

ERDC Numerical Modeling Alaska District Projects

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Alaska District
Hydrology and Hydraulics
August 10, 2010*



US Army Corps of Engineers
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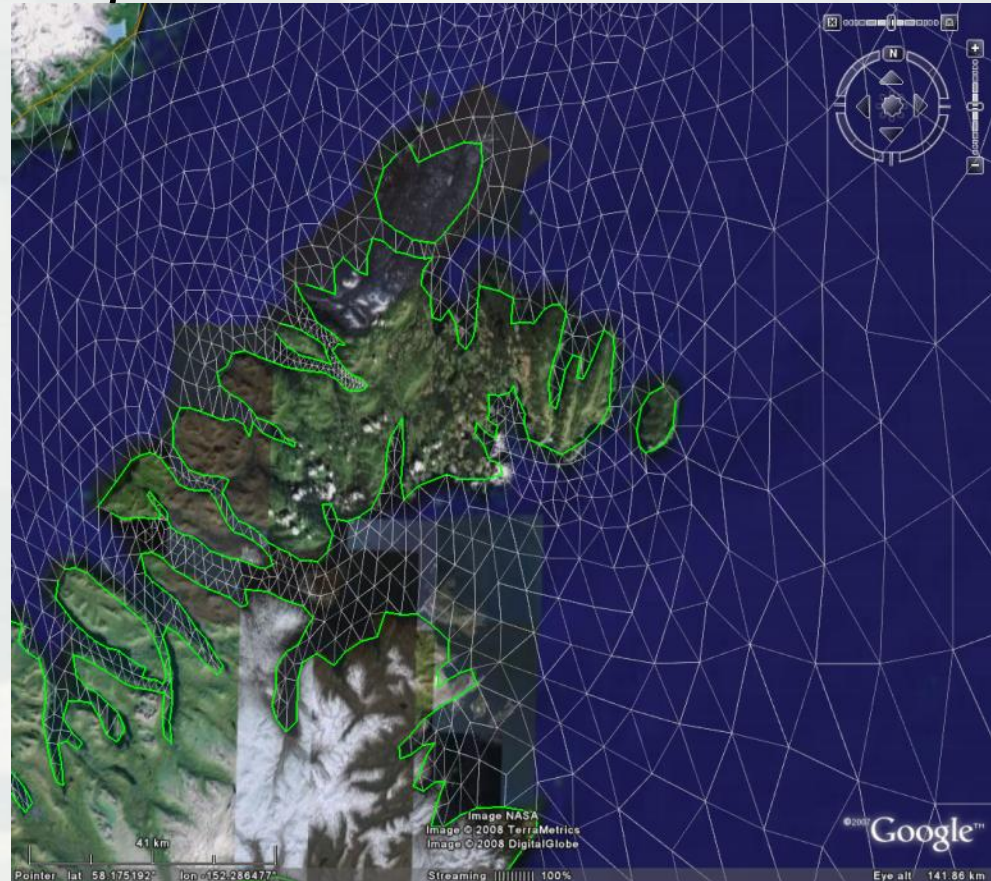
Building and Preserving Alaska's Future



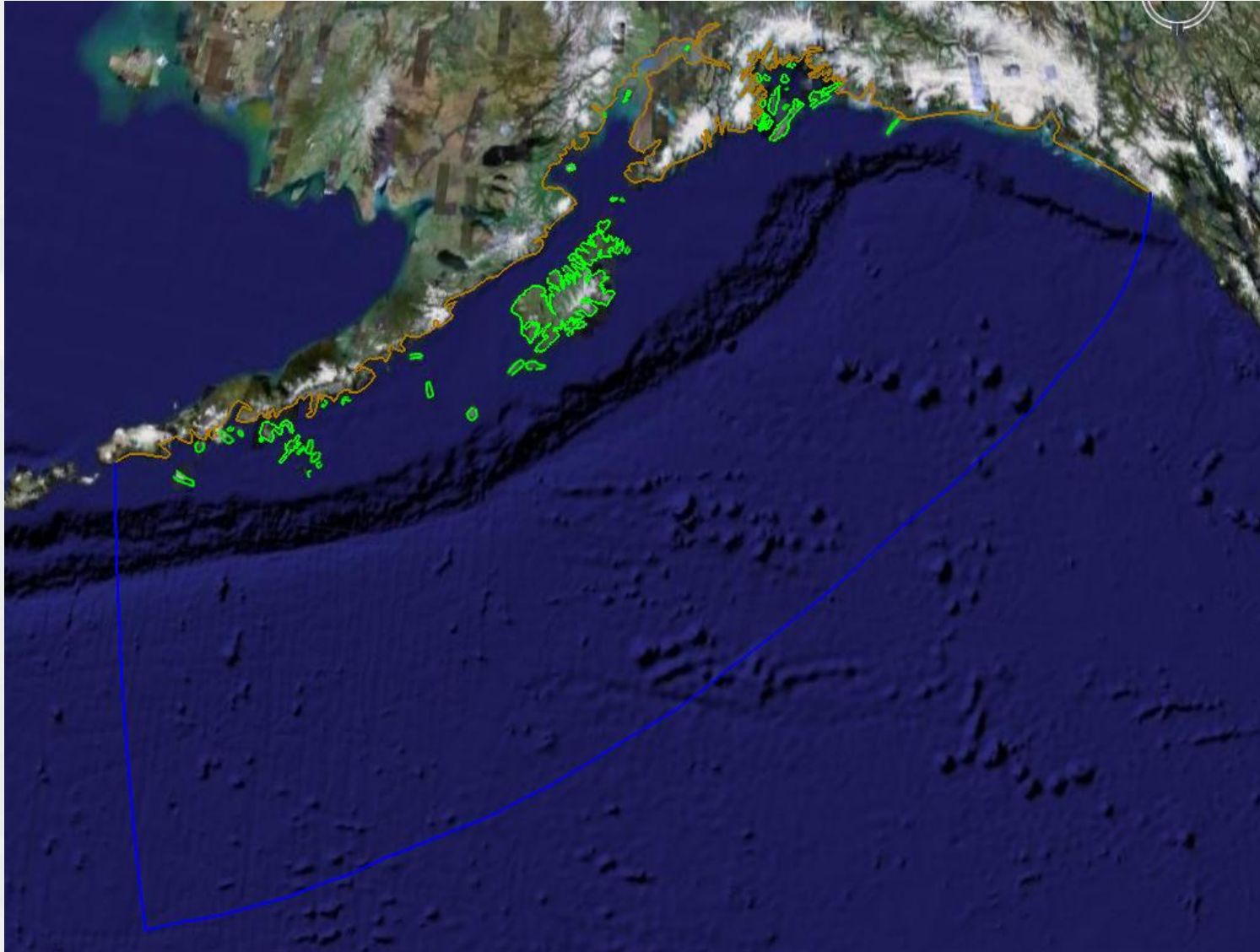
ADCIRC

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

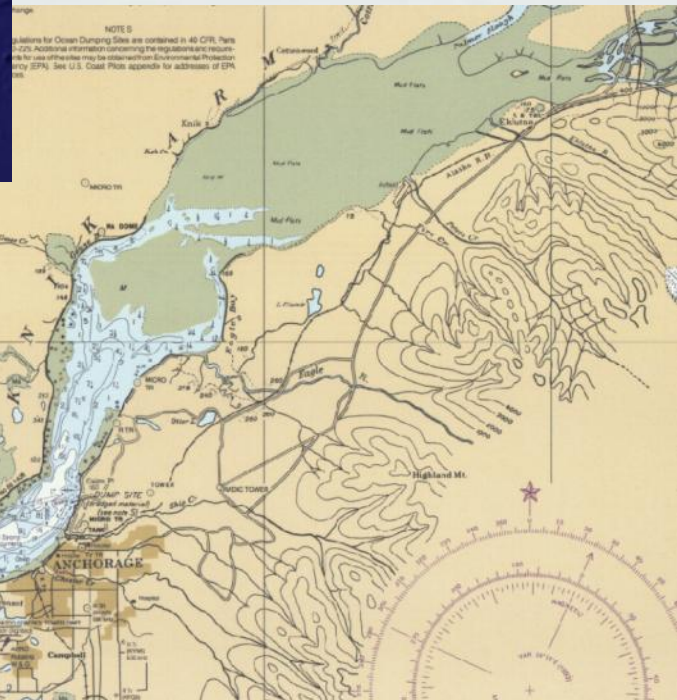
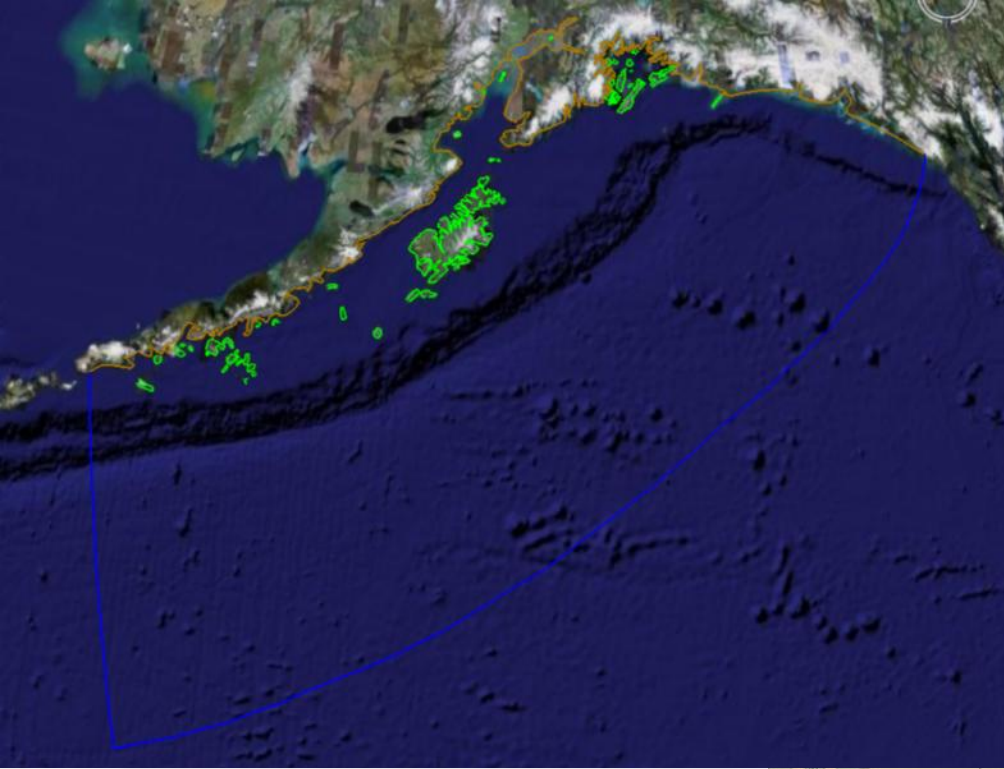


