Attendee Rules

- ❏ Mute yourself
- ❏ Turn off your camera

2022 Alaska Coastal & Ocean Mapping Summit

Technology Lightning Talks

November 16th, 2022

NOAA Coastal Mapping Project in Southeast Alaska as a Supporting Case for the Alaska Coastal Mapping Strategy

Colin Cooper – NV5

THE ALASKA COASTAL MAPPING STRATEGY & A SUPPORTING CASE OF NOAA'S COASTAL MAPPING PROGRAM IN SE AK

Colin Cooper and Scott Venables

NV5 GEOSPATIAL

ALASKA COASTAL MAPPING INITIATIVE

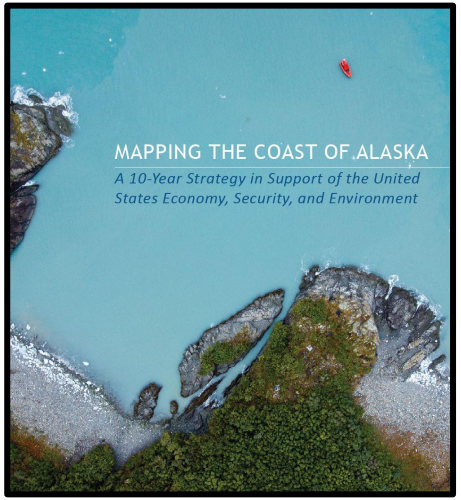
NV5 GEOSPATIAL

NOAA NGS RSD Coastal Mapping Program

Requires the collection of airborne topographic/bathymetric Light Detection and Ranging (lidar) and digital camera imagery data to enable accurate and consistent measurement of the national shoreline.

Bathy Lidar Quality Level	Source	Vertical accuracy coefficients a,b as in sqrt(a^2+(b*d)^2))	Nominal Pulse Spacing (m)	Point Density (pt/m^2)	Example Applications
QL0$_B$	Bathymetric Lidar	0.25, 0.0075	≤0.7	≥2.0	Detailed site surveys requiring the highest accuracy and highest resolution seafloor definition; dredging and inshore engineering surveys; high-resolution surveys of ports and harbors
QL1$_B$	Bathymetric Lidar	0.25, 0.0075	≤2.0	≥0.25	
QL2$_B$	Bathymetric Lidar	0.30, 0.0130	≤0.7	≥2.0	Charting surveys; regional sediment management General bathymetric mapping; coastal science and management applications
QL3$_B$	Bathymetric Lidar	0.30, 0.0130	≤20	≥0.25	Change analysis; deepwater surveys, environmental analysis

November 19, 2019:
DCPD-201900811
Presidential Memorandum on Ocean Mapping of the United Sates Exclusive Economic Zone and the Shoreline and Nearshore of Alaska



NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

ALASKA MAPPING Executive Committee

AOOS Alaska Ocean Observing System

USGS

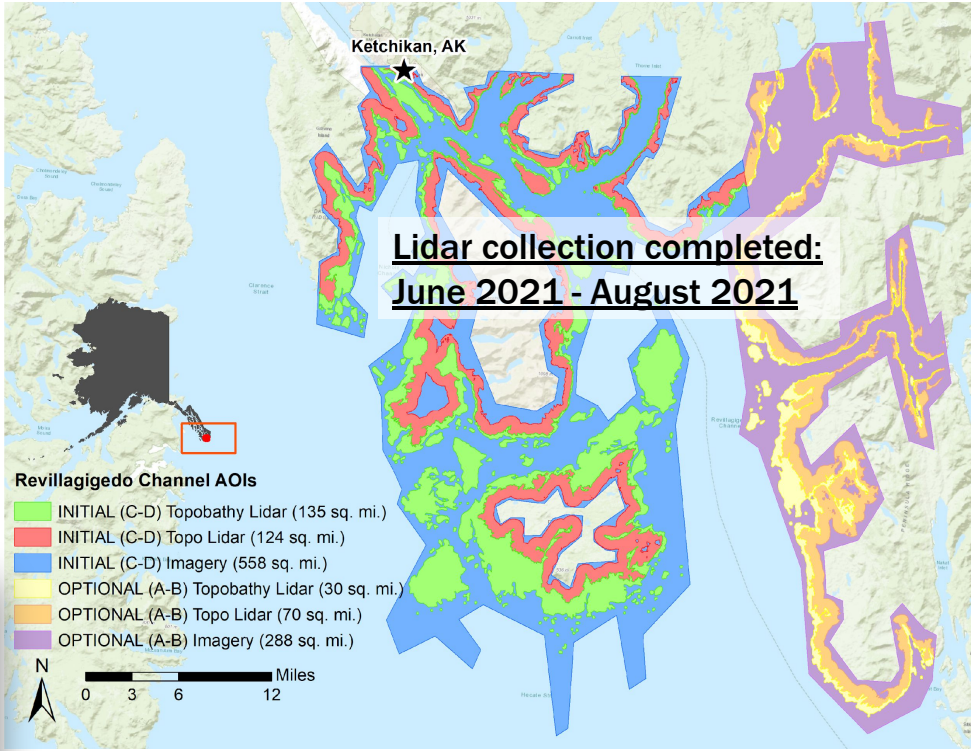
REVILLAGIGEDO CHANNEL

NV5 GEOSPATIAL

Tasked for Topobathymetric Lidar, 4-band Imagery, & Shoreline mapping Revillagigedo Channel

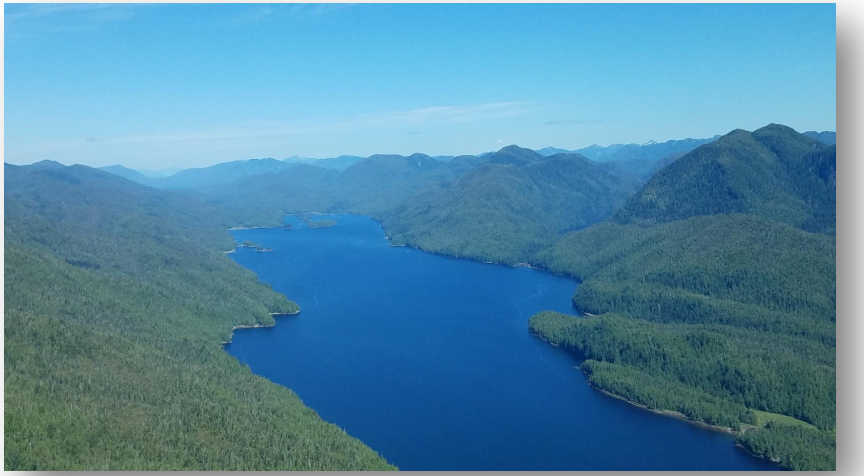
Sensors
Leica Chiroptera 4X/Hawkeye 4X (topobathy)
Riegl 1560ii (NIR)
UltraCam Eagle (4 band Imagery)

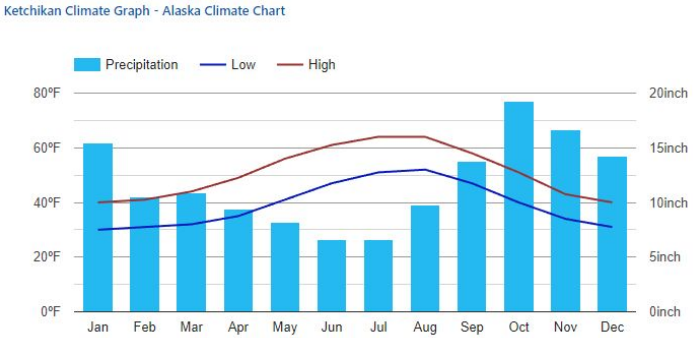
Ketchikan is home to the highest zip code in the US: 99950

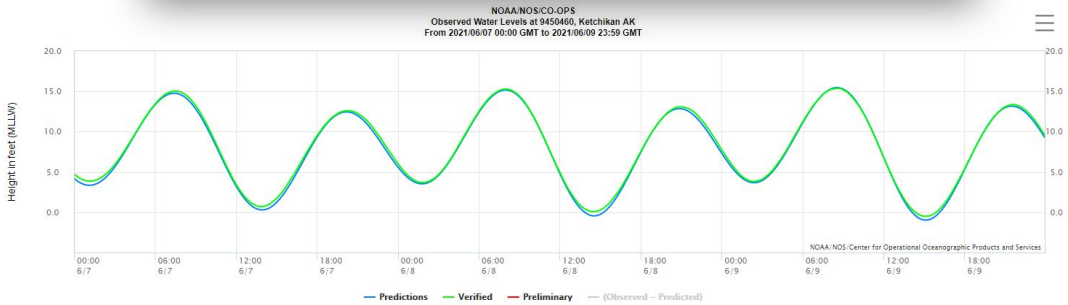


OPERATIONAL CONSIDERATIONS

- Weather
- Mountainous terrain, Fjords, Boxed canyons
- Tides
- Turbidity & Aquatic Vegetation
- Wind speed and direction
- Water surface conditions and wave height

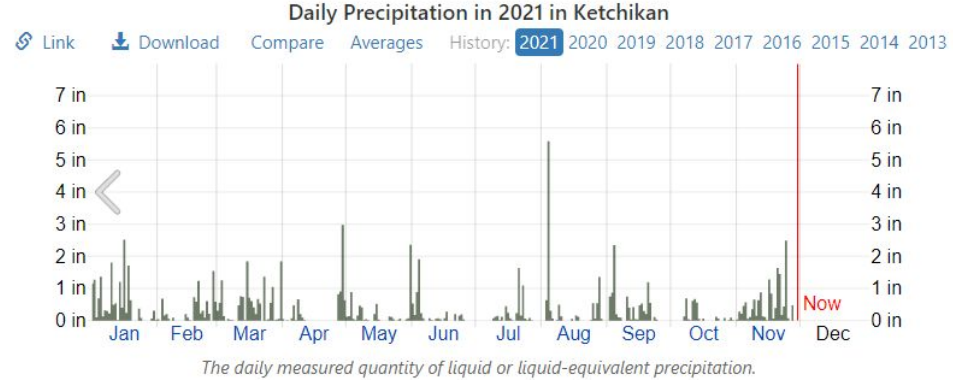




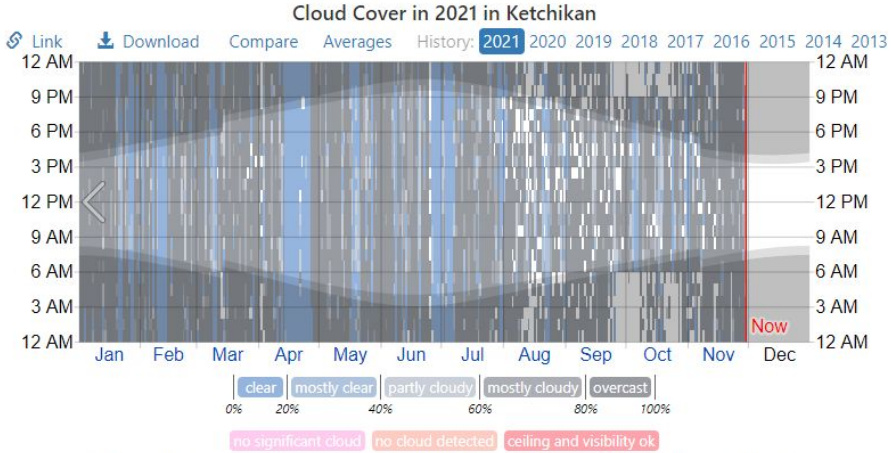


WEATHER A MAJOR FACTOR

NV5 GEOSPATIAL



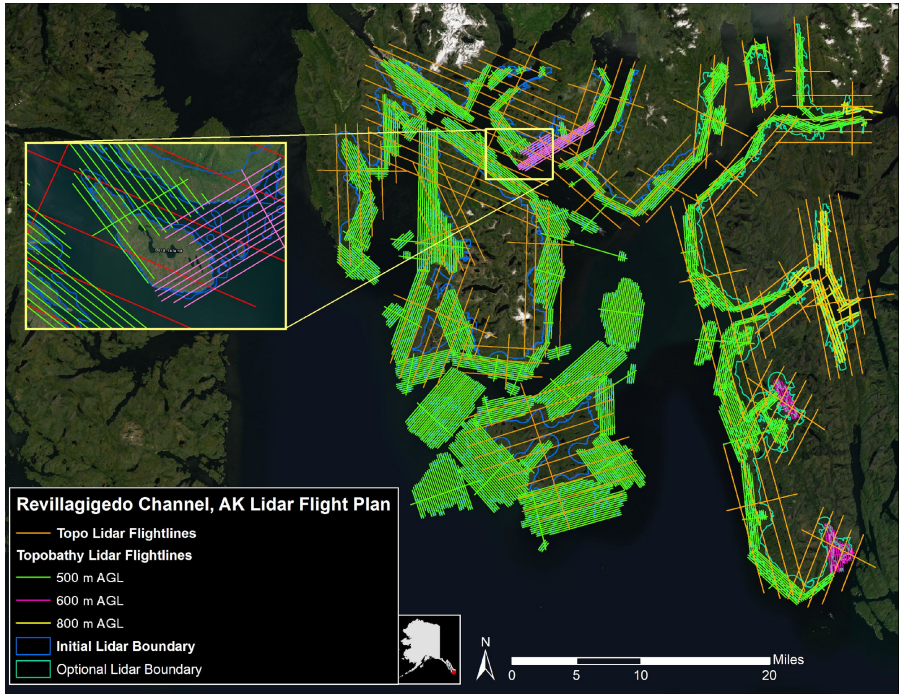
The daily measured quantity of liquid or liquid-equivalent precipitation.



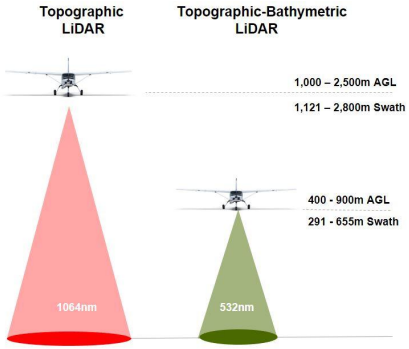
The hourly reported cloud coverage, categorized by the percentage of the sky covered by clouds.

DIVIDE & CONQUER

NV5 GEOSPATIAL



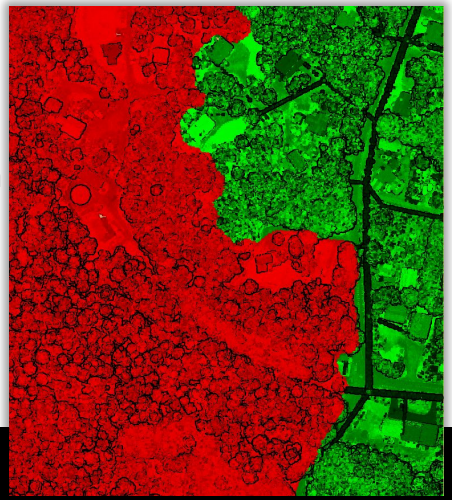
- Bathy sensors inefficient in terrain
- Decoupled bathy & inland
- Increased efficiency (fewer flight days)
- Decoupled inland from tide (increased flight windows)
- Maximized productivity during good weather windows

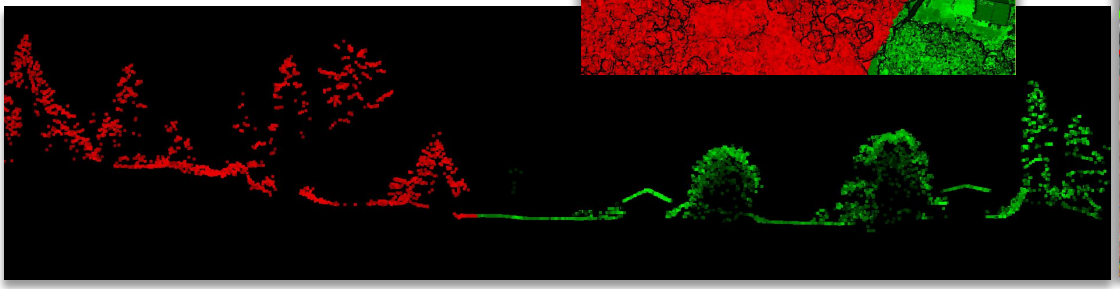


DATA INTEGRATION

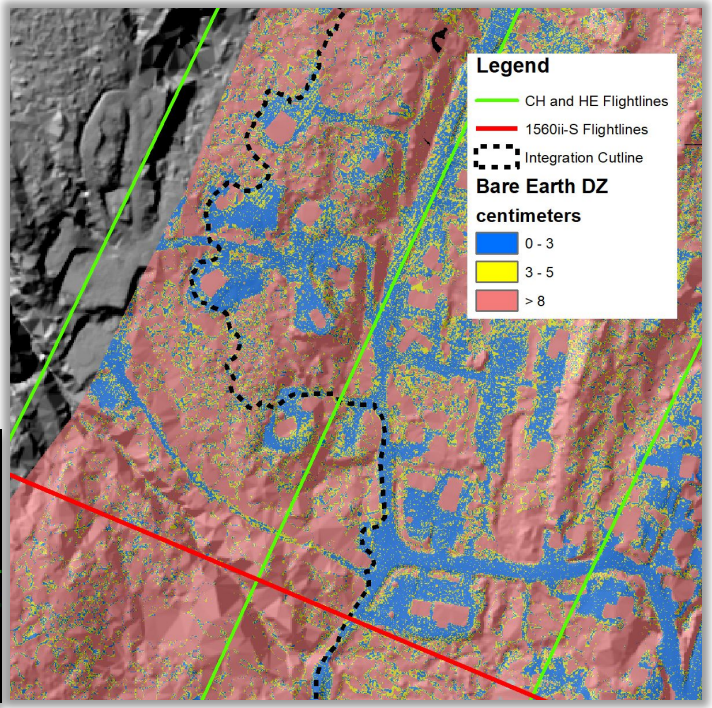
SEPARATE FLIGHTS FOR TOPO TERRAIN

- Fewer bathy days on station
- NIR sensor more efficient in Terrain
- Decouple inland area from tide windows



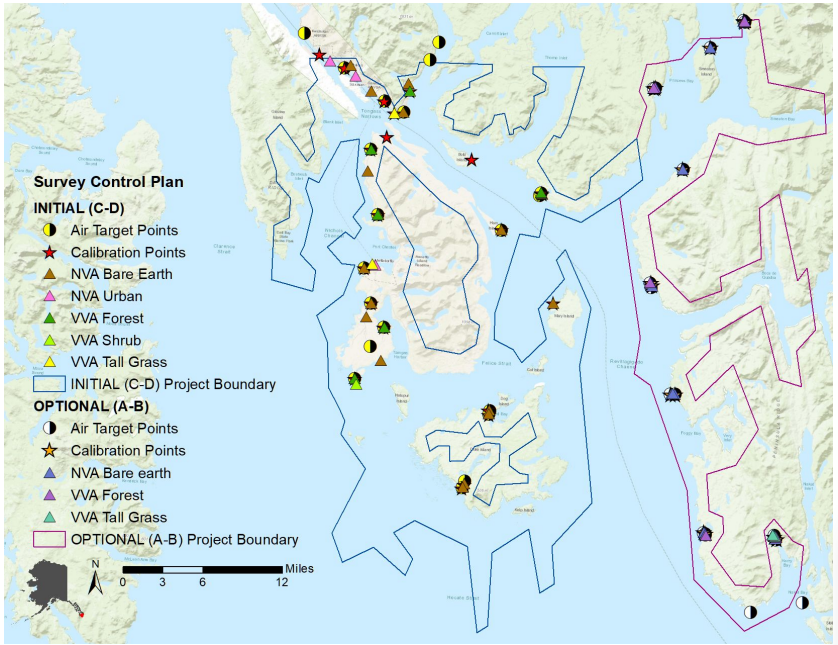


1560II-S AND CHIROPTERA NIR CUTLINE



SURVEY CONTROL

NV5 GEOSPATIAL



Ground Survey Point Summary

Type	Class	Area Km²	Total Area Km²	% Area	# Points
NVA	Bare Earth	14.52	15.45	1.48%	51
	Urban	0.93		0.09%	3
VVA	Forested	493.5	527.20	50.22%	14
	Shrub	33.7		3.43%	6
	Tall Grass/Weeds	0.024		0.00%	11
Not Applicable	Swamp/Wetland *	64.61	440.01	6.58%	0
	Open Water**	375.4		38.20%	

* Not used as a land class per USGS specs
** Not included in topographic project area calculated for NVA/VVA

Total Land Project Area Km²	982.65
Calibration Points	43
Air Targets	36
NVA	54
VVA	31
Total Points	164

TURBIDITY

June 7th

Suboptimal water quality

Low tide 3.68 feet

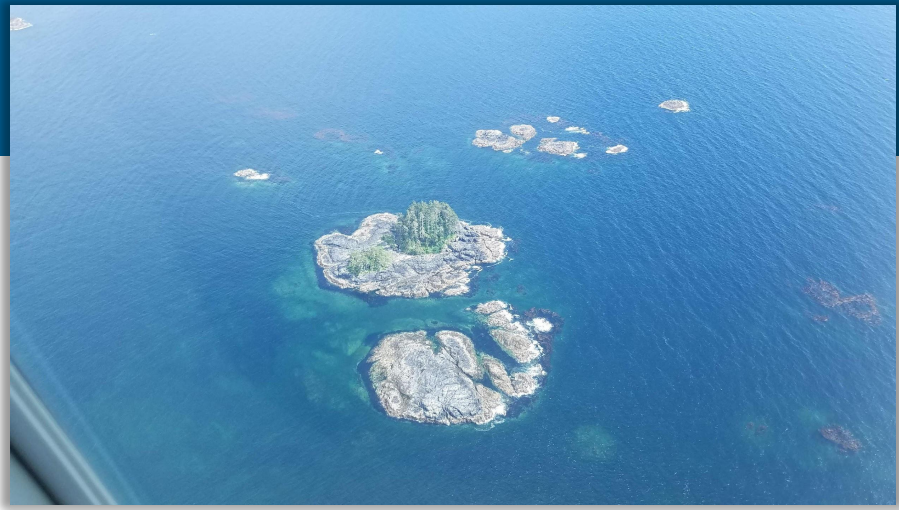
Wind: 7-9 Knots from SE

July 2nd

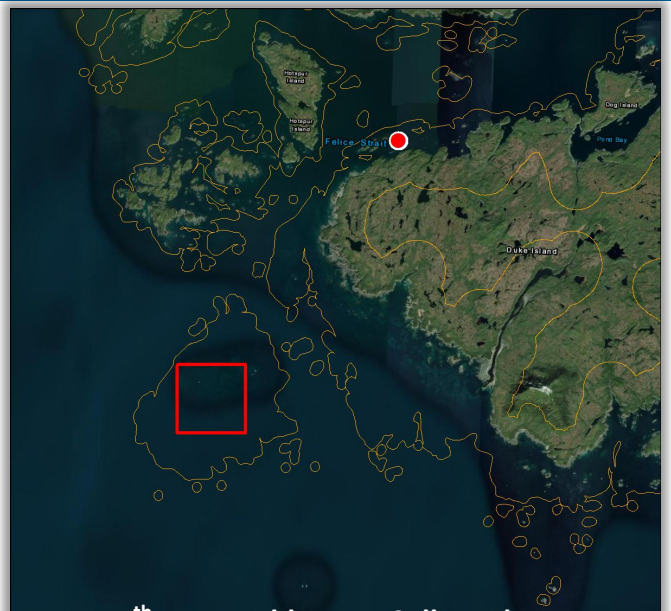
Improved water quality

Low tide 2.71 feet

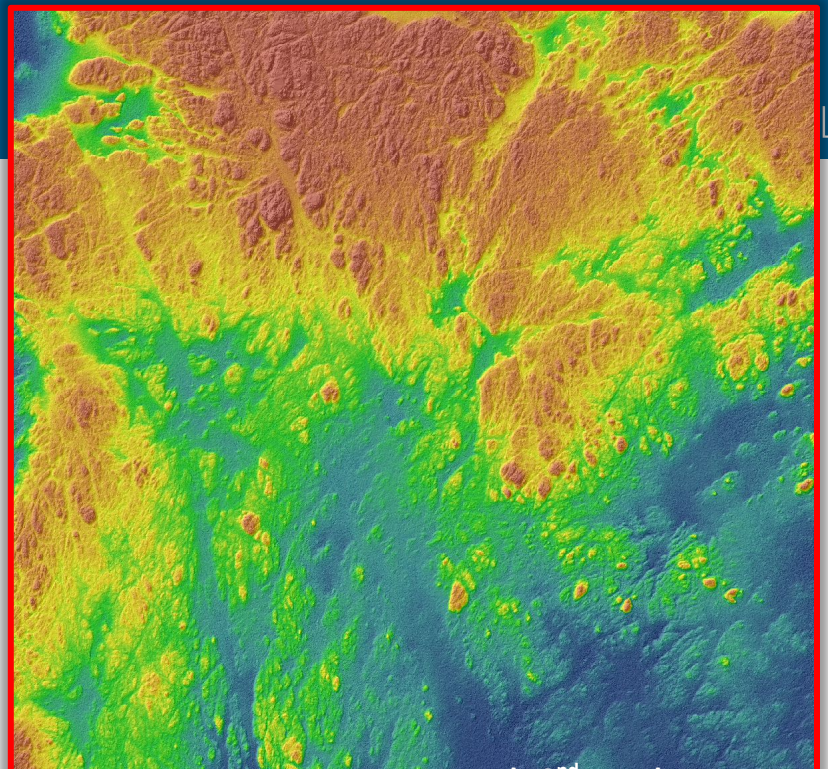
Wind: 9-12 Knots from WNW



REFLIGHTS

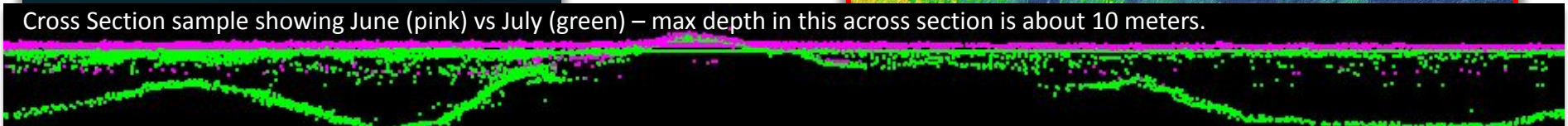


June 7th –No Usable Data Collected



July 2nd – Bathy DEM

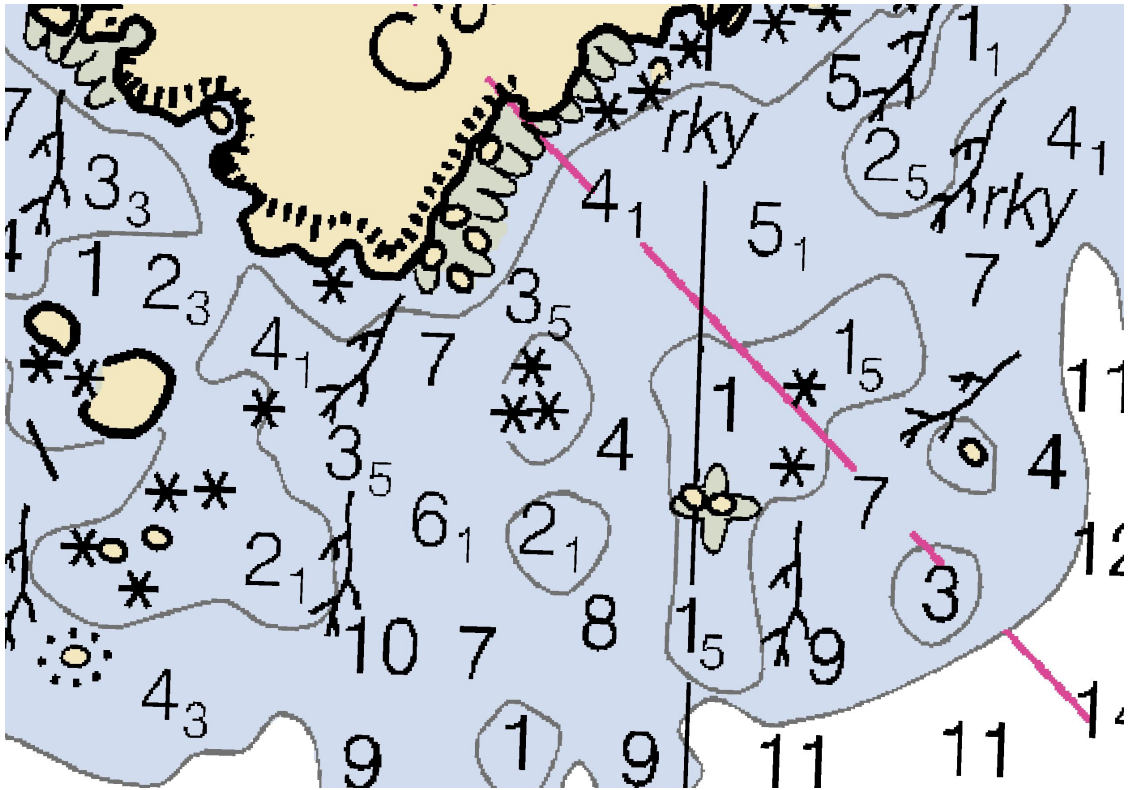
Cross Section sample showing June (pink) vs July (green) – max depth in this across section is about 10 meters.



NEARSHORE COVERAGE

NV5 GEOSPATIAL

- **NAVIGABLE AREA LIMIT LINE**
  - Inshore limit of safe navigation
- **SUPPORT MULTIBEAM**
  - Vessel operations logistically challenging
  - Shallow MBES intensive
  - Short operational season
  - Increase MBES efficiency
  - Having existing data is HUGE



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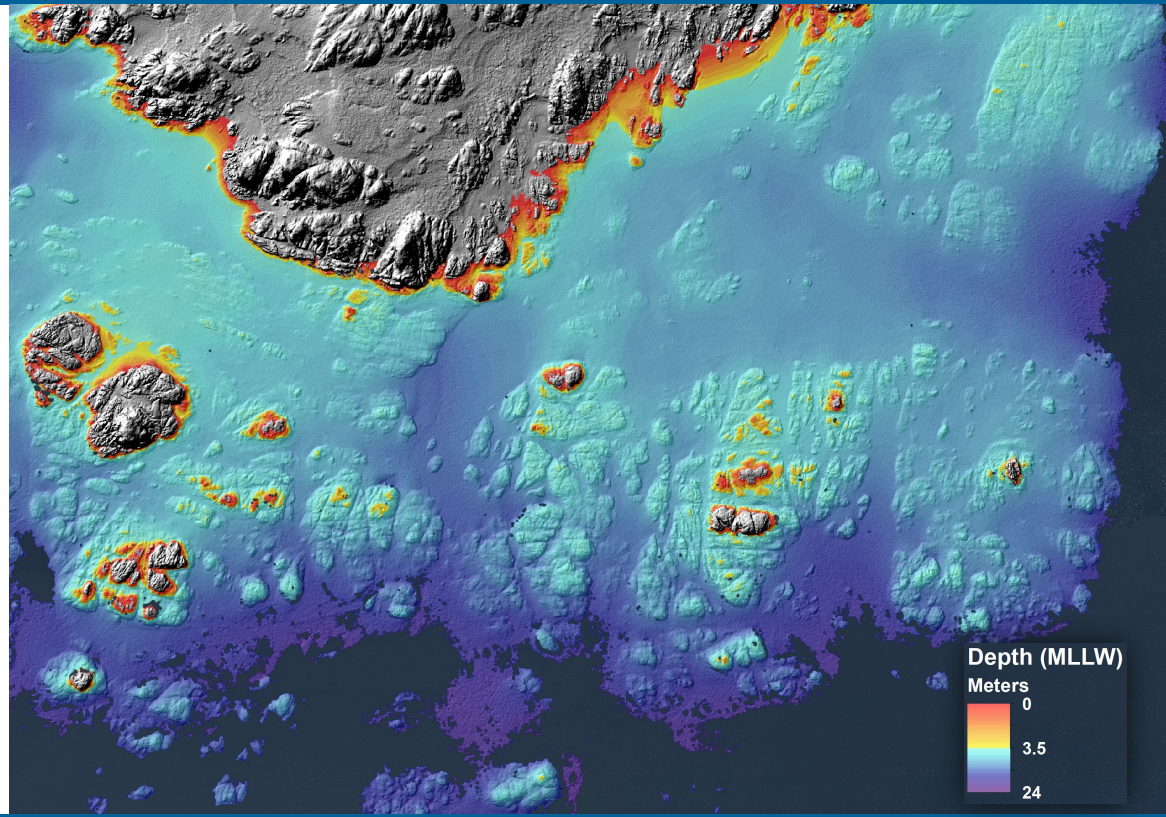

