ERDC Numerical Modeling
Alaska District Projects

Ken Eisses, PE
Alaska District
Hydrology and Hydraulics
August 10, 2010
ADJCIRC
ADvanced CIRCulation Model for Oceanic, Coastal, and Estuarine Waters

- Finite Element
- Depth-averaged
- Forcing
  - Tide
  - Wind
  - River
- Other factors
  - bathymetry
  - friction
  - shear/eddy formation
  - Coriolis
- Output
  - tides and currents
  - Water levels
ADCIRC Boundaries
Bathymetry

**Sources**
- NGIA, ETOPO
- 2003/2005 NOAA
- Charts
- USACE survey
- ad-hoc
Intertidal Flooding/Drying

- Sparse/dated bathymetry
- Dynamic
- Strongly influences hydrodynamics in Knik Arm

Approach:
- Idealize tide flat geometry based on:
  - Alaska District survey data
  - Aerial photos
  - Charts
  - Measurement of water exchange
Simulation
Field Data

NOAA 2002

ERDC 2006
Tide

Anchorage

$\text{gage}$

$\text{adcirc}$

$\text{time, UTC (2006)}$

$\text{tide, ft MLLW}$

$\text{Kodak}$

$\text{Nikiski}$

$\text{time, UTC (2006)}$

$\text{tide, ft MLLW}$

BUILDING STRONG®
Cairn Point Gyre
Storm Surge is a Large Component of the Design Water Level

ADCIRC Grid

Water level study for the western coast of Alaska
17 Selected Stations

1 Kivalina
2 Red Dog
3 Kotzebue
4 Shishmaref
5 Wales
6 Nome
7 Golovin
8 Shaktoolik
9 Unalakleet
10 Saint Michael
11 Agcklarok
12Hooper Bay
13Toksook Bay
14 Mekoryuk
15 Kongiganak
16 Cape Newenham
17 Dillingham
NUMERICAL GRID OF NORTON SOUND

WATER LEVEL STUDY FOR THE WESTERN COAST OF ALASKA
Comparison of observed and modeled water levels at Nome, Alaska October 2004

WATER LEVEL STUDY FOR THE WESTERN COAST OF ALASKA
Nome
Location:
Longitude: 165.4300°W
Latitude: 64.5000°N
Exposure: SSW
Top 10 surge events between 1954 and 2004

<table>
<thead>
<tr>
<th></th>
<th>Starting Date</th>
<th>Maximum Surge (ft MLLW)</th>
<th>Minimum Surface Pressure (mb)</th>
<th>Maximum Wind Speed (mph)</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10-Nov-74</td>
<td>10.12</td>
<td>968.5</td>
<td>47.9</td>
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<td>40.3</td>
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<tr>
<td>5</td>
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<td>52.8</td>
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<tr>
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<td>42.1</td>
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</tbody>
</table>

Frequency of Occurrence

<table>
<thead>
<tr>
<th>Return Period (years)</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>50</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surge Level (ft MLLW)</td>
<td>5.79</td>
<td>7.07</td>
<td>7.82</td>
<td>8.35</td>
<td>8.68</td>
<td>9.66</td>
<td>10.51</td>
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<tr>
<td>Std. Deviation (ft)</td>
<td>0.46</td>
<td>0.46</td>
<td>0.59</td>
<td>0.75</td>
<td>0.75</td>
<td>0.98</td>
<td>1.25</td>
</tr>
</tbody>
</table>

WATER LEVEL STUDY FOR THE WESTERN COAST OF ALASKA
**Shaktoolik**  
**Location:**  
Longitude: 161.1500°W  
Latitude: 64.3300°N  
**Exposure:** SW  
**Top 10 sure events between 1954 and 2004**

<table>
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<tr>
<th></th>
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<td>977.8</td>
<td>47.2</td>
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<td>12.47</td>
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<tr>
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<td>0.92</td>
<td>1.21</td>
<td>1.54</td>
<td>2.92</td>
<td>3.41</td>
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WATER LEVEL STUDY FOR THE WESTERN COAST OF ALASKA
Alaskan 20-yr Wind and Wave Hindcast Study

- Wind, Pressure and Ice Fields Provided by Oceanweather
- Wave Modeling with WAM (4.5.1C)
OWI Regional Scale Winds

- 1954 – 1984
  - 44 storm periods (varying lengths ~ 3 – 14 days)
- 1985 – 2004
  - Continuous data
- Coverage
  - 50 – 74°N, 155 – 203°E
- Resolution
  - Spatial – 0.25°
  - Temporal – 3 hour
- Parameters
  - Winds
  - Sea Level Pressures
  - Ice Concentrations
VERIFICATION OF MODEL RESULTS

Alaska 20-yr Hindcast Study [OI Winds]  BASIN  WAM4.5.1C [-178° / 57°]
NDMC = 45038 [-177.5764° / 67.0906°] at h 3717m

Hₘₚ

Tₚ

Tₘᵢₚ

Wave Dir.

No Directional Data

Days in Dec 2004

Wind Spd.

Wind Dir.
ALASKA 20-yr HINDCAST STUDY
MODEL RESULTS: WAMCY4.5.1C
Binned Mean Error to: Symmetric Regression for: 46035
Evaluation START: 1985 END: 2004
Total Number of Observations: 16022

http://frf.usace.army.mil/wis/ak/ak_main.html
Special Output Locations and 36 Documented in Report
OUTPUTS

• YEARLY WAVE HEIGHT TIME SERIES 2004
STATION 101 (OFF THE COAST OF NOME)