ADCIRC Boundaries



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Bathymetry



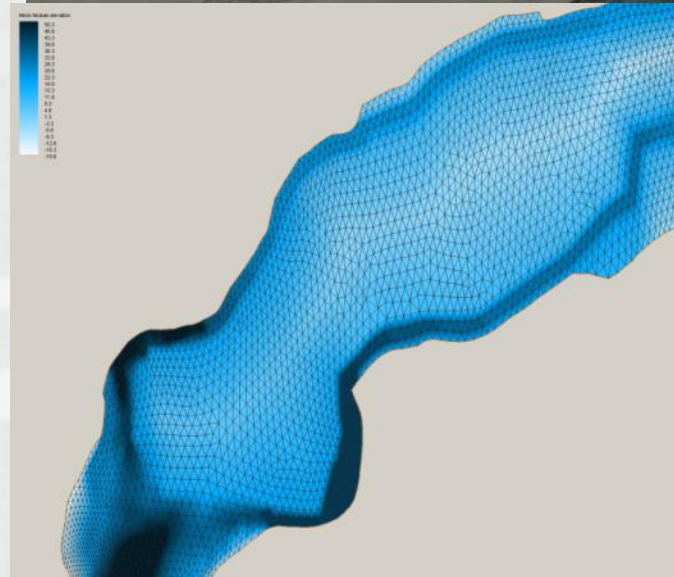
- Sources
 - NGIA, ETOPO
 - 2003/2005 NOAA
 - Charts
 - USACE survey
 - ad-hoc



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

9



Simulation

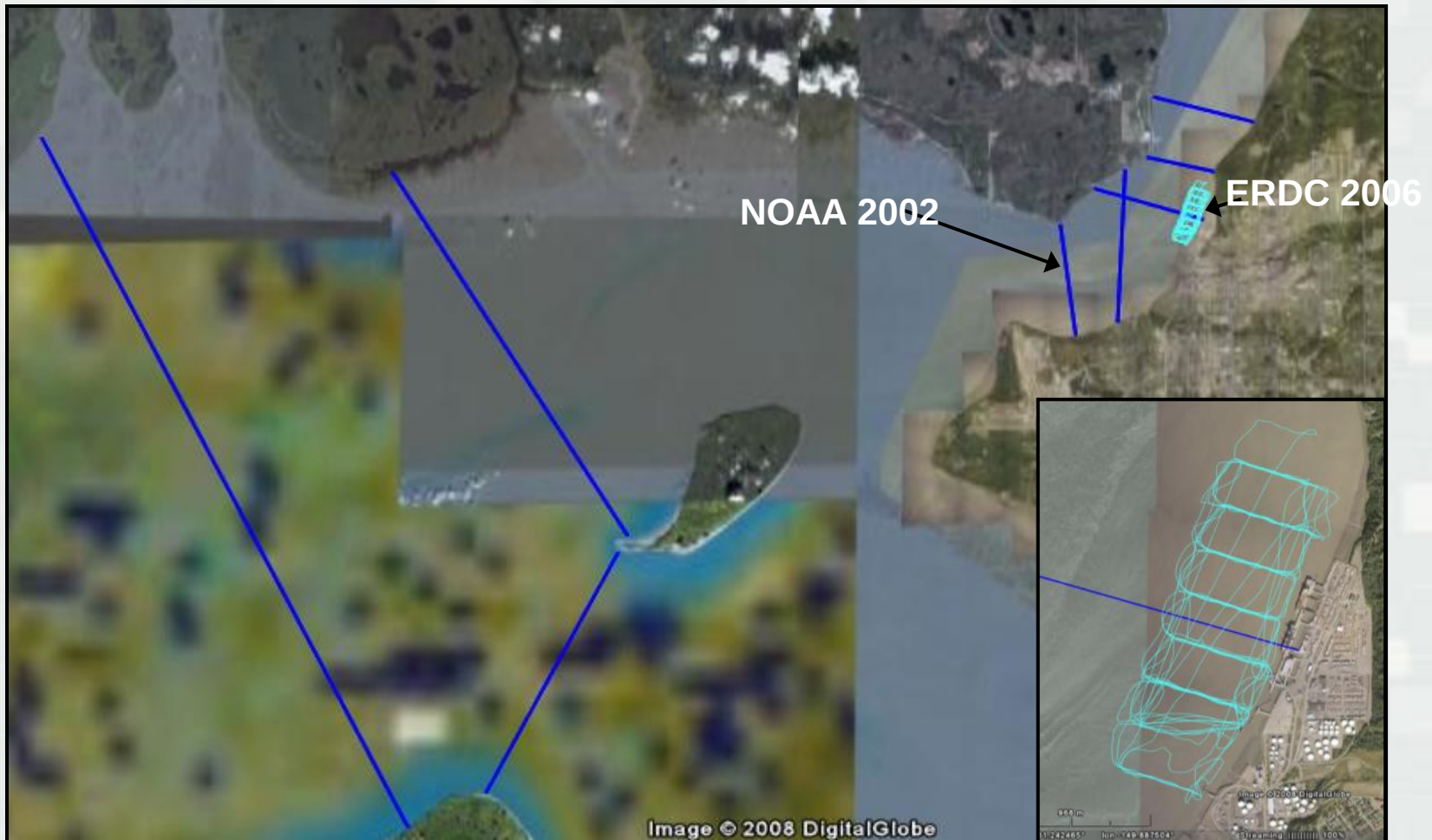


j5wk5c_Aug12-14_2006_wse.avi



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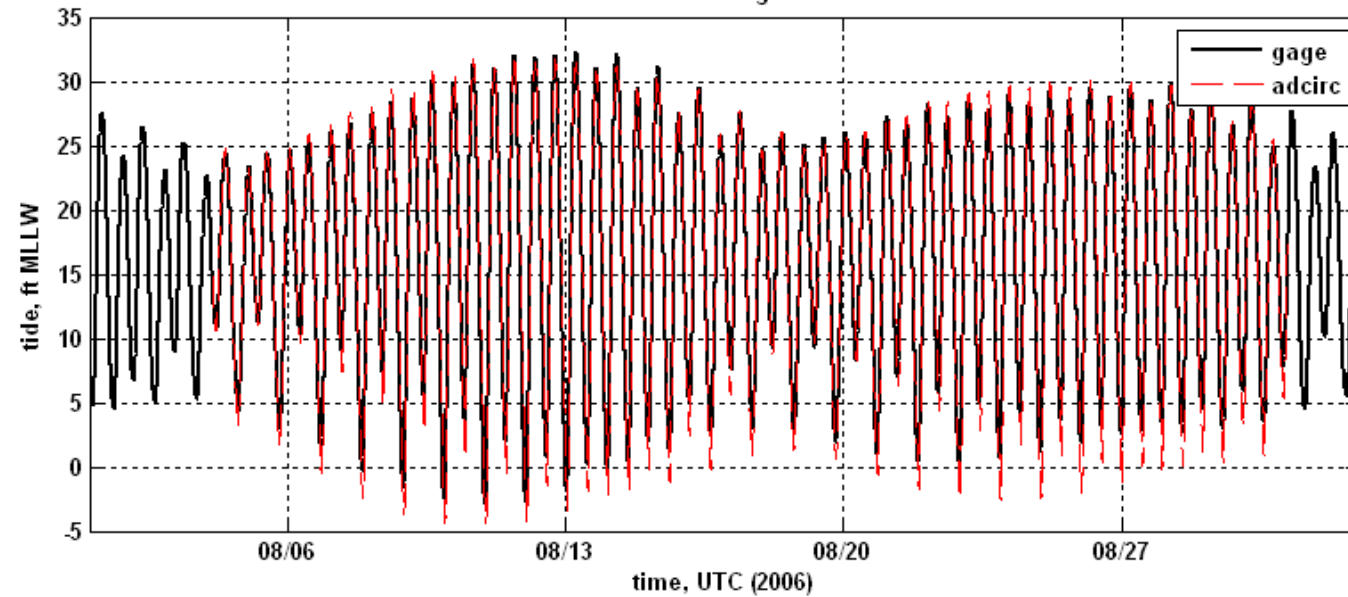
Field Data



