

# Site Modeling for Tidal Turbines

Kristen M. Thyng  
Advisor: James J. Riley

Northwest National Marine Renewable Energy Center  
University of Washington

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# Outline

- 1 Motivation and Methodology
- 2 Results
- 3 To Dos

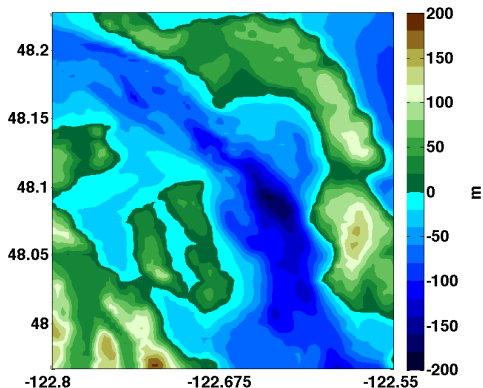
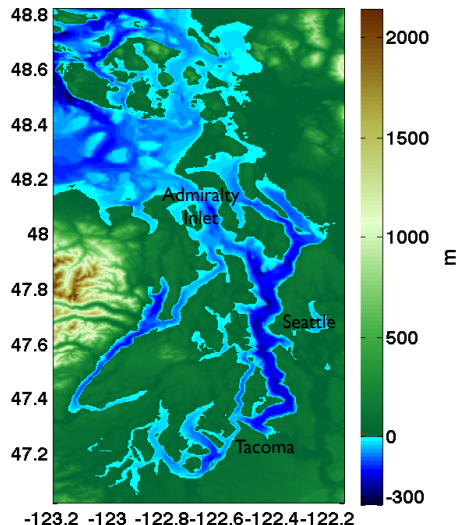
# Considerations for Site Characterization

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

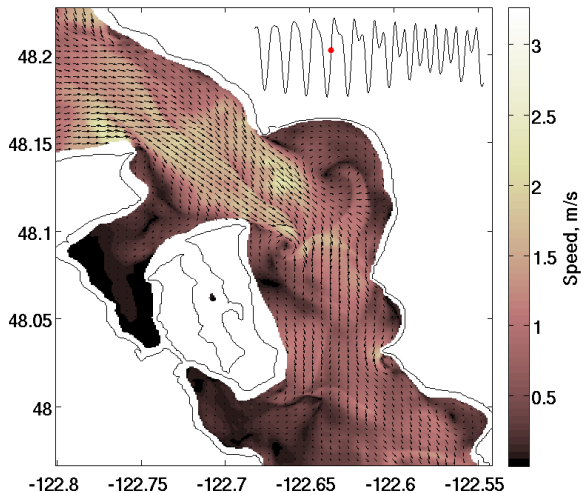
- Quantification of resource
  - Mean speed
  - Mean kinetic power density
  - Turbine operation time
  - Power available given turbine properties
- Qualification of resource
  - Bidirectionality
  - Power bias
- Turbine survivability and efficiency
  - Vertical velocity
  - Shear
  - Turbulence

⇒ 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)