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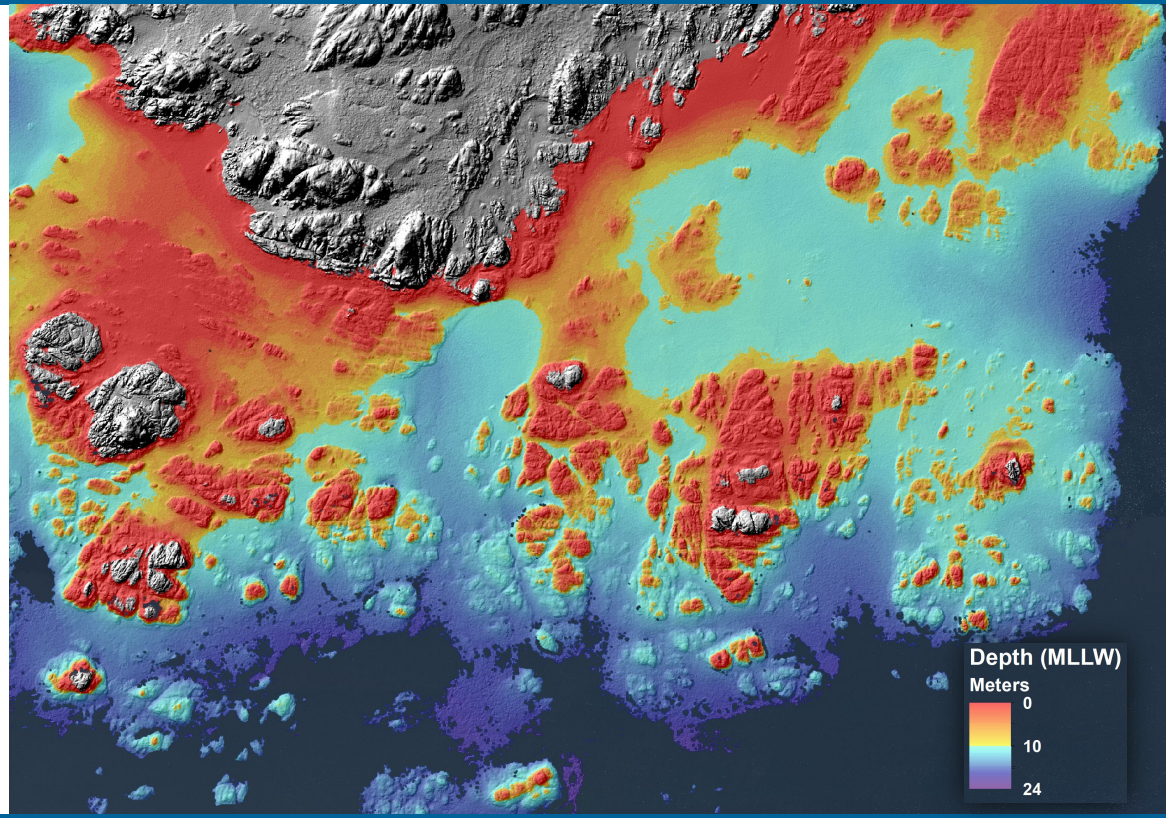
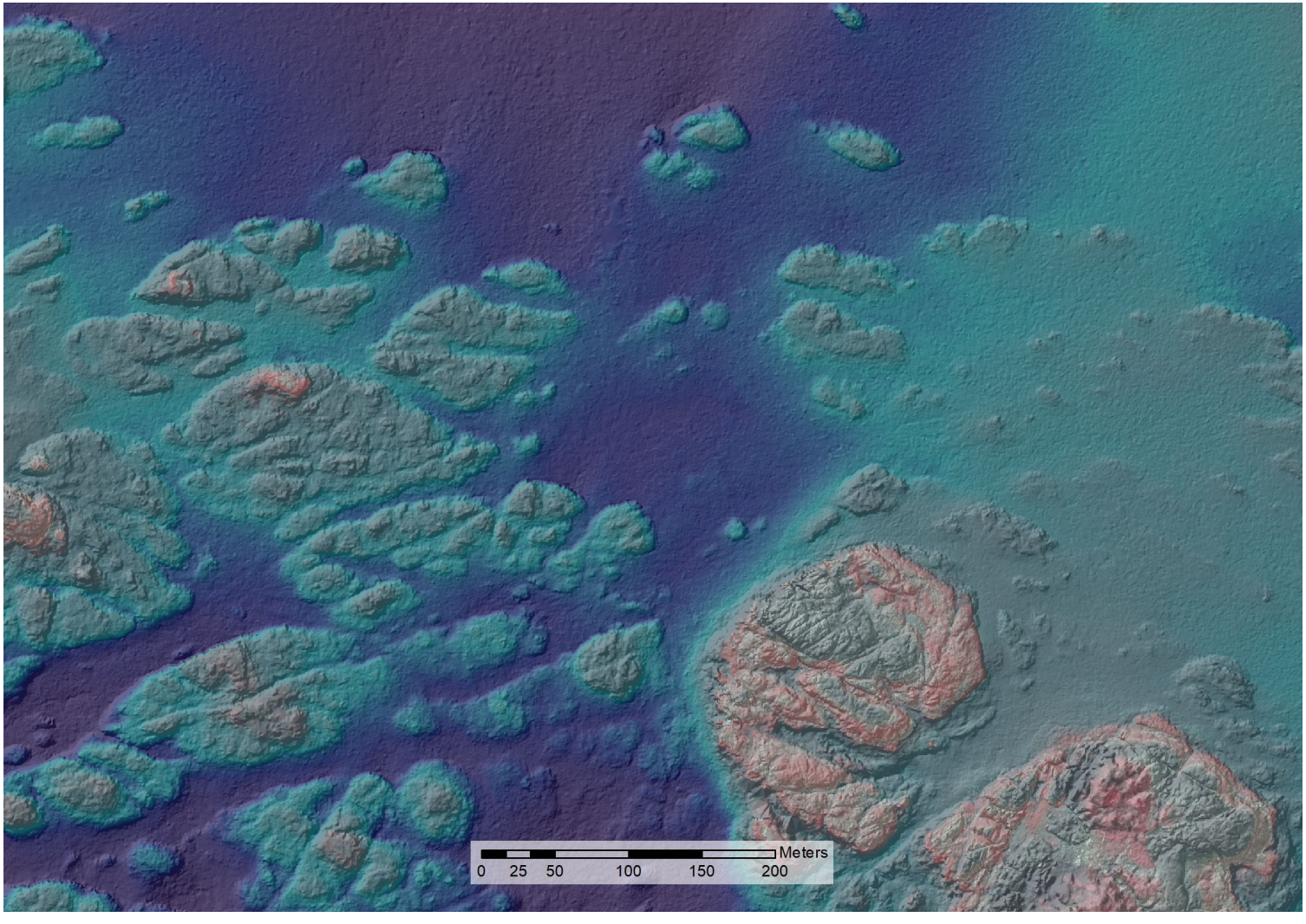
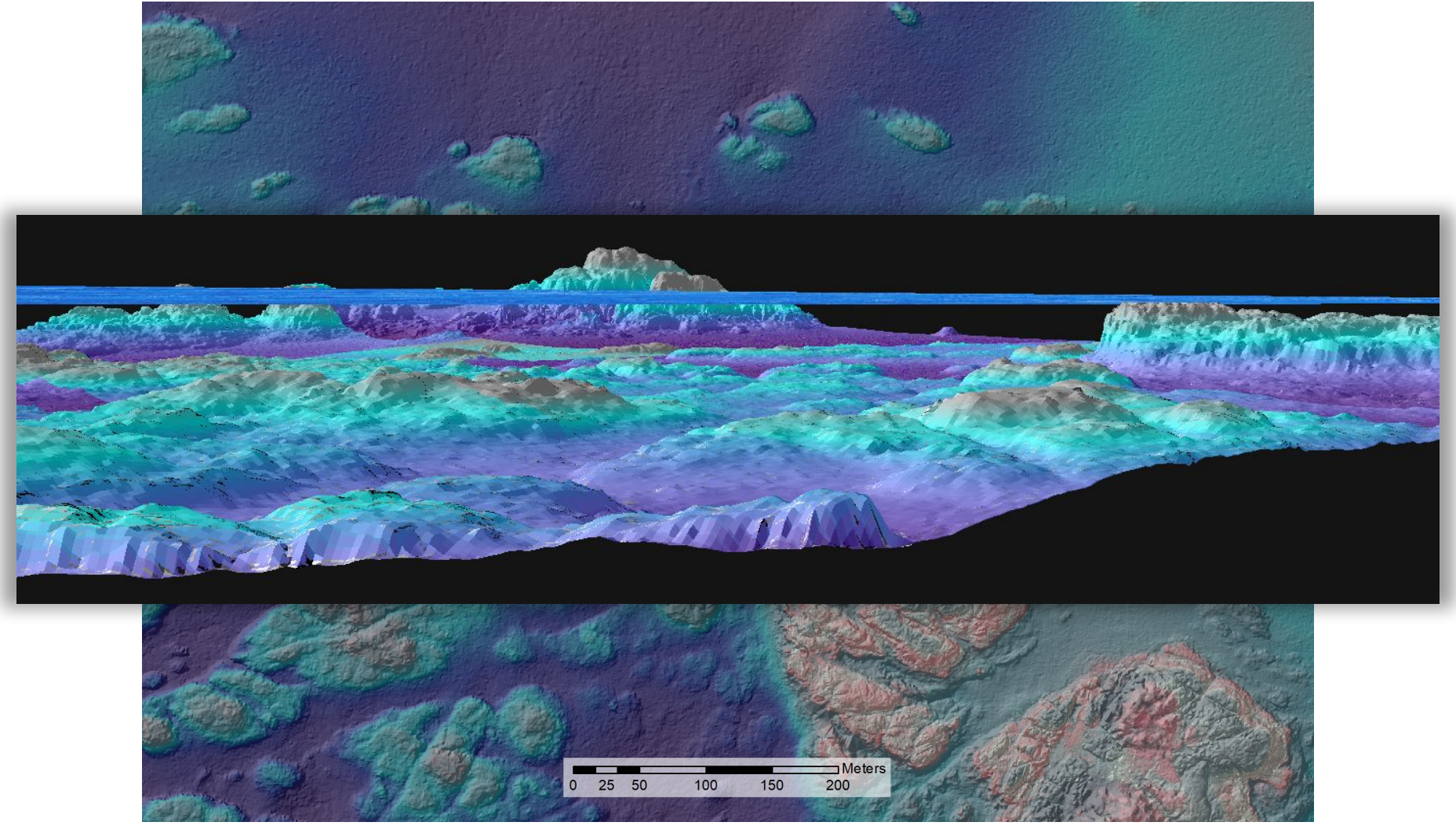
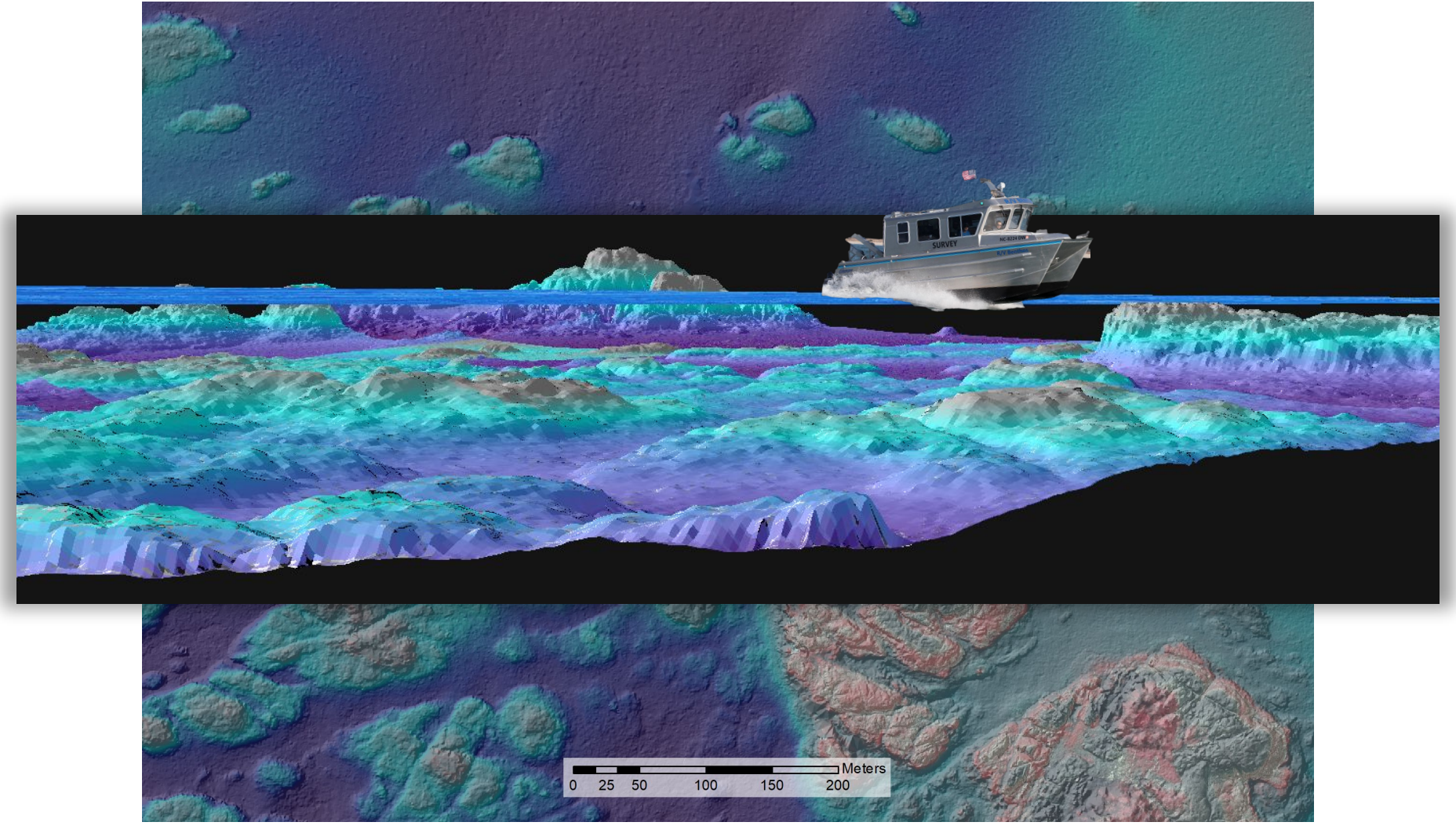
Increasing Safety

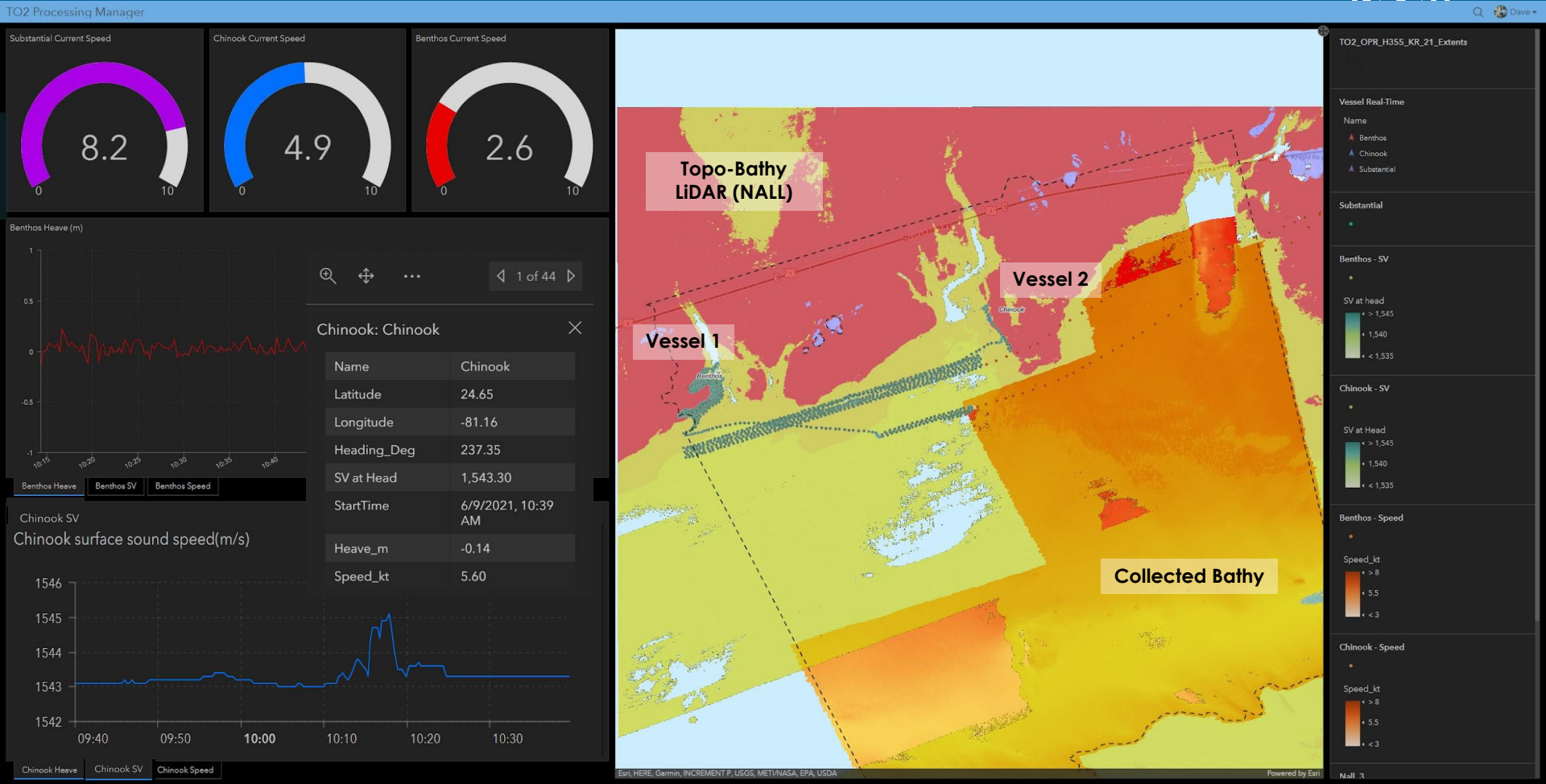



Meters
0 25 50 100 150 200


Meters
0 25 50 100 150 200


SURVEY
Meters
0 25 50 100 150 200

Survey Tracking

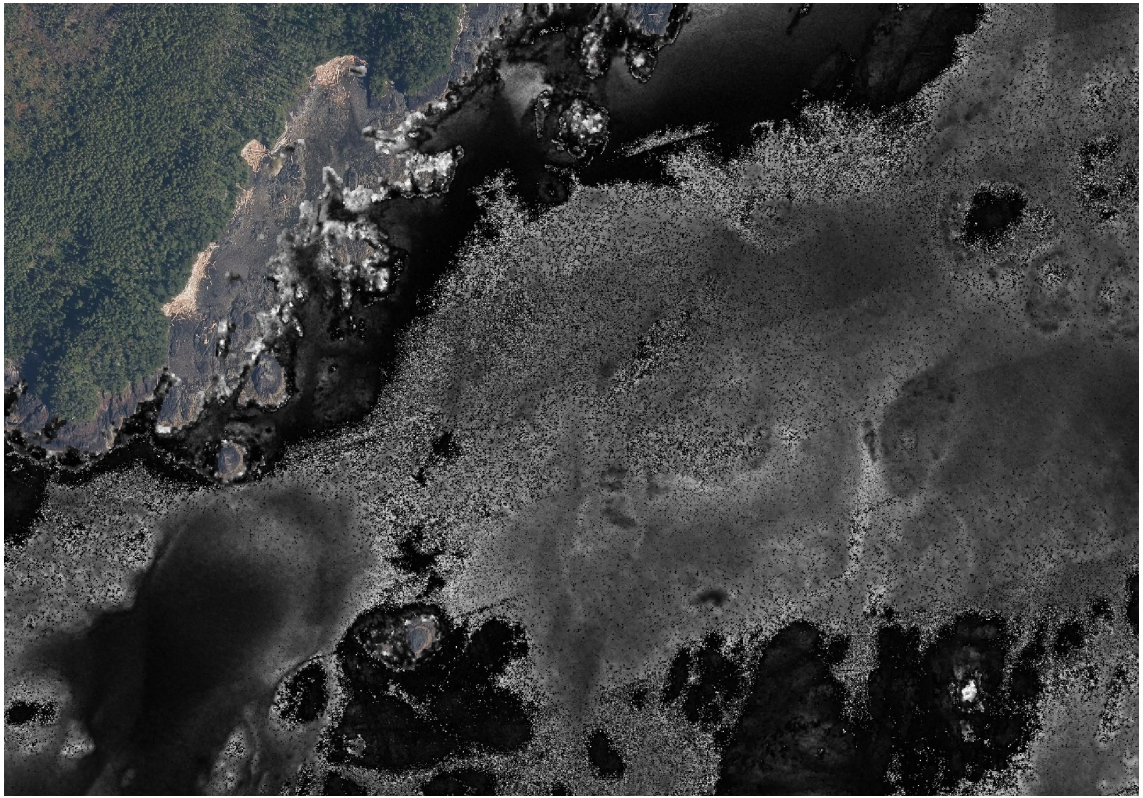


NORMALIZED INTENSITY

NV5 GEOSPATIAL

FACTORS

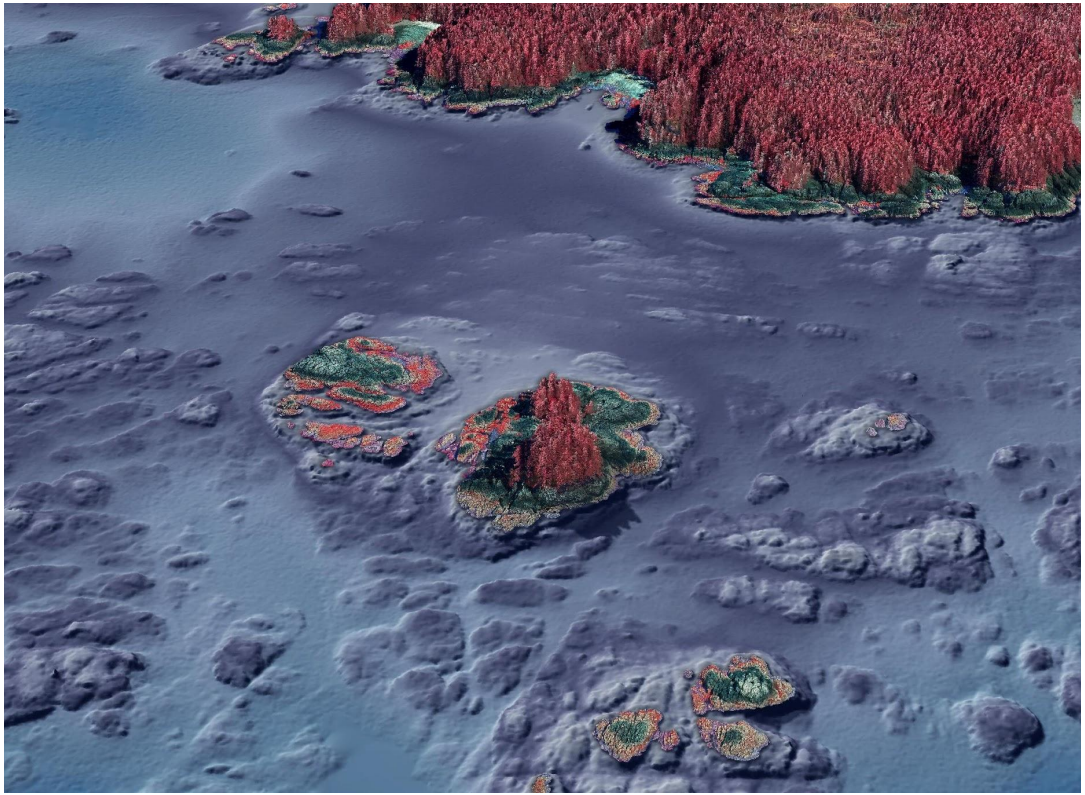
- Shallow vs Deep channels
- Various Flying heights
- Dynamic Environmental Conditions
    - Atmospheric
    - Sea state
    - Localized turbidity
    - Water column
- Temporal
- Bunch of stuff



IN SUMMARY

NV5 GEOSPATIAL

- NOAA NGS Coastal Mapping program can support the Alaska Coastal Mapping Initiative
- Logistically & environmentally challenging
    - Weather, terrain, remoteness, safety
    - Multi Sensor Approach
    - Sequence technologies
    - Complicates data processing
- Planning together and data sharing will be key



End of Presentation

Thank you!

Tidal Coordination for Data Acquisition

Nathan Wardwell – JOA Surveys, LLC

Tidal Coordination for Data Acquisition

Alaska Coastal & Ocean Mapping Summit 2022

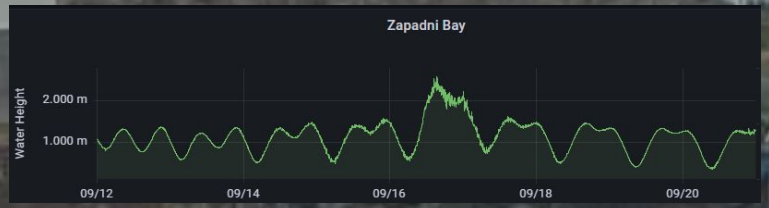
JOA Surveys, LLC

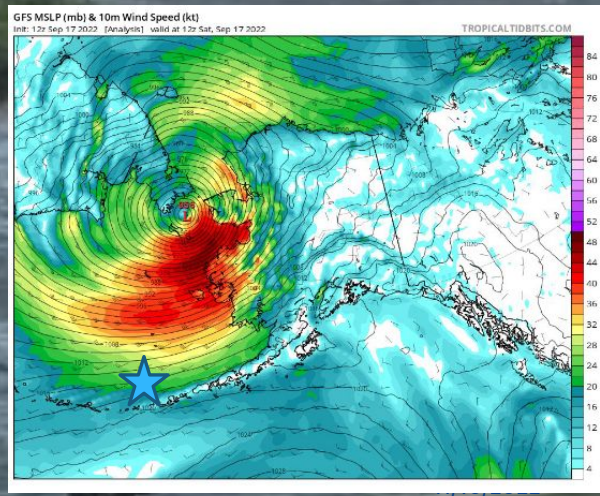
Company Overview

* Small Business located in Anchorage AK
* Owners (3)
* Full Time Employees (7)
* Part Time/Seasonal Employees
* Land Surveyor Licensed in Alaska (3)
* International Hydrographic Organization Cat A Hydrographer (1)
* Geospatial Information Science Certificate (1)

Water Level Station Installations

Photo by Emil Lestenkof



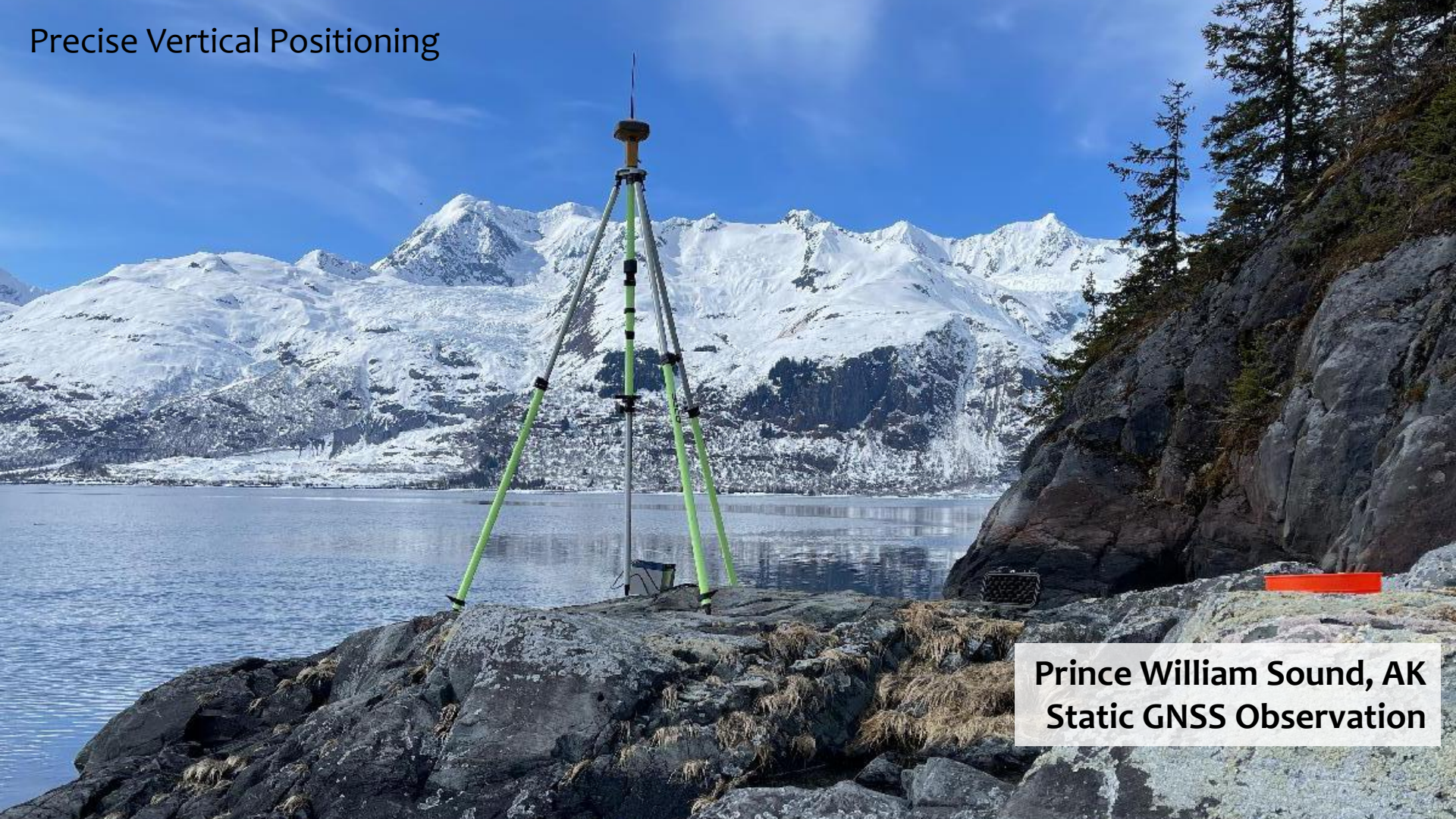


St. George Island
September 17, 2022
Remnants of
Typhoon Merbok

Precise Vertical Positioning

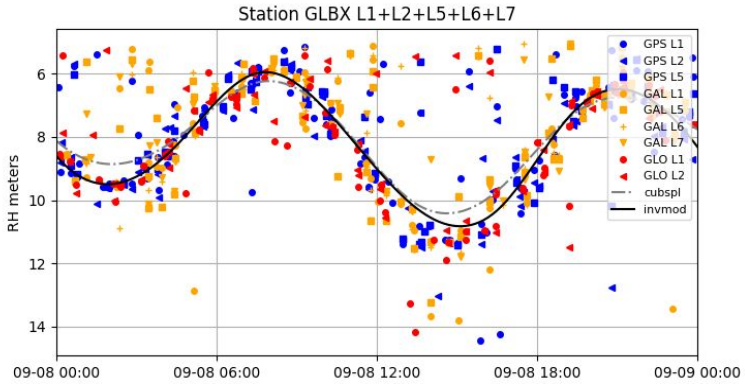
Prince William Sound, AK
Second Order Class I
Differential Leveling

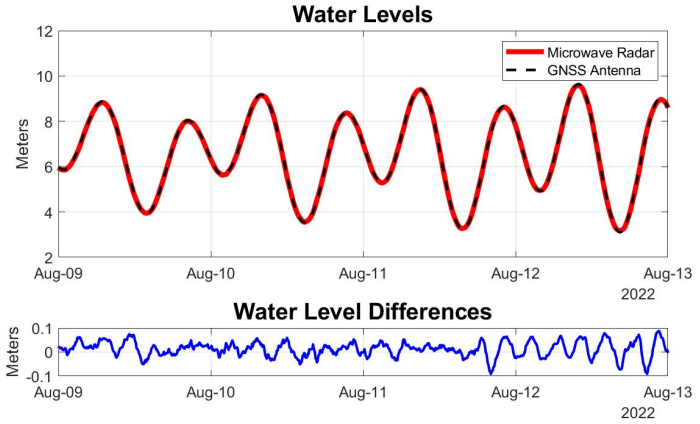
Precise Vertical Positioning



Prince William Sound, AK
Static GNSS Observation

Emerging Technologies





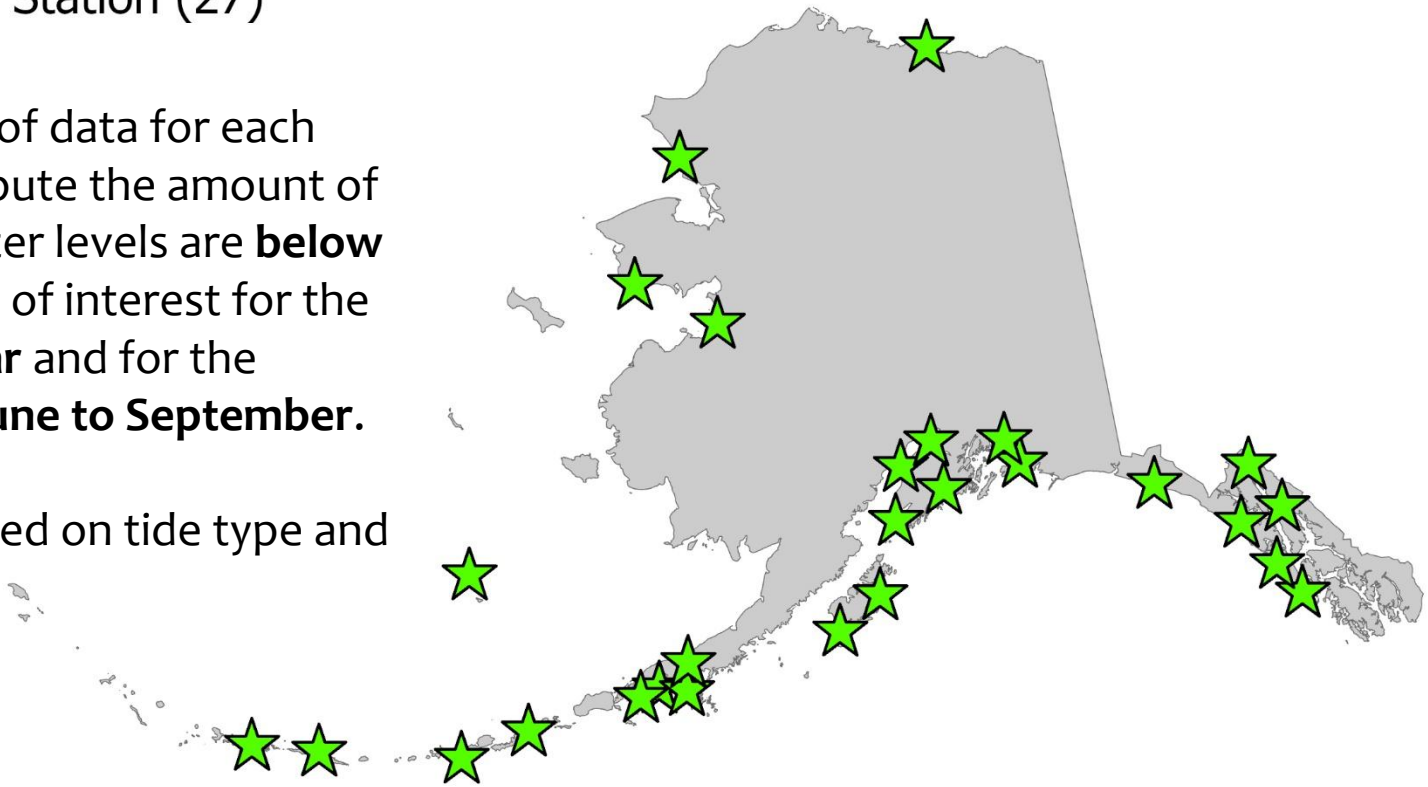
Processed using: github.com/kristinemlarson

JOA Surveys, LLC
At the boundary between land and sea

NWLON Station (27)

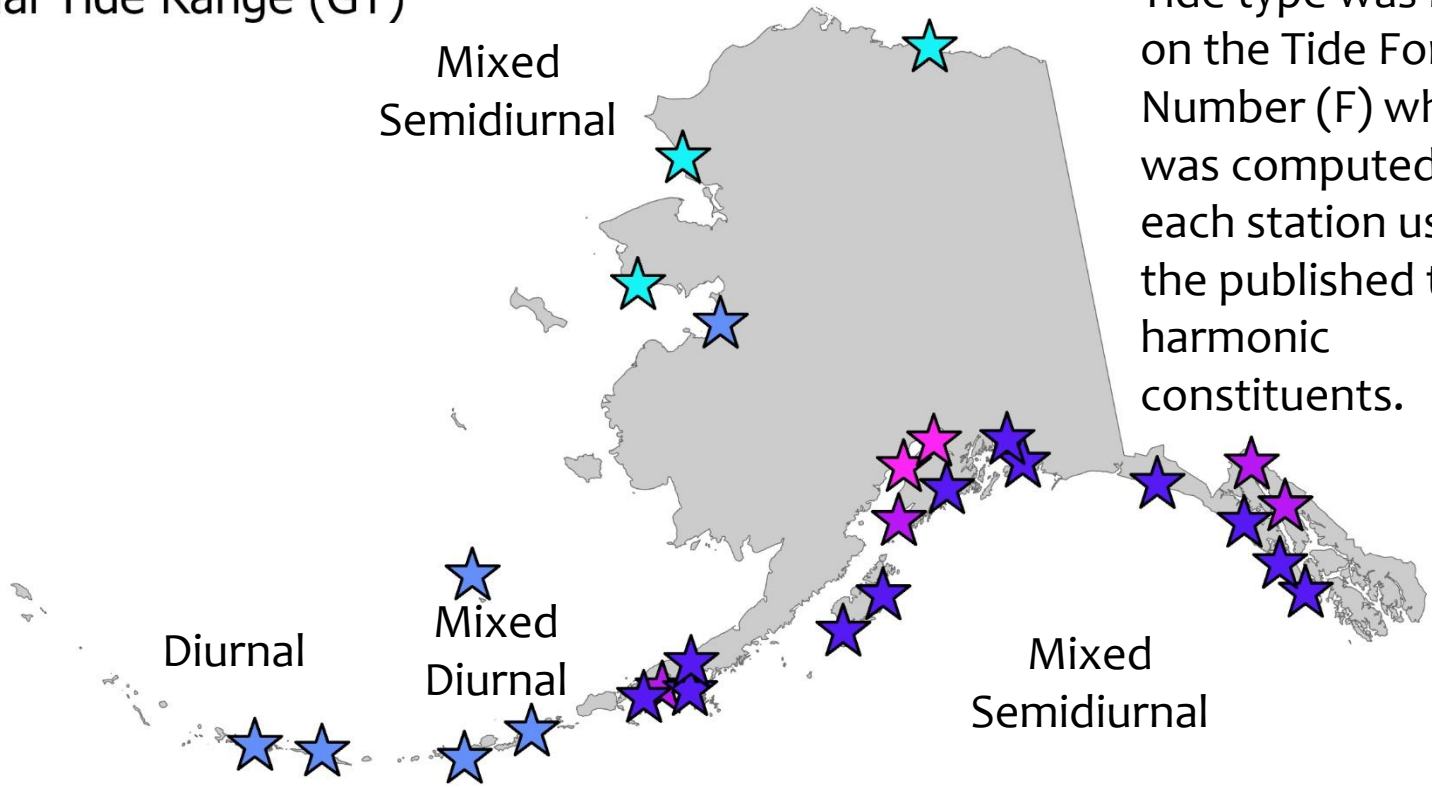
Using 1 year of data for each station compute the amount of time the water levels are **below tidal datums** of interest for the **calendar year** and for the months of **June to September.**

Evaluate based on tide type and region.