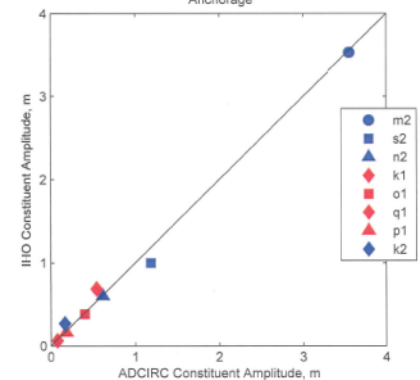
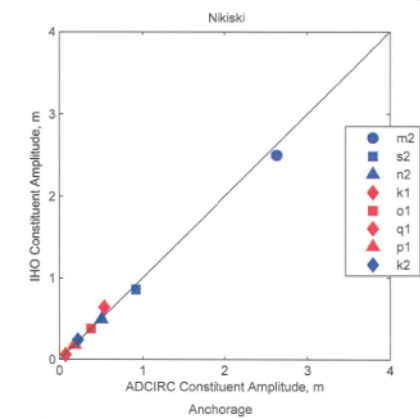
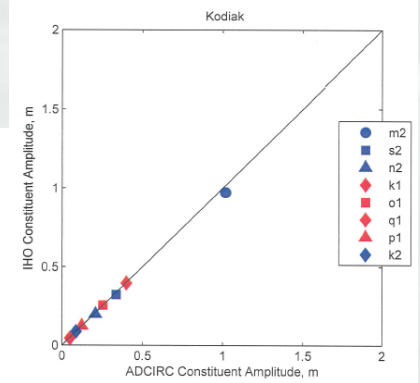
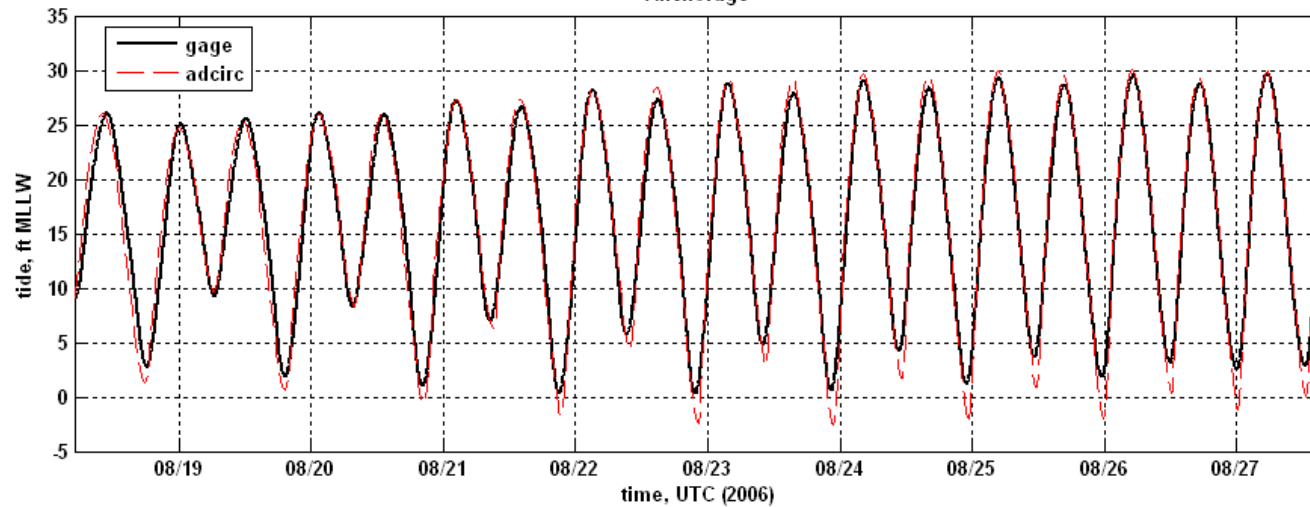
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Tide

Anchorage

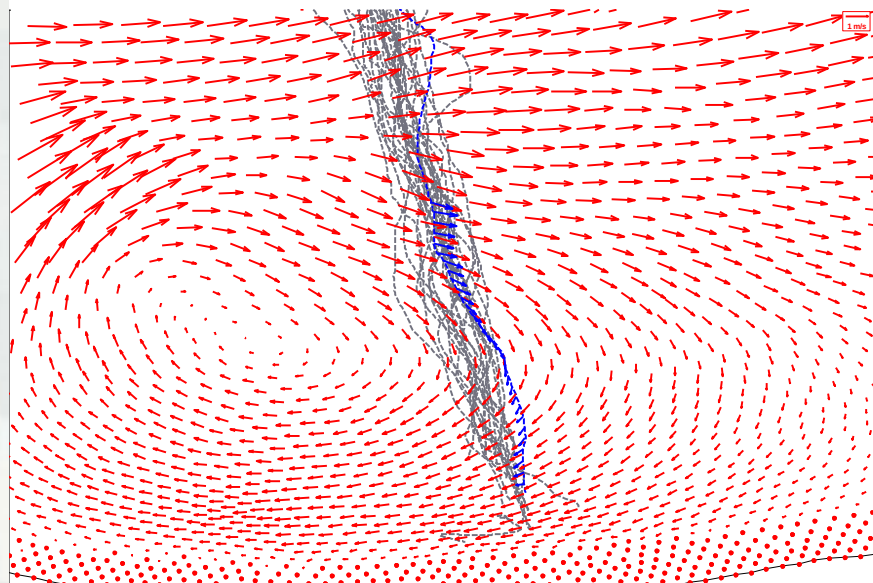
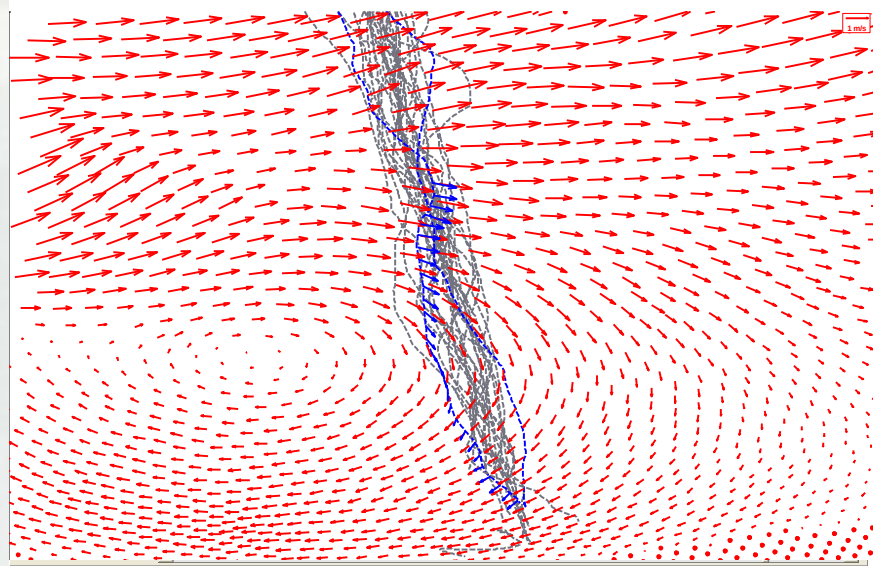


