

Wave and Hydrodynamic Modeling within the Nearshore Beaufort Sea

5-Year BOEM Funded Study (2017-2022)



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UNIVERSITY of ALASKA
ANCHORAGE™



148°0'0"W

147°0'0"W

Wave and Hydrodynamic Modeling within the Nearshore Beaufort Sea

-  Future Proposed Location of Liberty Drilling Island (LDI)
-  Federal-State Boundary
-  Bathy Contours

70°30'0"N

70°30'0"N

Midway Islands

Reindeer I.

Stefansson Sound

Naryhal Island

Boulder Patch

Proposed LDI Location

70°20'0"N

70°20'0"N

Prudhoe

Bay

Sagayauktok River

Foggy Island Bay

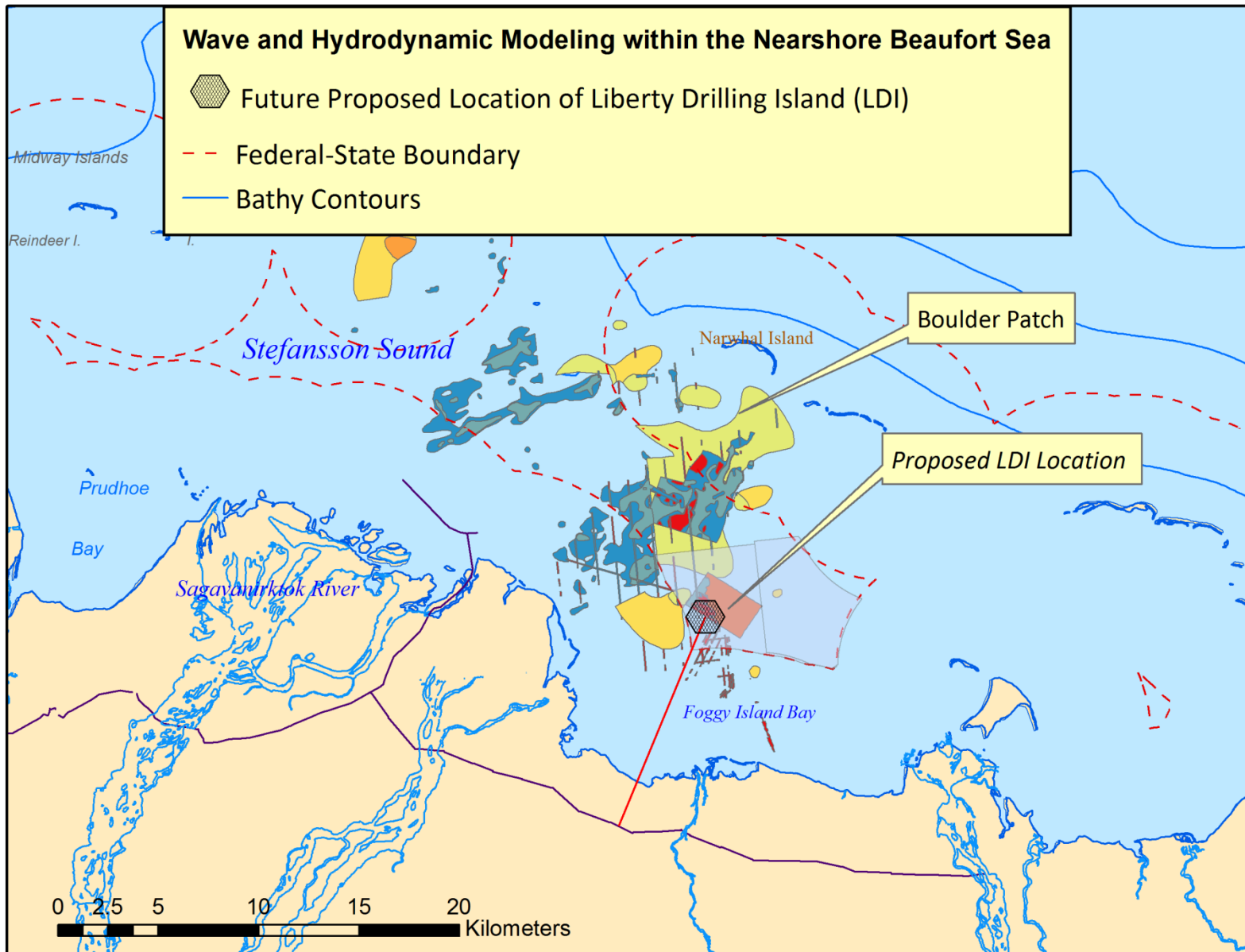
70°10'0"N

70°10'0"N



148°0'0"W

147°0'0"W



Why BOEM is Funding this Study?

