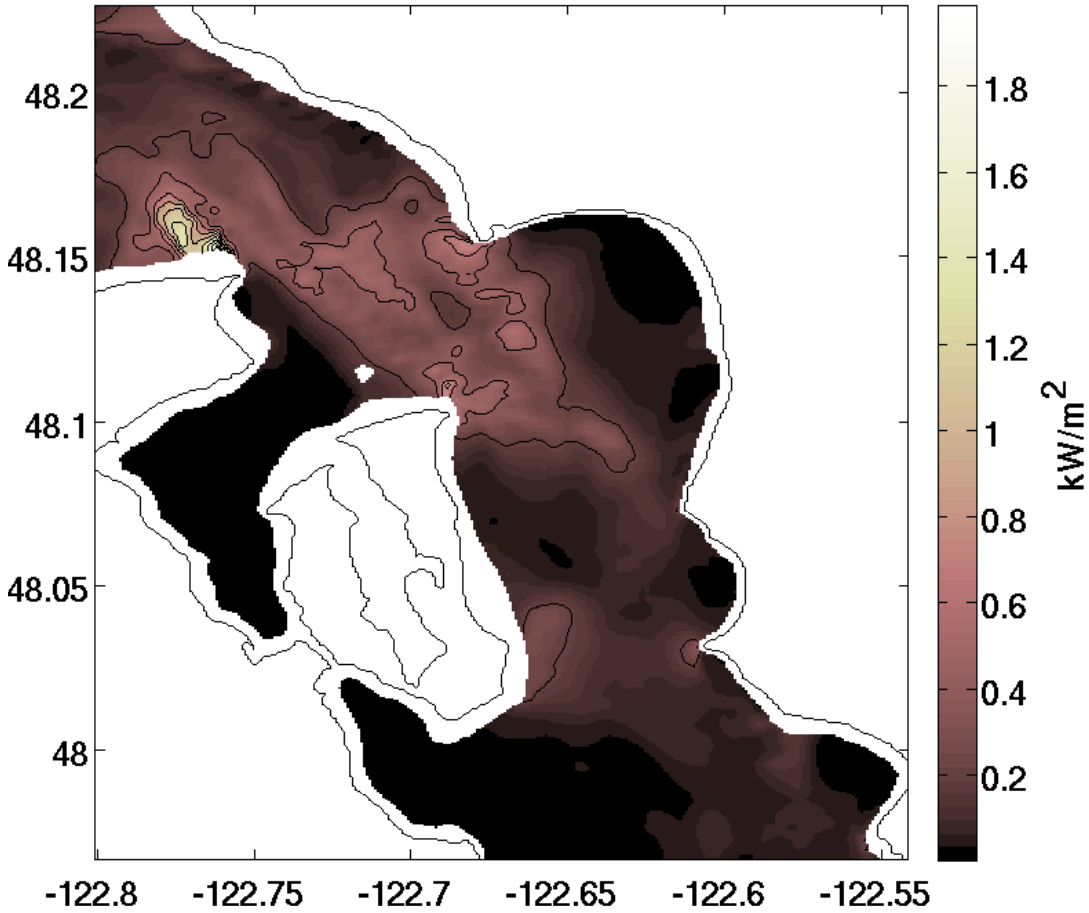
- Higher horizontal resolution (65 meter)
- Higher effective vertical resolution
- Longer run time (30 days)
- More output (every 15 minutes)