Anchorage



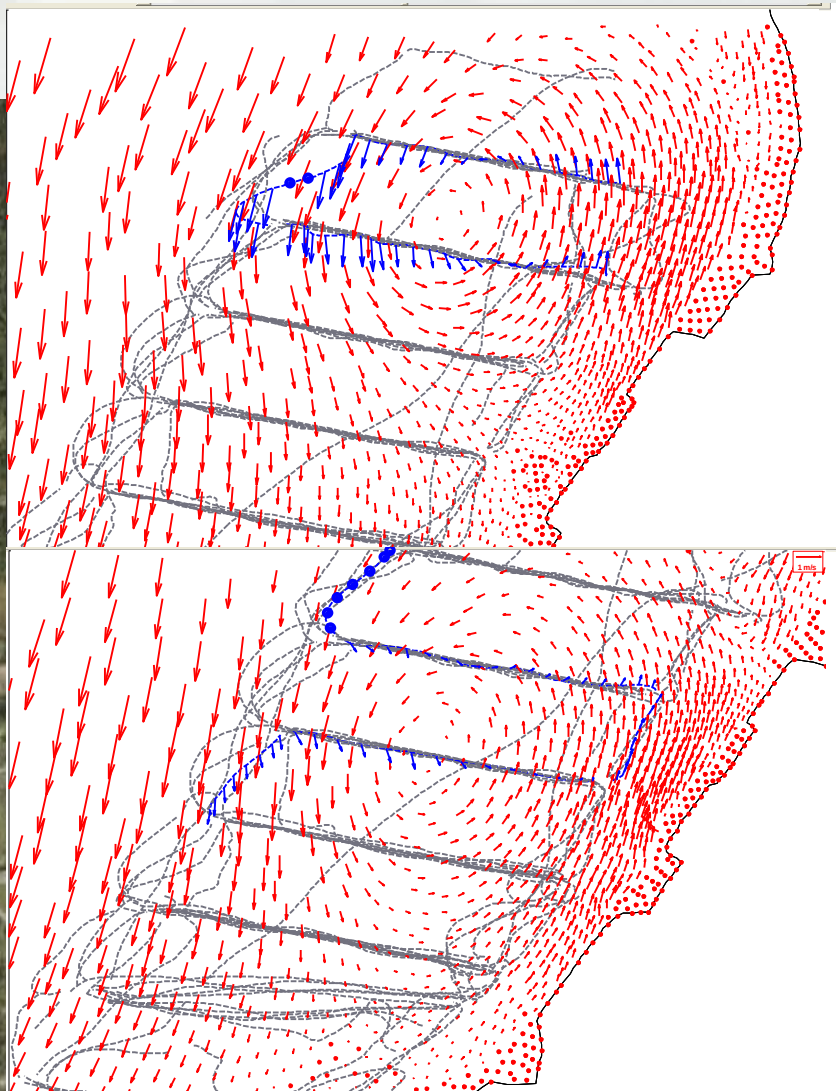
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Pt Woronzof Gyre



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Cairn Point Gyre



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Storm Surge is a Large Component of the Design Water Level

ERDC/CHL Letter Report

Coastal and Hydraulics Laboratory



US Army Corps
of Engineers®
Engineer Research and
Development Center

Storm Damage and Flooding Evaluation

Storm-Induced Water Level Prediction Study for the Western Coast of Alaska

Raymond S. Chapman, Sung-Chan Kim, and David J. Mark

October 2009

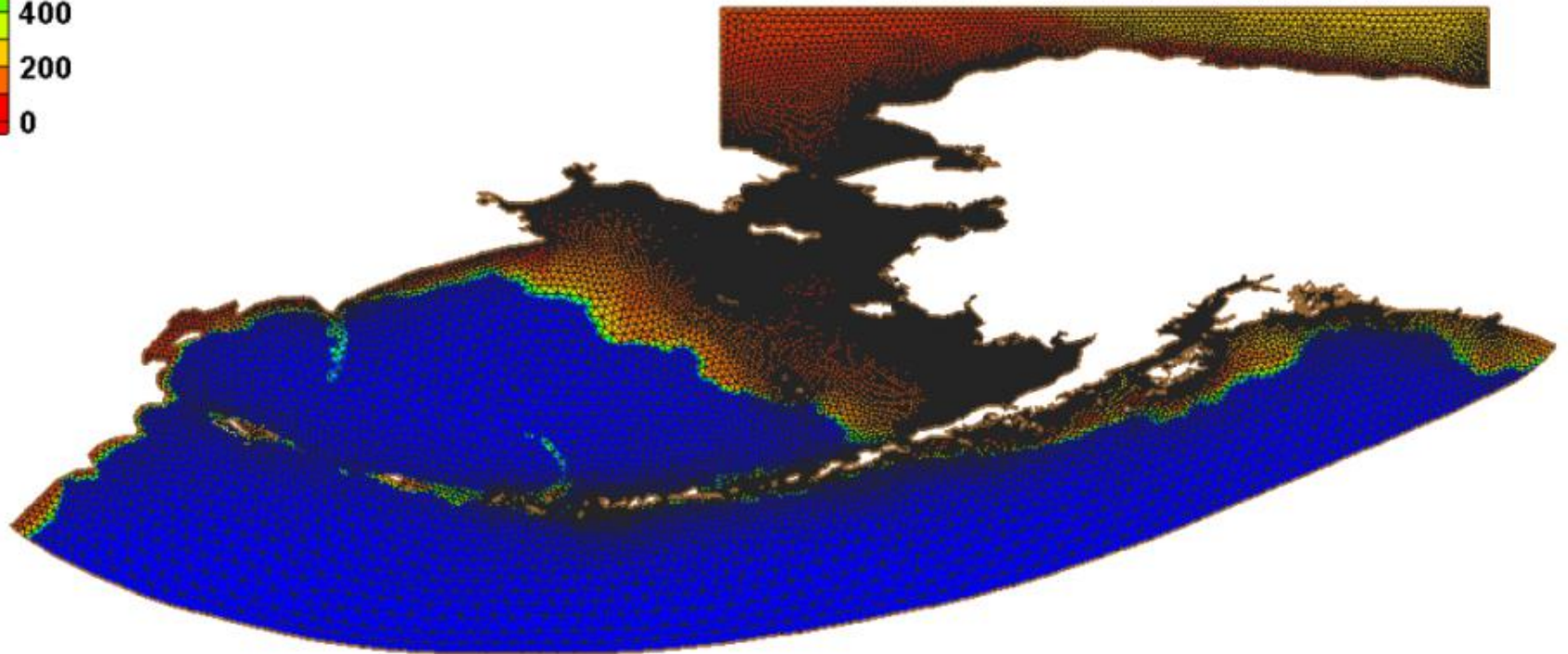
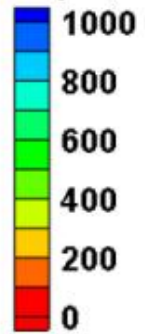
<http://www.poa.usace.army.mil/en/cw/Docs%20Available%20for%20Public%20Review/ERDCWater-LevelReportAK.pdf>