- Hilcorp, Alaska plans to develop an offshore Oil Field in Foggy Island Bay called the Liberty Development Project.
- During the winter months, Hilcorp, Alaska will construct the offshore Liberty Development Island (LDI) in Foggy Island Bay and excavate a pipeline trench from the LDI to shore.
- Once production begins, oil will be transported to shore via a sub-seabed pipeline connecting to existing onshore infrastructure.
- The LDI will be maintained for the life of the proposed production, which is approximately 20-30 years.

What Information is BOEM going to Obtain from this Study?

- Past, present, wind, wave and storm surge conditions and outputs (1979-2019).
- Similar forecast products as ice recedes in the area (2020-2049).
- Changes in coastal erosion and sediment impacts.
- Validated wave, hydrodynamic, and sediment transport models.
- Model outputs of sediment transport and concentrations from construction activities associated with proposed Liberty Development Project and long term trends (outputs) due to expected changes in region-wide environmental conditions.

Expected Environmental Changes

Warmer Air and Water Temperatures

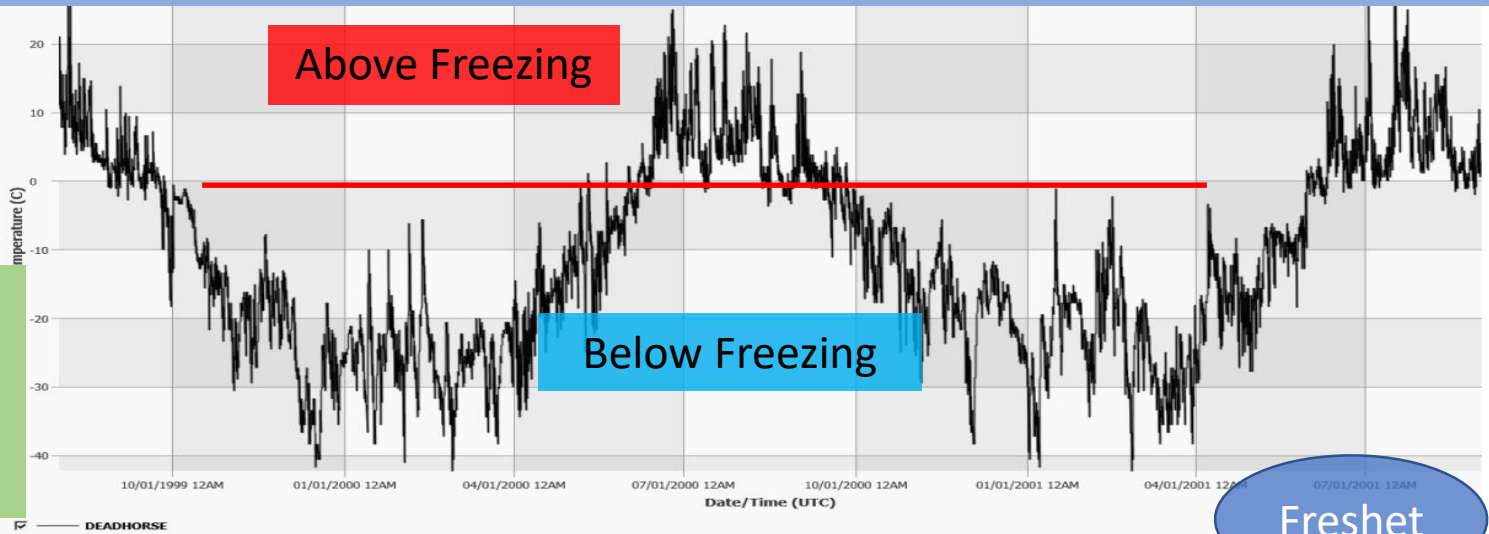
Diminishing Sea Ice Cover

Increased Precipitation?