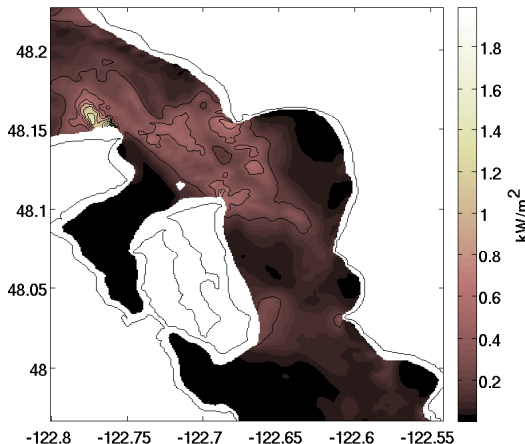
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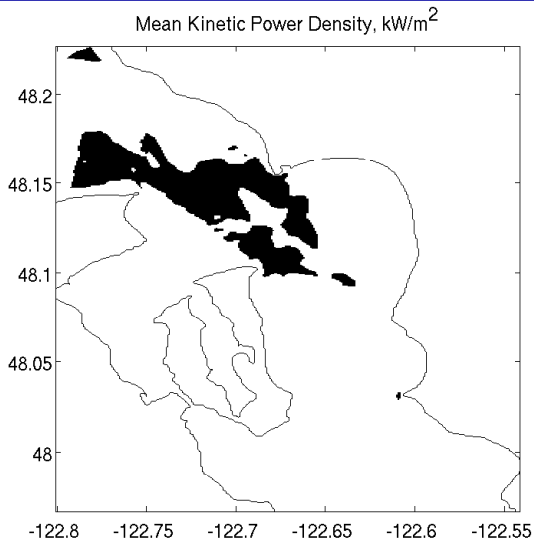
# Mean Kinetic Power Density, Shown at Hub Height

A measure of the  
average resource  
available

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

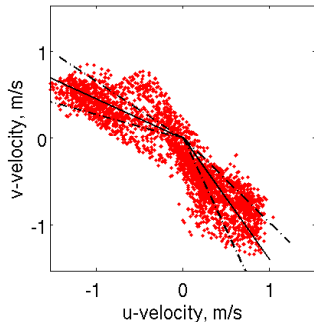


# High Mean Kinetic Power Density Areas



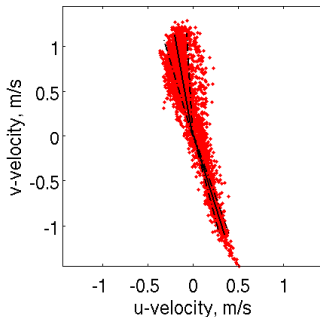
# Tidal Asymmetry: Bidirectionality and Spread of Direction

Mean Ebb Angle: 295, Mean Flood Angle: 145  
 Std Dev Ebb: 9, Std Dev Flood: 10  
 a: 30, std: 10



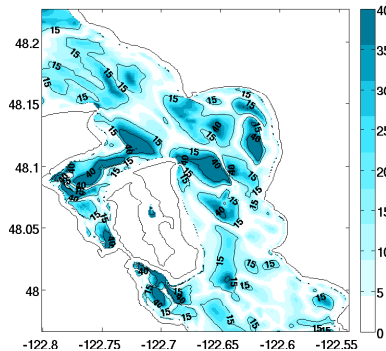
(a) Low Bidirectionality, Higher Directional Deviation

Mean Ebb Angle: -10, Mean Flood Angle: 163  
 Std Dev Ebb: 7, Std Dev Flood: 3  
 a: 7, std: 7