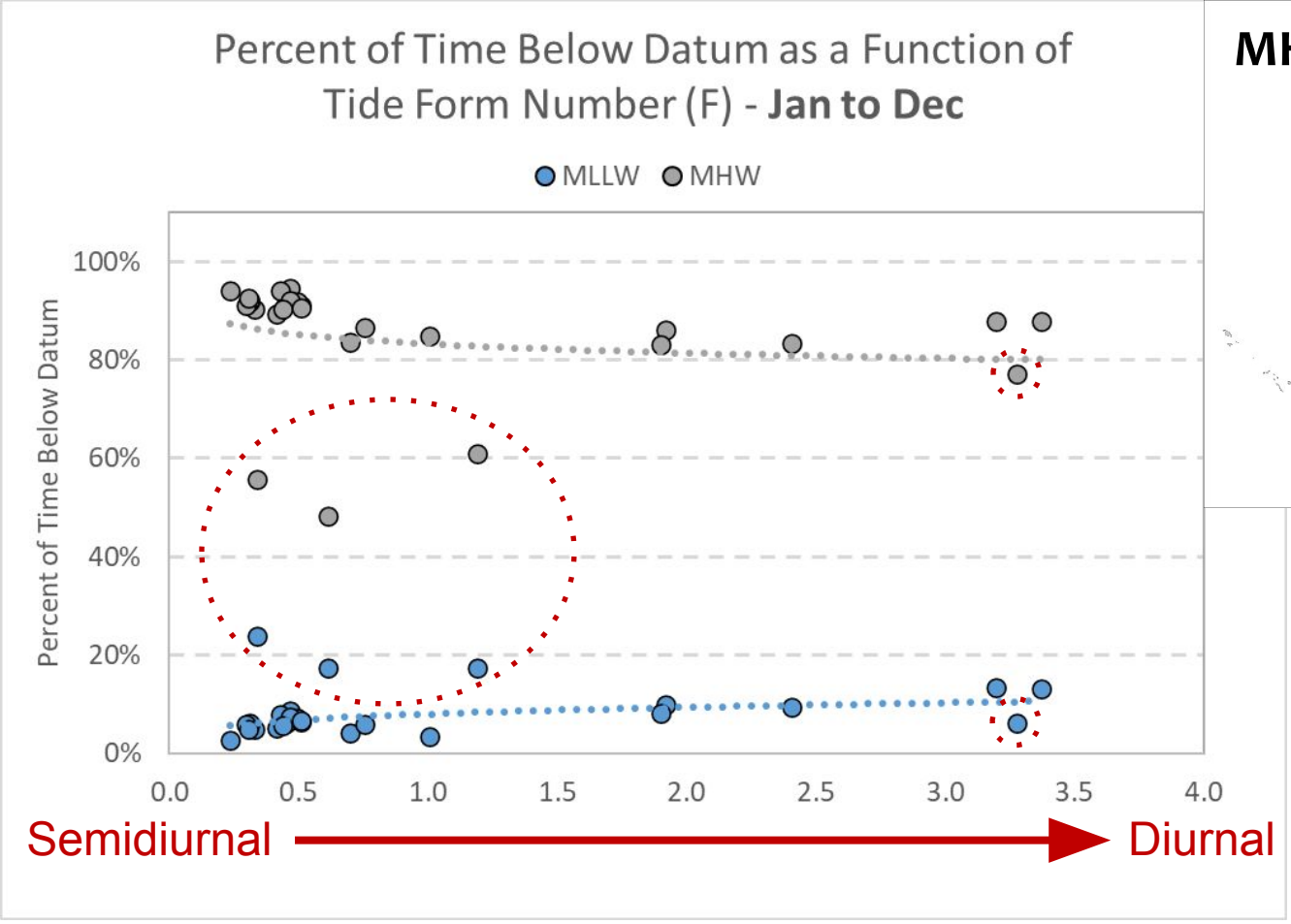


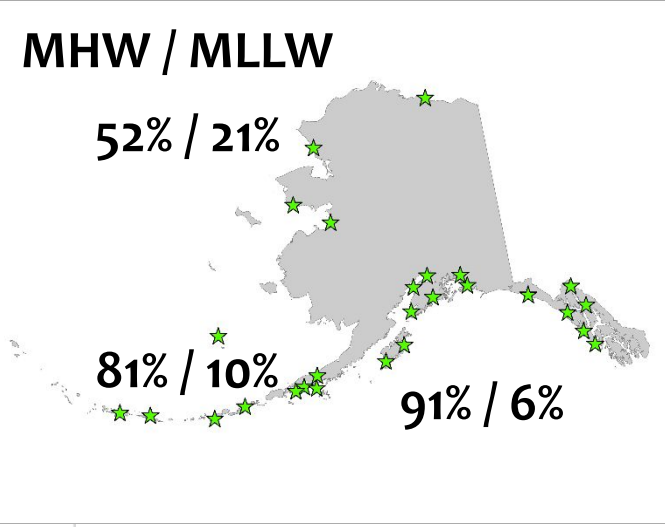
Great Diurnal Tide Range (GT)

- ≤0.5 m
- ≤2.0 m
- ≤4.0 m
- ≤6.0 m
- ≤9.0 m



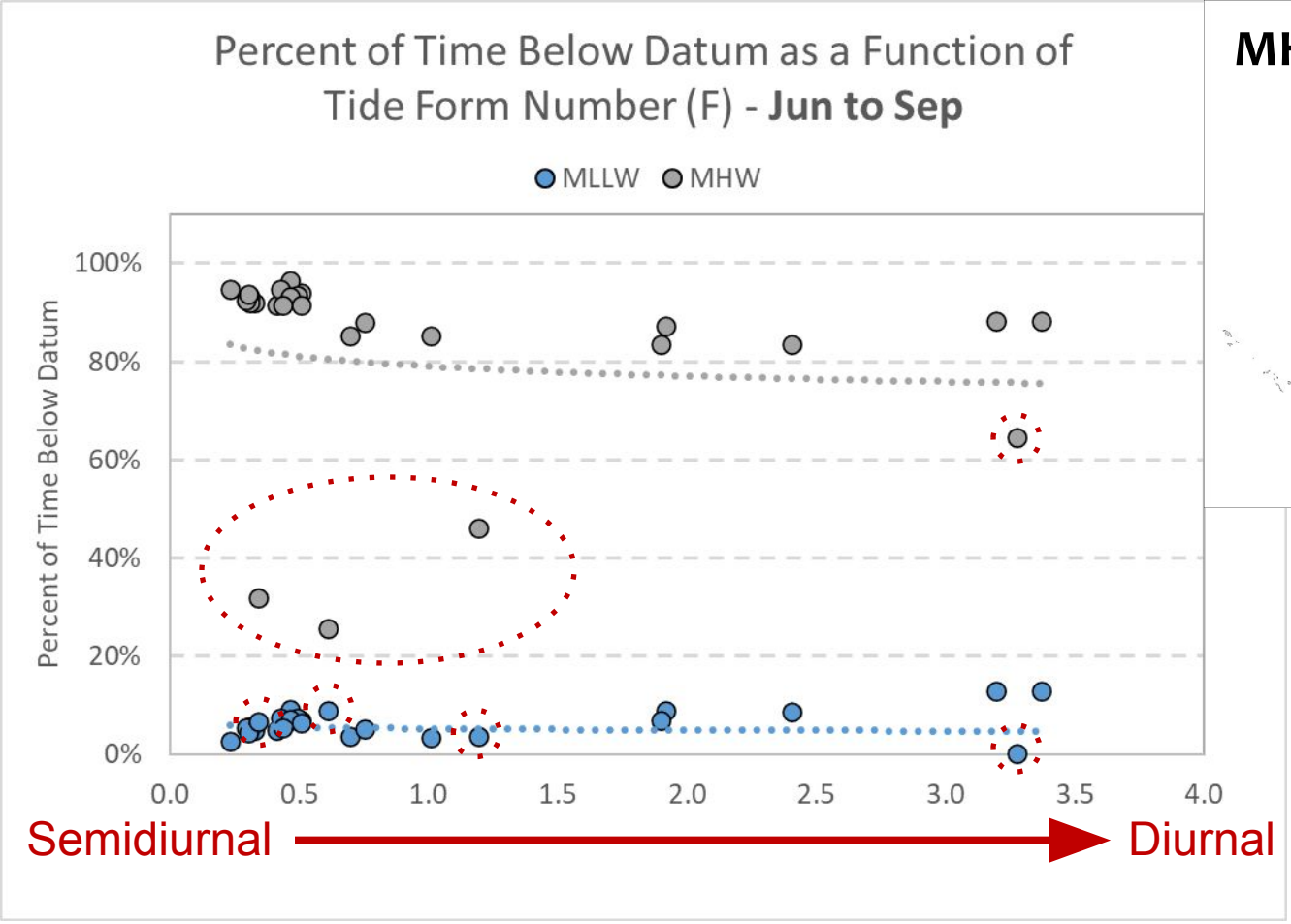
Tide type was based on the Tide Form Number (F) which was computed for each station using the published tidal harmonic constituents.

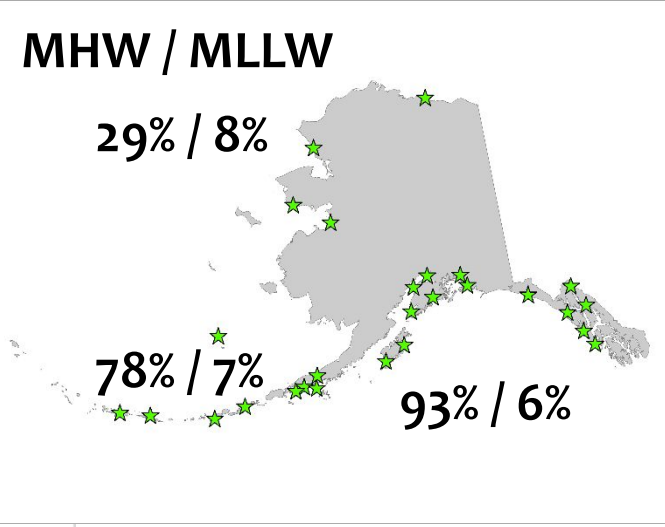




The percent of time water levels are below MLLW is slightly higher for diurnal stations than for semidiurnal stations.

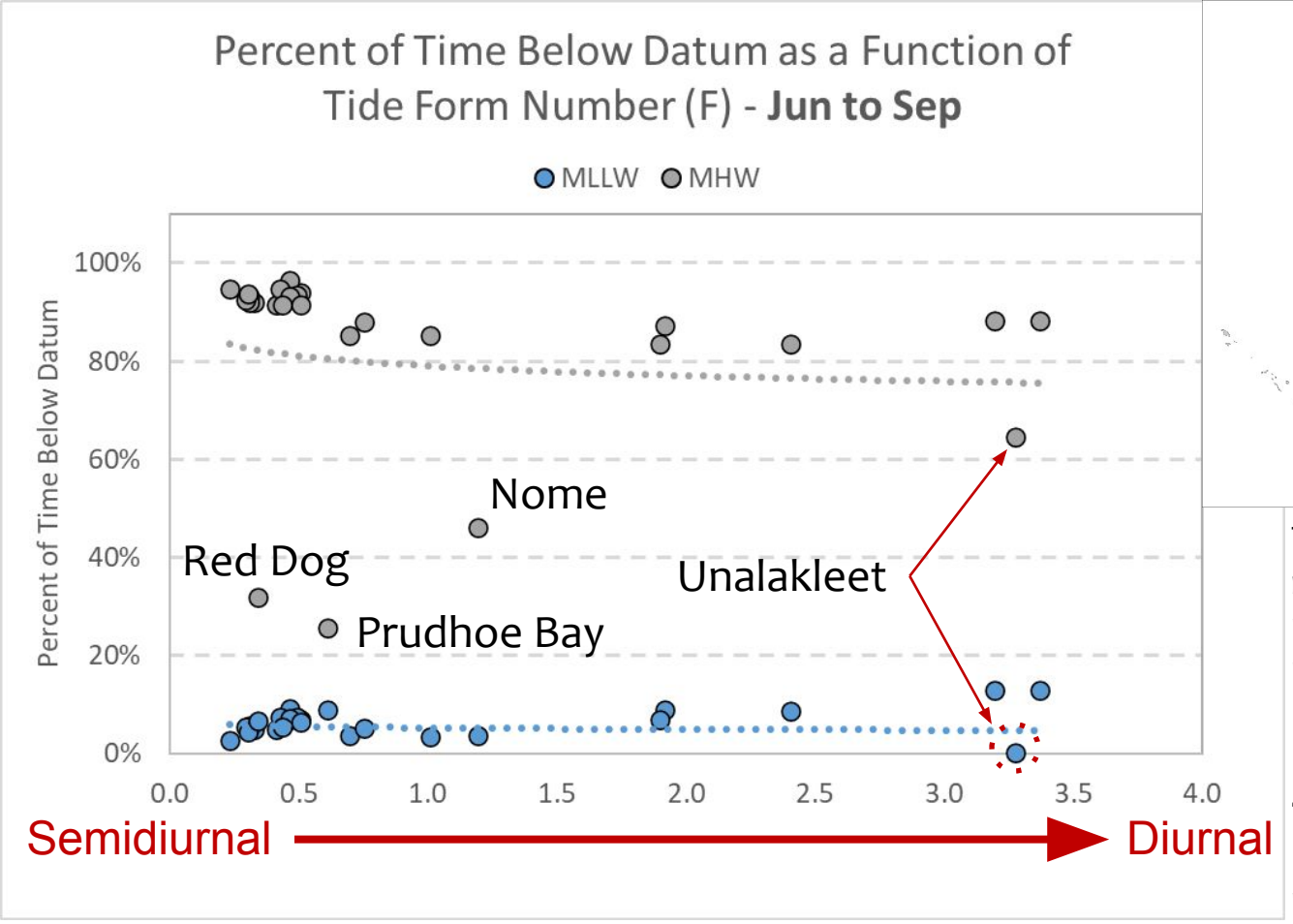
That is the opposite for MHW.

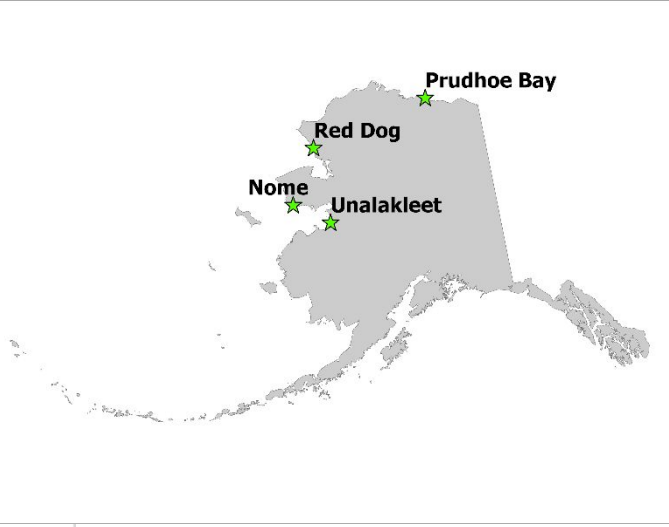




Seasonality has a large affect in the Bering and Arctic.

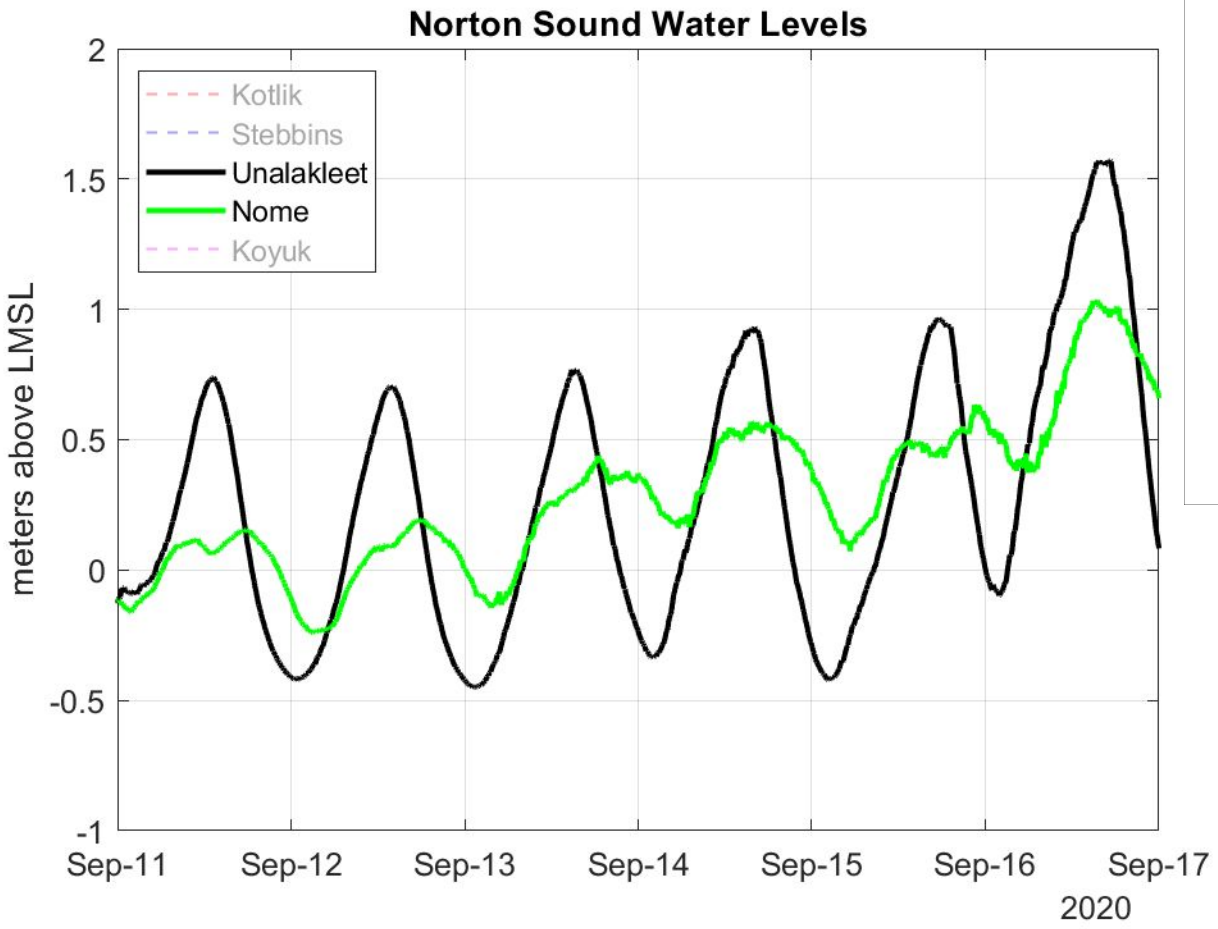
In the Arctic the average % of time water levels are below MLLW drops from **21%** for the **calendar year** to **8%** for the months of **June to September.**

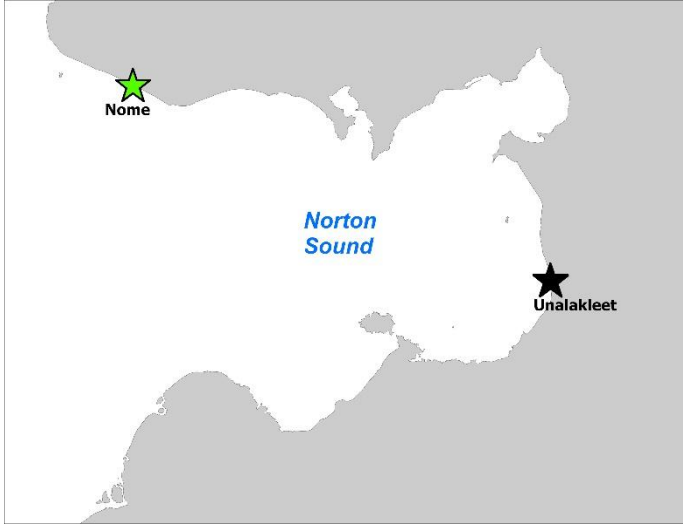




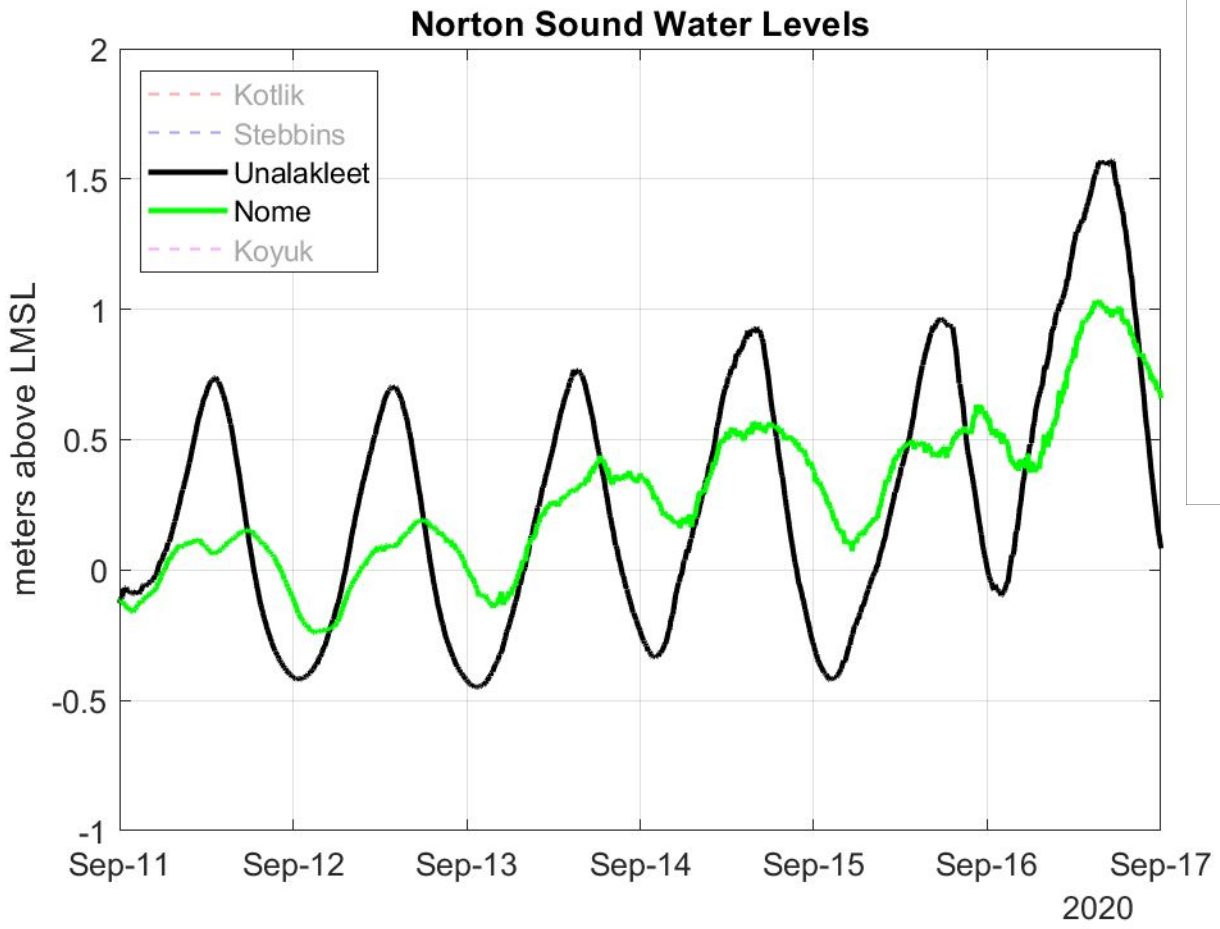
The **seasonality** affect is even **more drastic** for **MHW** where it reduces from **52%** to **29%** in the months of **June to September.**

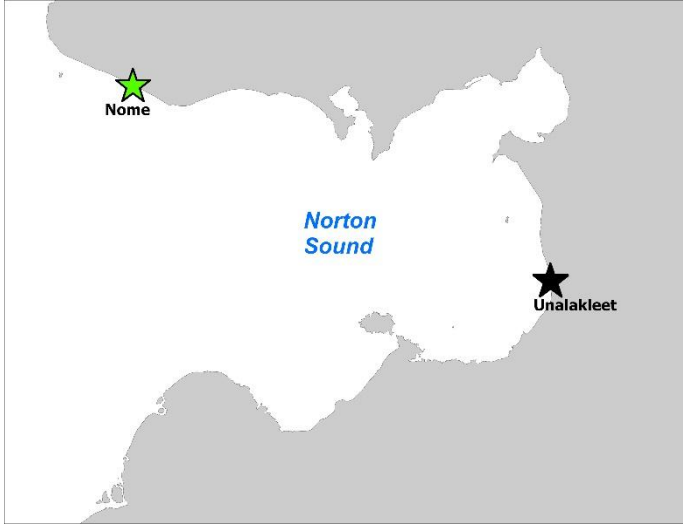
From June to Sep of 2020 the water level at Unalakleet never dropped below MLLW!





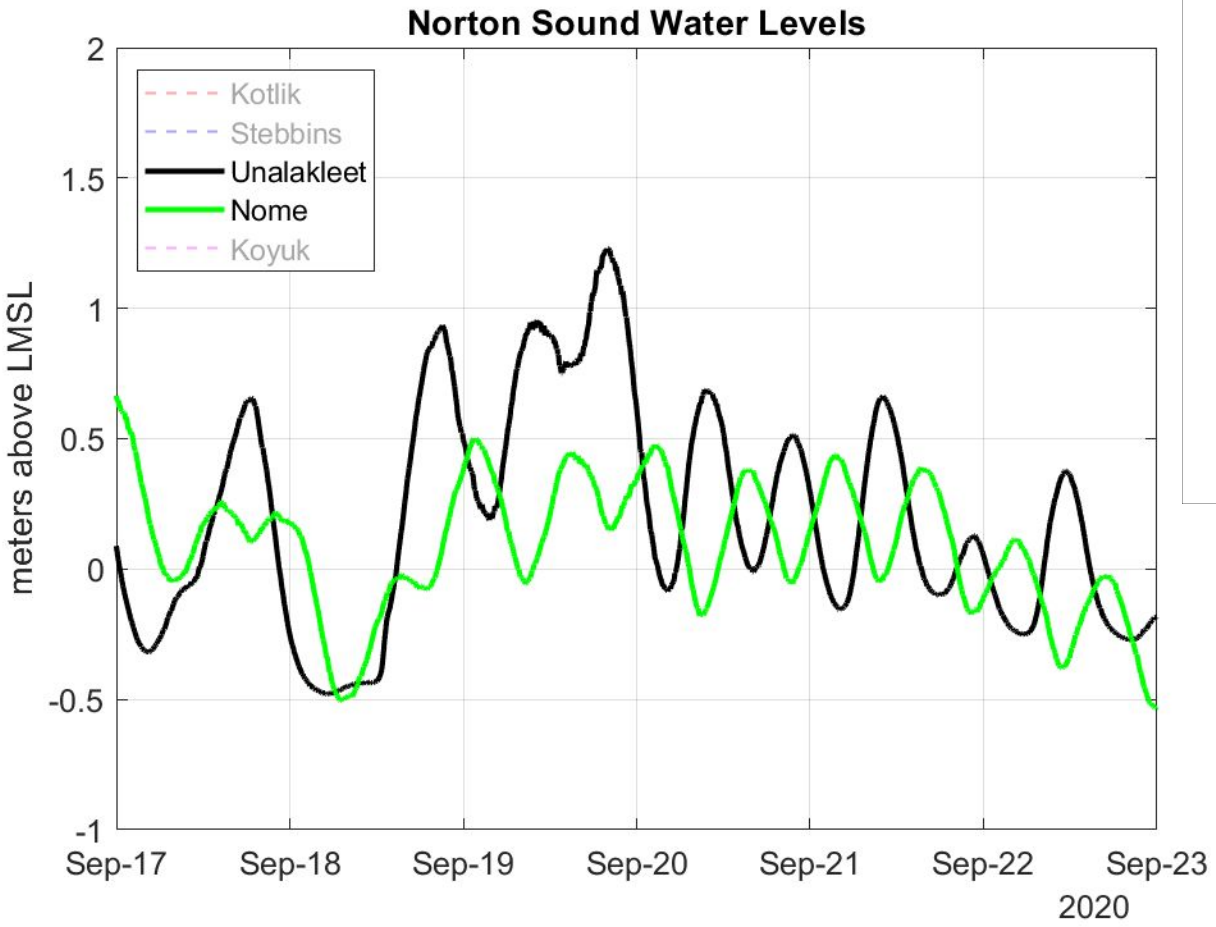
Nome and Unalakleet are National Water Level Observation Network stations with real-time water level data.

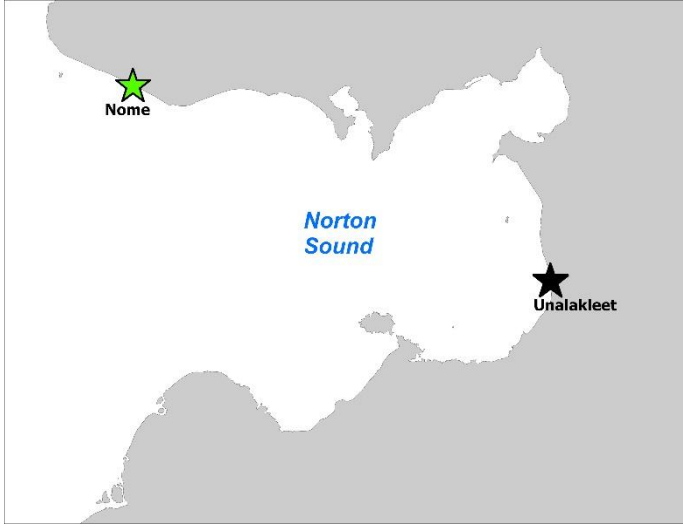




During this time period the tides are **diurnal** and **in phase.**

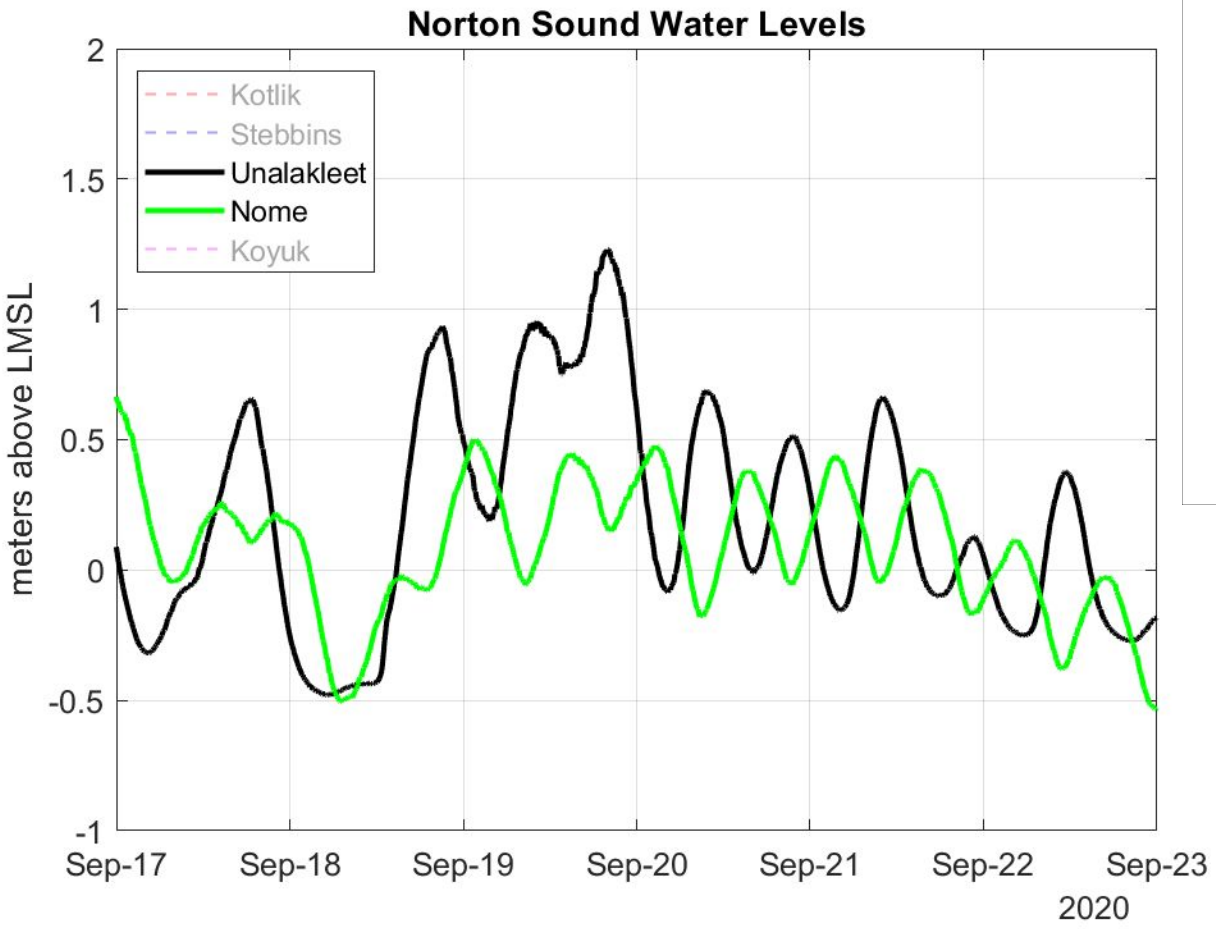
The tide range at Unalakleet is about twice as large as the tide range at Nome.

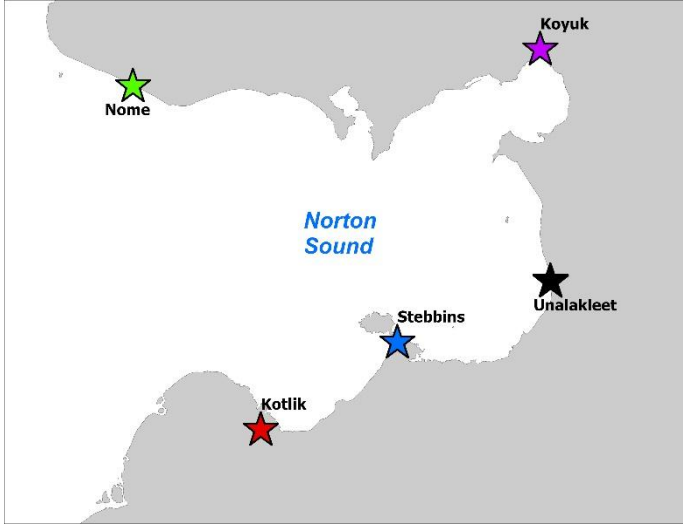




The next week they transition to **semidiurnal** and **out of phase.**

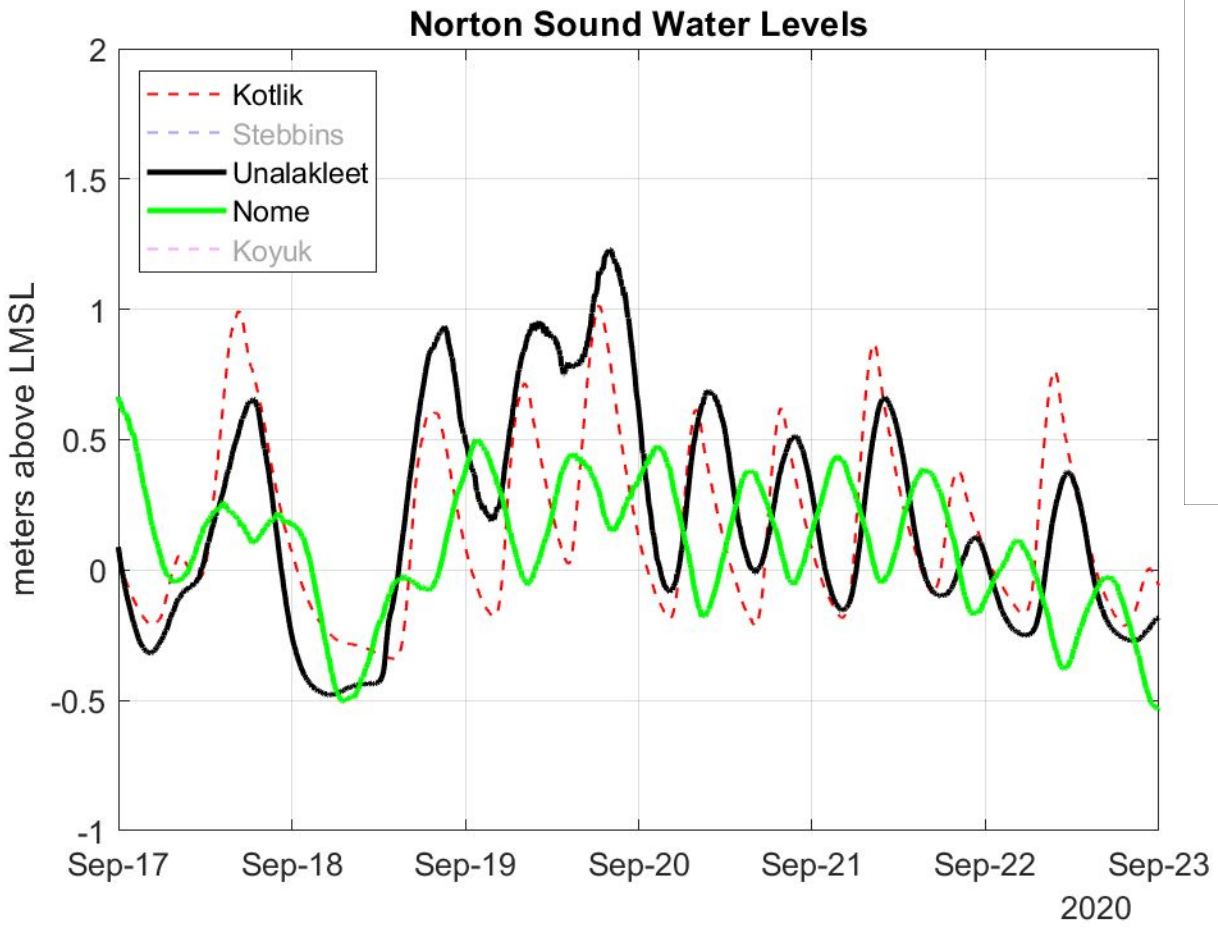
The tide range at Unalakleet is now smaller.

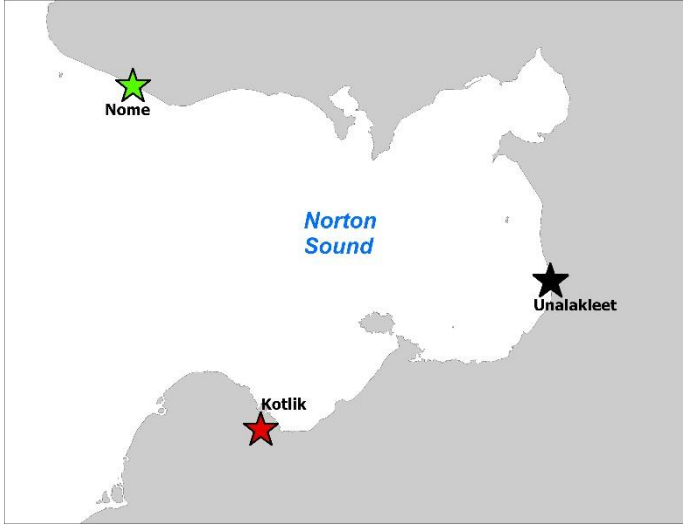




There were three temporary stations operating in Norton Sound during this time period.