May lead over time to:

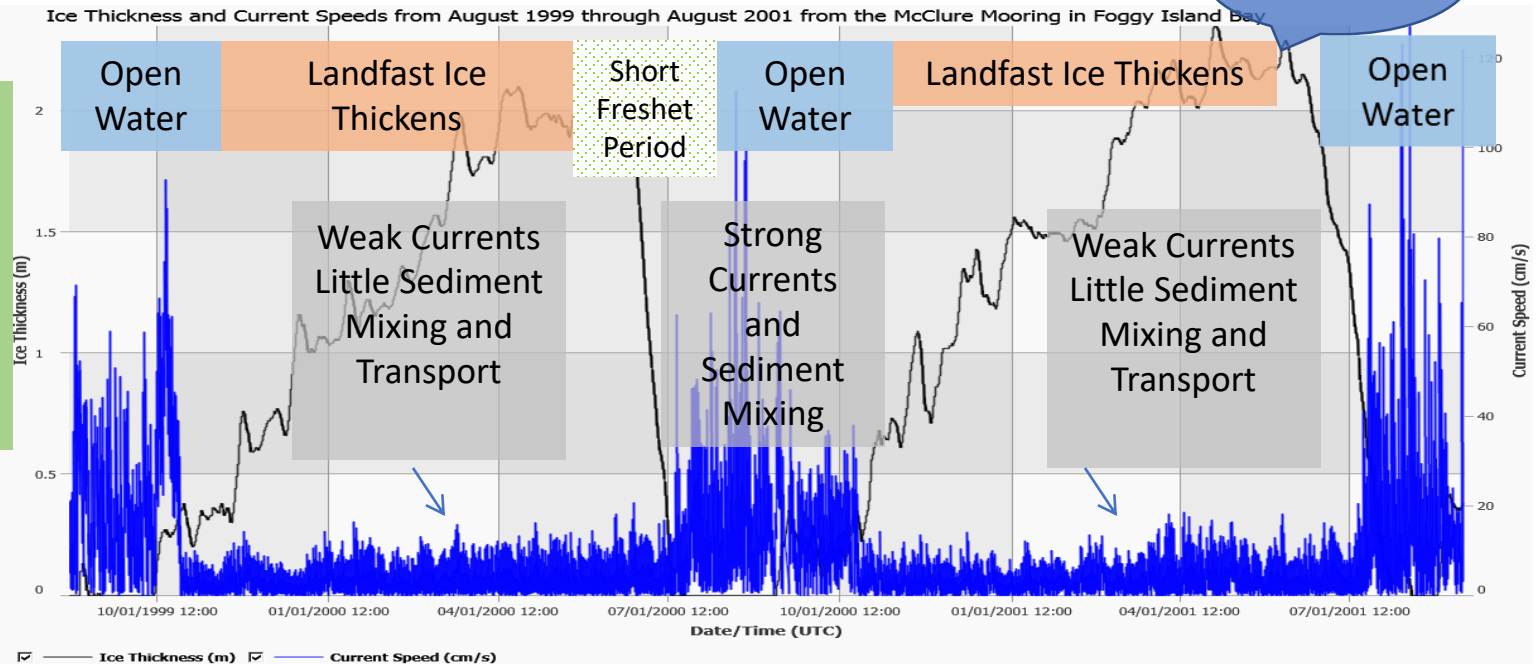
- Longer periods of open water
- Increased wave intensity and duration
- Increased storm surge extents
- Increased coastal erosion of permafrost cliffs
- Increases in fresh water and sediment flux into the coastal lagoons.