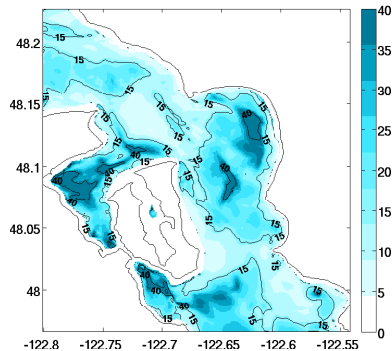


(b) High Bidirectionality, Lower Directional Deviation

# Tidal Asymmetry: Bidirectionality and Spread of Direction

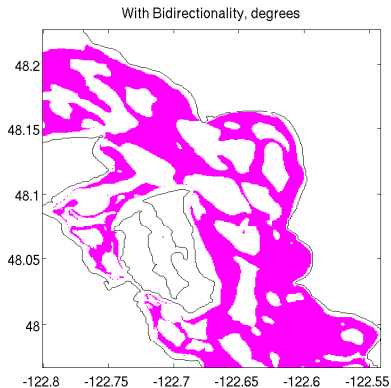


(c) Bidirectionality

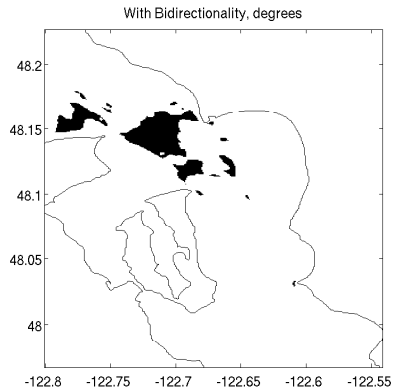


(d) Directional Deviation

# Bidirectionality

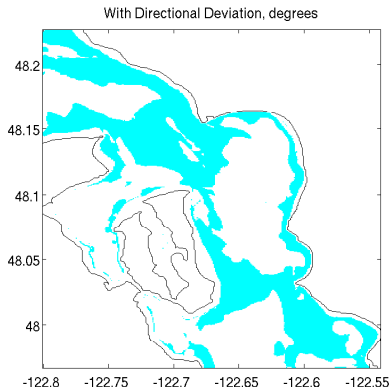


(e) With Cut-off

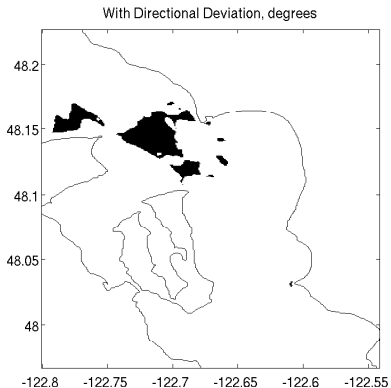


(f) Overlaid on MKPD

# Directional Deviation



(g) With Cut-off

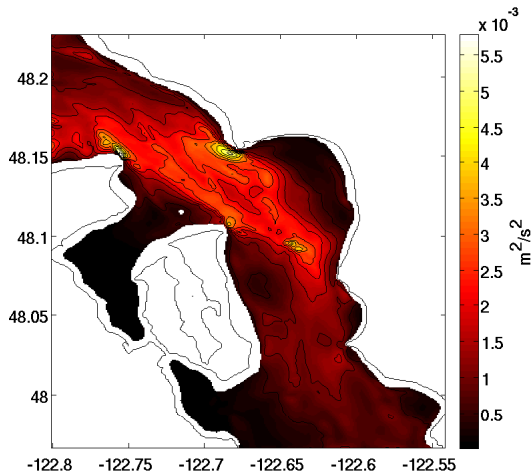


(h) Overlaid on MKPD and Bidirectionality

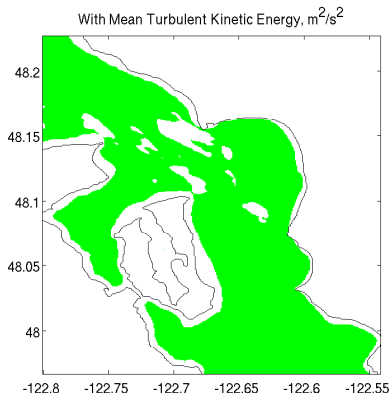
# Mean Turbulent Kinetic Energy

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

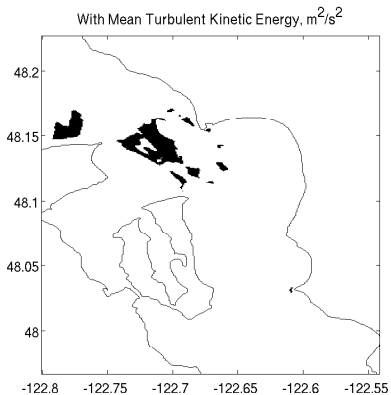
$$\text{TKE} = \frac{1}{2} ((u'^2) + (v'^2) + (w'^2))$$



# Mean Turbulent Kinetic Energy



(i) With Cut-off



(j) Overlaid on MKPD and Tidal Asymmetry Metrics

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# 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