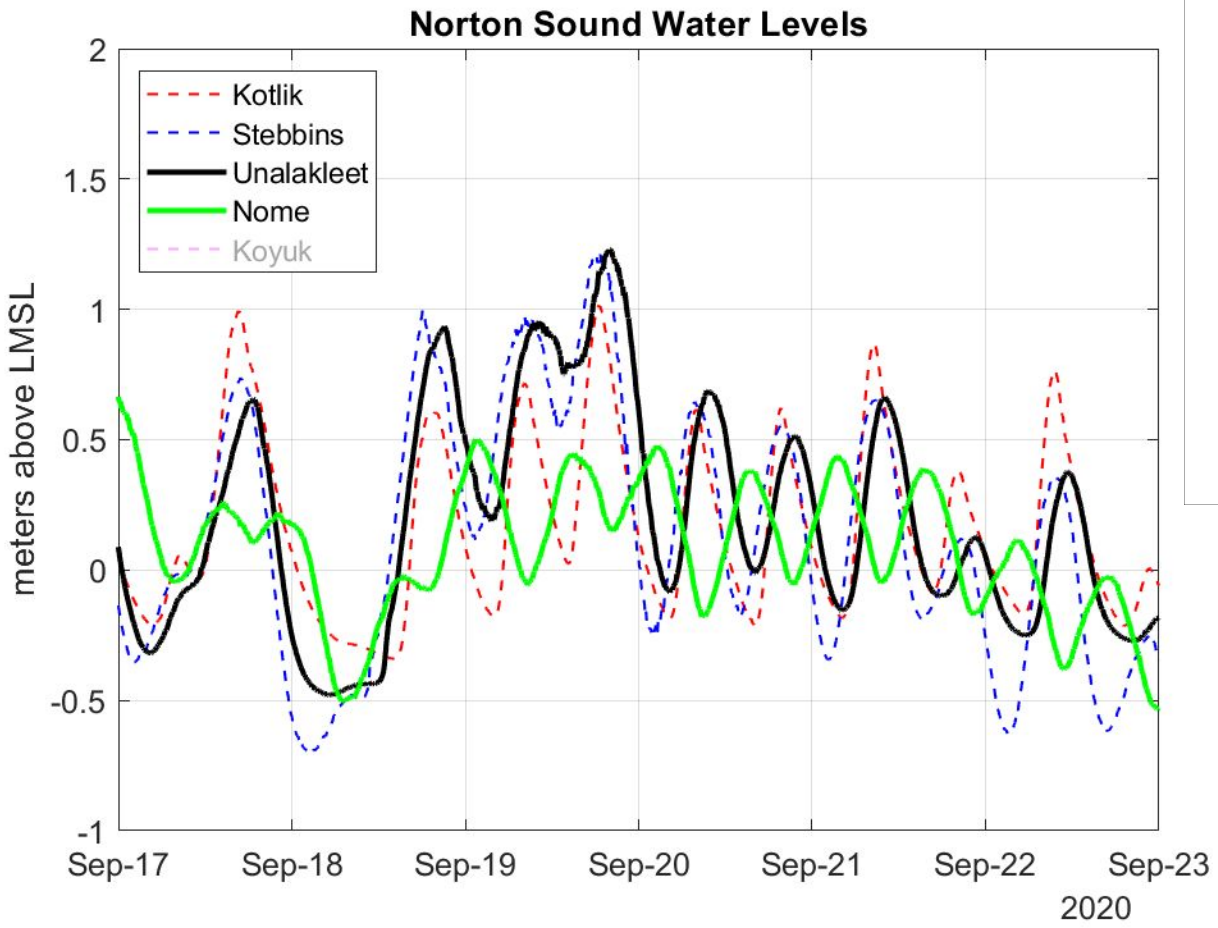
Kotlik, Stebbins and Koyuk

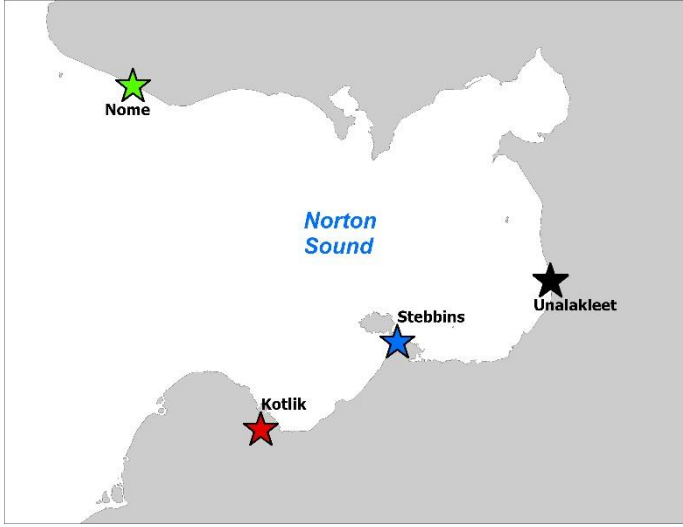




The tidal characteristics at Kotlik are similar to Unalakleet.

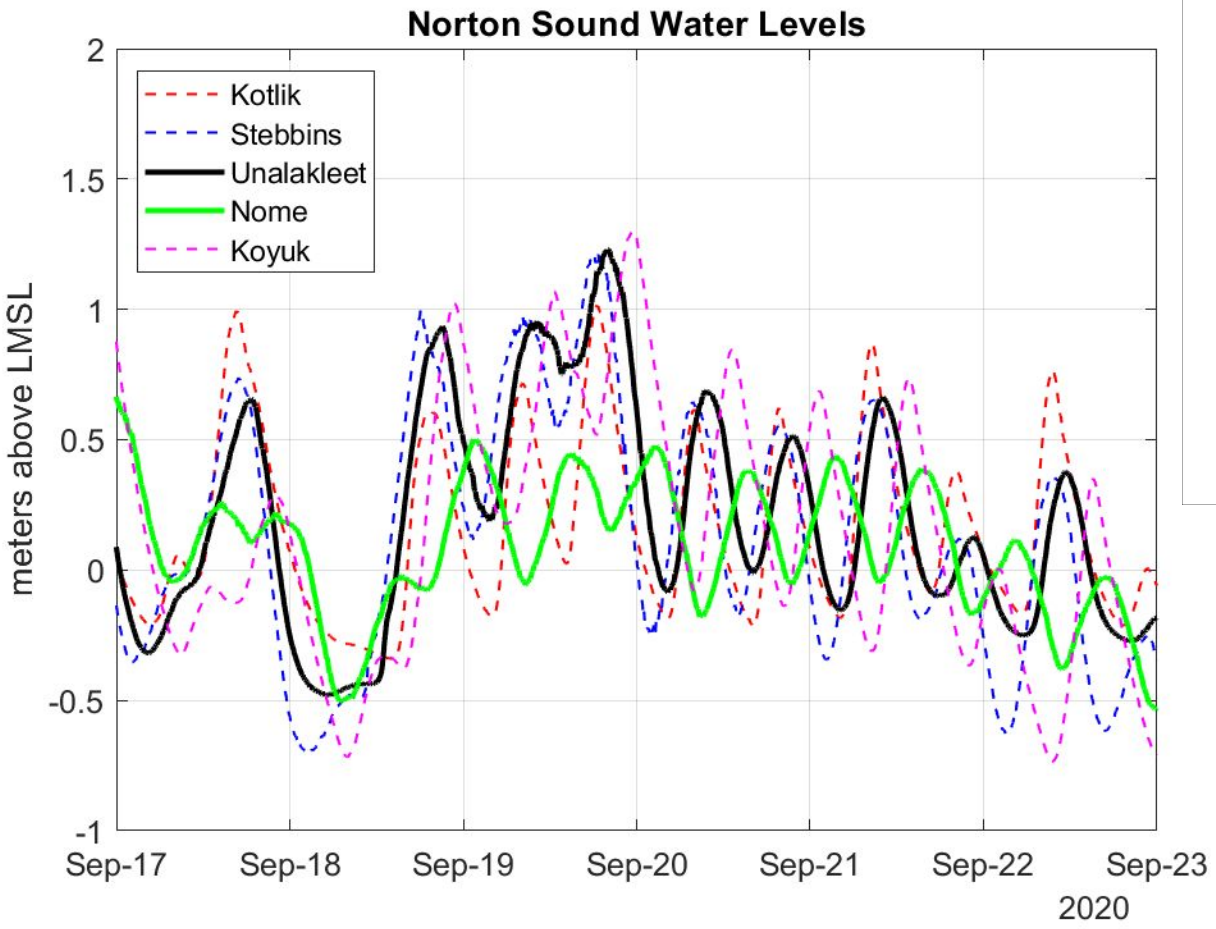
Kotlik is close to in phase with Unalakleet and out of phase with Nome.

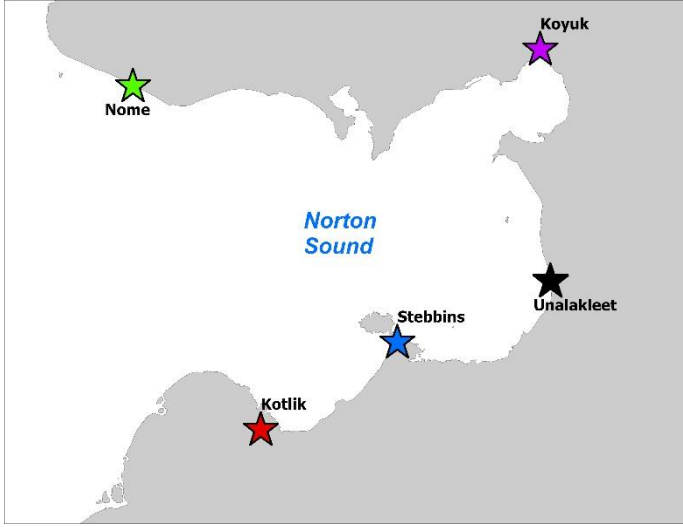




The tidal characteristics at Stebbins are similar to Unalakleet and Kotlik.

Stebbins is close to in phase with Unalakleet and Kotlik while out of phase with Nome.





The tidal characteristics at Koyuk are similar to Unalakleet, Kotlik and Stebbins.

The time of the high and low tides is between Unalakleet and Nome.

Take Aways

* Tide coordinated mapping is Alaska is challenging, especially in the Arctic

* There are not enough real-time water level stations in Alaska to provide a complete picture for tide coordinated coastal mapping operations

* When considering coastal mapping project specifications consider tide type and region of the state so you can set realistic objectives

Thanks!

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www.joasurveys.com

Coastal Geo-data: what's new in means and methods of collection and thoughts on maximizing ROI

Rada Khadjinova – Fugro

Coastal Geo-data

What's new in means and methods of collection and thoughts on maximizing ROI

Alaska Coastal and Ocean Summit Nov. 16-17, 2022

Unlocking insights from Geo-data

We are the world's leading Geo-data specialist, collecting and analyzing comprehensive information about the Earth and the structures built upon it.

Work in Alaska focuses on advice, acquisition and analyses of land and marine Geo-data

66,000 miles of shoreline.

Coastal zone mapping requires multiple technologies for the acquisition of nearshore, shoreline, and coastal elevation and imagery.

Image: Yukon Delta NWR, USFWS

Alaska's top-ranked applications for coastal data

Coastal Hazards

- Storm surge & tsunami models
- Safety of navigation products
- National elevation & shoreline mapping

Coastal Infrastructure

- Community resilience and flood defense
- Modernization to accommodate new and deeper draft vessel traffic

Sustainable Use of Oceans

- Boundary and jurisdictional definition
- Resource assessment & management
- Ocean health and ecosystem services

Role of Private Sector Surveyors

Clear goals, leveraging resources, meaningful engagement of the private sector can help

Mapping Technology

- Safety improvements
- Quality/efficiency improvements
- Carbon footprint reduction

Data Buy Models

- Speculative data collections
- Procurement experience on comparable programs

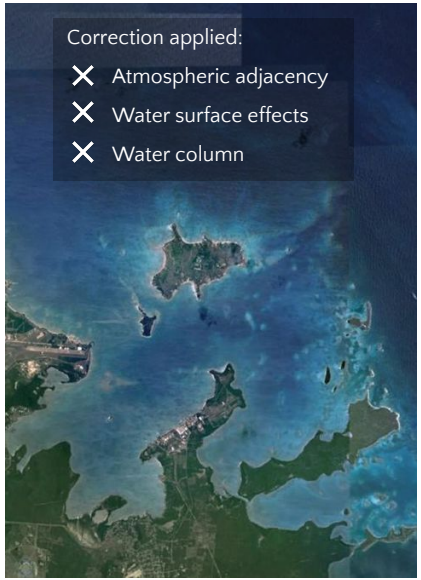
Partnerships

- Private sector contributions
- Enhanced Value to the end user

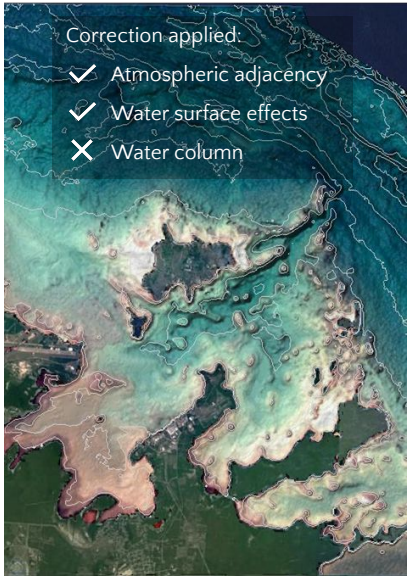
Innovations in mapping technology

Workflows, Sensors, Automation, Communication, Computing

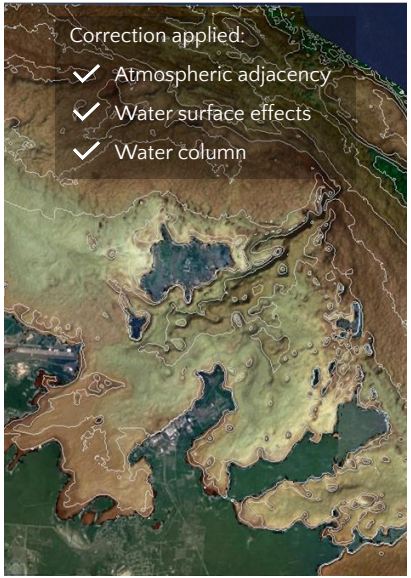
Satellite Imagery
habitat mapping, geomorphology, bathymetry



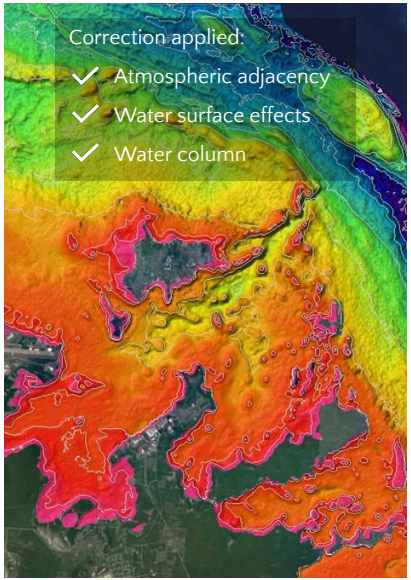
General info, but typically not well suited for aquatic and benthic analysis.



More detailed info on geomorphologic zoning, spatial and spectral patterns of the seafloor and benthic habitats.



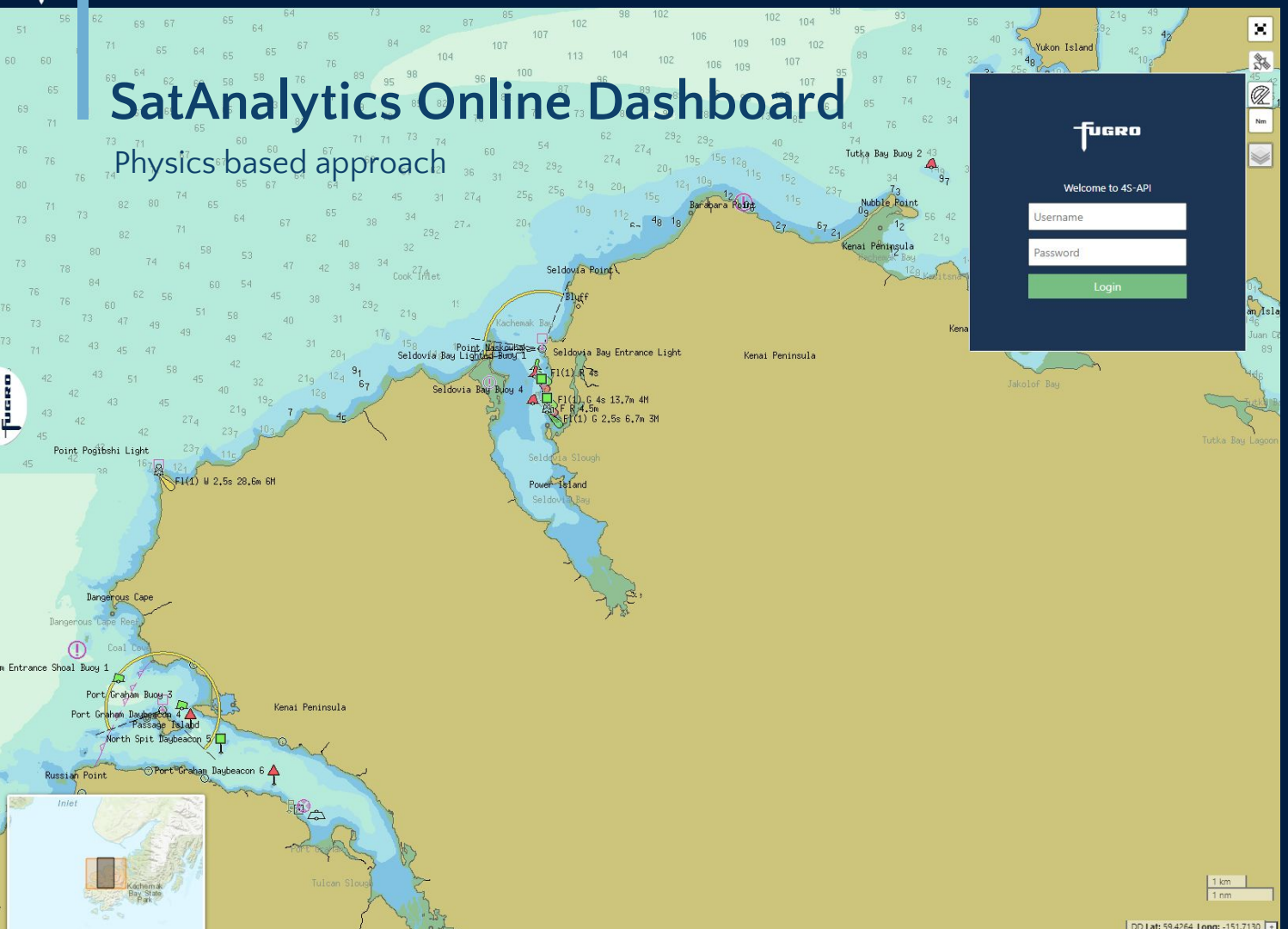
Very detailed info on geomorphologic zoning, spatial and spectral patterns of the seafloor and benthic habitats. Represents clear view to the surface being corrected for water column effects and perfect baseline for benthic habitat mapping.



Bathymetric info in dense grid. Data are mapped using EOMAP's physics-based inversion algorithms, which have been applied in hundreds of areas worldwide.