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ADCIRC Grid

Depth, m



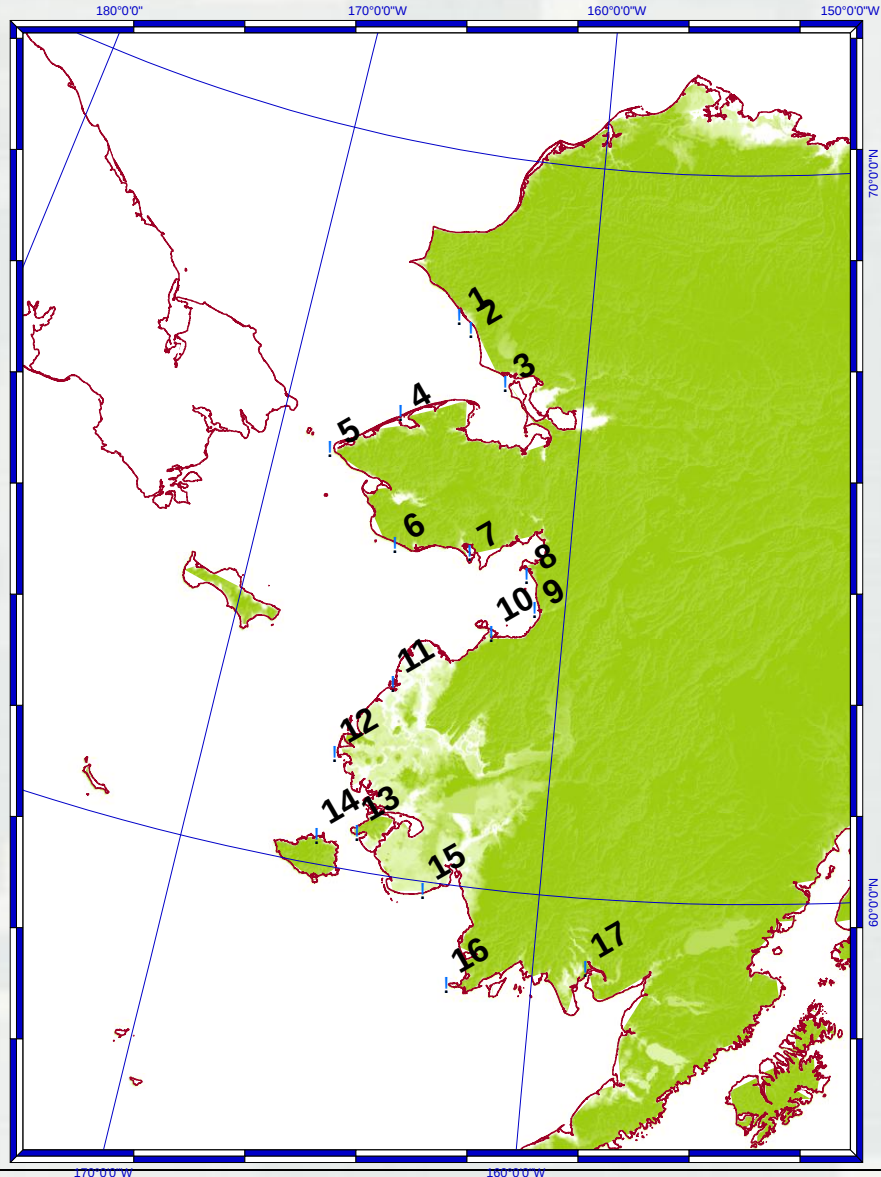
WATER LEVEL STUDY FOR THE WESTERN COAST OF ALASKA



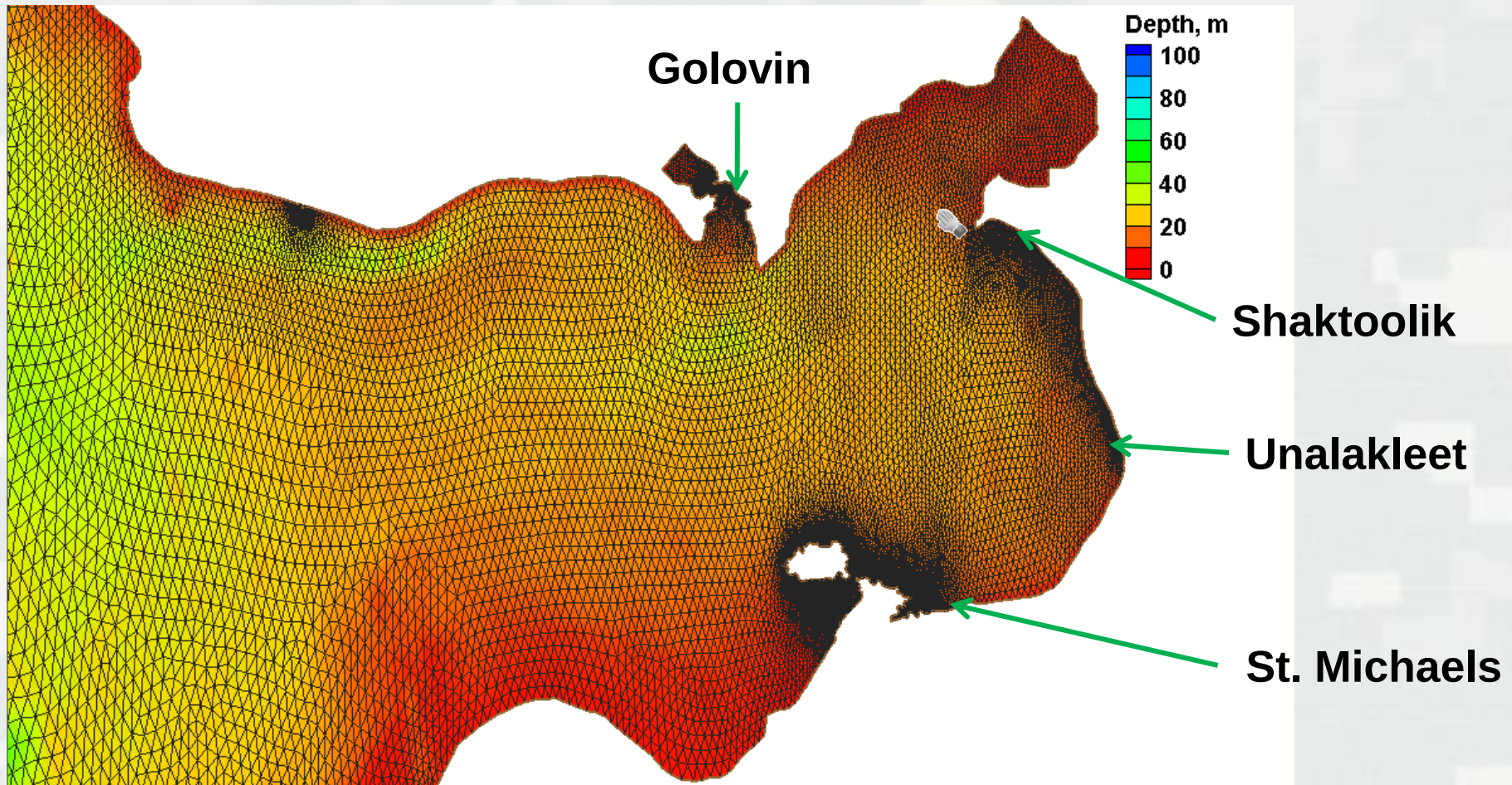
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17 Selected Stations

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



NUMERICAL GRID OF NORTON SOUND

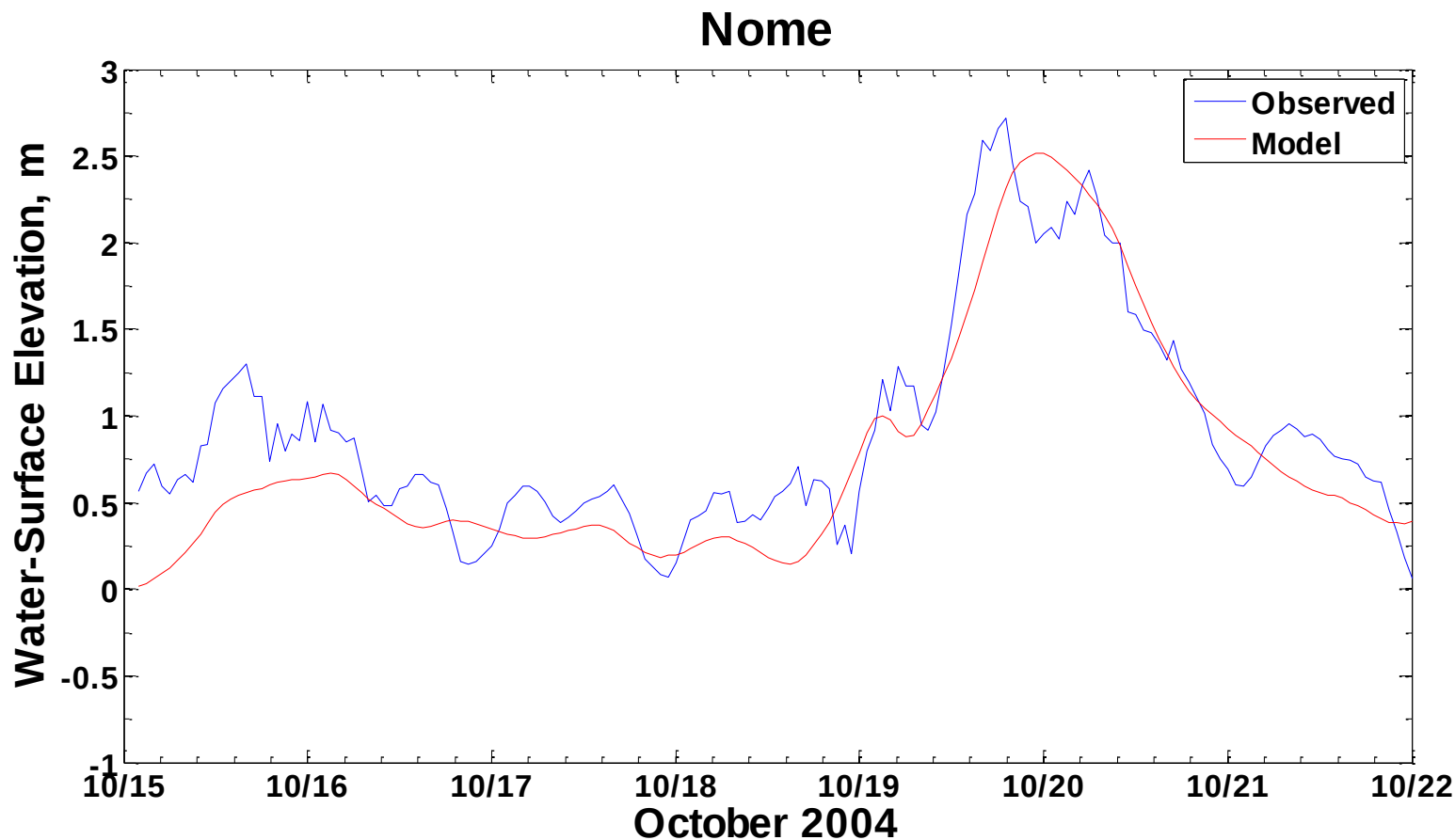


WATER LEVEL STUDY FOR THE WESTERN COAST OF ALASKA



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Comparison of observed and modeled water levels at Nome, Alaska October 2004



WATER LEVEL SUDY FOR THE WESTERN COAST OF ALASKA



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Nome

Location:

Longitude: 165.4300°W

Latitude: 64.5000°N

Exposure: SSW

Top 10 surge events between 1954 and 2004

	Starting Date	Maximum Surge (ft MLLW)	Minimum Surface Pressure (mb)	Maximum Wind	
				Speed (mph)	Direction
1	10-Nov-74	10.12	968.5	47.9	S
2	15-Oct-04	8.94	974.0	44.5	ESE
3	01-Oct-60	8.87	973.2	48.3	SW
4	08-Nov-78	8.05	993.6	40.3	SSE
5	25-Oct-96	7.82	1000.2	36.2	S
6	06-Nov-85	7.40	990.1	37.4	SSE
7	14-Nov-66	7.07	993.8	52.8	SSE
8	26-Nov-70	6.97	994.5	43.2	SW
9	12-Nov-96	6.71	1002.4	38.3	SE
10	02-Oct-92	6.64	975.8	42.1	SSE

Frequency of Occurrence

Return Period (years)	5	10	15	20	25	50	100
Surge Level (ft MLLW)	5.79	7.07	7.82	8.35	8.68	9.66	10.51
Std. Deviation (ft)	0.46	0.46	0.59	0.75	0.75	0.98	1.25

WATER LEVEL SUDY FOR THE WESTERN COAST OF ALASKA



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Shaktoolik
Location:

Longitude: 161.1500°W

Latitude: 64.3300°N

Exposure: SW

Top 10 sure events between 1954 and 2004

	Starting Date	Maximum Surge (ft MSL)	Minimum Surface Pressure (mb)	Maximum Wind	
				Speed (mph)	Direction
1	01-Oct-60	14.27	977.8	47.2	SW
2	10-Nov-74	12.47	981.6	40.0	SSE
3	26-Nov-70	10.73	1001.5	38.7	SW
4	14-Nov-66	10.50	1002.1	40.7	SSE
5	08-Nov-78	10.10	1001.9	37.8	SSE
6	25-Aug-75	9.19	1000.8	41.2	SSW
7	15-Oct-04	9.15	984.6	33.6	ESE
8	12-Nov-65	8.66	975.6	41.4	S
9	25-Oct-96	8.63	1008.7	25.9	S
10	18-Oct-91	7.22	1004.7	32.2	WSW

Frequency of Occurrence

Return Period (years)	5	10	15	20	25	50	100
Surge Level (ft mllw)	8.09	10.99	12.14	12.90	13.55	16.21	19.10
Std. Deviation (ft)	0.79	0.98	0.92	1.21	1.54	2.92	3.41

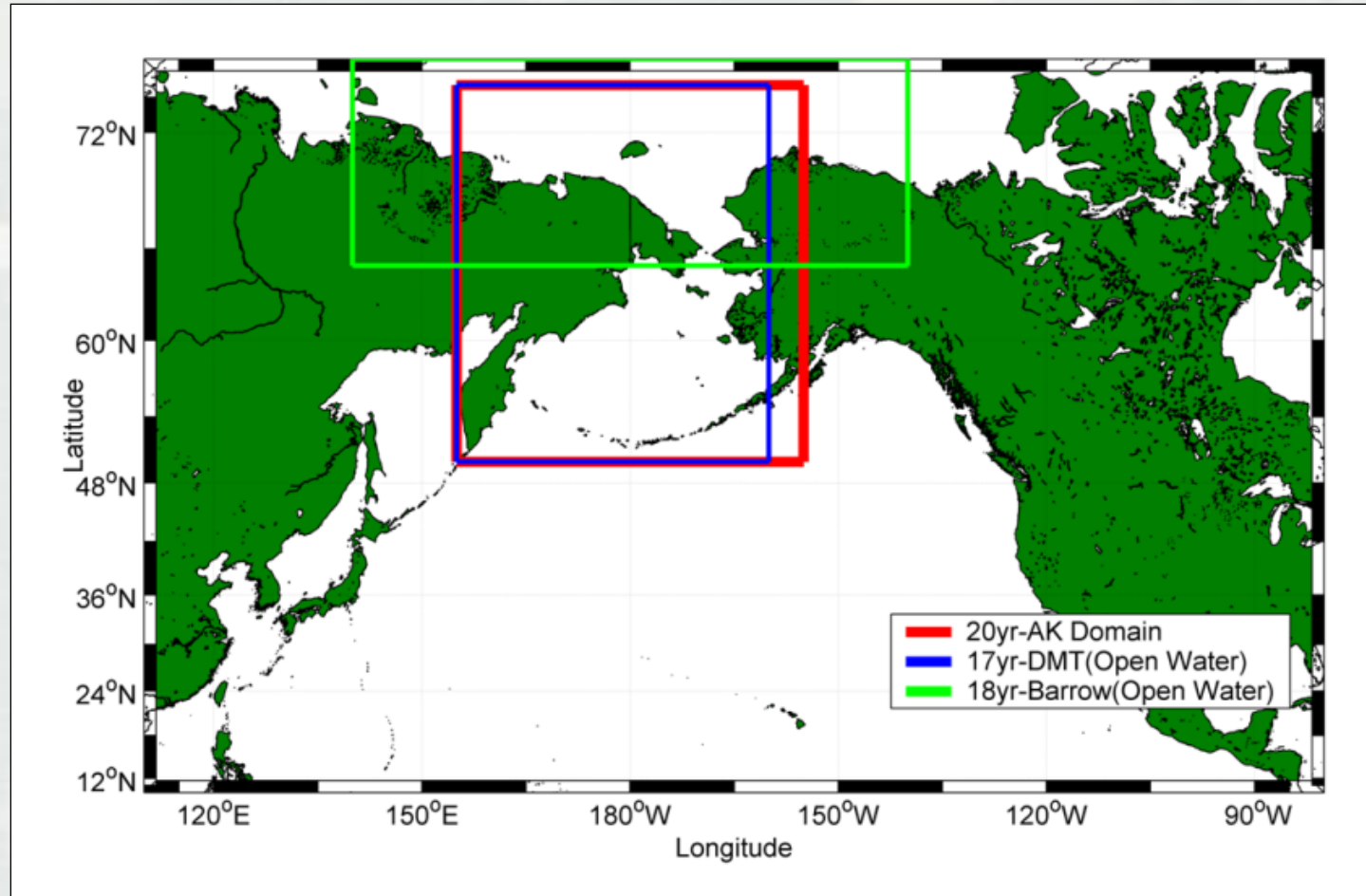
WATER LEVEL SUDY FOR THE WESTERN COAST OF ALASKA



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Alaskan 20-yr Wind and Wave Hindcast Study