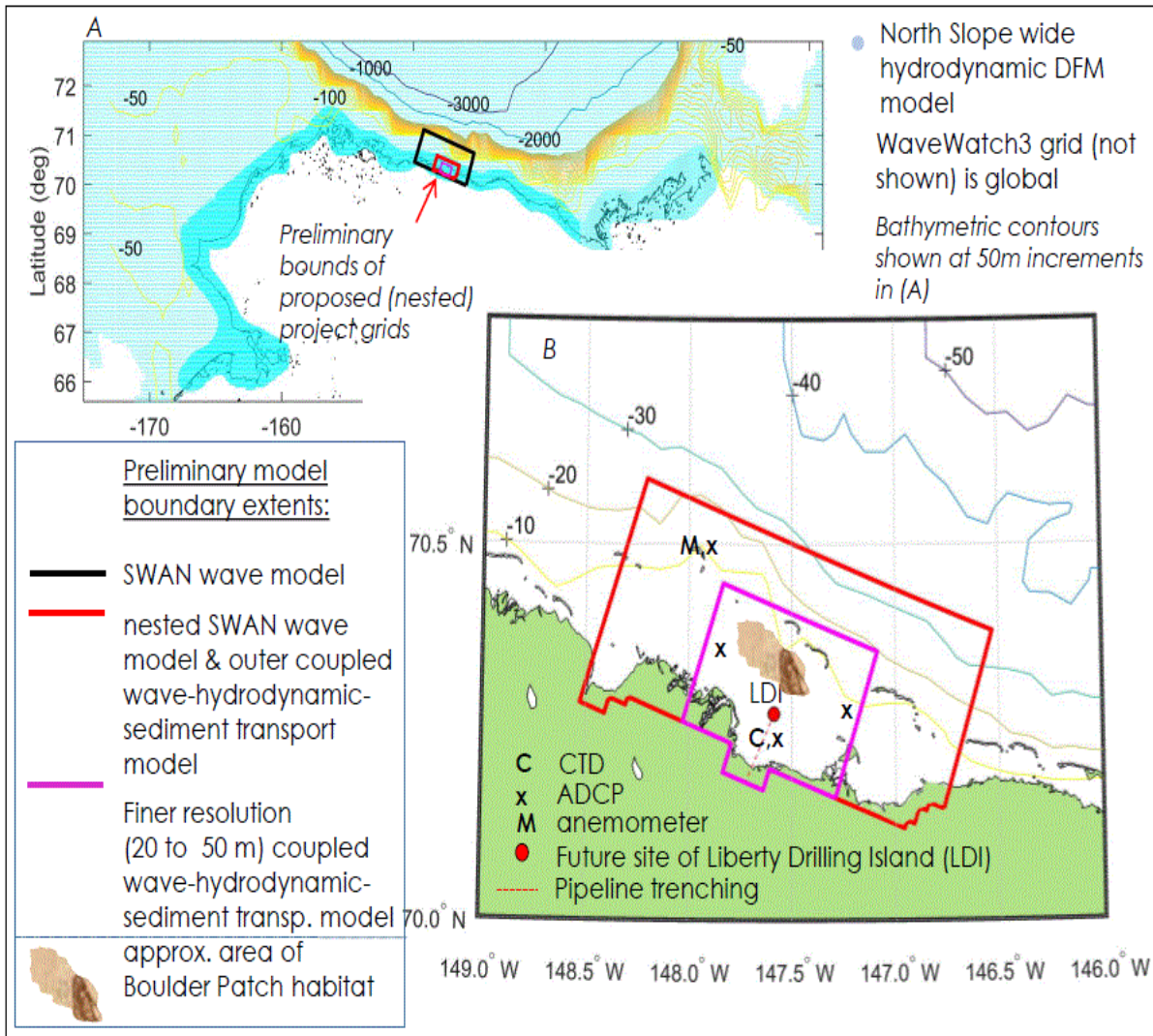
Seasonal Cycles of Landfast Ice Growth and Ablation within Foggy Island Bay 1999-2001



Seasonal Air Temperatures at Deadhorse, Alaska

Seasonal Sea Ice Thickness And Subsurface Currents





GOAL

to characterize and quantify

➤ **wave conditions, storm surge, and currents**

(Stefansson Sound and surrounding coastline)

➤ **sediment transport** (Foggy Island Bay)