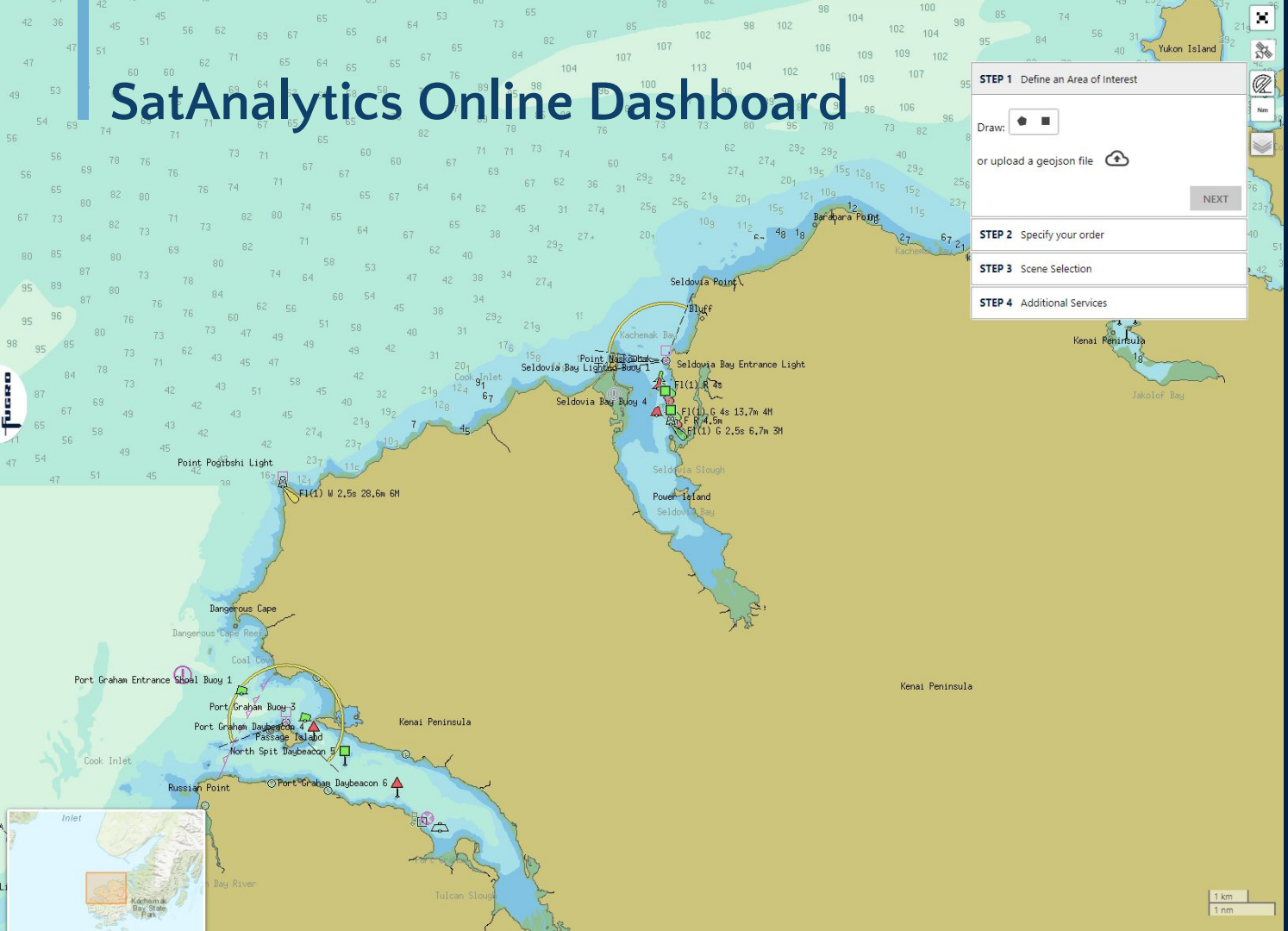
SatAnalytics Online Dashboard

Physics based approach



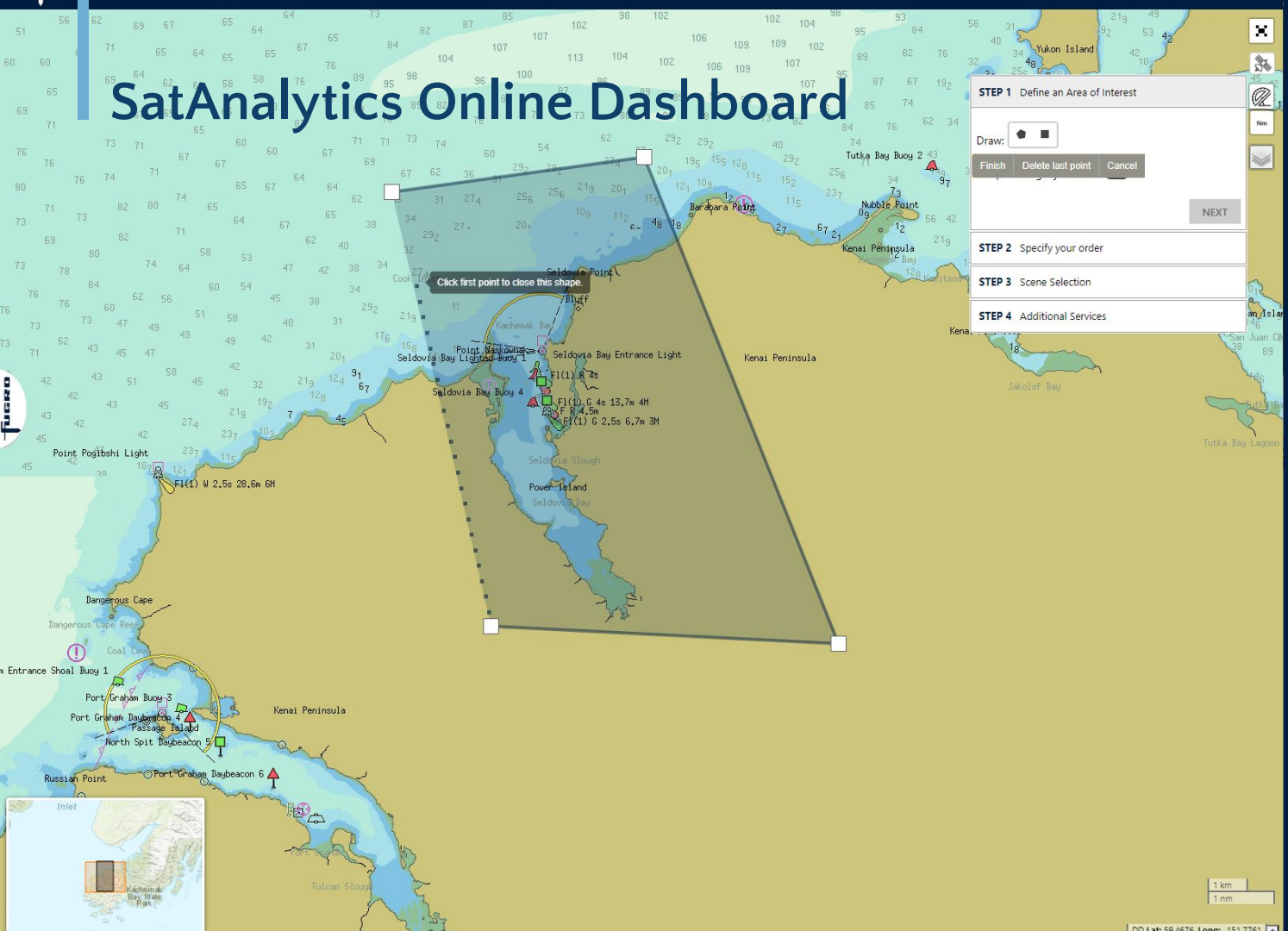
Secure Login

SatAnalytics Online Dashboard

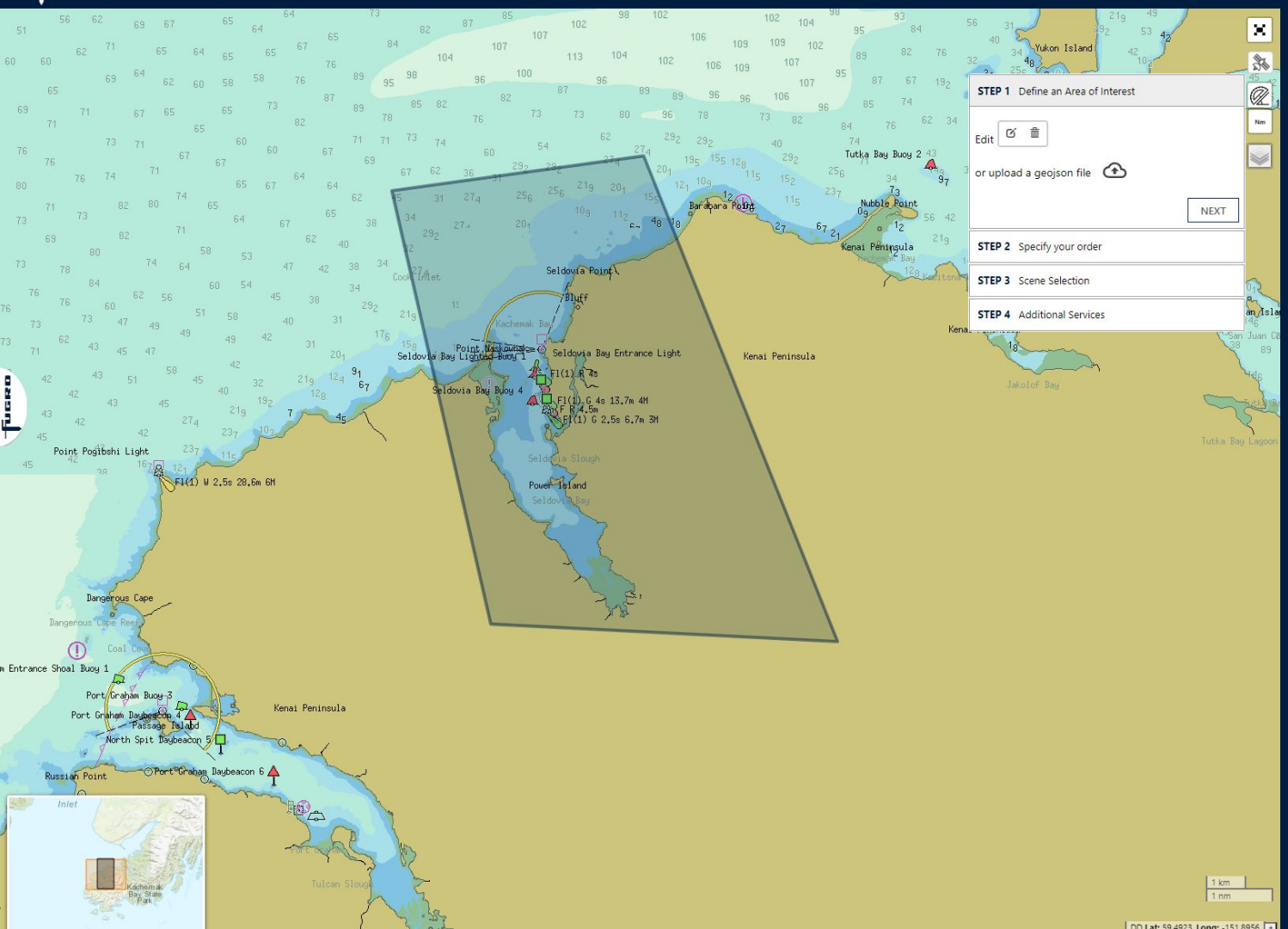


Step 1: Draw AOI

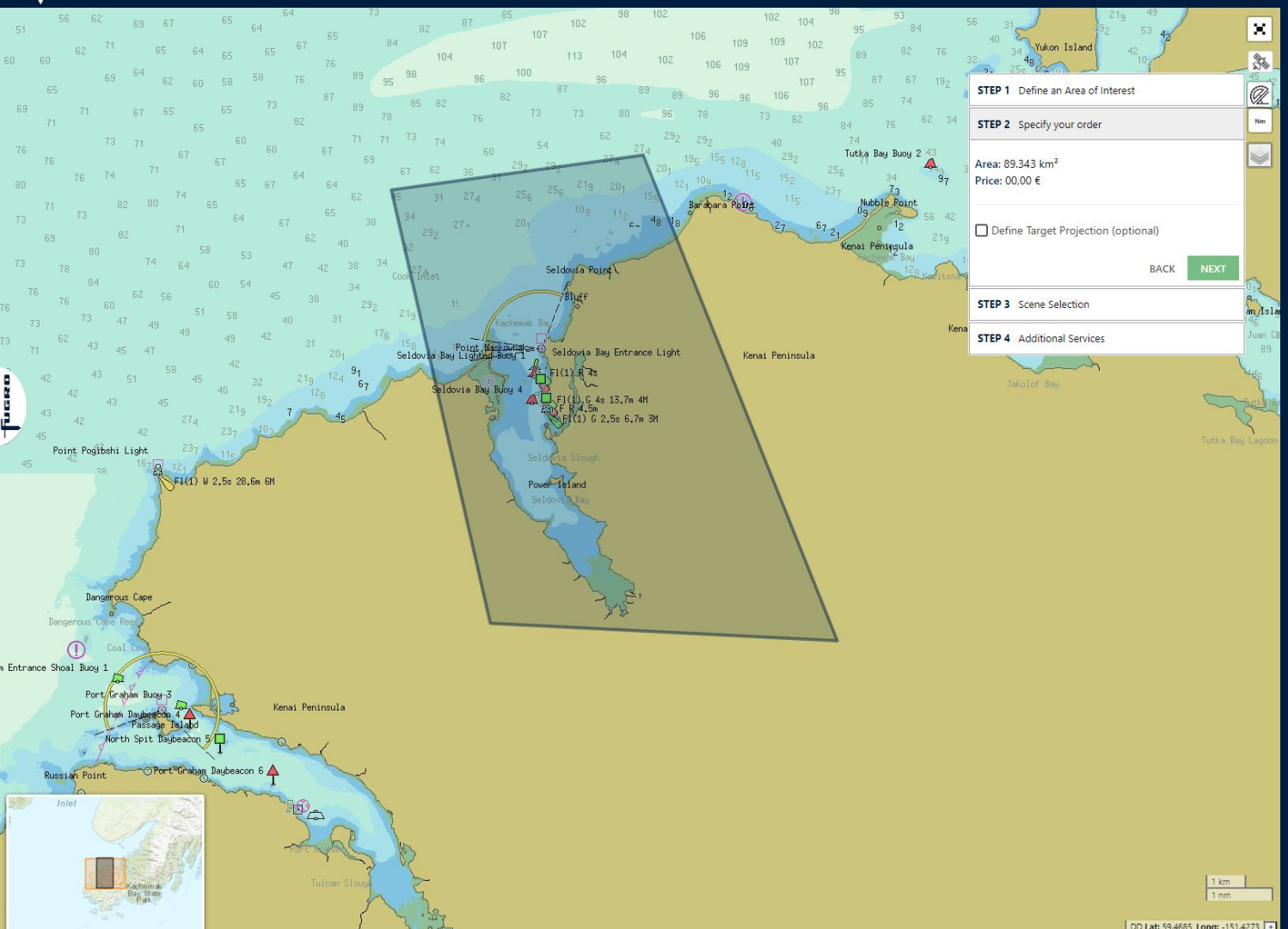
SatAnalytics Online Dashboard



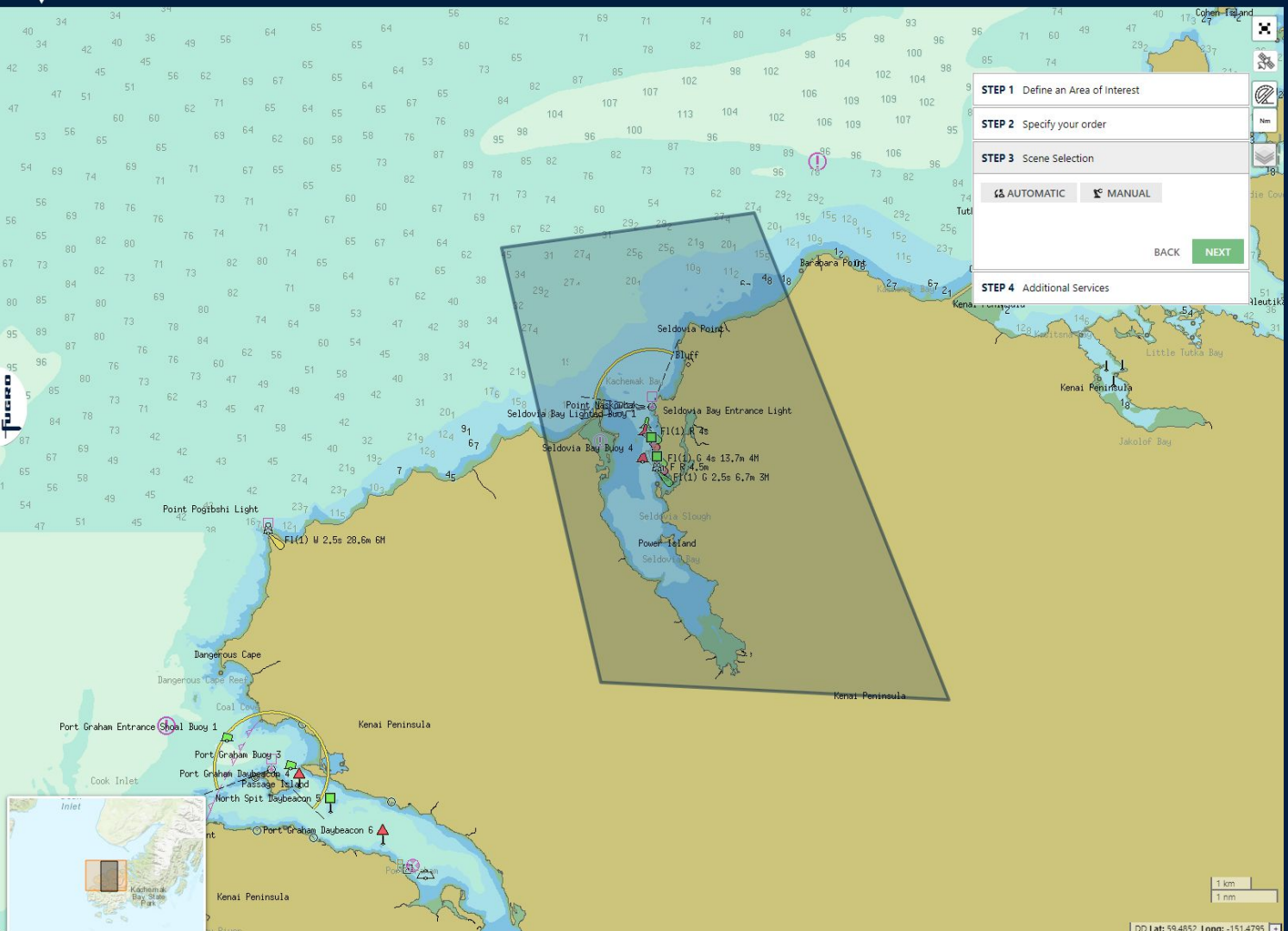
Step 1: Draw AOI



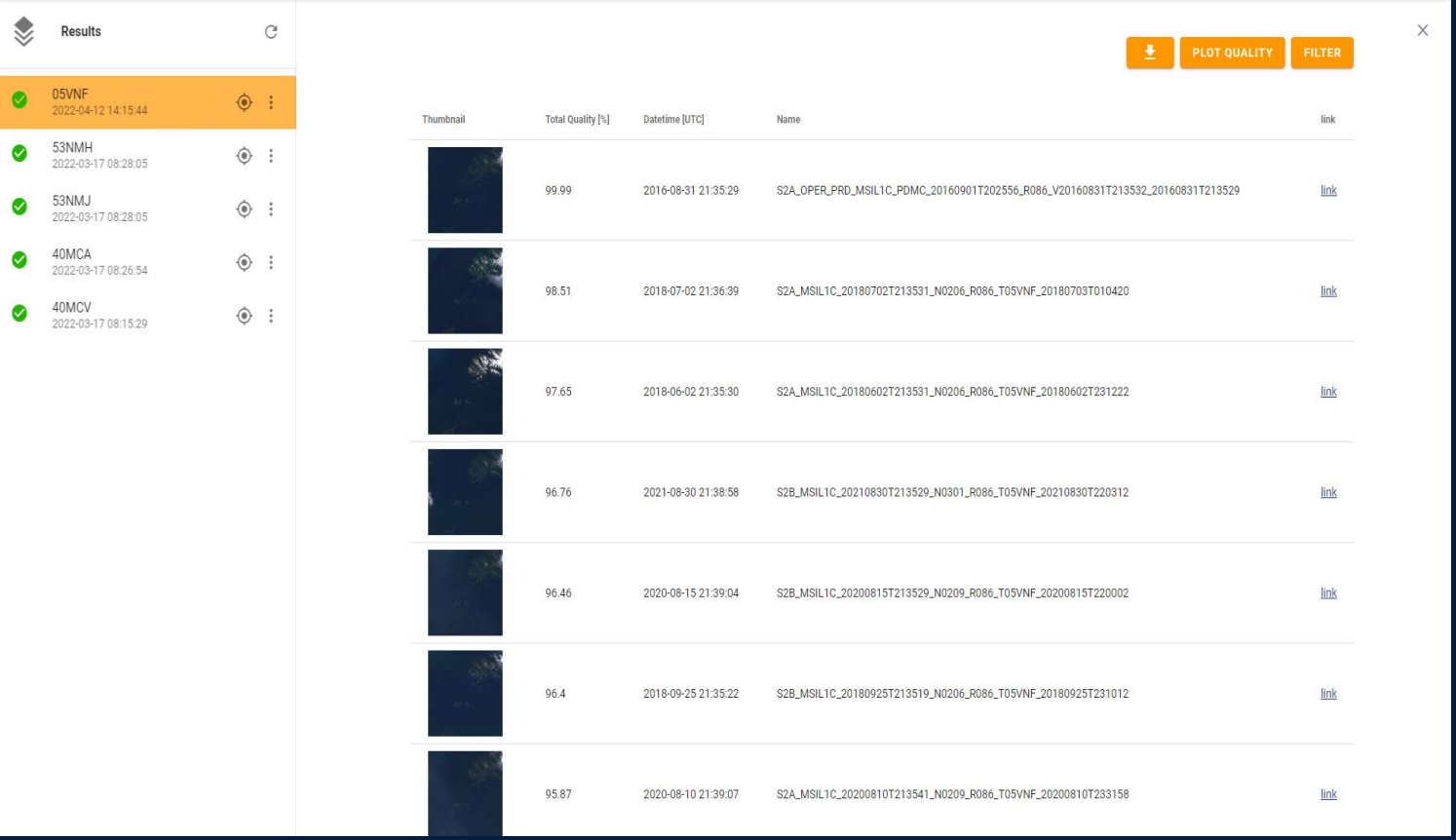
Step 1: Draw AOI



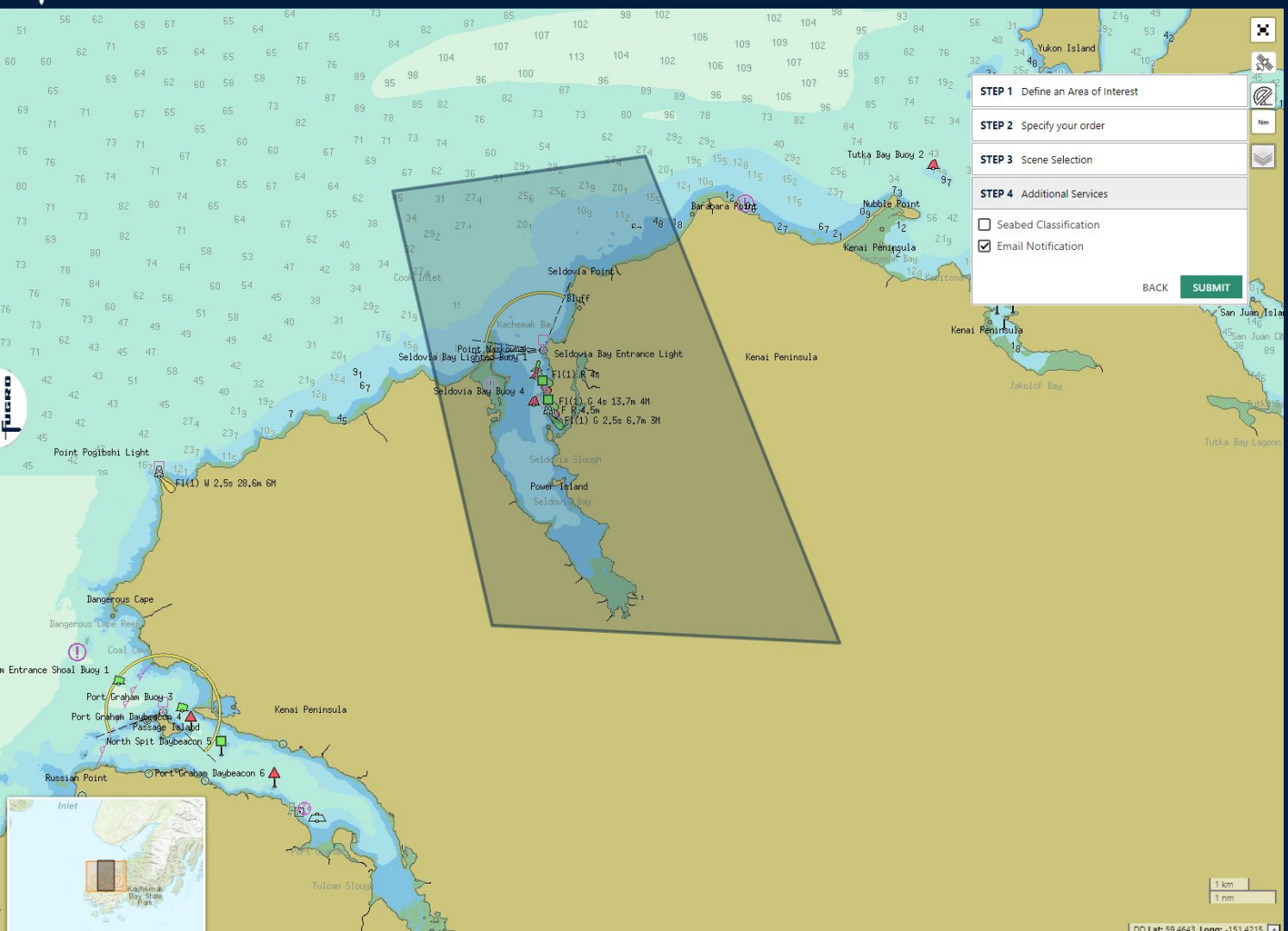
Step 2: Review Order



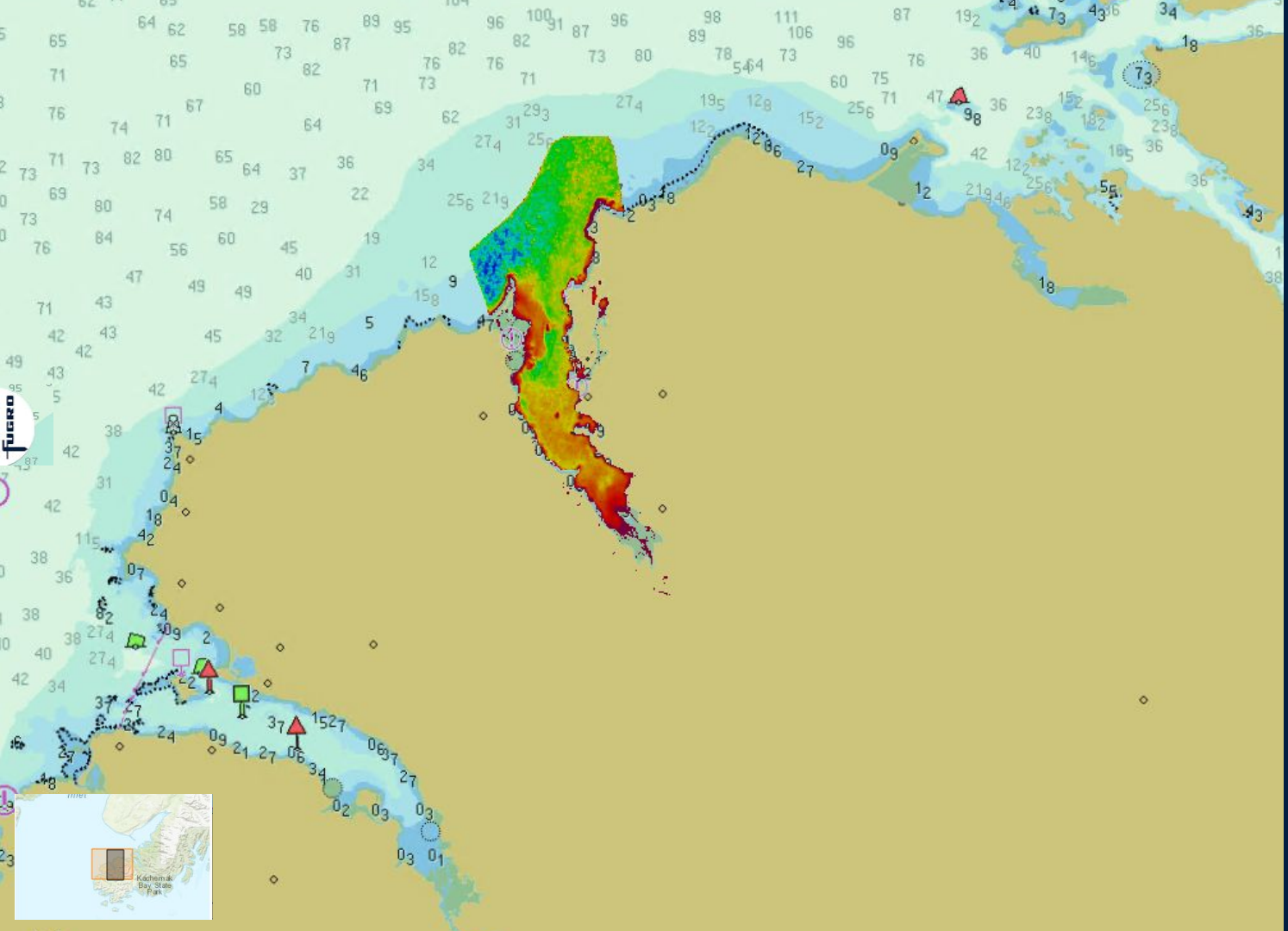
Step 3: Select Scene



Step 3: Scene Selection



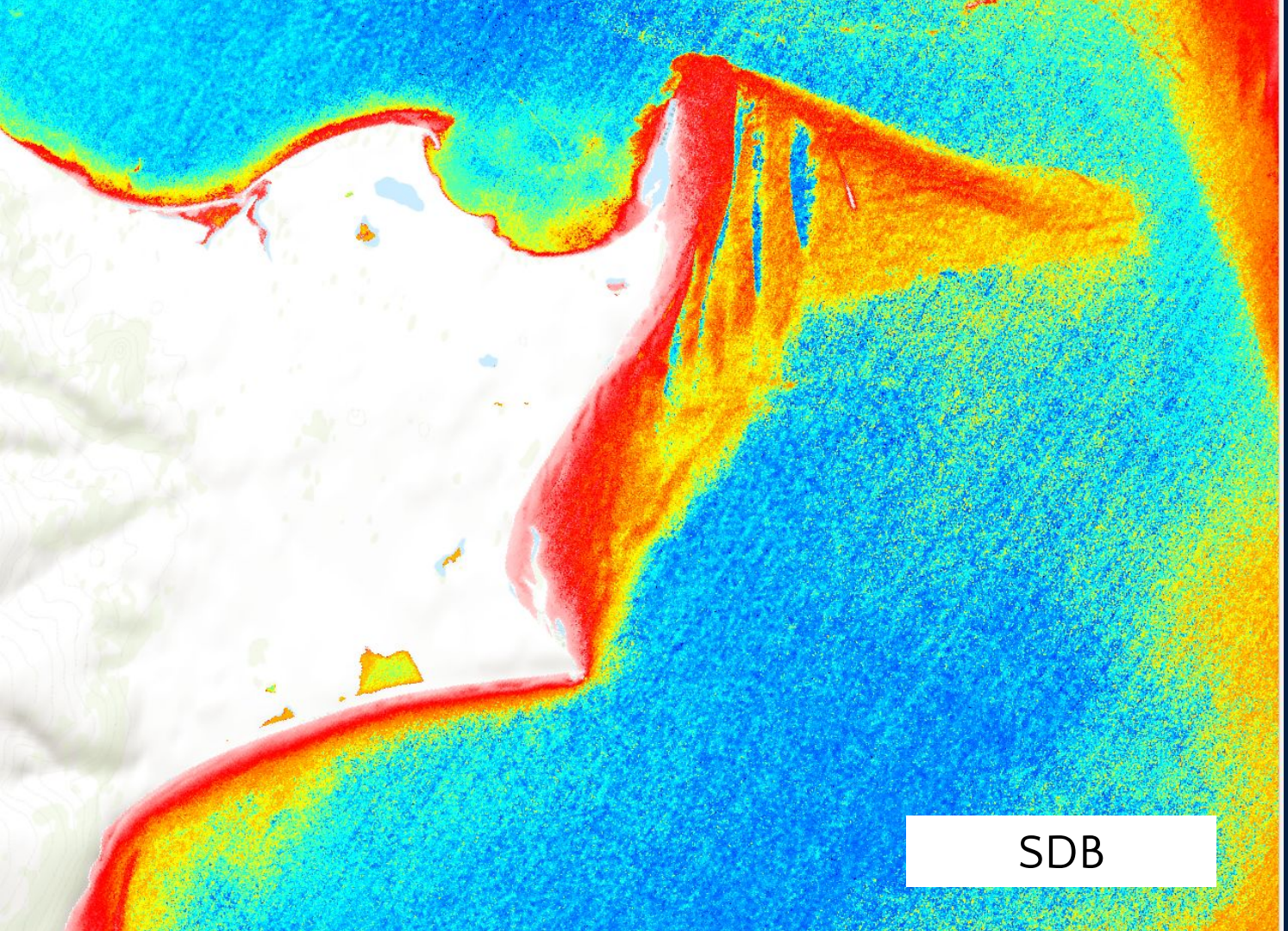
Step 4: Select Services



Output

20 min

SDB vs ALB Results Comparison Golovin, AK



2019 USACE NCMP
Topobathy Lidar DEM

Golovin, AK

VS

SDB

Tile: 03WWM

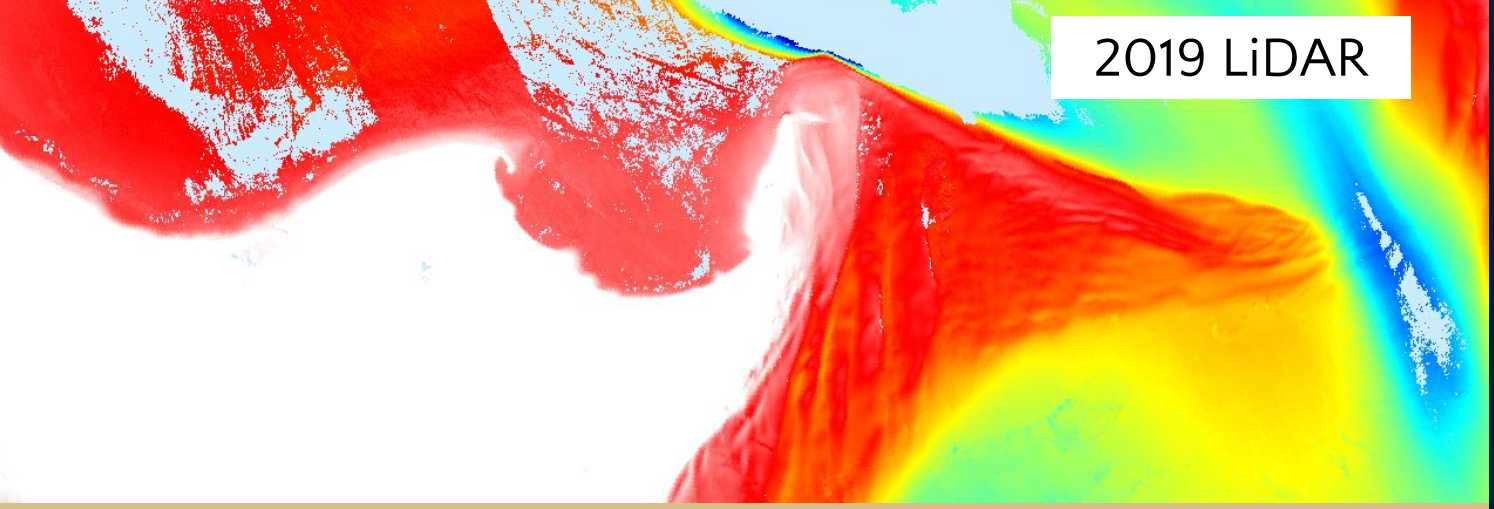
Date: 2019-07-07

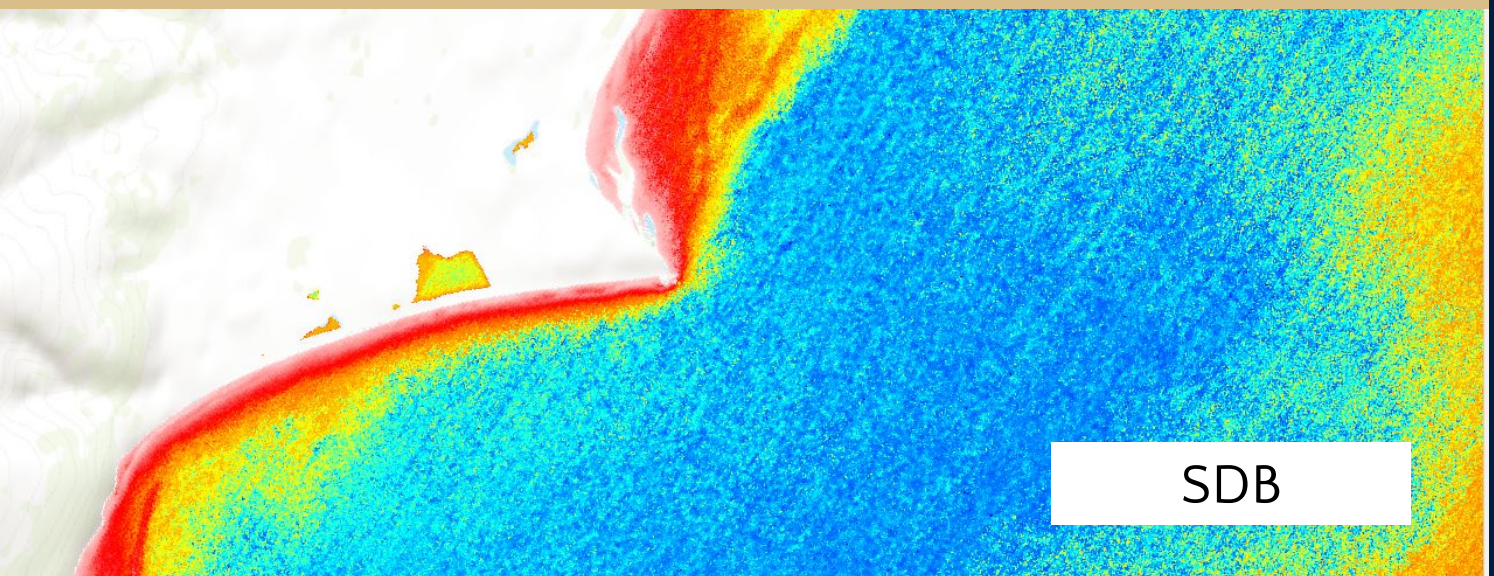
Depth (m),
MLLW

0

10

FUGRO





2019 USACE NCMP
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Tile: 03WWM

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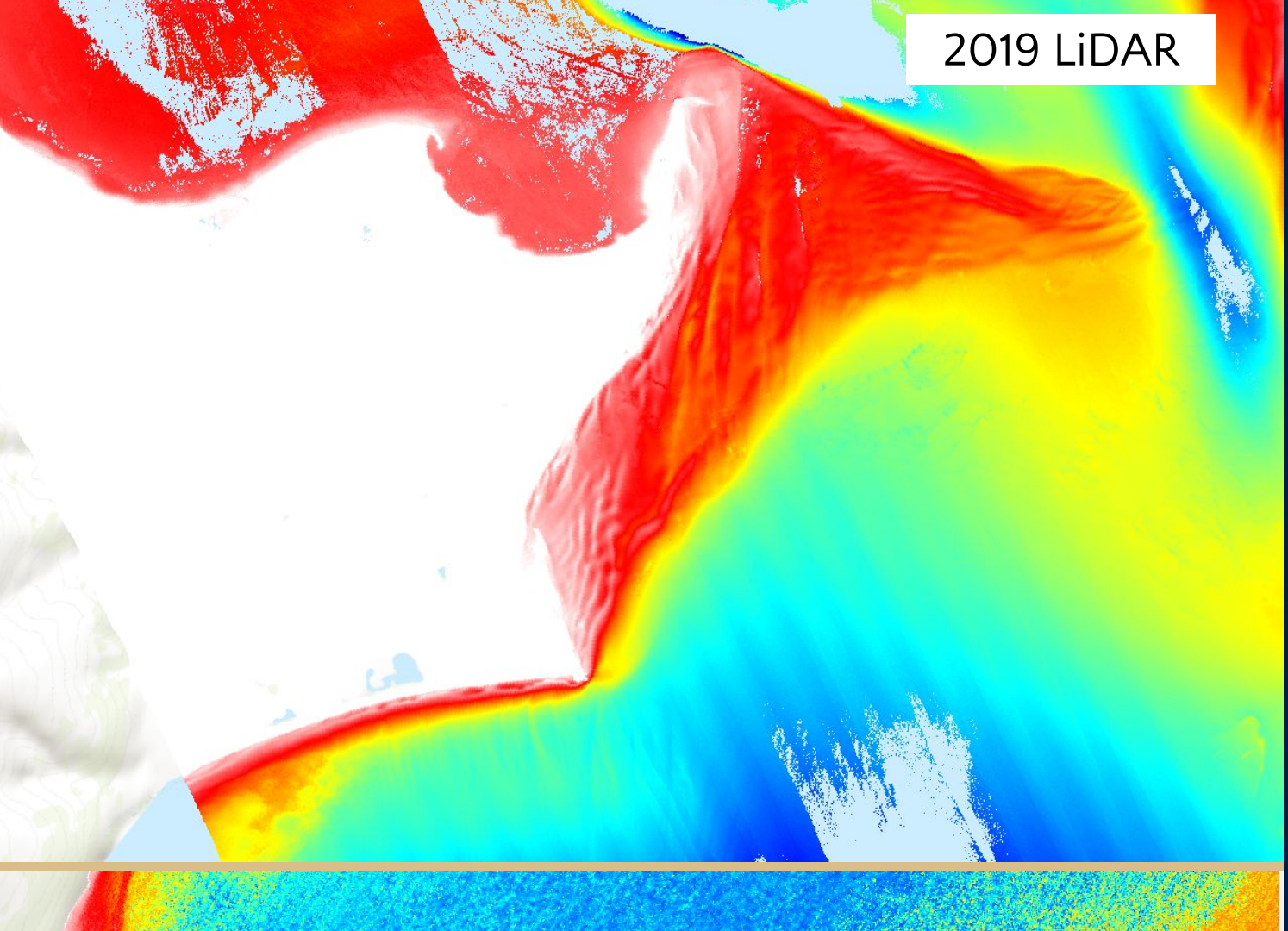
Depth (m),
MLLW

0

10

FUGRO



2019 USACE NCMP
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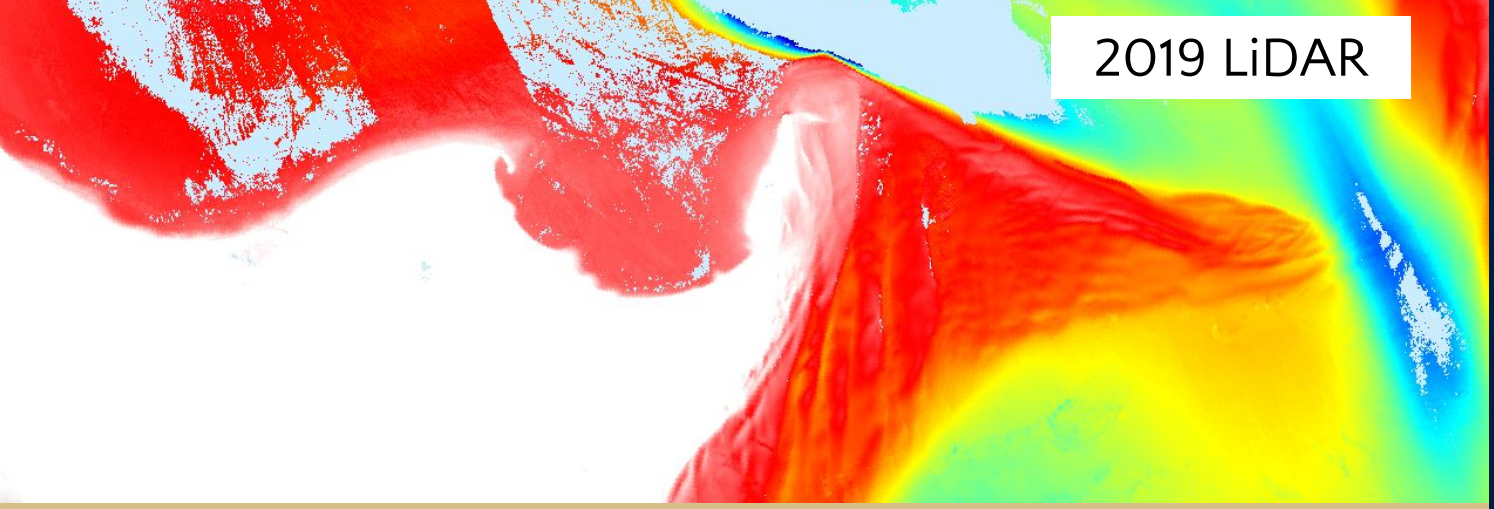
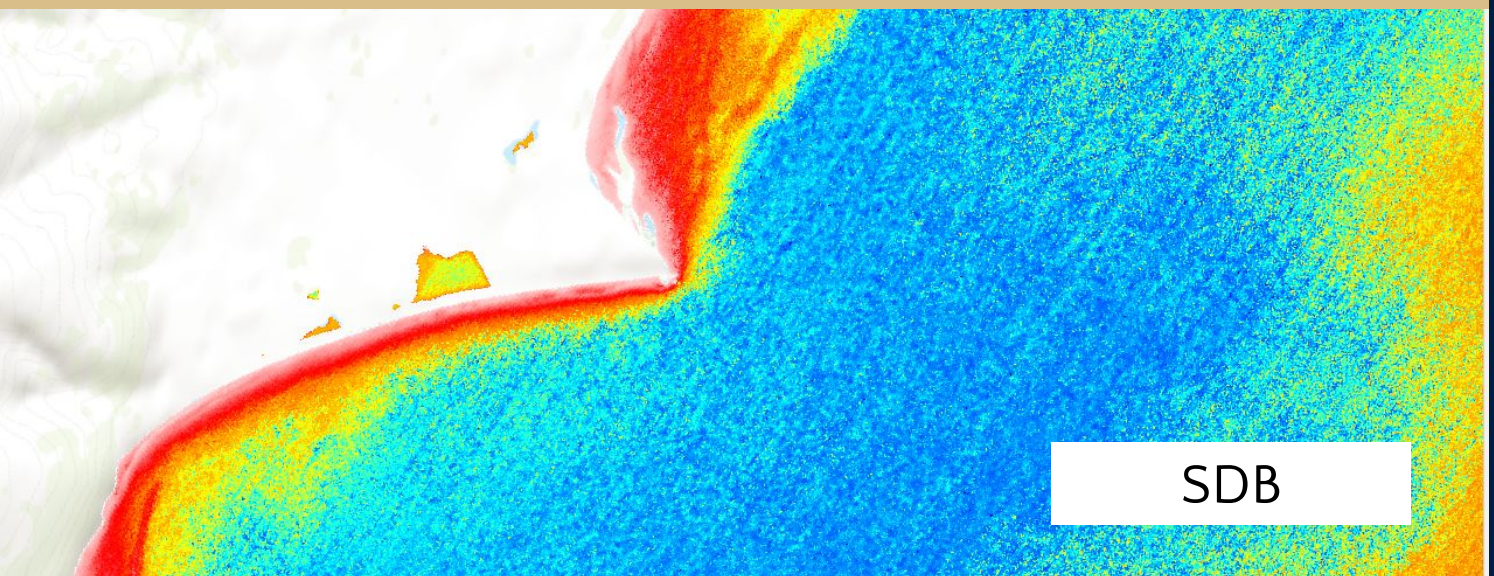
Depth (m),
MLLW

0

10

FUGRO





2019 USACE NCMP
Topobathy Lidar DEM

Golovin, AK

VS

SDB

Tile: 03WWM

Date: 2019-07-07

Depth (m),
MLLW

0

10

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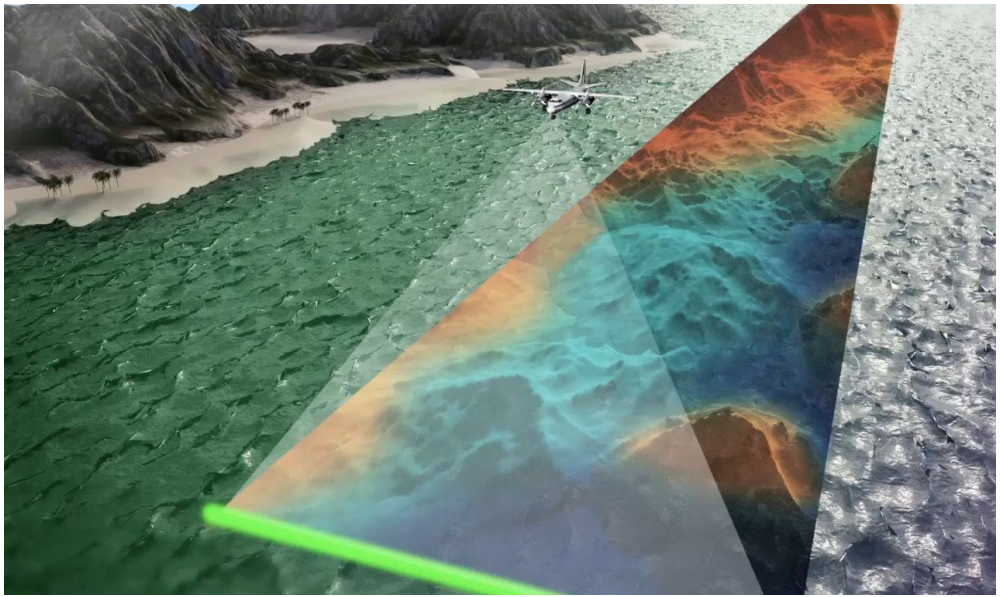
Coastal Mapping Sensor Innovations

RAMMS: Leveraging robotics, remote operations, sensor integration, cloud automation

More

- Superior data density and depth penetration > 45m
- No moving parts = reliability
- Small aircraft / UAV = non-paved, short airstrips, vessel deck deployment
- Compact / energy efficient = multi-sensor co-bundling



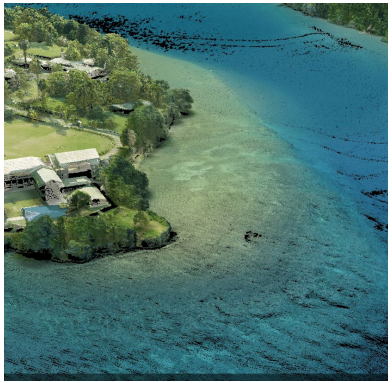
With Less

- Reduced carbon footprint
- Reduced logistics complexity
- Reduce risks with less personnel
- Streamlined data delivery

Innovations in Acquisition – Coastal Mapping Suite

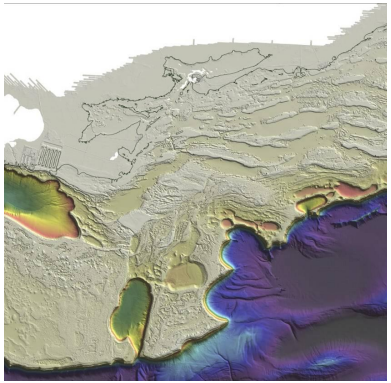
RAMMS=Superior ALB system solution

- Superior depth penetration
- IHO-quality bathymetry
- Lightweight = 80% À CO2



Simultaneous, multi-sensor data acquisition

- Bathymetric lidar
- Topographic lidar
- Orthoimagery
- SDB



Seamless land-to-sea data

- 290 m swath (independent of water depth)
- ~150 line km per day
- 1/7 the cost for large, shallow water projects

ALB Acquisition by drones

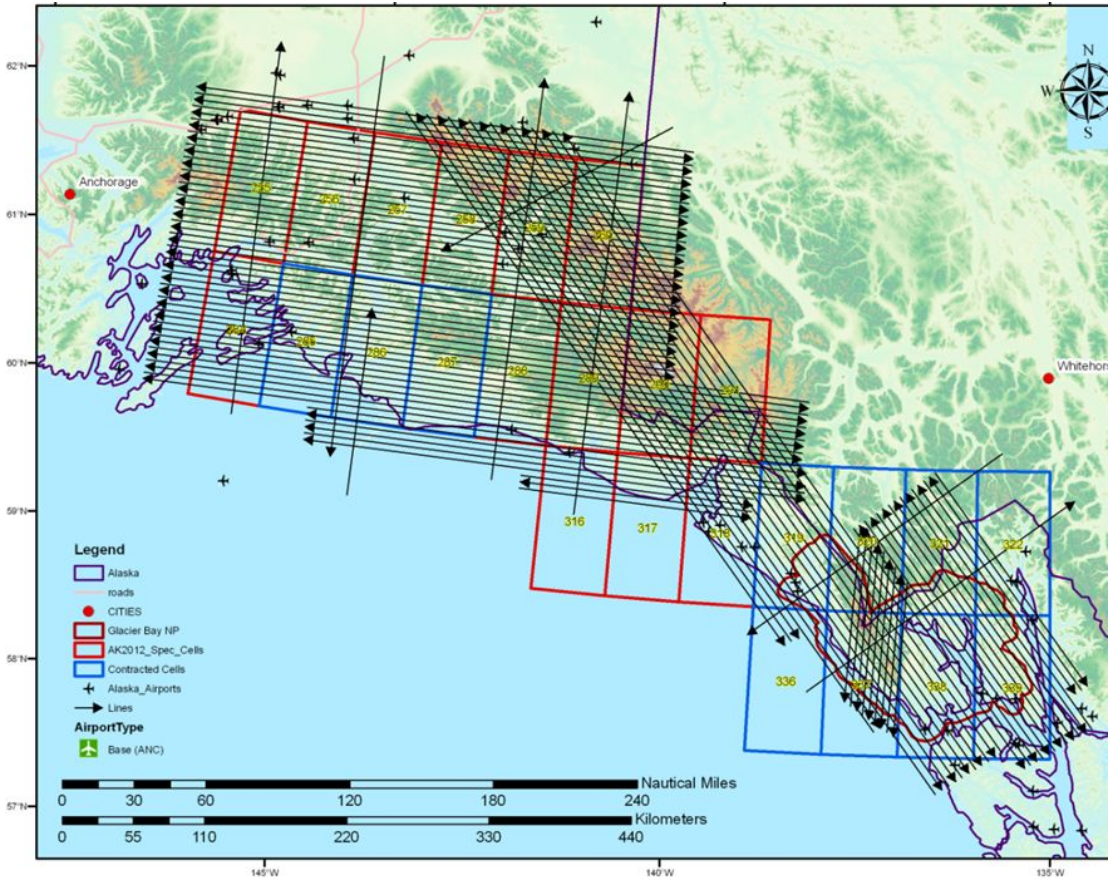
- Successfully tested
- Ready for pilot projects
- Reduction of 98% CO2 compared to legacy airborne lidar surveys

Data Buy Models
Learnings from SDMI-type approach, to enable cost effective implementation

IfSAR – Alaska Success Story

Collection on Speculation

1. Reduced costs: fewer mobilizations, more efficient line plan, larger area to mitigate adverse conditions
2. Faster Completion pace: annual funding gaps were absorbed by the private sector
3. Cost predictability: pre-negotiated rates based on unit rate per AOI.



