Site Characterization of Tidal Resources: Admiralty Inlet

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Scope of Thesis Work

• Predictability of tidal currents using stationary ADCP data
  – Develop a set of requirements for accurate long-term predictions

• Development of a quantitative application for use of shipboard ADCP data
  – Resolve uncertainty in current amplitude and phase between survey tracks
  – New survey patterns
ADCP Deployments

April / May

May / August

August / Nov

& Nov / Feb
Prediction of Tidal Currents: Why?

• Estimation of tidal resource
  – Location and orientation of device
  – Long-term tidal resource prediction (feasibility)
  – Noise generation due to device operation

• NOAA predictions are given for a single point
  – Surface currents only
  – Bathymetry, Turbulence, etc. cause 3-D velocity variations
Prediction of Tidal Currents: Why?

- Recovery of sea-spider (11/10/09) during slack water
- Strong currents increase noise which could mask the acoustic release signal

**Legend (all free drifting):**
- Velocity survey + towfish
- Water quality cast
- Acoustic survey + drifter
- ROV video (new target)
T Tide- Tidal Analysis

- Performs harmonic analysis of tidal signal resolving the data as a superposition of sin waves due to tidal constituents

\[ u(t) = \sum A_i \cos(\omega_i t - \phi_i) \]

- Rayleigh criterion and signal to noise ratio (SNR) determine which constituents can be resolved
- Finds the least-squares fit to the current velocity data
- Statistical error analysis
- Principal Axis Velocity
Rayleigh Criterion

- A methodology developed by Foreman (1977) to determine which tidal constituents can be resolved with T Tide

\[ |\omega_2 - \omega_1| \times T > R \]

Ex. Resolving the K1 vs. P1 Tidal Constituents

K1, \textit{Luni-solar diurnal constituent}, \( \omega = 0.04178075 \) cycles / hr

P1, \textit{Solar diurnal constituent}, \( \omega = 0.04155259 \) cycles / hr

\[ |\omega_{K1} - \omega_{P1}| \times T > 1 \rightarrow T \approx 182 \text{ days} \]

For T < 182 days, K1 contains P1 information
## Rayleigh Criterion

<table>
<thead>
<tr>
<th>Days (T)</th>
<th># Constituents</th>
<th>Variance Explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8 (5)</td>
<td>93.6 %</td>
</tr>
<tr>
<td>15</td>
<td>17 (15)</td>
<td>95.1 %</td>
</tr>
<tr>
<td>30</td>
<td>29 (26)</td>
<td>97.9 %</td>
</tr>
<tr>
<td>70</td>
<td>35 (32)</td>
<td>98.3 %</td>
</tr>
</tbody>
</table>

Var. Explained = \( \frac{\text{Variance}_{T \_ \text{Tide}}}{\text{Variance}_{\text{Data}}} \)
T Tide vs. ADCP

May 20-August 3, Depth Averaged ADCP Data

Time

m/s

06/18 06/19 06/20 06/21 06/22 06/23 06/24
How well does T Tide work?

Ideal Case

May 20-August 3, "Surface" Velocity

Actual Case

May 20-August 3, "Surface" Velocity

Velocity Bins, bin size = 0.1 m/s

Prediciton Error: 0.1 m/s bins
May 20-August 3, Slack Water Timing: "Surface" Velocity

Minutes between NOAA & ADCP Slack Water (NOAA-ADCP)

Number of Observations

Flood to Slack: Mean = 92.9 min, Standard Deviation = 37.2 min
Ebb to Slack: Mean = 75.7 min, Standard Deviation = 21.6 min
May 20-August 3, Slack Water Timing: "Seabed" Velocity

Flood to Slack:  Mean = 31.6 min,  Standard Deviation = 26.8 min
Ebb to Slack:    Mean = 93.1 min,  Standard Deviation = 20.5 min
November Current Prediction: "Surface" Velocity

- Velocity Magnitude (m/s)
- November
- 11/09, 11/10, 11/11, 11/12
- May/August- 70 days
- Peaks & Slack
- NOAA pred
- NOAA pred data
Coming Work

- Fourier analysis of residual between T Tide and ADCP data
- Estimating sea surface height from backscatter intensity
Mobile ADCP Data

Survey Track: ADM_0409_016

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Questions?