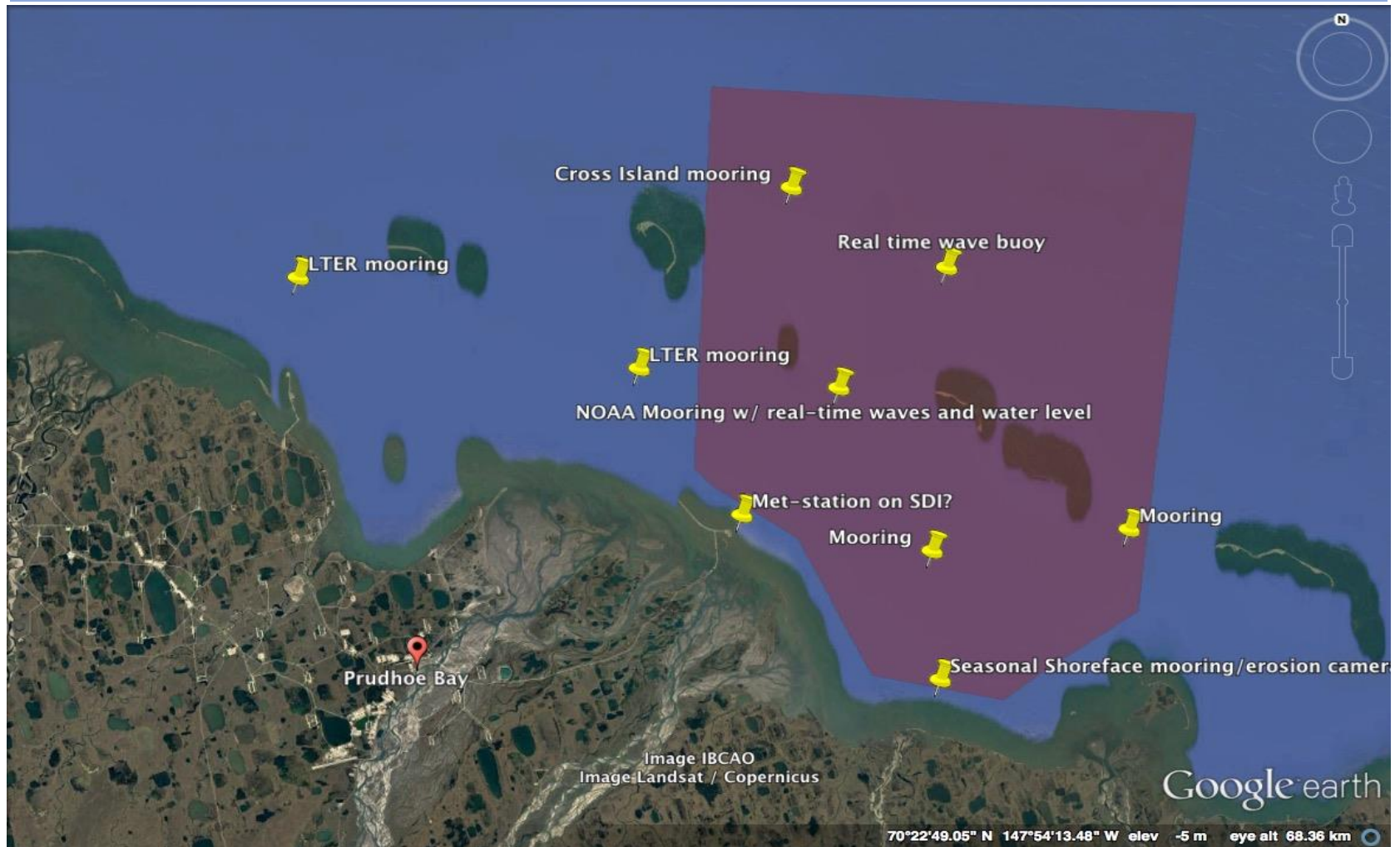
□ **hindcast 40 years** (1979 – 2019)

□ **project 30 years** into the future (2020–2049) (using projected changes in atmospheric conditions and sea ice)

Modeling

- WaveWatch (Deep Water) forced SWAN (Shallow Water) simulations.
- North Slope Wide DFM (Hydrodynamic) and WaveWatch models (40-year hindcast (1979 – 2019))
- Arctic Xbeach modeling of coastal change and the supply of sediment to the nearshore via erosion (hindcast and forecast)
- Higher resolution coupled wave-sediment-hydrodynamics simulations for select *seasonal scenarios* (**open water, landfast ice, spring freshet and no island(LDI), artificial island (LDI), pipeline trenching** etc.)
- Two 30-year projections using calibrated and validated hydrodynamic, wave and sediment transport models