Data Collection on Speculation – Surveyor Perspective

Consideration Type	Consideration Details
Physical	Distance from the nearest airport, logistics to install ground control points or water clarity check points, restrictions with crossing specific lands or airspace, complexity of the shoreline, min. water depth penetration, max. topo elevation;
Environmental	Tidal coordination, wind, waves, cloud cover, water clarity, seasonal limitations i.e. leaf off, ice/snow free, spring run-off turbidity, etc.
Commercial	Cost of money, time to recoup investment, confidence of purchase
Conflict Avoidance	Processes in place to avoid conflicts among multiple contract surveyors. i.e. pure speculation vs. overcollection near contracted-area block(s)

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Other Data Buy Models

Program	Data Buy Model Details
California Coastal Mapping (State-managed)	▪ PPP between State Agency, NOAA, USGS, CSU and Surveyor (Fugro) – collaboration on developing acquisition plan, data specification, engagement of other funders; ▪ Combined vessel-based and aerial surveys over several years (topo lidar, bathy lidar, MBES, imagery products) ▪ Pre-negotiated fee per specific region / area

Florida Coastal Mapping (State Managed)	▪ Entire area of interest for the program is defined
	▪ Requested per km2 unit rate for
	  ▪ 0-20 m for Topo lidar and ALB collection
	  ▪ 20-100 m for sonar-based collection

Partnerships
Role and Value of the Private Sector Stakeholders

NOAA's plan for New Blue Economy

"Collaboration and partnership with private sector organizations are central to NOAA's mission to support the development and growth of the New Blue Economy, helping to deliver the information and knowledge needed to support sustainable use of the ocean and coastal resources, while protecting ocean health and ecosystem services."

- Leverage public-private partnerships;
- Harness emerging technologies and innovations;
- Data driven value-adds to users;

Partner of Choice in the Blue Economy Globally, in the USA and in Alaska

- Technology innovator
- Trusted, long-term survey contractor
- Open Geo-data contributor
- Facilitator of Geo-data donations from other private data holders


FUGRO
Unlocking Insights
from Geo-data

End of Presentation

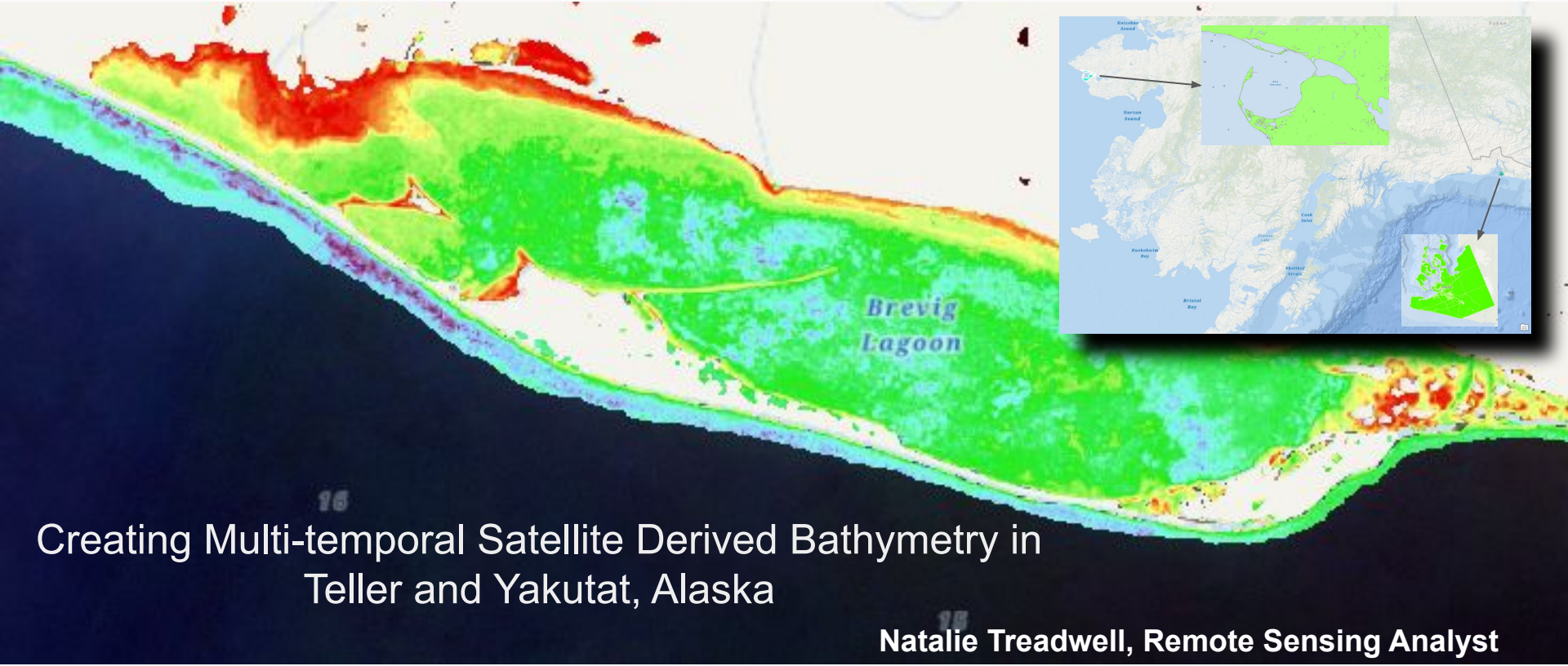
Thank you!

Satellite Derived Bathymetry

Natalie Treadwell – TCARTA

TCARTA

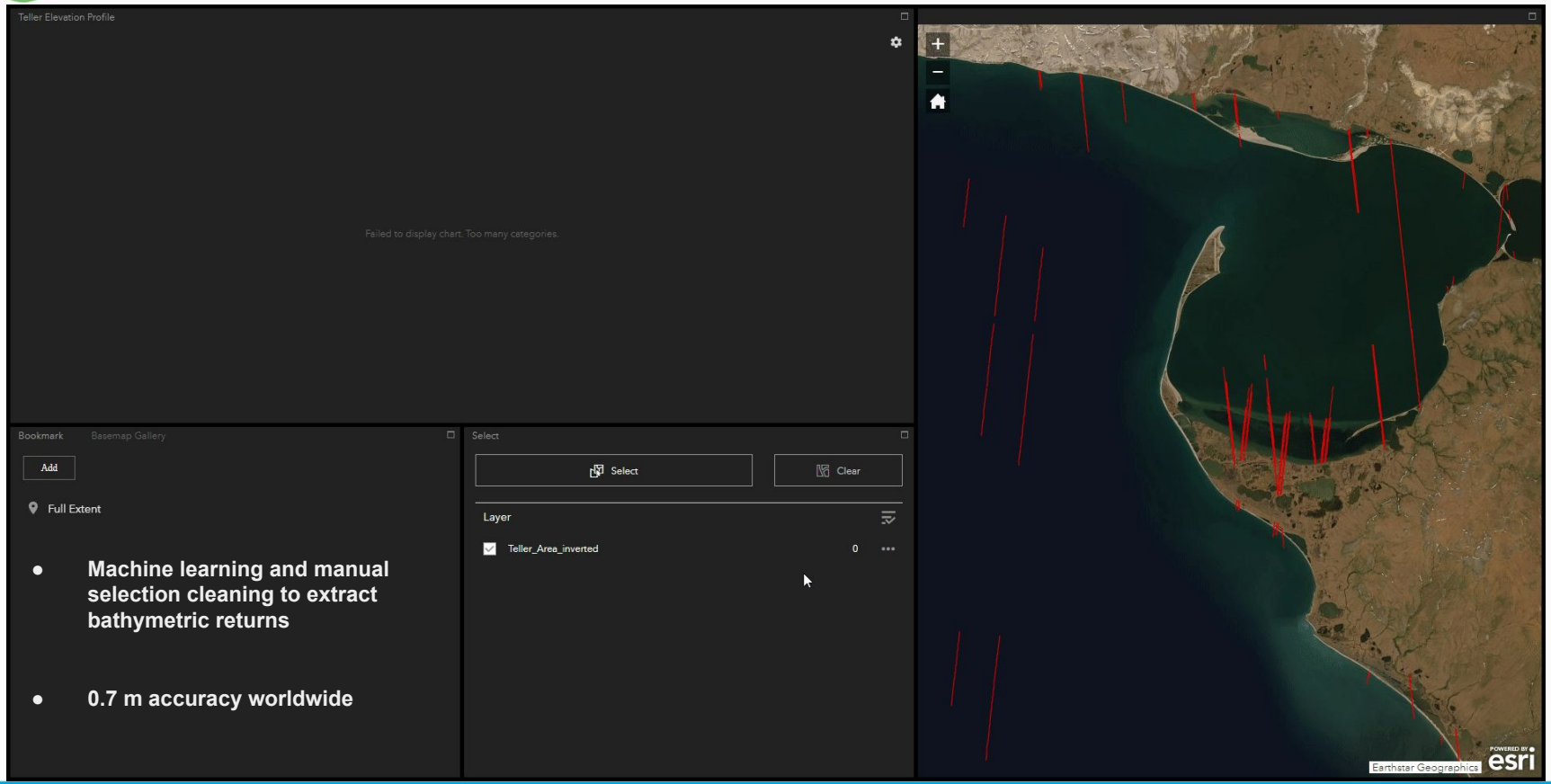
The leading global provider of innovative marine geospatial services & products and satellite based earth observation analysis



Creating Multi-temporal Satellite Derived Bathymetry in Teller and Yakutat, Alaska

Natalie Treadwell, Remote Sensing Analyst

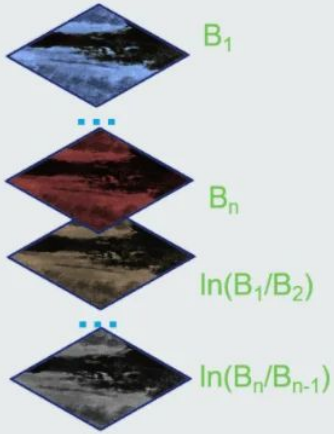
ICESat-2 ATL03 Bathymetric LiDAR Collection



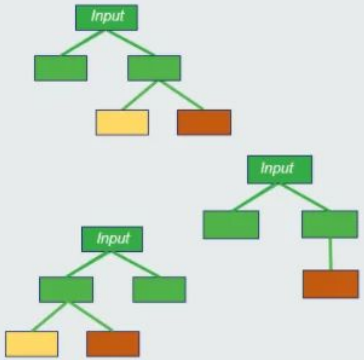
- Machine learning and manual selection cleaning to extract bathymetric returns
- 0.7 m accuracy worldwide

Satellite Derived Bathymetry Methods

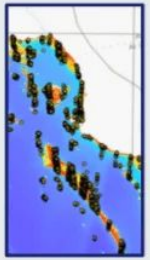
Random Forest Model



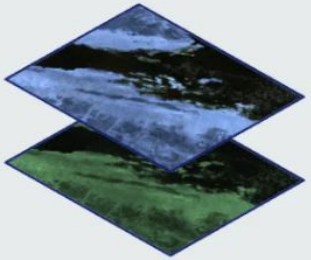
Spectral bands (B) and band ratio permutations (pixel value)



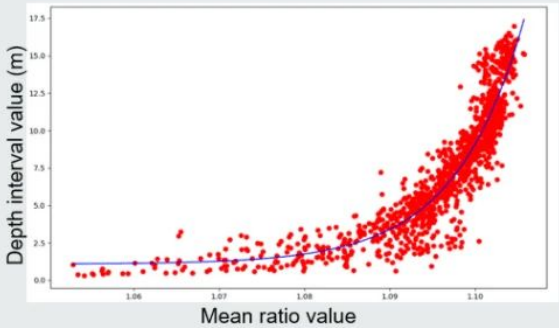
Trained with point data (ICESat-2)



Band Ratio Method



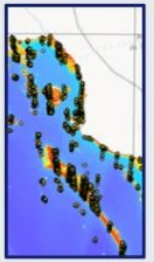
$\ln(B_2/B_3)$



Spectral bands:

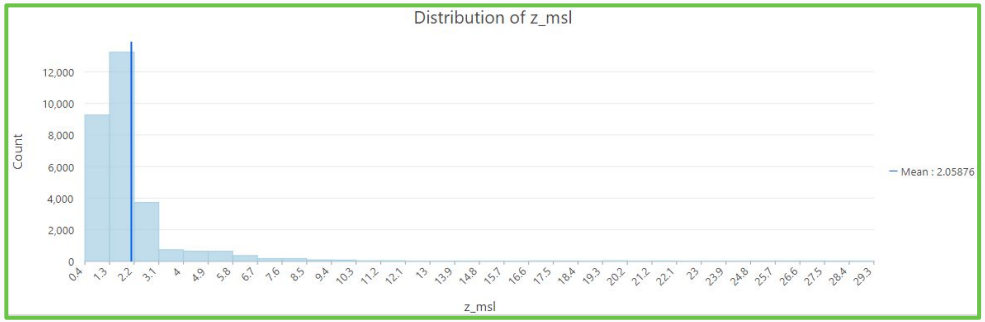
B_2: Blue band
B_3: Green band

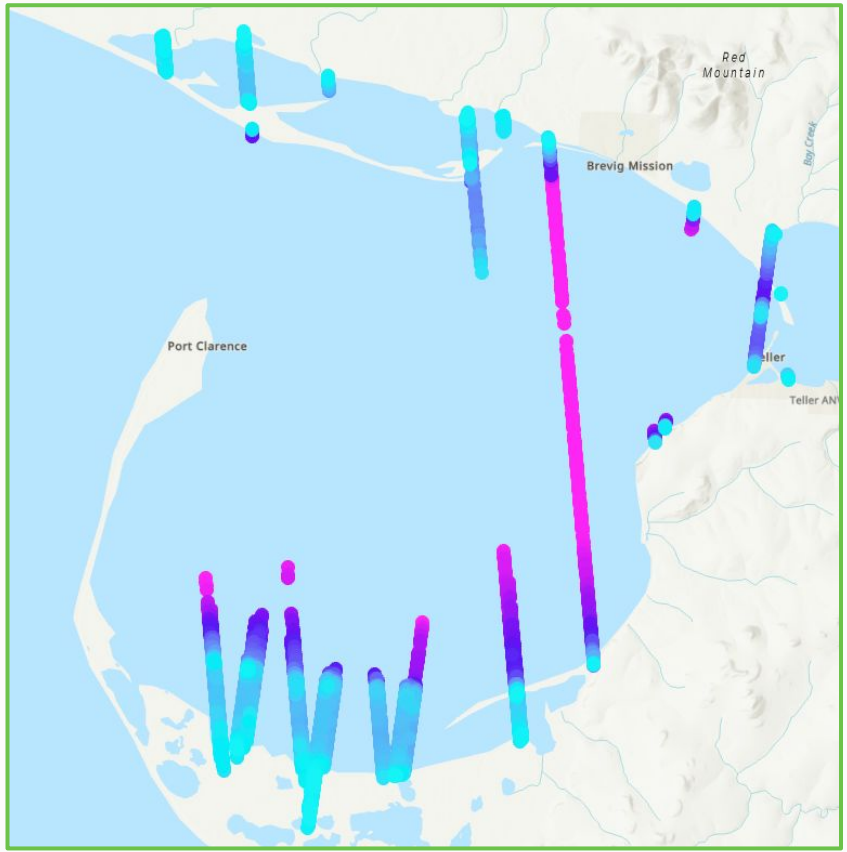
Fit curve between band ratio and depth from calibration data (ICESat-2)



Teller ICESat-2 Collection

Depth Range	0.35m - 29.28m
# Data Points	29,435
DOI	2018-2022
Vertical Datum	EGM2008





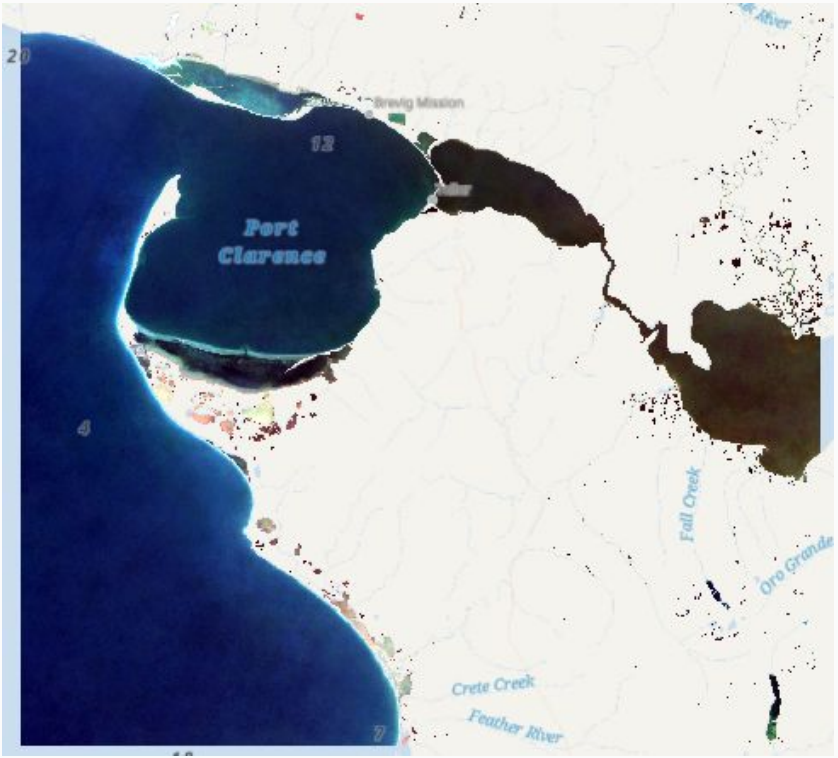
Imagery

(1) Planetscope 3 m

95 images | 43 Mosaics | 1 Composite

(2) Sentinel-2 10 m

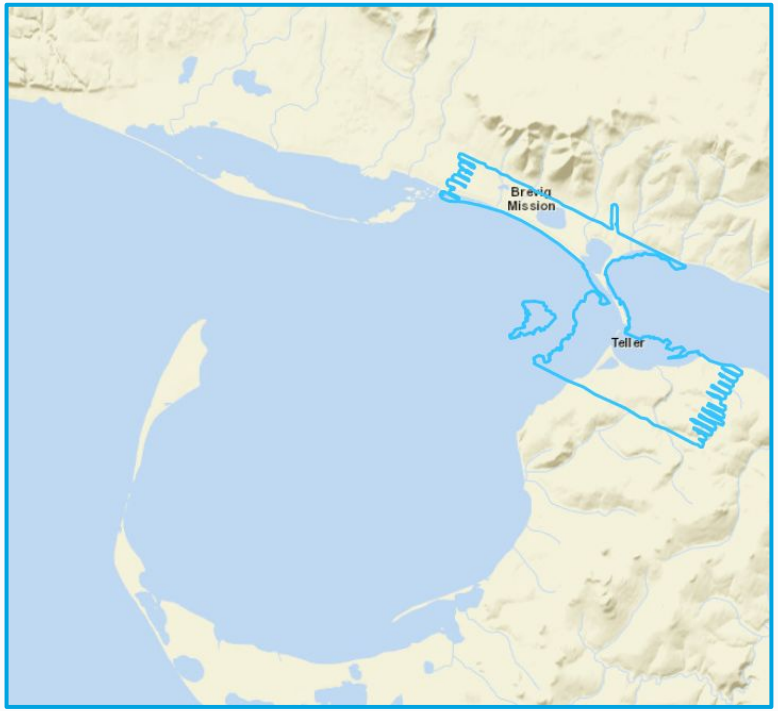
621 images | 1 Composite



In-situ Data log

(2) NOAA *(ingested in 2020)*

2019 USACE NCMP | Topobathy Lidar Start: 2019-07-09 End: 2019-07-28

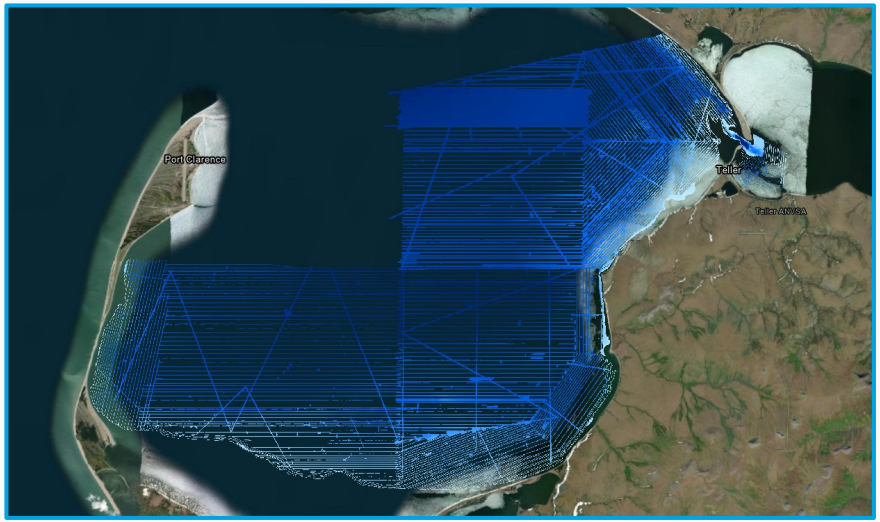


(3) NOAA *(ingested in 2017-2018, 3 datasets in ellipsoidal reference)*

NOAA MBES | 474085 H12798 Start: 2017-07-12 End: 2017-08-31

NOAA MBES | 474301 H12800 Start: 2017-07-21 End: 2017-08-23

NOAA MBES | 474299 H12799 Start: 2017-07-21 End: 2017-08-29



Alaska, The Great Frontier

H = Orthometric Surface

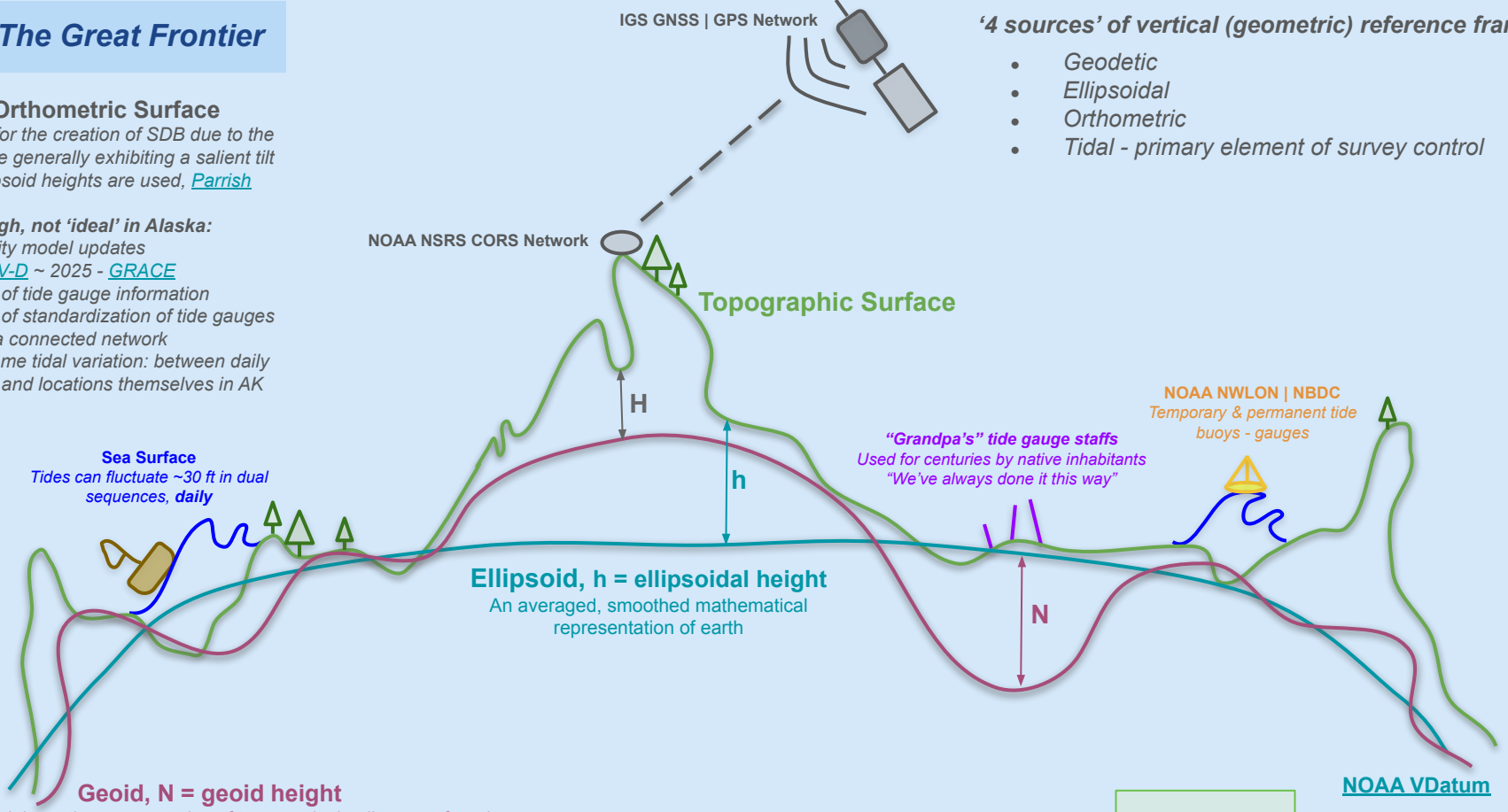
Best to use for the creation of SDB due to the water surface generally exhibiting a salient tilt when ellipsoid heights are used, Parrish

though, not 'ideal' in Alaska:

- *Gravity model updates GRAV-D ~ 2025 - GRACE*
- *Lack of tide gauge information*
- *Lack of standardization of tide gauges and a connected network*
- *Extreme tidal variation: between daily tides and locations themselves in AK*

'4 sources' of vertical (geometric) reference frames

- *Geodetic*
- *Ellipsoidal*
- *Orthometric*
- *Tidal - primary element of survey control*



Geoid, N = geoid height

Gravity model mostly representative of true gravity in all areas of earth - the datum that can be closely tied to what 'MSL is as a datum' analogous to most locations. Although MSL does *not* equal this.

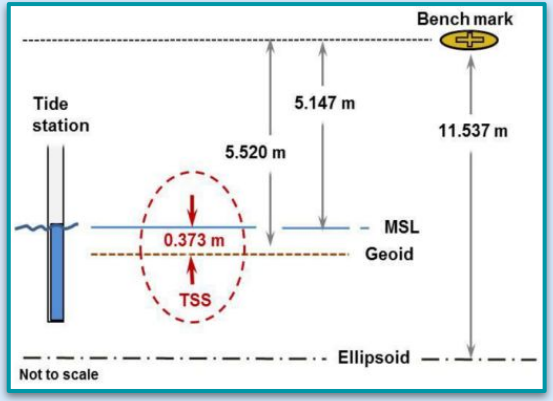
H = h - N

NOAA VDatum

NOAA NGS Toolkit

Citation

Alaska, The Great Frontier



Using Water Levels in Alaska

Resources

1. **NOAA** LT Bart Buesseler
   Using Water Levels in Alaska

Tidal Concurrent Tidal Measurements
TCARI or zoned tide files: reduce data to MLLW based on timestamp: NWLON or NBDC station for tides, NTDE

Ellipsoidal Referenced Separation Models
Separation model (surface) to reduce data to MLLW based on position

VDatum *Does not work in Alaska*
TSS - topography of the sea surface: ortho-tidal offset | NAVD88 - LMSL, MLLW
Transformations between tidal and geodetic datums

Poor Man's VDatum local tidal benchmarks (where the water is) + the geoid (where the water should be ~MSL) = TSS (topography of sea surface) + ellipsoidal heights, ERS = PMVD solution, SEP coverage with minimal curvature interpolation

"Tidal datums are the infrastructure on which the maritime community operates"

2. **Alaska,** DNR
   Alaska Tidal Datum Portal USGG2012 with GRS80 Ellipsoid

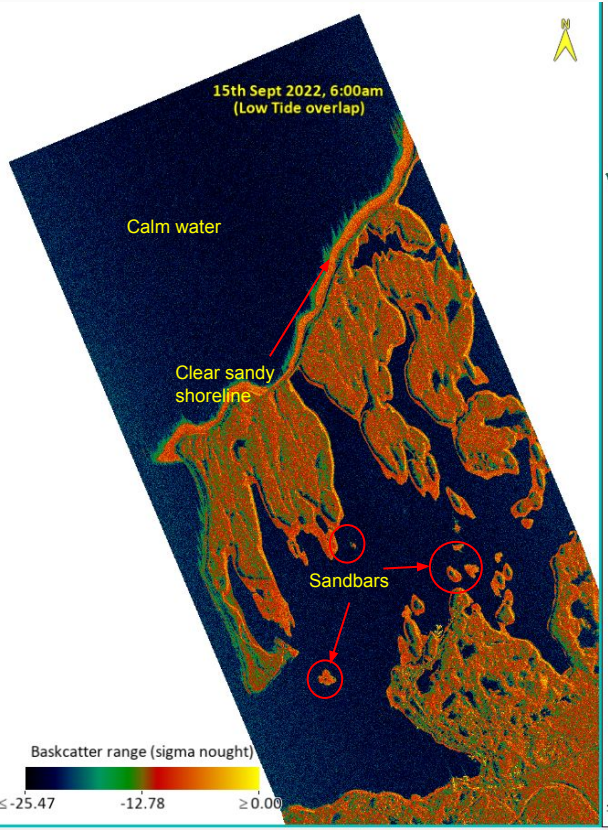
TCarta Workaround

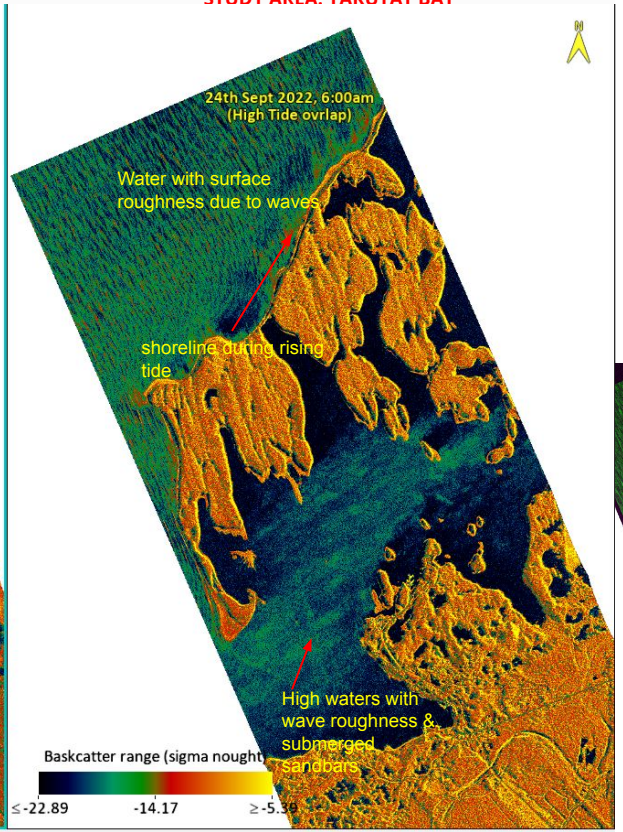
Elliposdal | ICESat-2 & Images → **Orthometric |** SDB Surface Creation → **Ellipsoid-Spheroid |** Calibration and Validation of in-situ data (MBES, SBES, Topobathy lidar) → **Gravimetric Geoid |** Final SDB Surface *approx in reference to local MSL, Alaska*

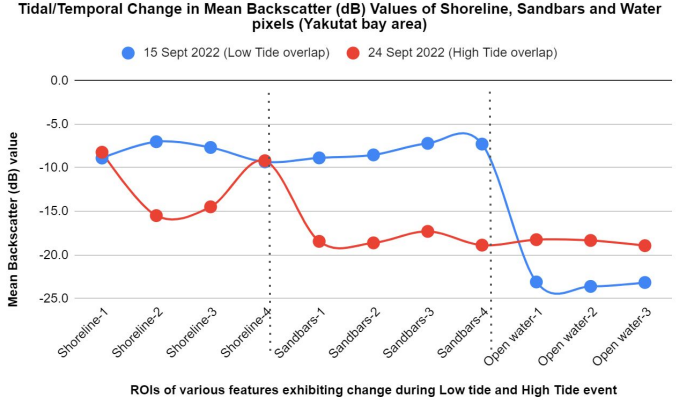
Synthetic Aperture Radar Shoreline Identification

Coastal Feature identification and Temporal changes in backscatter values(feature wise) during HT & LT

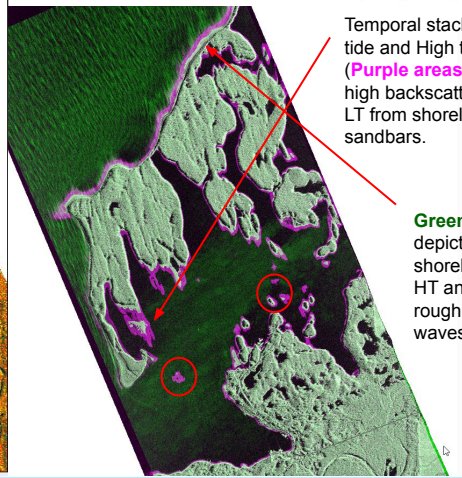
STUDY AREA: YAKUTAT BAY







ROIs of various features exhibiting change during Low tide and High Tide event

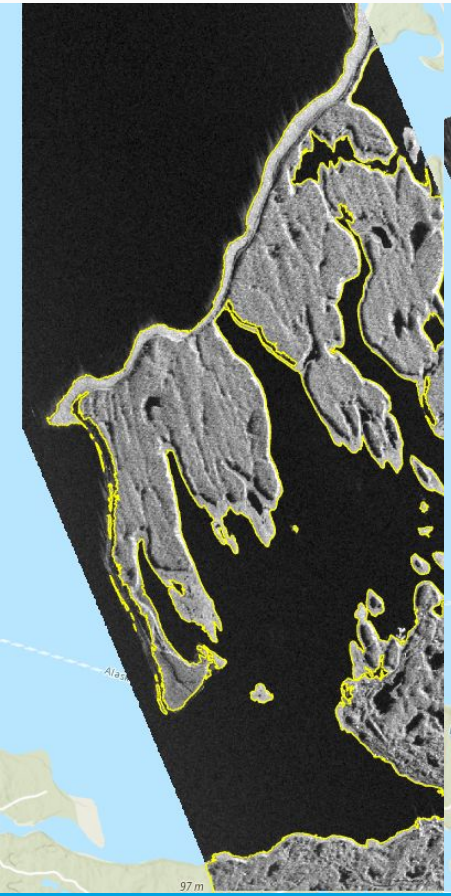


Temporal stack of Low tide and High tide image (**Purple areas** depict high backscatter during LT from shoreline, and sandbars.