Outline

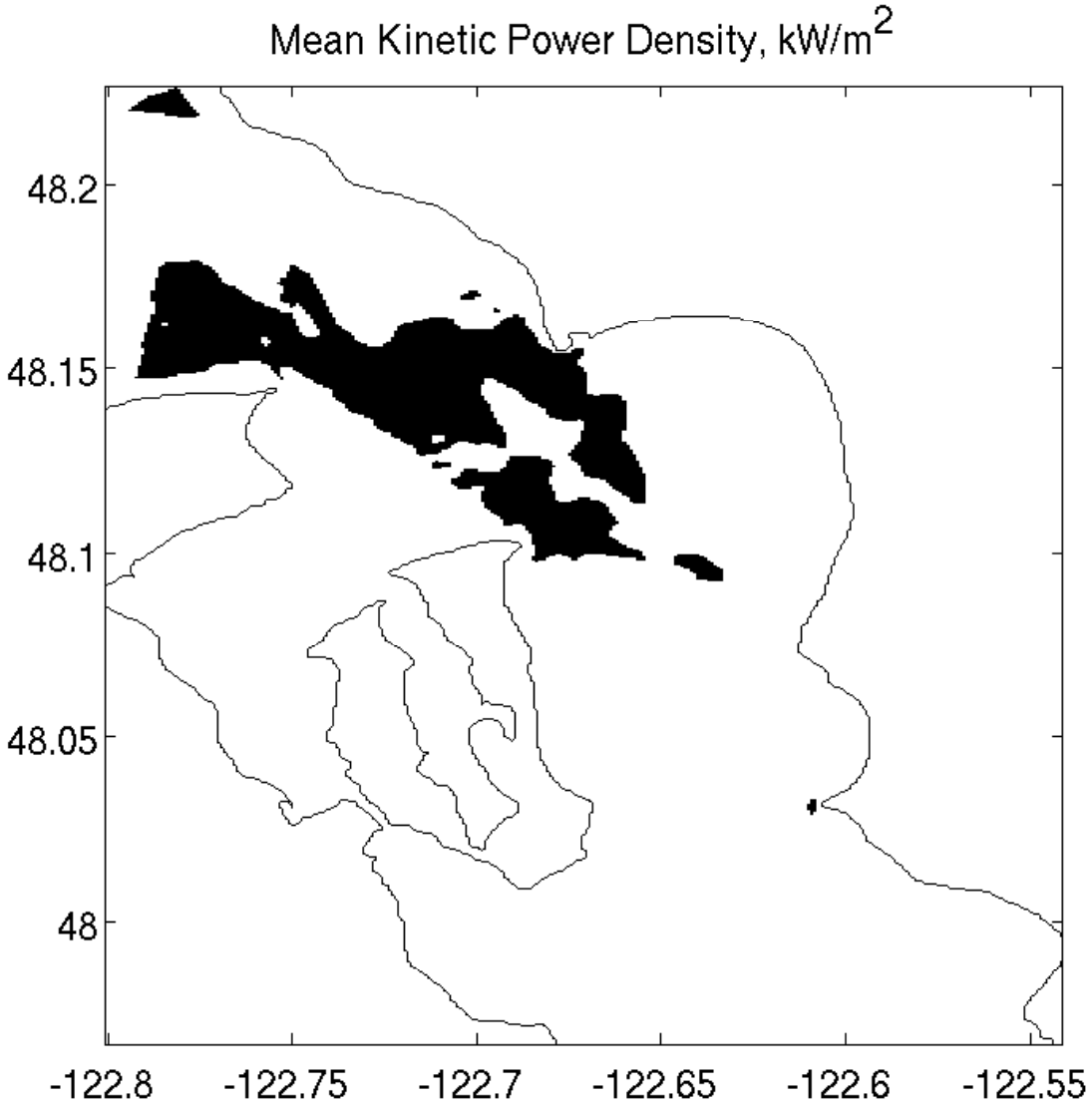
Mean Kinetic Power Density, Shown at Hub Height