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

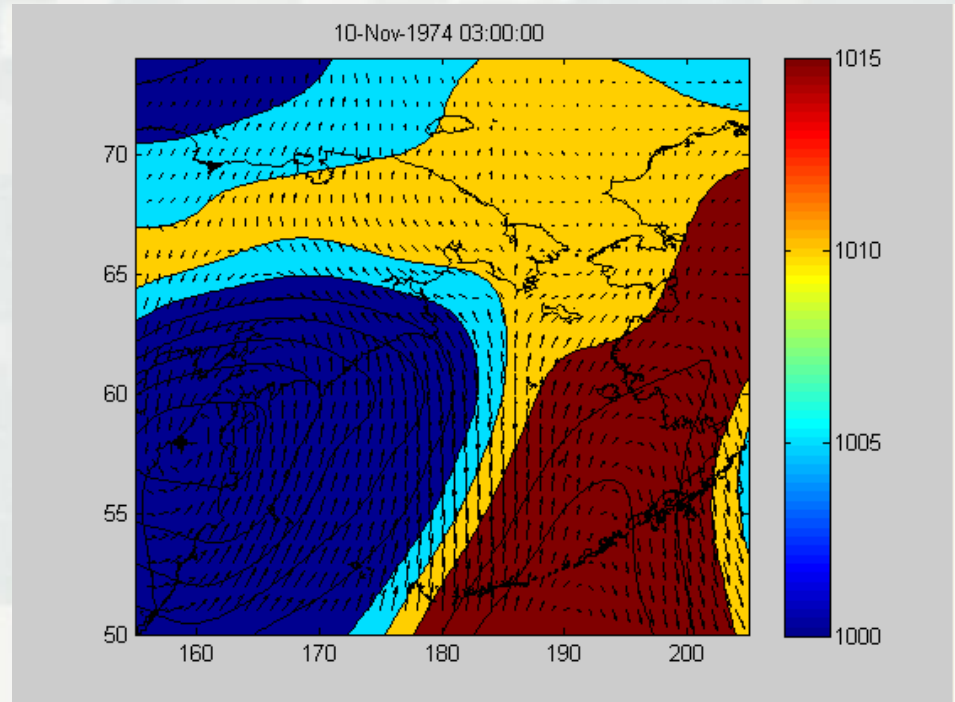


Model Domains

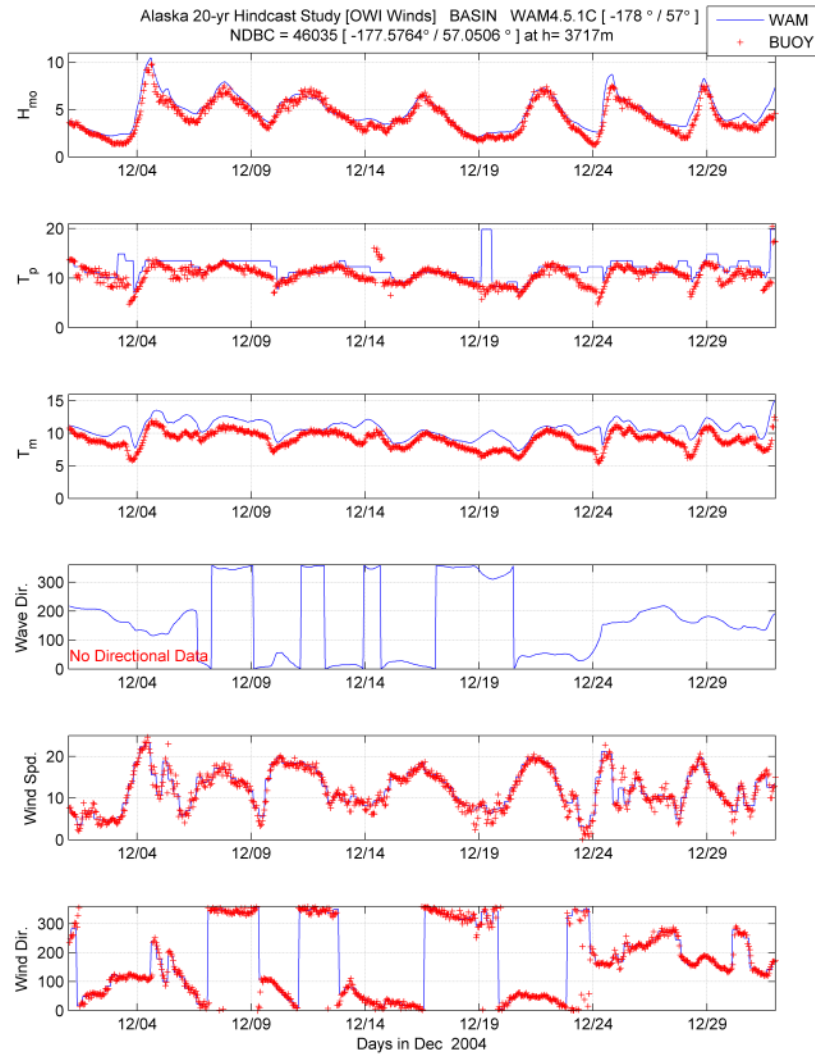


OWI Regional Scale Winds

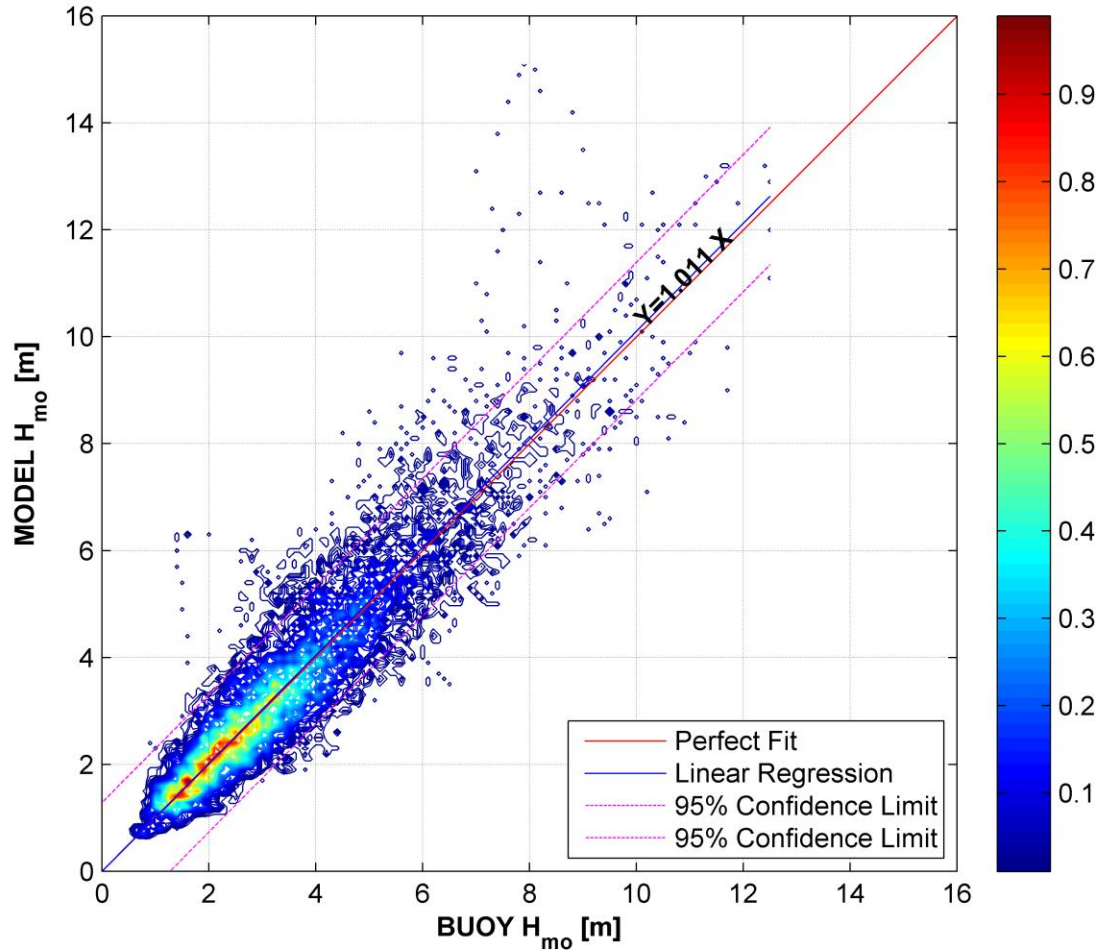
- 1954 – 1984
 - 44 storm periods (varying lengths ~ 3 – 14 days)
- 1985 – 2004
 - Continuous data
- Coverage
 - 50 – 74°N, 155 – 203°E
- Resolution
 - Spatial – 0.25°
 - Temporal – 3 hour
- Parameters
 - Winds
 - Sea Level Pressures
 - Ice Concentrations