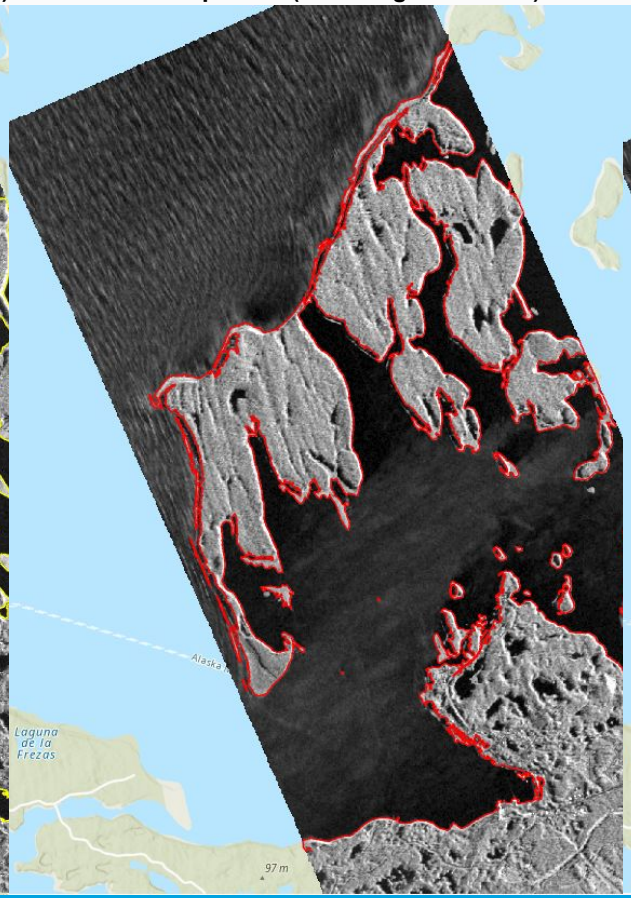
Green areas depicting shoreline during HT and surface roughness due to waves in water)

High and Low Tide for Yakutat, Alaska

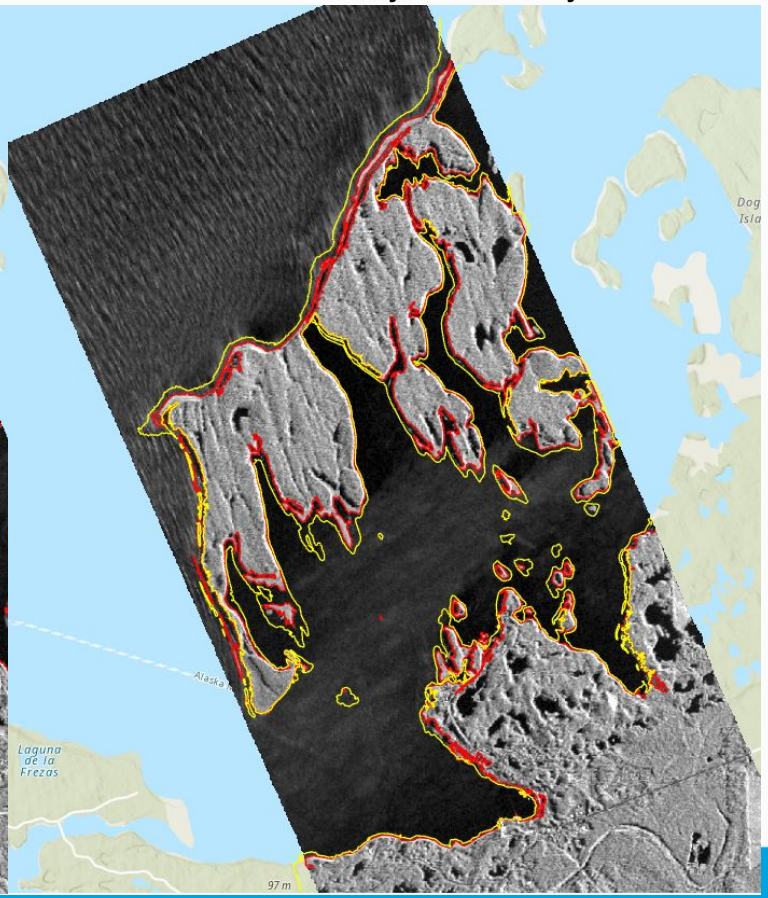
15 Sept 2022 (Final Low Tide Line)



24 Sept 2022 (Final High Tide Line)



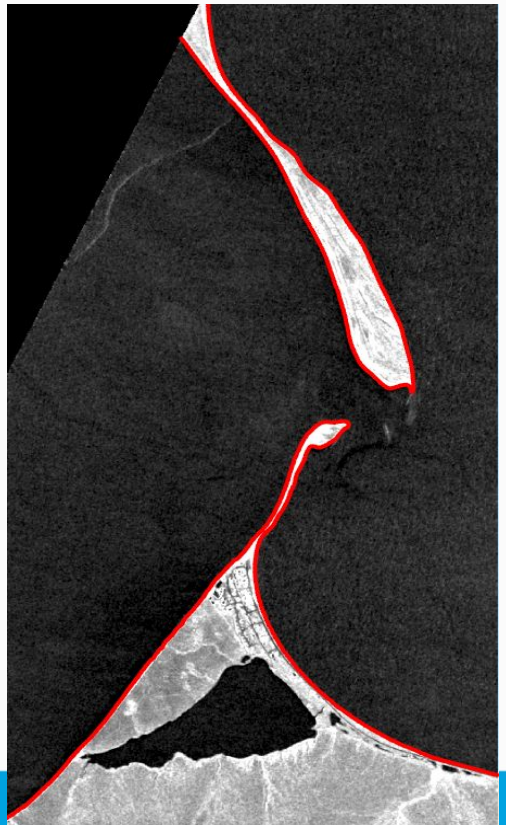
LTL & HTL Overlay for Yakutat bay



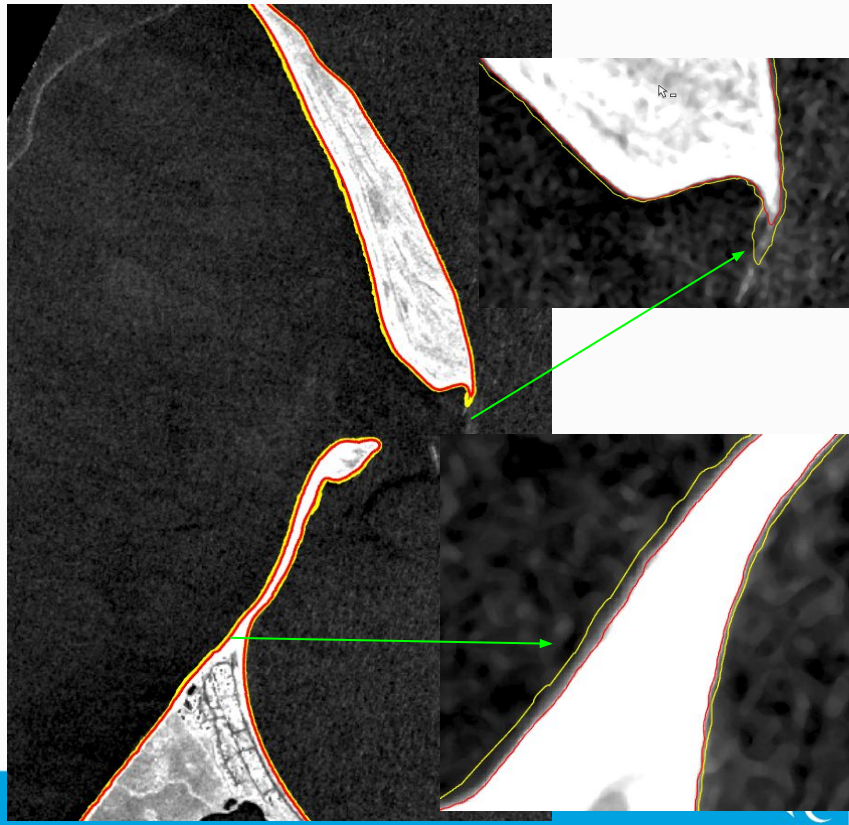
High and Low Tide for Teller, Alaska

Single Mean Low Tide Line
(computed from 2 LT images)

Single Mean High Tide Line
(computed from 4 HT images)



Mean LTL & HTL Overlay

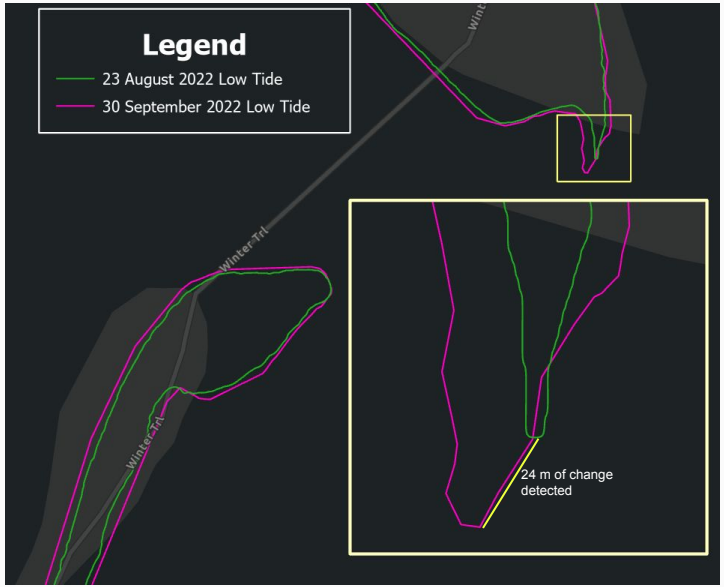


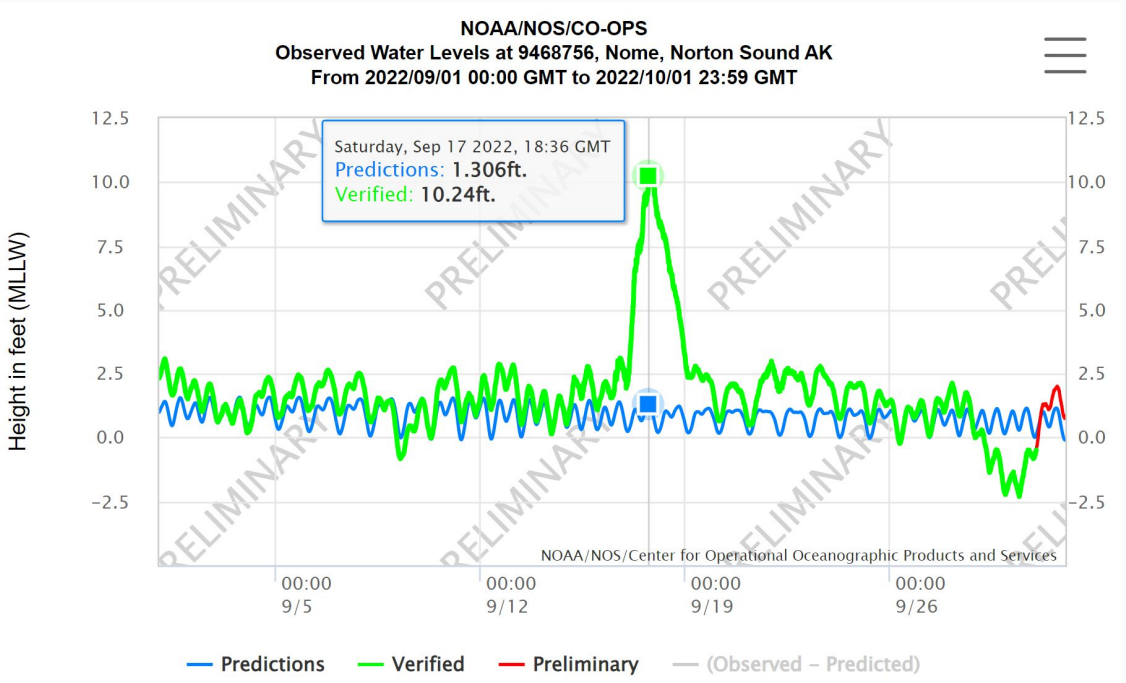
Shoreline change after Typhoon Merbok

Capella SAR

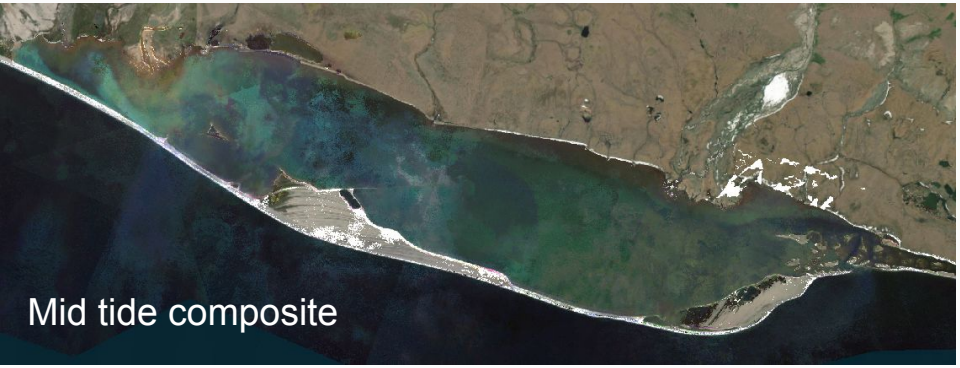
- 1.5 m to 1.6 m resolution
- Accuracy of +/- 5 m

- Shoreline change of 0-25 m across the low tide line





Planet Composites

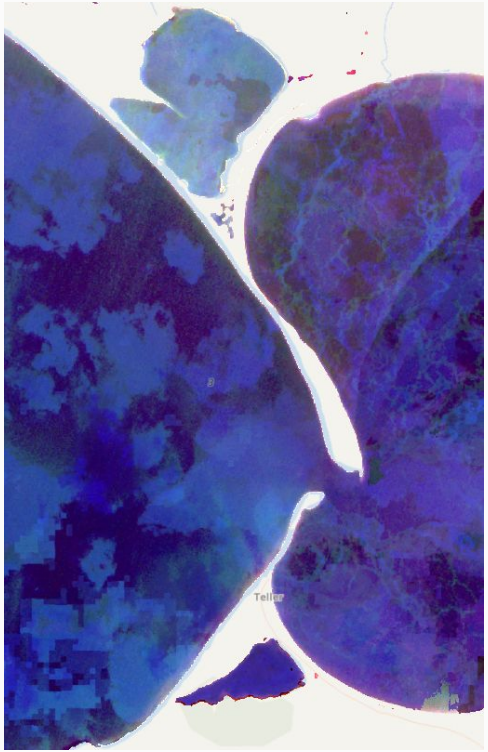


Composites created based on metadata parameters

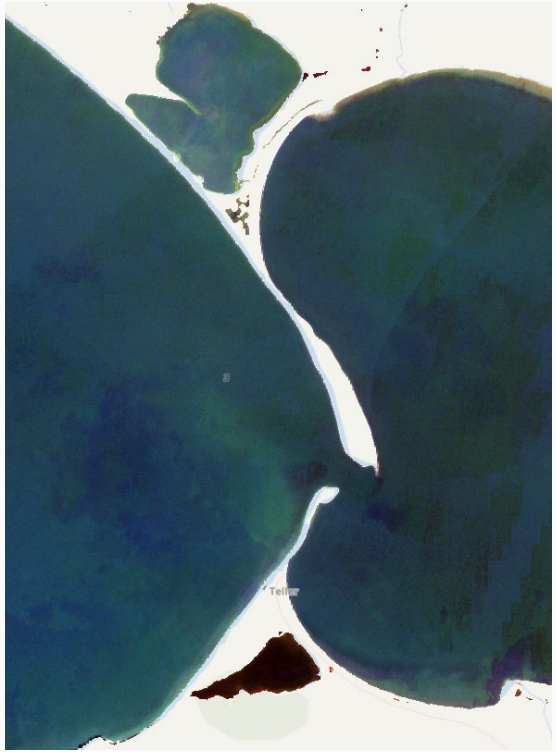
- Tidal range
- Illumination Azimuth
- Turbidity
- Cloud Cover Percentage

Sentinel-2 Percentile 10 Composites

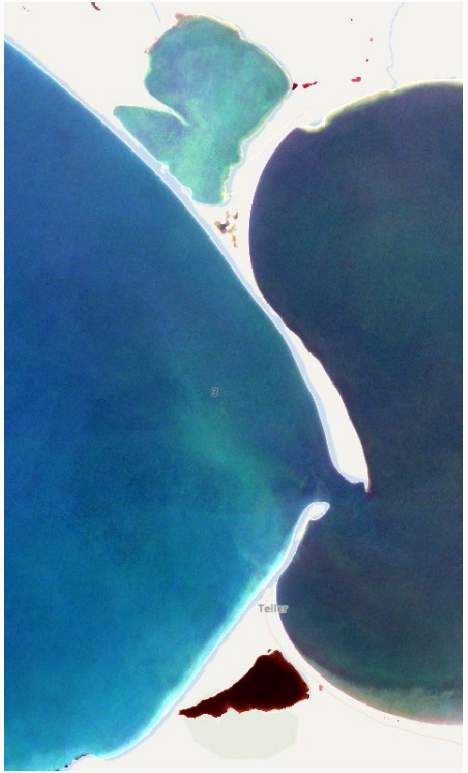
2018- 2019 May - Oct



2017- 2019 June - Sept



2018- 2022 June - Sept



Planet Results 3m

Value (m)
5.41
0.48

ICESat-2 70/30 QAQC

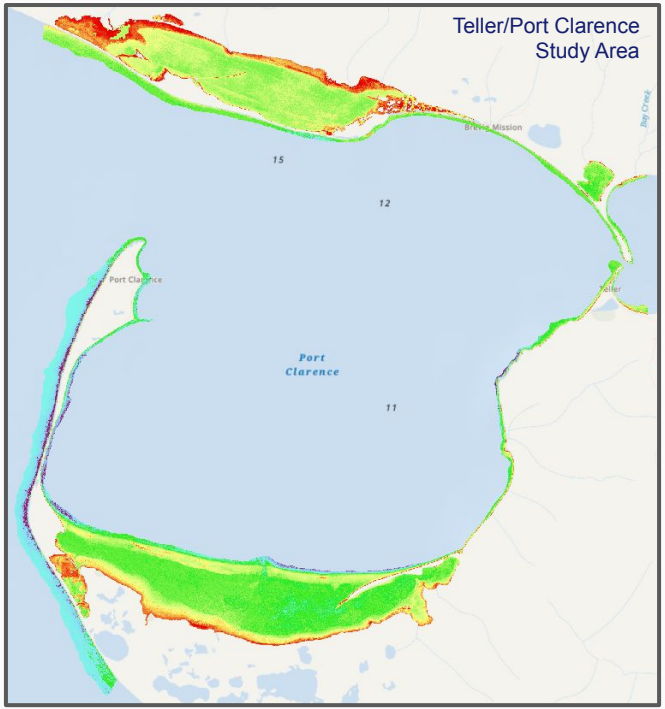
Interval	ME	MAE	MSE	RMSE	MAPE
0.36m - 8.28m	0.01	0.227	0.126	0.355	14.439
0m - 1m	-0.114	0.142	0.057	0.239	15.988
1m - 5m	0.036	0.243	0.12	0.346	13.74
5m - 10m	2.535	2.535	7.691	2.773	93.891

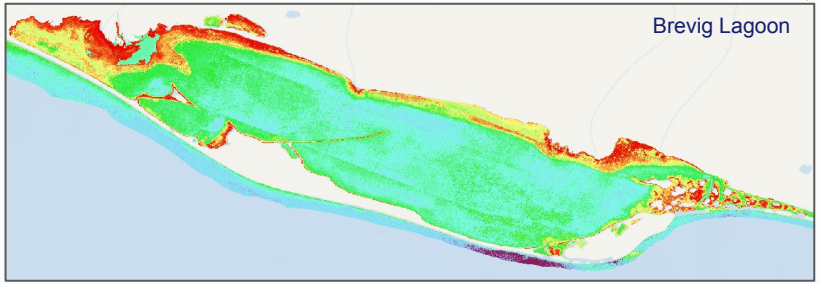
Multibeam Sonar QA QC

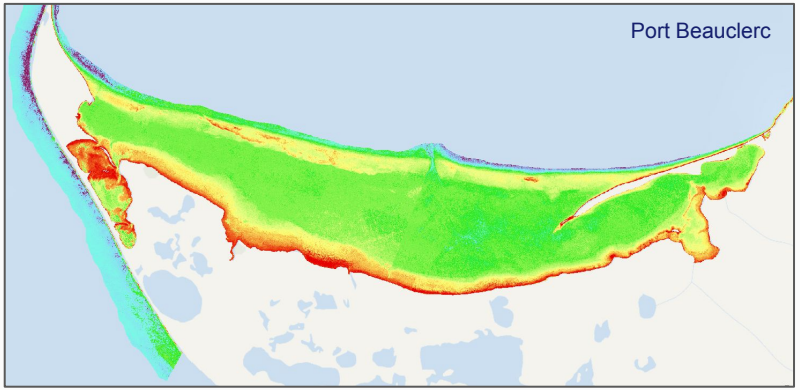
Interval	ME	MAE	MSE	RMSE	MAPE
0m - 3.79m	-2.978	2.981	10.679	3.268	84.68
0m - 1m	-3.115	3.115	11.168	3.342	82.382
1m - 5m	-2.475	2.485	7.667	2.769	61.028

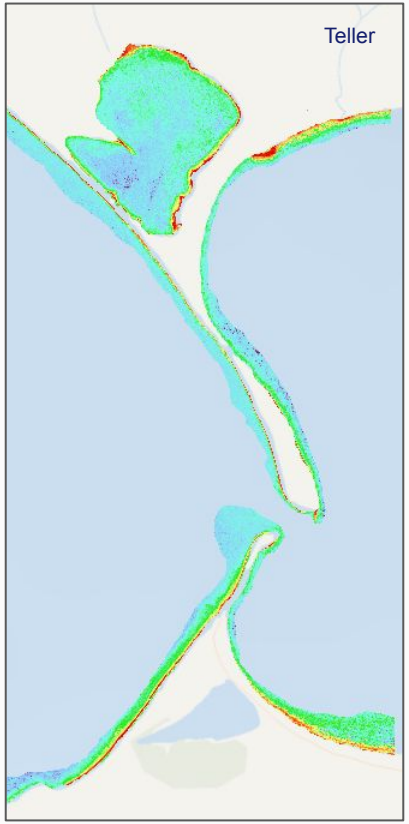
LiDAR QA QC

Interval	ME	MAE	MSE	RMSE	MAPE
0m - 7.0m	1.786	1.933	5.637	2.374	158.629
0m - 1m	-1.273	1.273	1.671	1.293	62.662
1m - 5m	1.56	1.658	3.978	1.994	128.092
5m - 10m	4.533	4.533	21.361	4.622	453.671









Sentinel-2 Results 10m

Value (m)
4.58
0.46

ICESat-2 70/30 QAQC

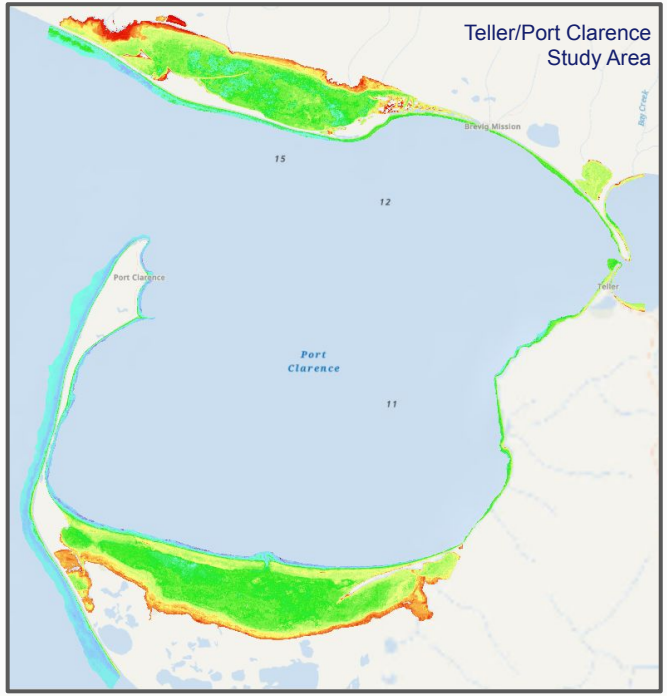
Interval	ME	MAE	MSE	RMSE	MAPE
0.36m - 8.28m	0.007	0.209	0.109	0.33	13.468
0m - 1m	-0.132	0.155	0.065	0.255	16.507
1m - 5m	0.037	0.215	0.094	0.307	12.402
5m - 10m	2.554	2.554	8.406	2.899	91.671

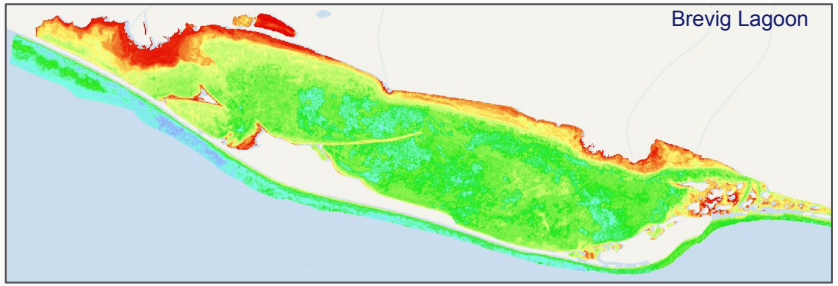
Multibeam Sonar QA QC

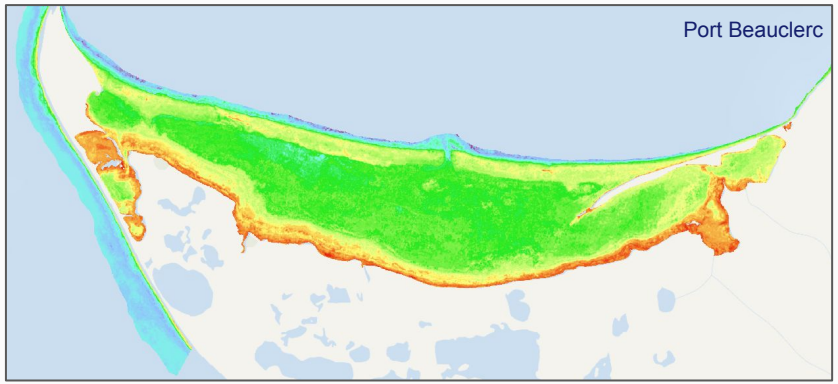
Interval	ME	MAE	MSE	RMSE	MAPE
0m - 3.79m	-2.503	2.506	7.177	2.679	84.15
0m - 1m	-2.434	2.434	6.454	2.54	79.656
1m - 5m	-2.181	2.189	5.218	2.284	60.887

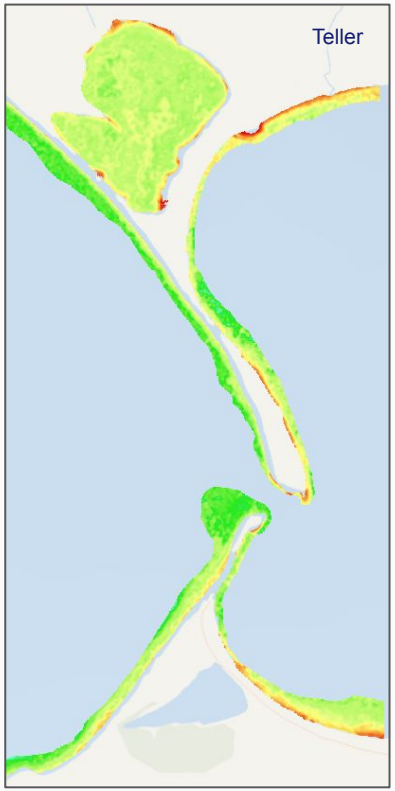
LiDAR QA QC

Interval	ME	MAE	MSE	RMSE	MAPE
0m - 7.0m	1.949	2.053	5.568	2.36	168.231
0m - 1m	-1.202	1.202	1.508	1.228	61.167
1m - 5m	1.834	1.899	4.635	2.153	151.708
5m - 10m	4.376	4.376	19.431	4.408	424.007









End of Presentation

Thank you!

Satellite Derived Bathymetry

Lauren Decker & Leslie Canavara – Polarctic

PolArctic
CENA: Coastline Evolution & Nearshore Approximation

Oceanography & Data Science for the Arctic

November 16th, 2022

PolArctic

Develops custom Artificial Intelligence and Machine Learning (AI/ML) tools for the Arctic based on the science of Oceanography

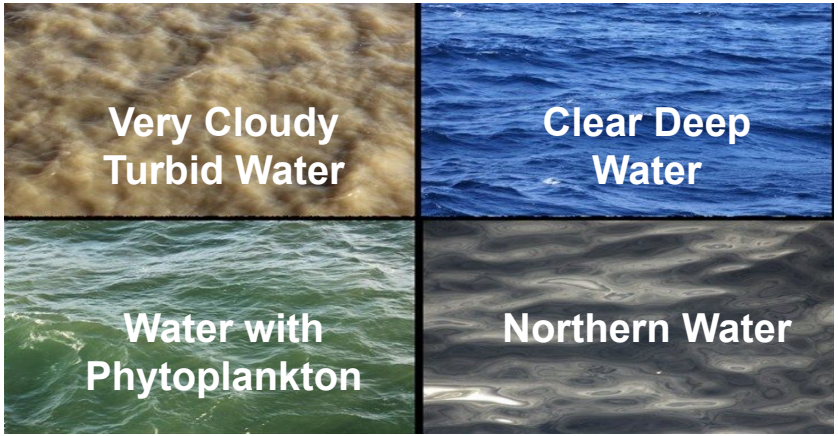
Focus Areas

Sea Ice Forecast

Coastline Evolution & Nearshore Approximation

Aquaculture/Mariculture & Precision Fishing Support

Arctic Water



The color of the ocean is determined by:

- Depth
- Organic Matter
- Sediment
- Temperature (Ice)

👀This looks bad but it was done to prevent land from eroding away. It was cleaned up and a seawall is up now.

Clifton Bates ▸ **Bethel Alaska** January 13 at 1:49 PM ·

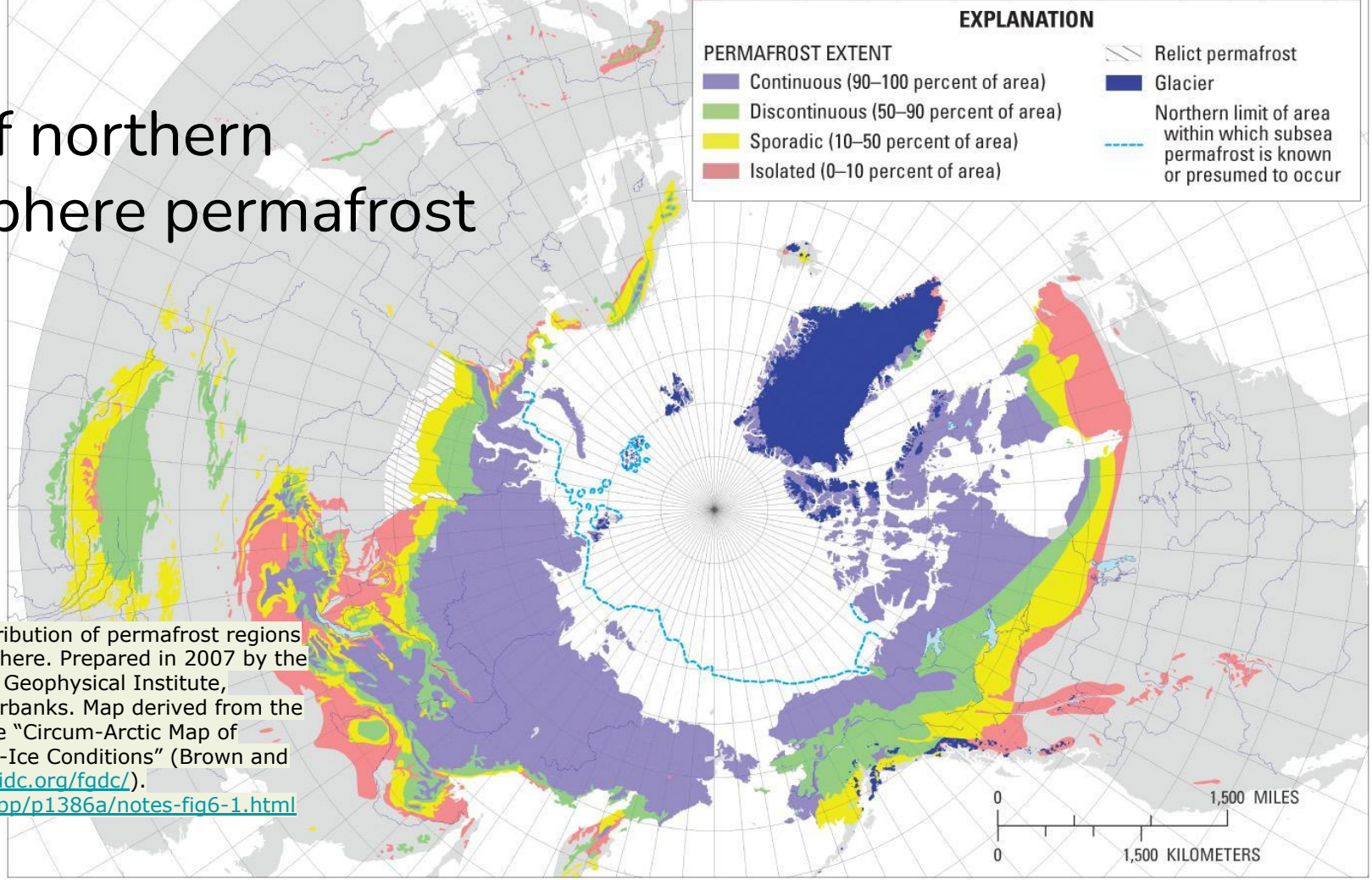
Bethel Downtown waterfront 1977

Bethel Bank Stabilization, Bethel, Alaska

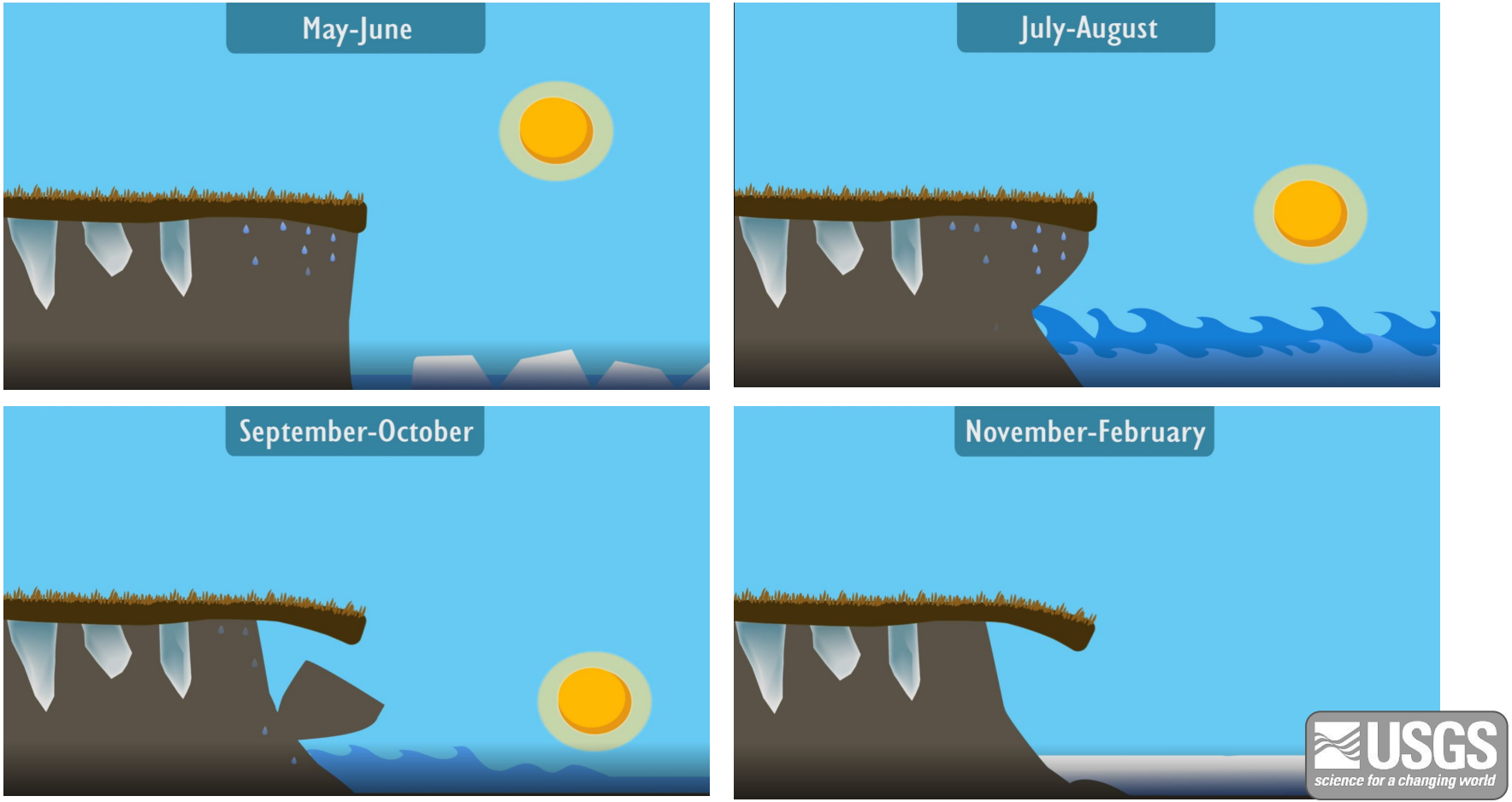
The Port of Bethel along the Kuskokwim River, August 2019