A measure of the average resource available

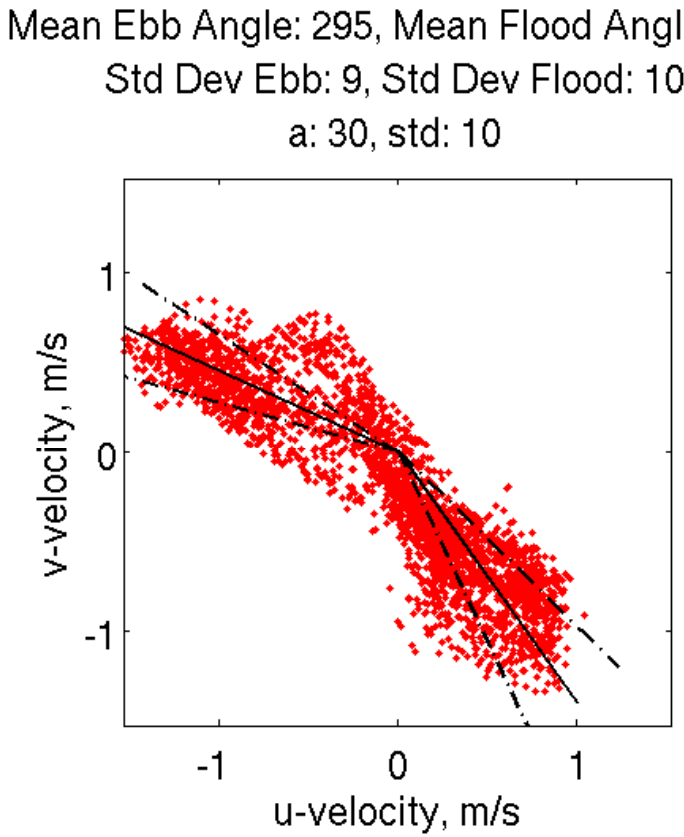
$$\text{KPD} = \frac{1}{2}\rho s^3$$



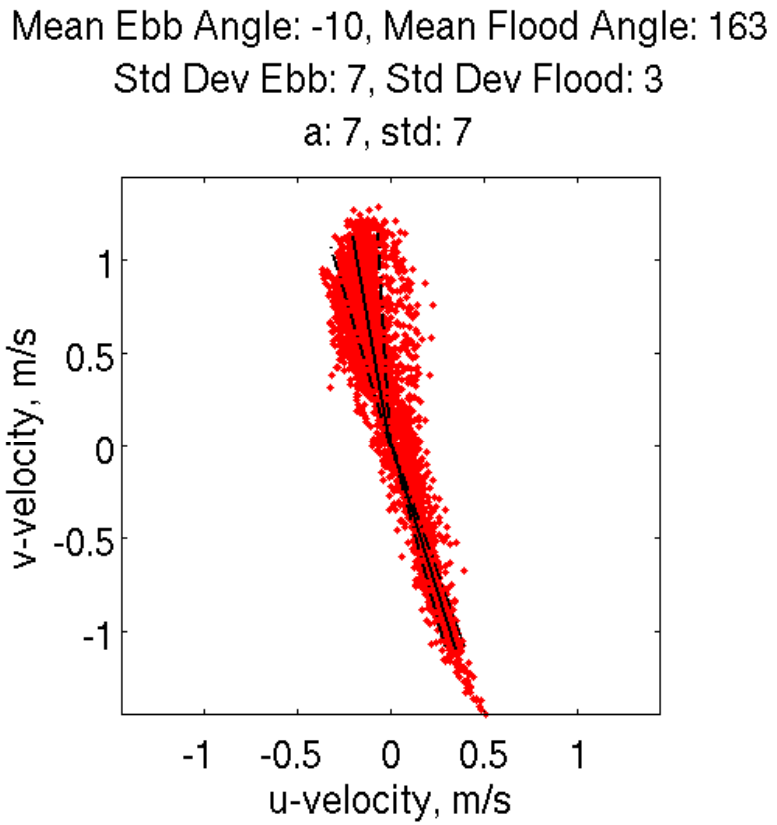
High Mean Kinetic Power Density Areas



Tidal Asymmetry: Bidirectionality and Spread of Direction