VERIFICATION OF MODEL RESULTS



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

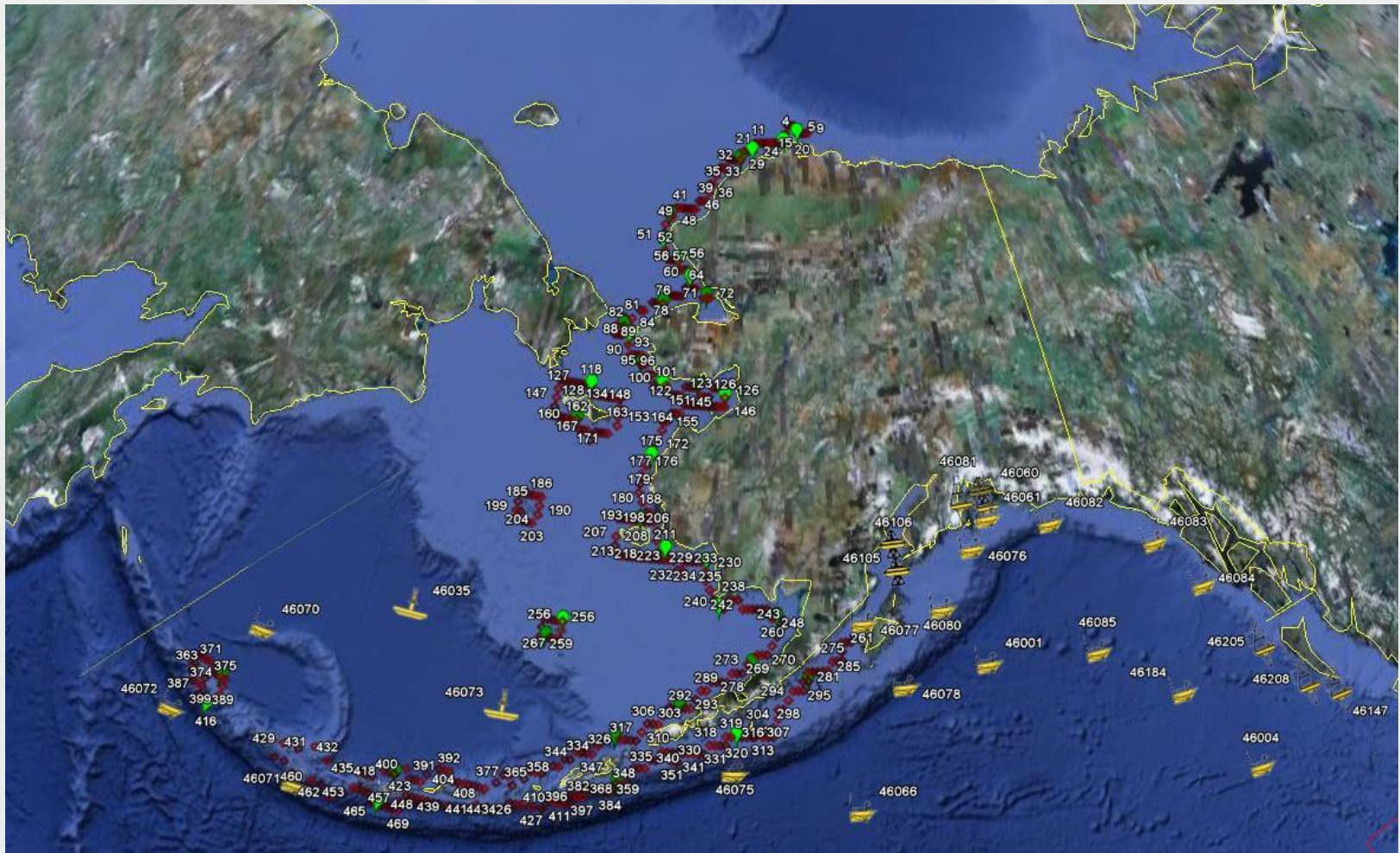


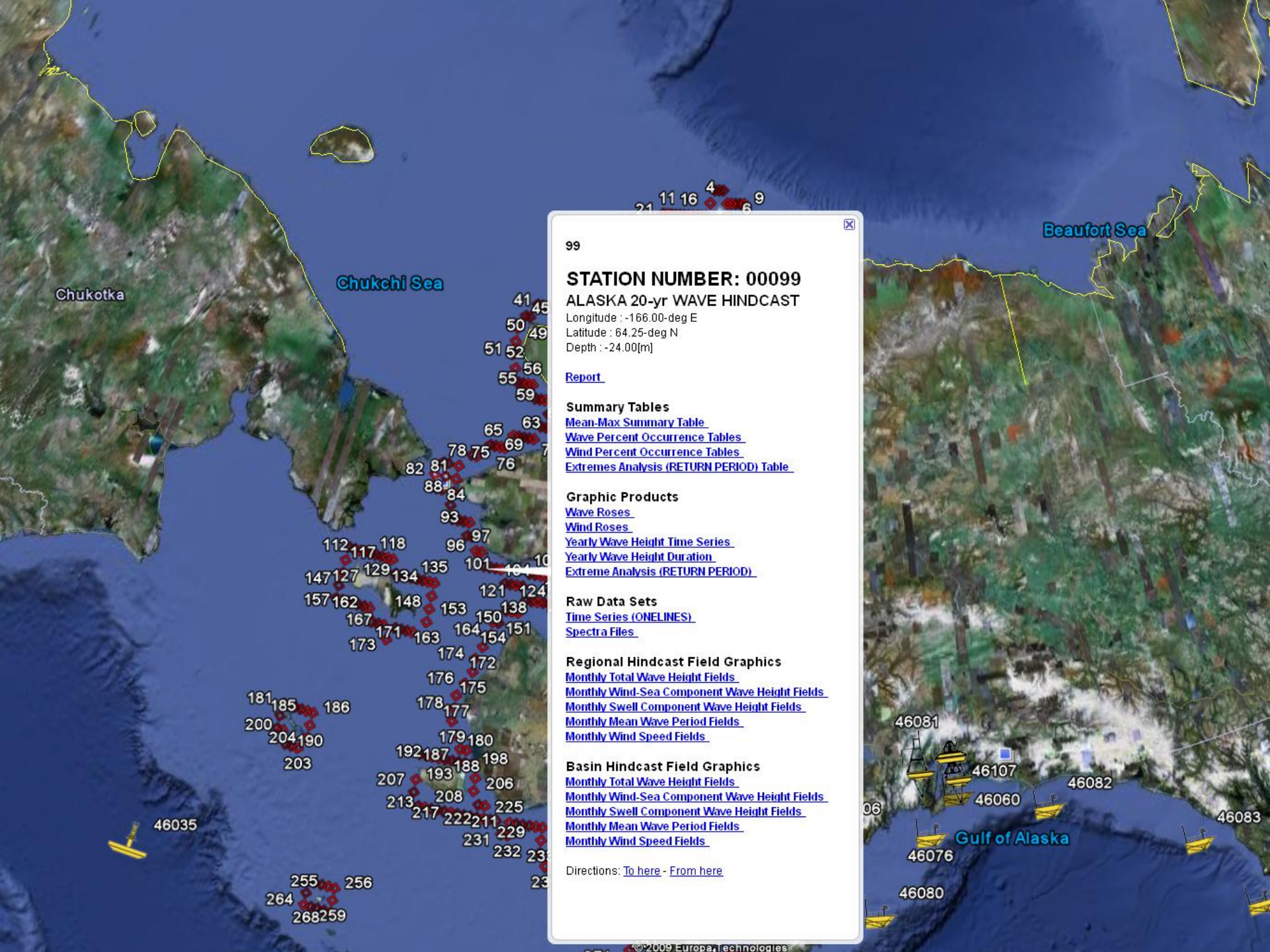
http://frf.usace.army.mil/wis/ak/ak_main.html



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Special Output Locations and 36 Documented in Report





99

STATION NUMBER: 00099

ALASKA 20-yr WAVE HINDCAST

Longitude : -166.00-deg E

Latitude : 64.25-deg N

Depth : -24.00[m]

[Report](#)

Summary Tables

[Mean-Max Summary Table](#)

[Wave Percent Occurrence Tables](#)

[Wind Percent Occurrence Tables](#)

[Extremes Analysis \(RETURN PERIOD\) Table](#)

Graphic Products

[Wave Roses](#)

[Wind Roses](#)

[Yearly Wave Height Time Series](#)

[Yearly Wave Height Duration](#)

[Extreme Analysis \(RETURN PERIOD\)](#)

Raw Data Sets

[Time Series \(ONELINES\)](#)

[Spectra Files](#)

Regional Hindcast Field Graphics

[Monthly Total Wave Height Fields](#)

[Monthly Wind-Sea Component Wave Height Fields](#)

[Monthly Swell Component Wave Height Fields](#)

[Monthly Mean Wave Period Fields](#)

[Monthly Wind Speed Fields](#)

Basin Hindcast Field Graphics

[Monthly Total Wave Height Fields](#)

[Monthly Wind-Sea Component Wave Height Fields](#)

[Monthly Swell Component Wave Height Fields](#)

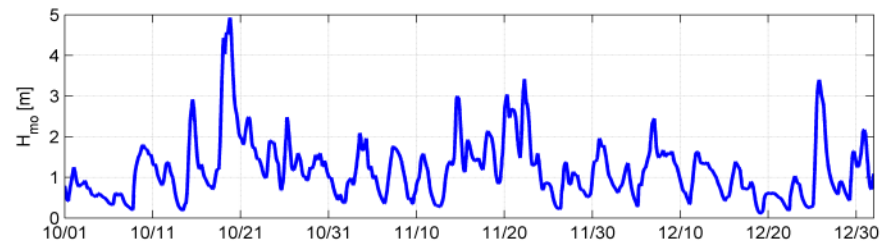
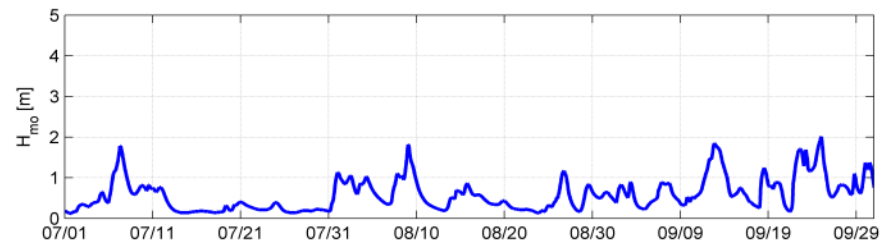
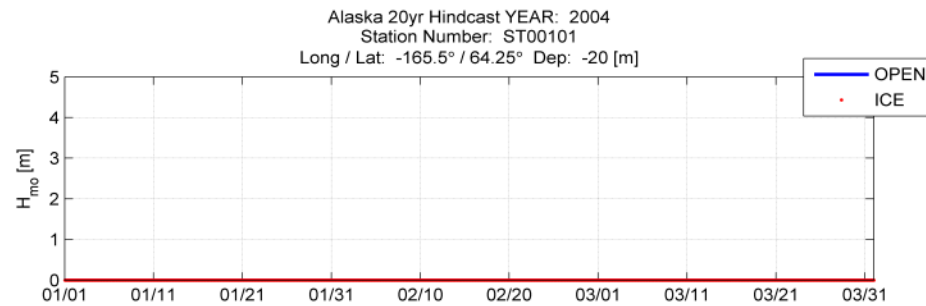
[Monthly Mean Wave Period Fields](#)

[Monthly Wind Speed Fields](#)

Directions: [To here](#) - [From here](#)

OUTPUTS

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





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