Planned Observations for Model Validation

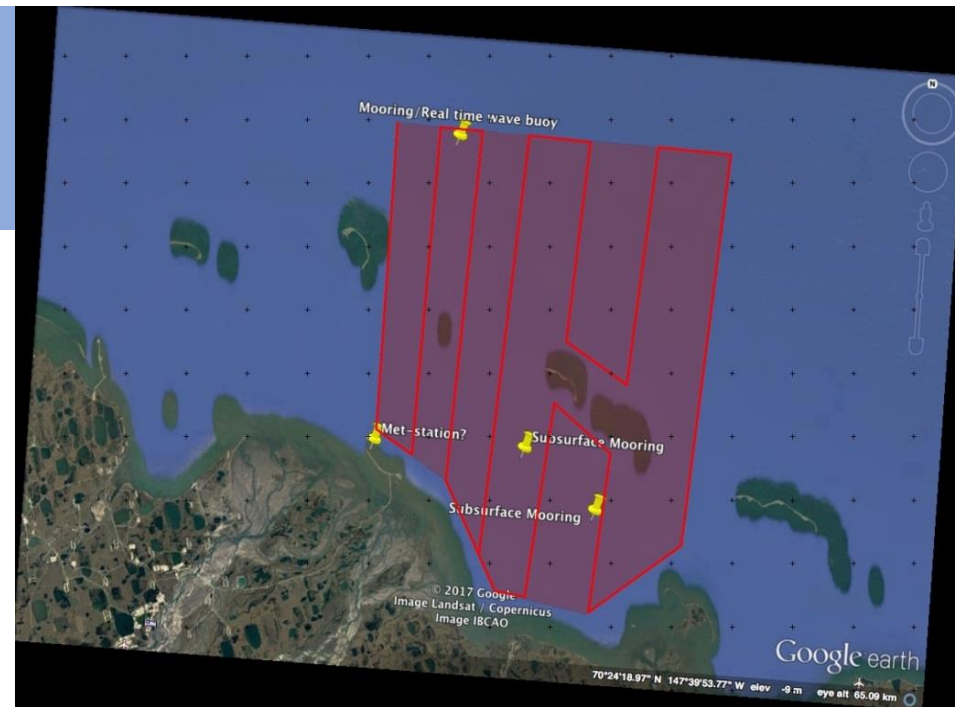


Observations for Model Validation

- **Historical data collection *plus* new observations** to include:
- Repeat **bathymetric surveys** to estimate bedload transport and bed elevation changes.
- **Hydrographic surveys** to map fronts, hydrography, suspended sediment and transport.
- 4 year-round **oceanographic moorings** (ADCP, CTD etc..).
- Seasonal shore face mooring to measure sediment flux.
- **Met-station**, time-lapse camera to assess coastal erosion.
- **2 real-time wave buoys (Offshore and Nearshore)**
- **Coastal elevation** transects to quantify coastal change
- **Seasonal through ice measurements. (water column)**
- **(Partnering) LongTermEcologicalResearch LTER “Beaufort Sea Lagoons: An Arctic Coastal Ecosystem in Transition”**

Tentative Field Schedule

- ~9 days of CTD, multi-beam sonar surveys and mooring deployments in 2018, 2019 from the R/V Ukpik.
- Most of the vessel-based work concentrated in- and around- Foggy Island Bay (red shaded area)
- Final mooring recoveries in 2020
- Real-time wave data Summer/Fall 2018 and 2019
- Real-time met station (location TBD)



Multiple Collaborators

- **University of Alaska Fairbanks (INE and IARC)**
 - UAF: Project Management, Observations of waves, sediment transport and hydrography, model validation
 - IARC: Dynamical downscaling of hindcast and forecast GCM output
- **USGS Pacific Coastal and Marine Science Center**
 - Wave, sediment transport, surge and hydrodynamic modeling (hindcast and forecast), Model validation
- **University of Alaska Anchorage**
 - Modeling of coastal erosion, sediment characterization and sediment transport observations
- **Alaska Ocean Observing System and Axiom Data Science**
 - Project Website, Data Compilation and Management and Outreach