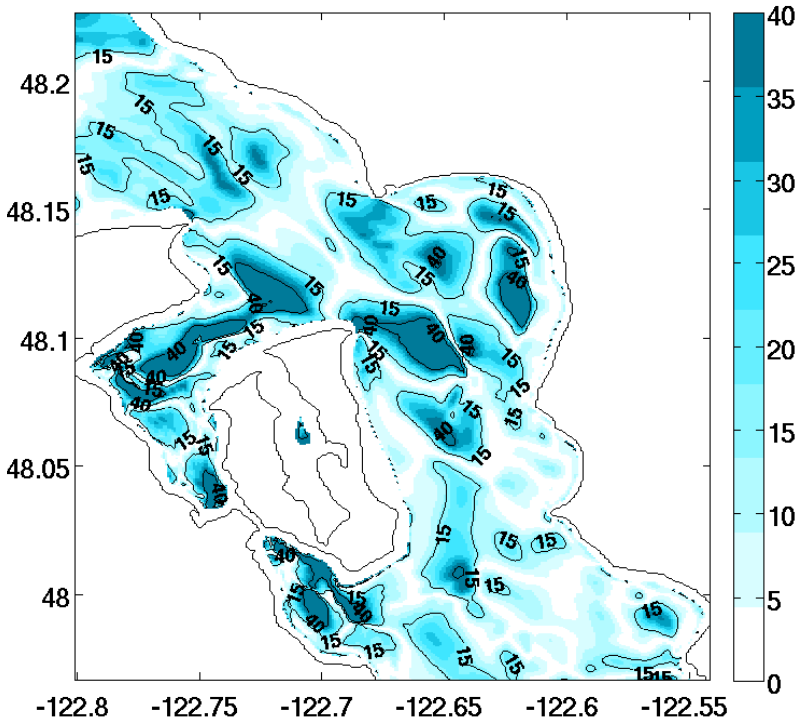


(a) Low Bidirectionality, Higher Directional Deviation

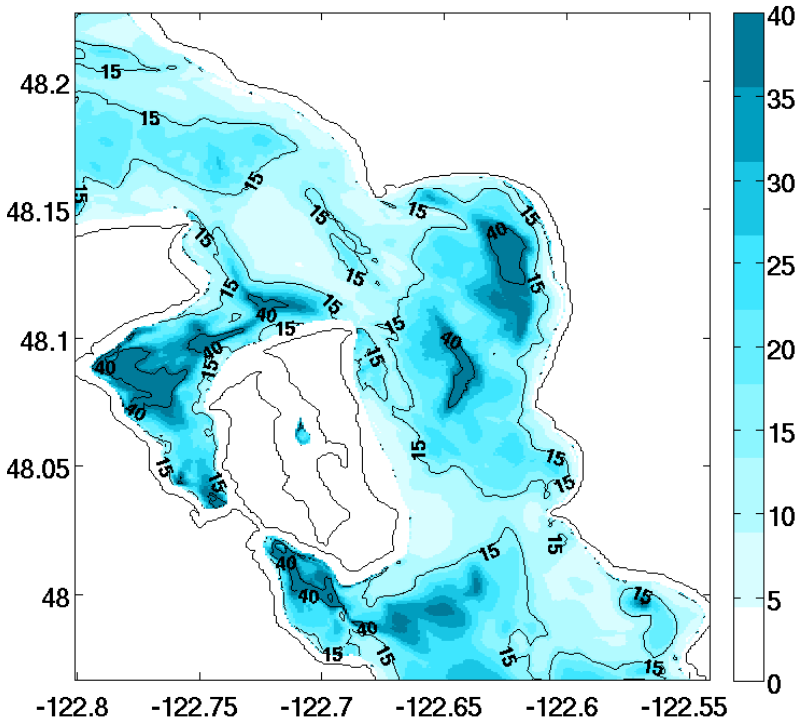


(b) High Bidirectionality, Lower Directional Deviation

Tidal Asymmetry: Bidirectionality and Spread of Direction

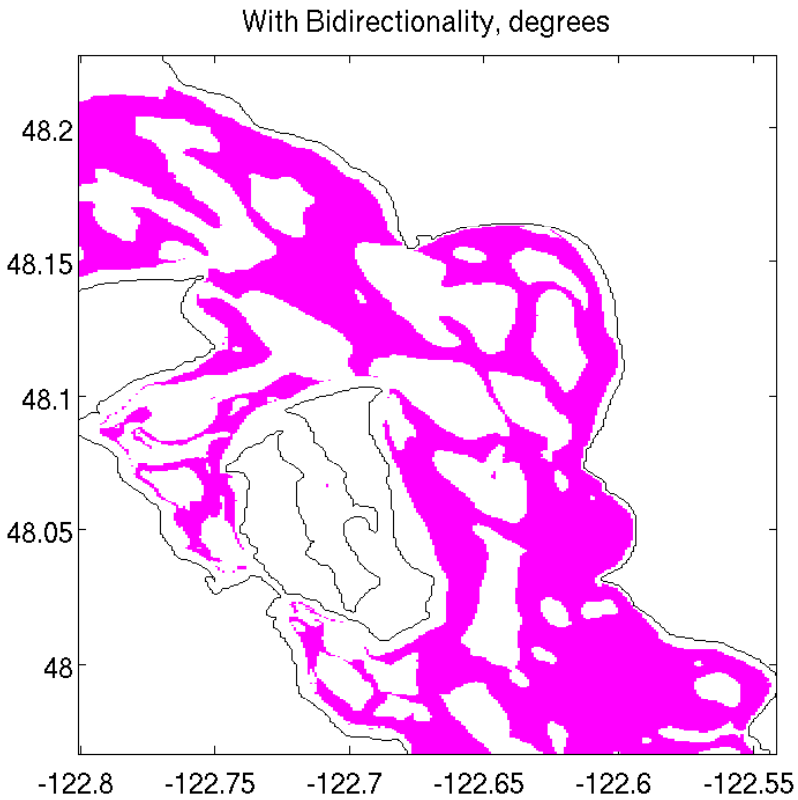


(c) Bidirectionality

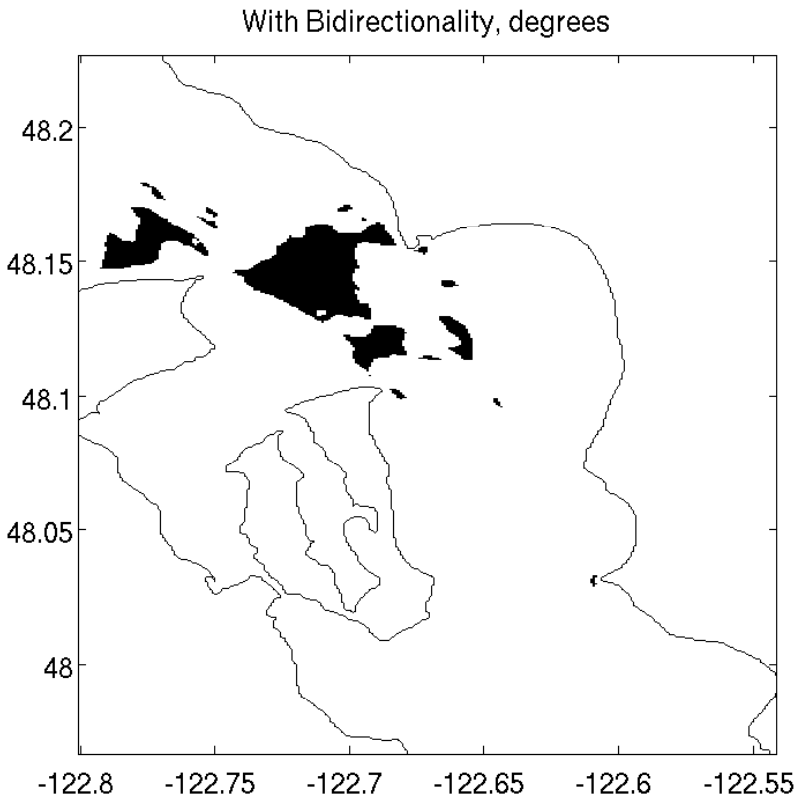


(d) Directional Deviation

Bidirectionality

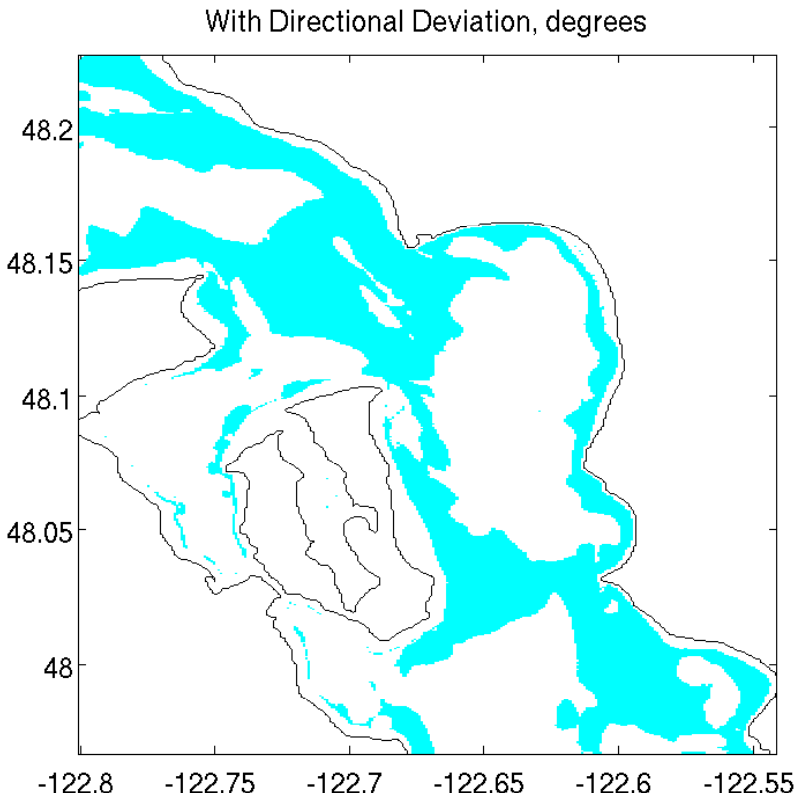


(e) With Cut-off

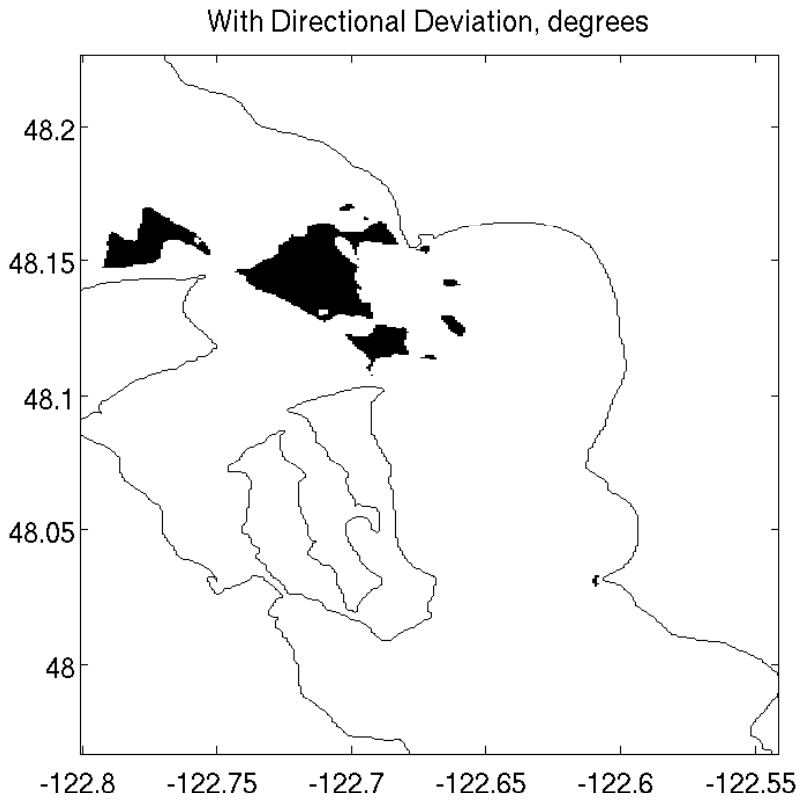


(f) Overlaid on MKPD

Directional Deviation



(g) With Cut-off

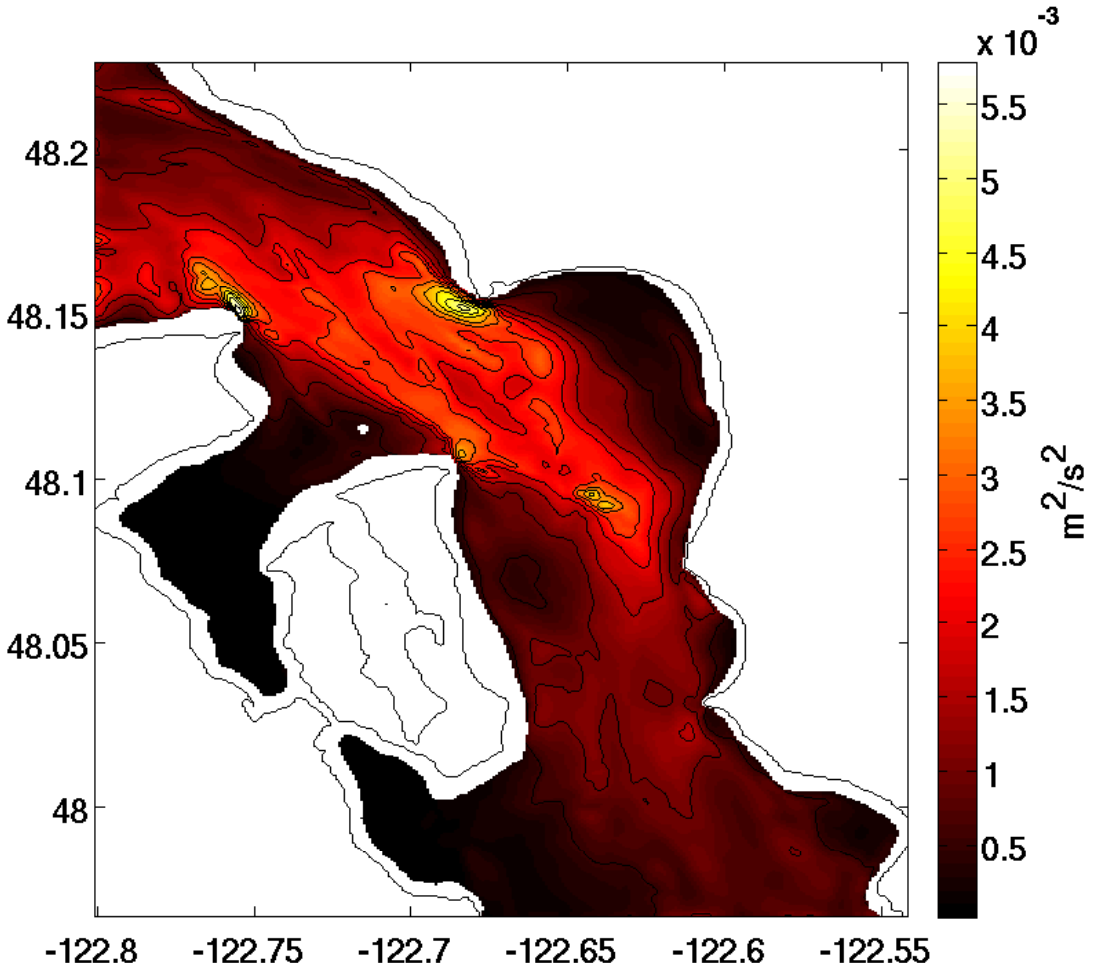


(h) Overlaid on MKPD and Bidirectionality

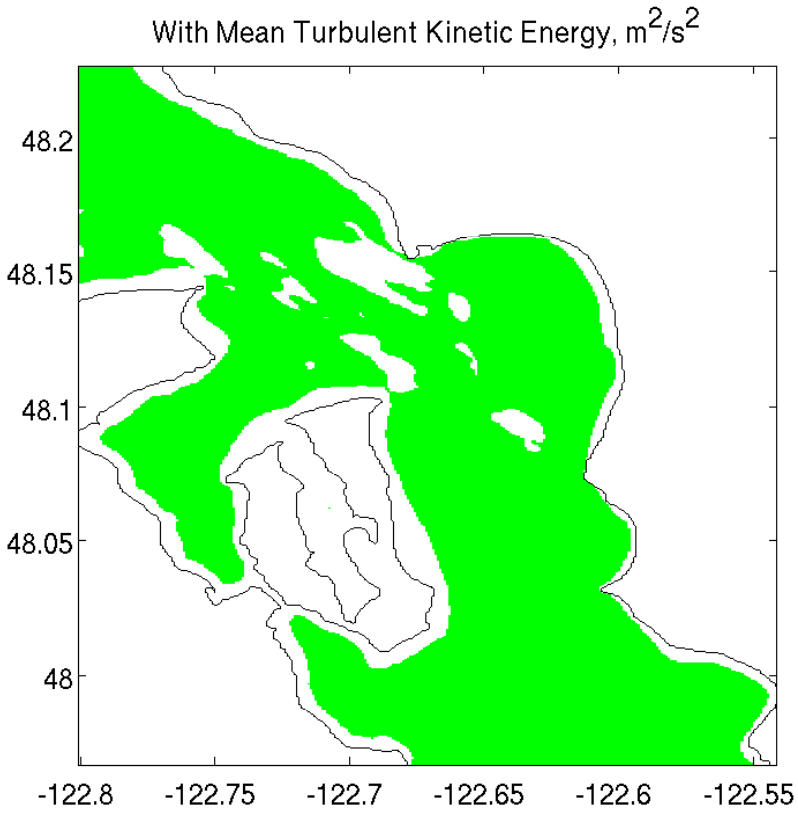
Mean Turbulent Kinetic Energy

Measure of the energy in the velocity fluctuations, is parameterized in the model

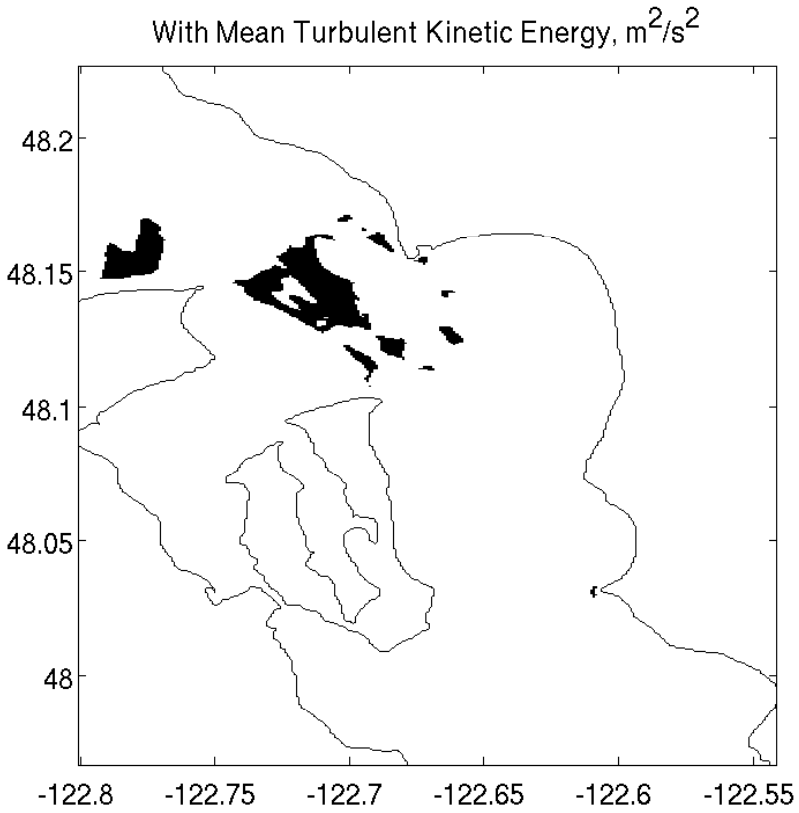
$$\text{TKE} = \frac{1}{2}\left(\left(u'^2\right) + \left(v'^2\right) + \left(w'^2\right)\right)$$



Mean Turbulent Kinetic Energy



(i) With Cut-off



(j) Overlaid on MKPD and Tidal Asymmetry Metrics

Outline

To Dos

- Continue investigating why properties appear where they do
- Help to determine strong locations for turbine deployment based on metrics
- Do another simulation with boundary velocities multiplied by a factor to get speeds up to more realistic levels
- Attempt to do some time series data comparisons with clever ways to line-up data that are not from the same time period