Bethel Bank Stabilization along Brown's Slough, June 2007

Map of northern hemisphere permafrost extent



Map showing areal distribution of permafrost regions in the Northern Hemisphere. Prepared in 2007 by the Permafrost Laboratory, Geophysical Institute, University of Alaska Fairbanks. Map derived from the electronic version of the "Circum-Arctic Map of Permafrost and Ground-Ice Conditions" (Brown and others, 1997, http://nsidc.org/fgdc/).
https://pubs.usgs.gov/pp/p1386a/notes-fig6-1.html



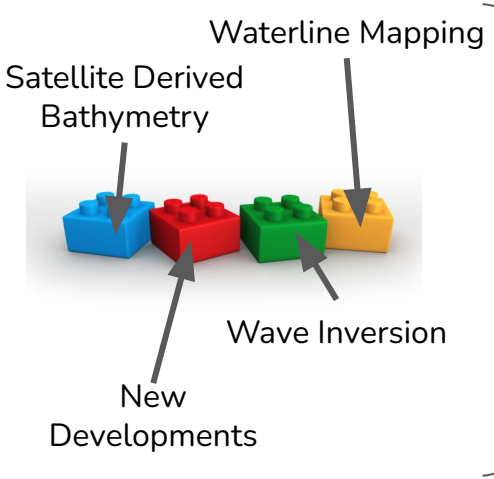
https://www.usgs.gov/centers/pcmsc/science/climate-impacts-arctic-coasts

CENA: *Coastline Evolution & Nearshore Approximation*

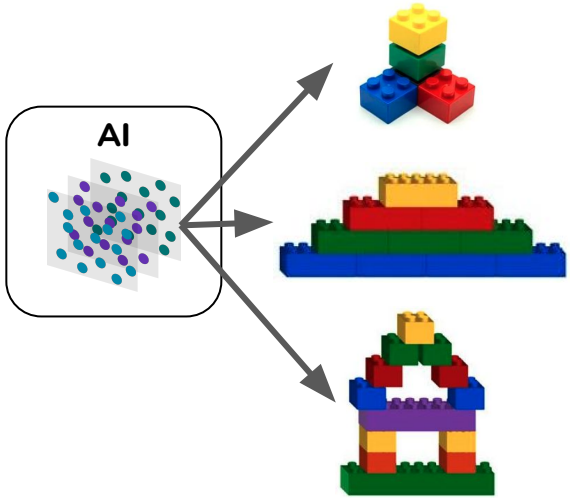
PolArctic's innovative AI architecture to estimate nearshore bathymetry

Small Business Innovative Research (SBIR) Award

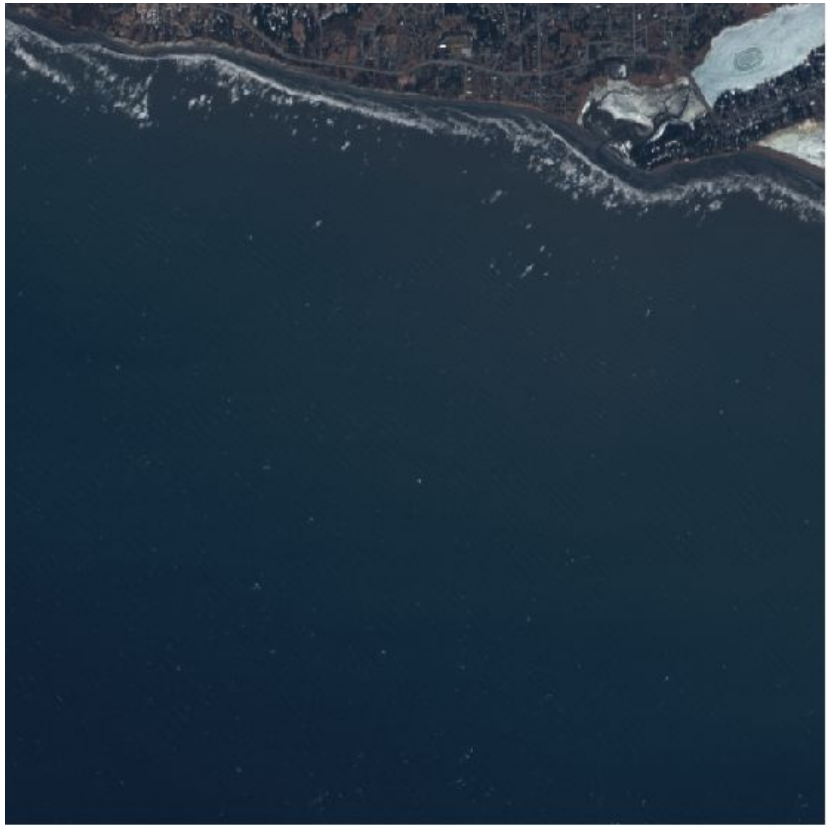
Building Blocks: Scientific methods



Construction: AI ensembling of a new, custom model



Test site: Homer, Alaska

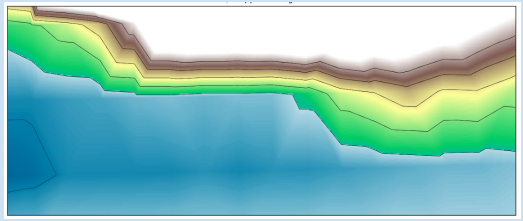


Sentinel 2 Images

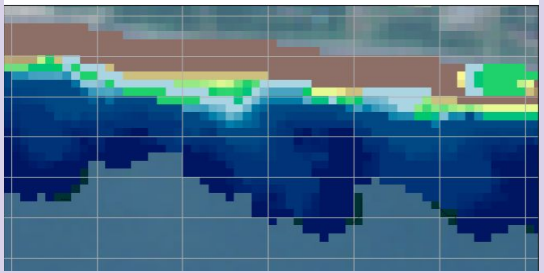
AI to Map Nearshore Coastline & Beach Classification

PolArctic's AI Identifies Unique Arctic Coastline at a Regional Scale

Original NOAA-750m Resolution



PolArctic's-10m Resolution

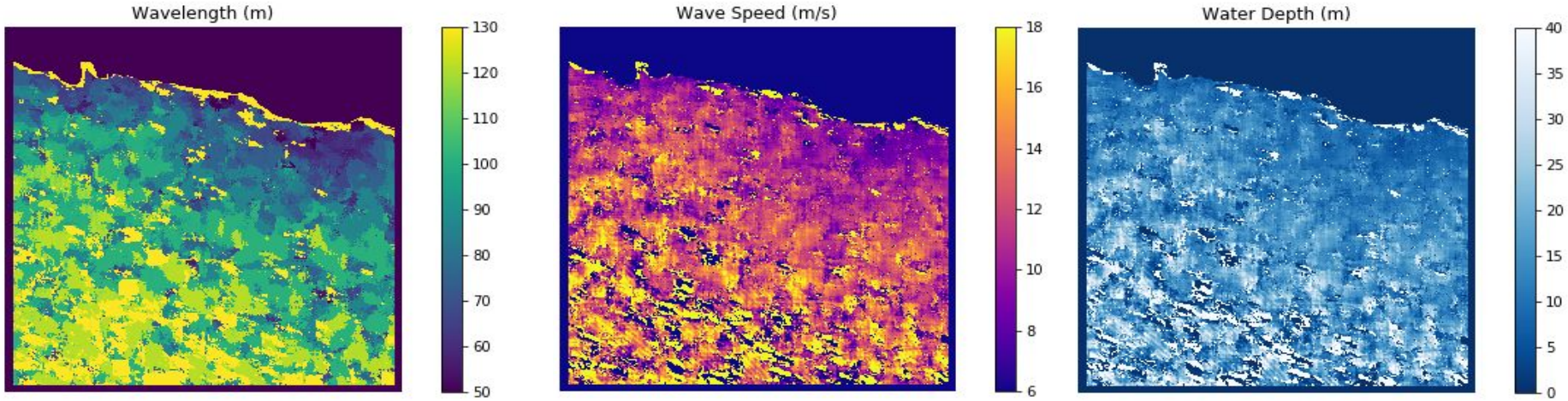


Mudflats

Ocean

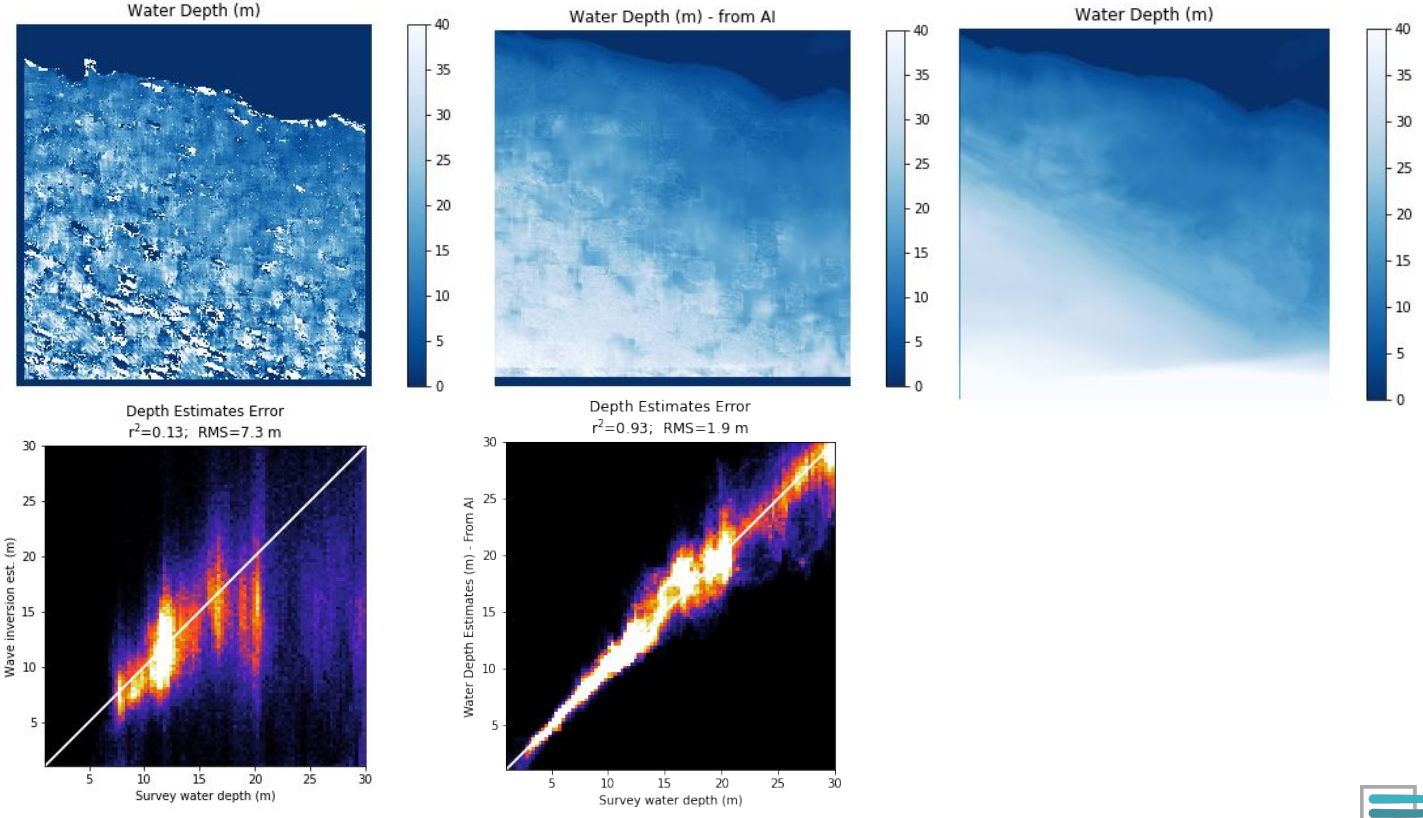
Image: Alaska ShoreZone Imagery (2009)

Bathymetry from Wave Inversion

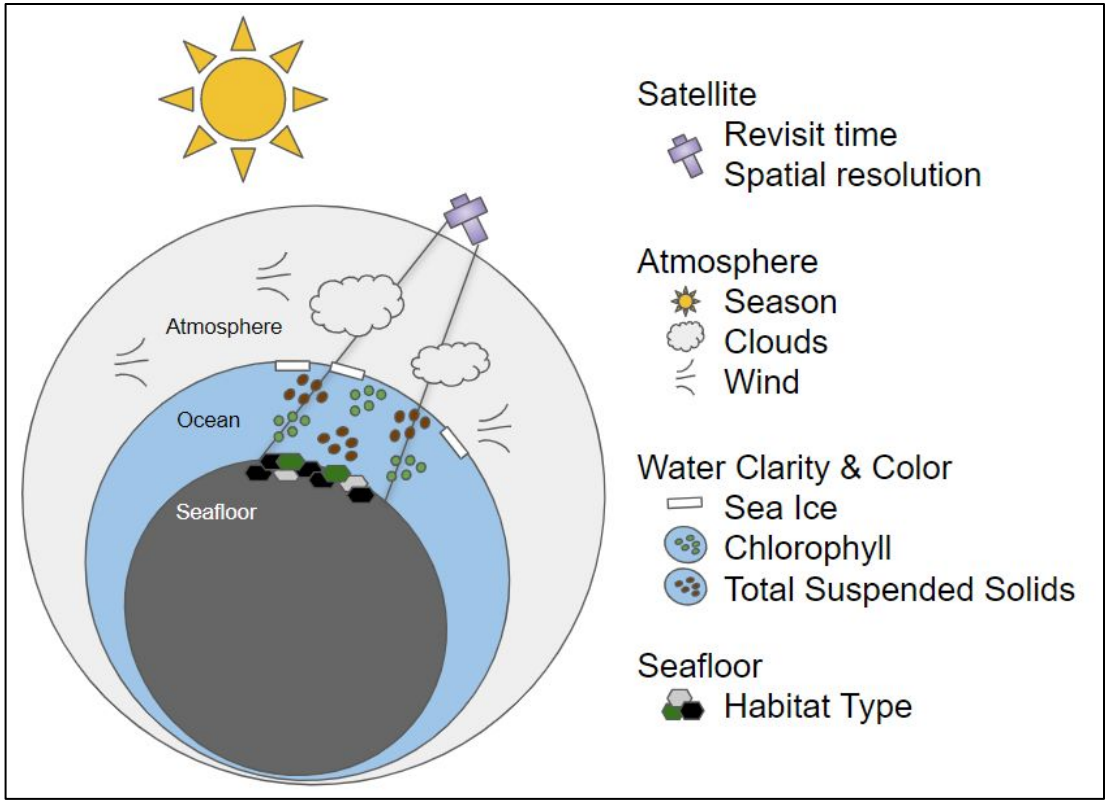


- Waves interact with bottom bathymetry at ~½ wavelength of the wave
- This technique is ‘feeling’ the bottom with waves
- Works in high-turbidity environments, like many silty locations in the Arctic

Bathymetry from Wave Inversion + AI



Satellite Derived Bathymetry (SDB)



Must be able to see to the bottom to estimate it

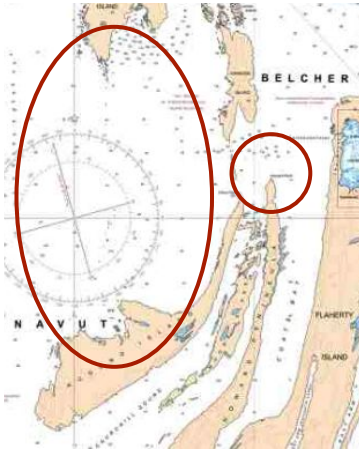
Lighter = Shallow,
Darker = Deeper

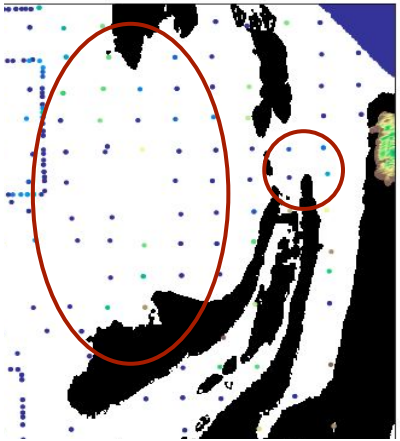
Statistical method to align color changes in green and blue bands with depth

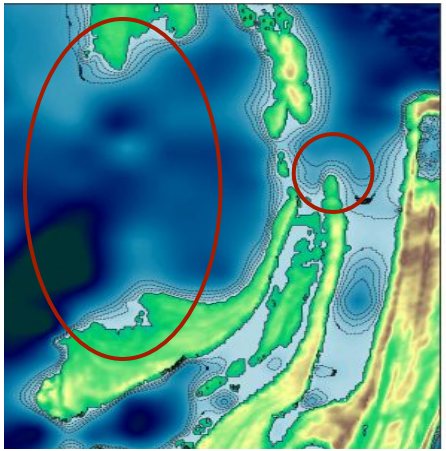
Using AI to Identified Uncharted Hazards

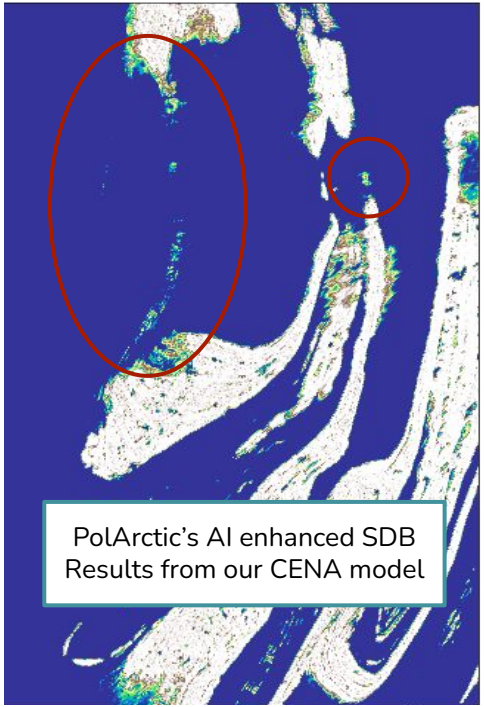
PolArctic Found an Uncharted Subsurface Sea Mount in Hudson Bay, CA

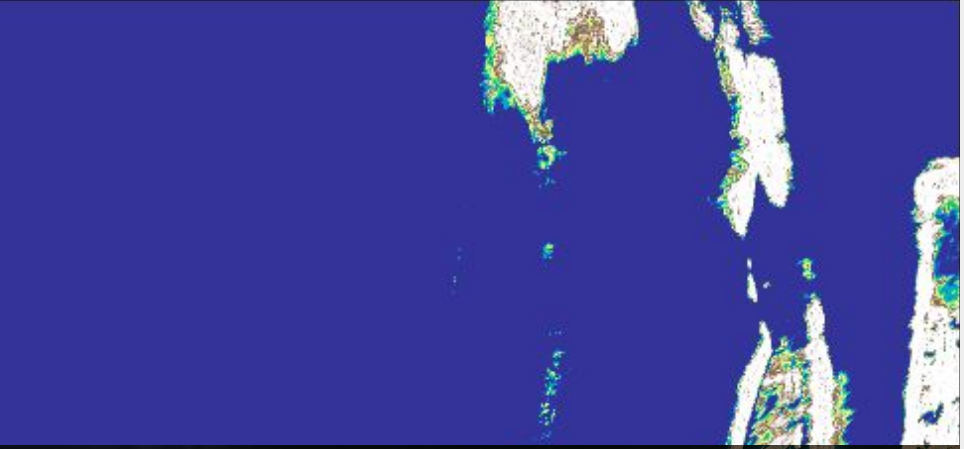
Nautical Charts, Survey Data, and General Bathymetric Chart of the Oceans (GEBCO) were all missing a subsurface sea mount impacting shipping operations and ocean models for the community.











Final Thoughts

- Alaska’s coastline and shallow nearshore is dynamic and impacted by erosion
- Remote sensing bathymetry is more than just clear-water SDB or LiDAR
- CENA is PolArctic’s tool for remote sensing nearshore bathymetry - developed for the Arctic environment

Based in the USA, we have an office on the East Coast in the greater Washington DC area, and on the West Coast near Seattle, Washington.

www.PolArcticLLC.com

Thank you!
Quyana!
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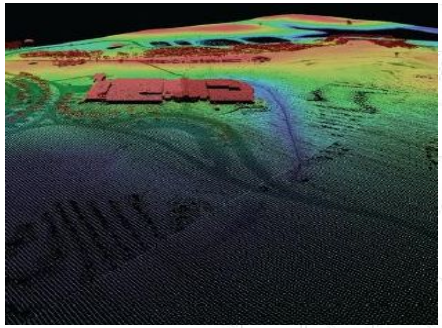
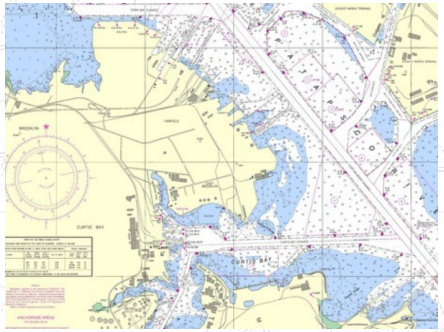
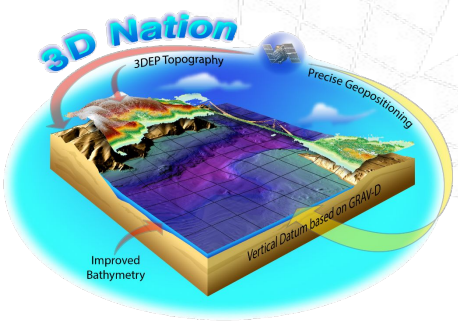
3D Nation Study Update

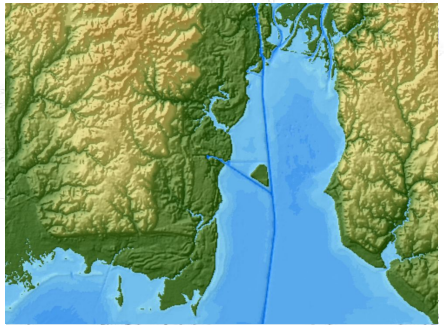
Sue Hoegberg – Dewberry

3D Nation Elevation Requirements and Benefits Study









Study Leads

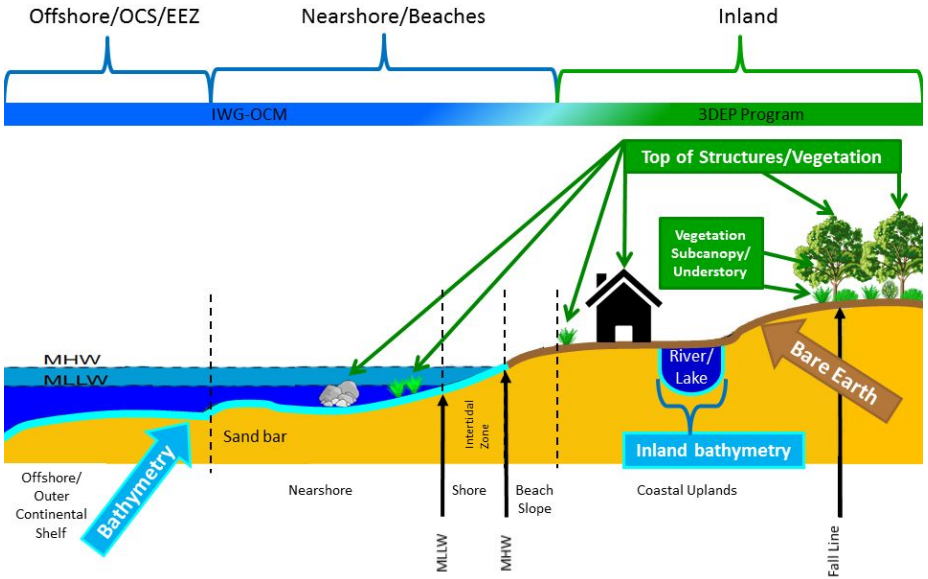
3D Nation - Builds a modern elevation foundation from the peaks of our mountains to the depths of our waters for stronger, more resilient communities and U.S. economy.

Sue Hoegberg, Dewberry

Mapping a 3D Nation: Study Goals

Understand 3D Elevation Data Requirements

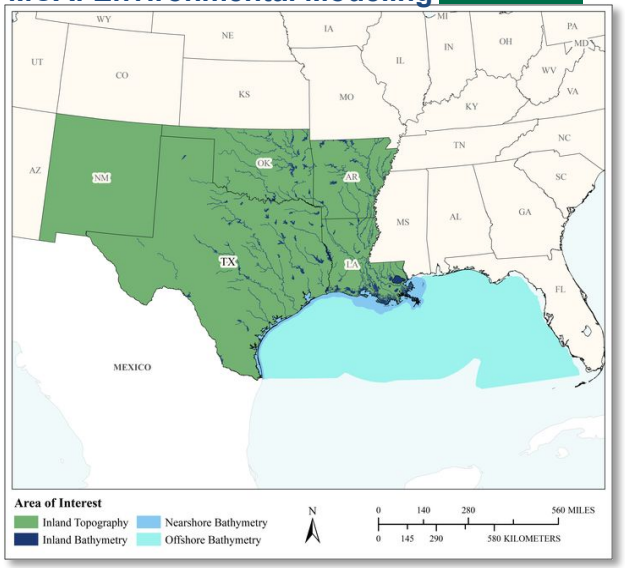
- Understand inland, nearshore, and offshore elevation data requirements and benefits
- Understand how requirements and benefits dovetail in the coastal zone
- Improve understanding of needs to guide planning for NOAA and the next generation of 3DEP for USGS after completion of nationwide coverage
- Gather technology-agnostic user information to assess new technologies against requirements and tradeoffs between different approaches



Study Terminology

- 3D elevation data
  - **Topographic** – precise 3D measurements of the terrestrial terrain
  - **Bathymetric** – 3D measurements of underwater depths and topography
- Mission Critical Activity (MCA)
  - Activity that uses some form of elevation data, including derivative products, to accomplish a Business Use.
  - *Mission Critical* - Indispensable/essential for effective/efficient operations in accomplishing the core mission of the organization.
- Business Use (BU)
  - Ultimate use of services/products from the MCA to accomplish an organized mission.

MCA: Environmental Modeling



Examples

BU Flood Risk Management

MCA dam break modeling & inundation mapping

BU Marine and Riverine Navigation & Safety

MCA commercial shipping

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What we asked about

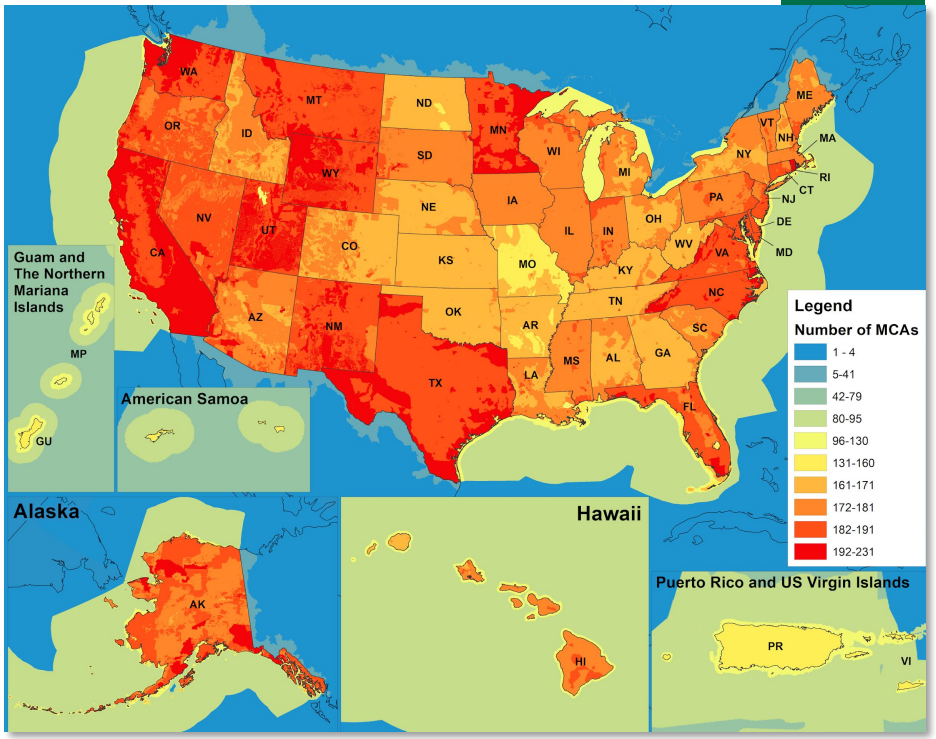
3D Elevation Data Needs

- Geographic extent of MCA
- Characteristics of 3D elevation data needed to perform the MCA
  - Quality Level/IHO Order
  - Update frequency
  - Acceptable error (Horizontal & Vertical)
  - Beach profile
  - Cross sections/transects
  - Hydrologic processing
  - Tide correction
  - Seamlessness
  - Data products
  - Integration with other datasets
- Benefits of having 3D elevation data
  - Operational Benefits - Time or cost savings, mission compliance
  - Customer Service Benefits - Products or services, response or timeliness, customer experience
  - Societal Benefits (not quantified) - Education or outreach, environmental, public safety, including lives and property

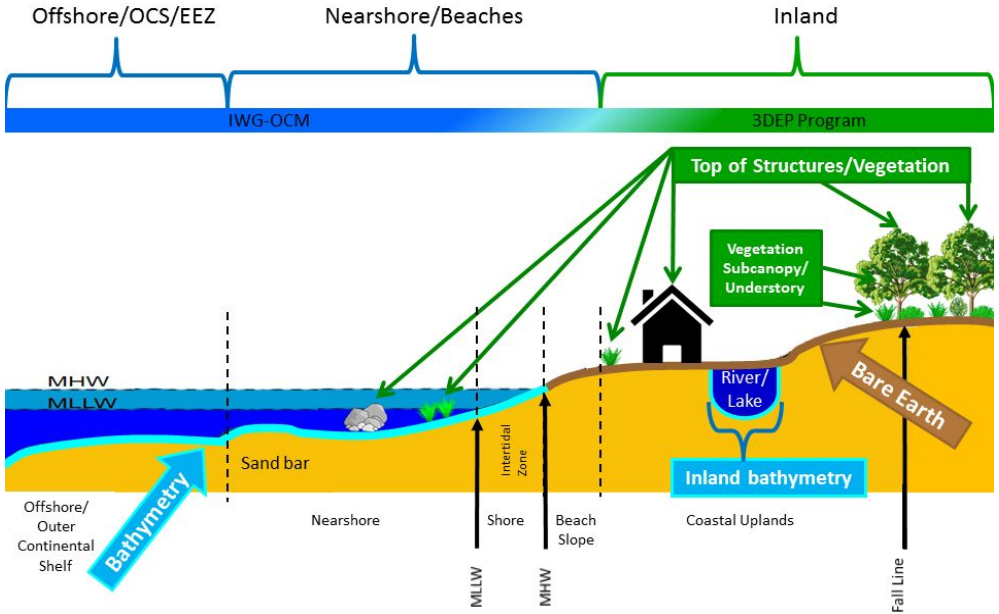
Study Results

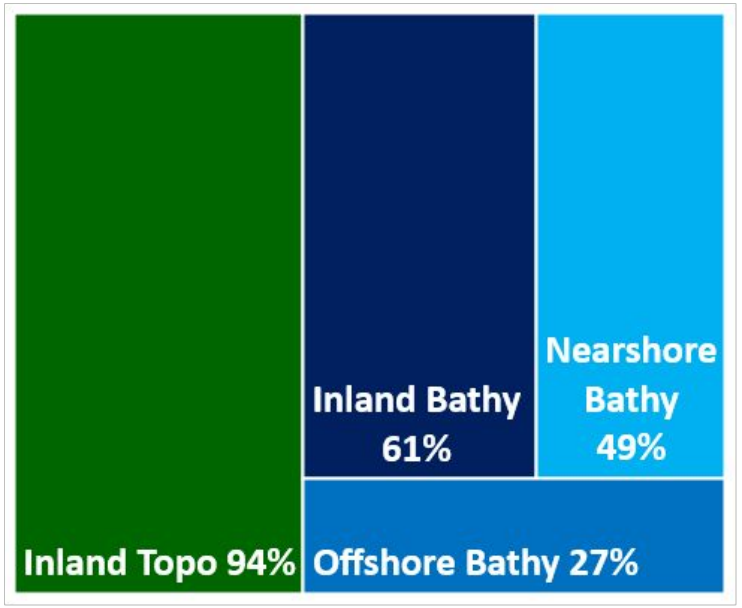
- Respondents
  - 45 Federal agencies
  - 56 State, 99 Local, 8 Tribal governments
  - 10 Non-Governmental Orgs
  - 14 Academics
  - 34 Private companies
- 1350+ Mission Critical Activities binned into 30 different business cases and 4 Geography Types

Number of MCAs - by Area of Interest



Multiple Geographies allowed per MCA





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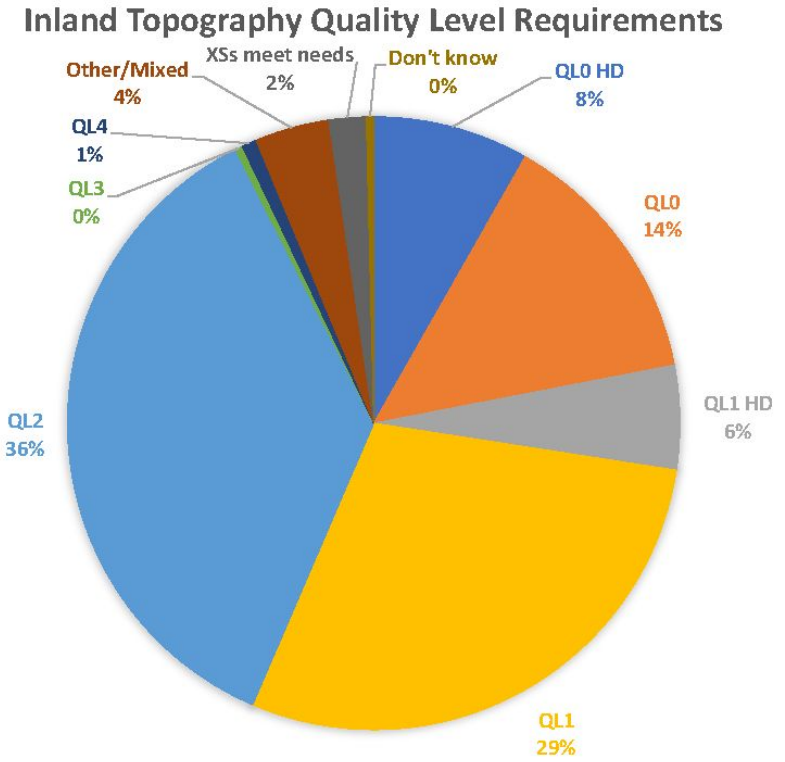
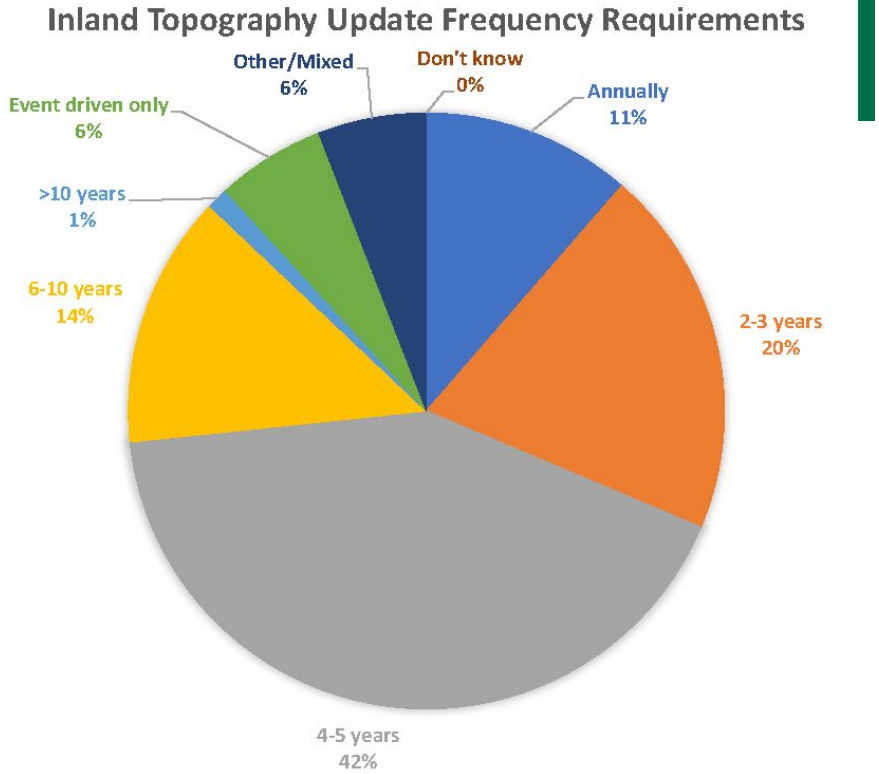
Alaska Inland Topography Requirements





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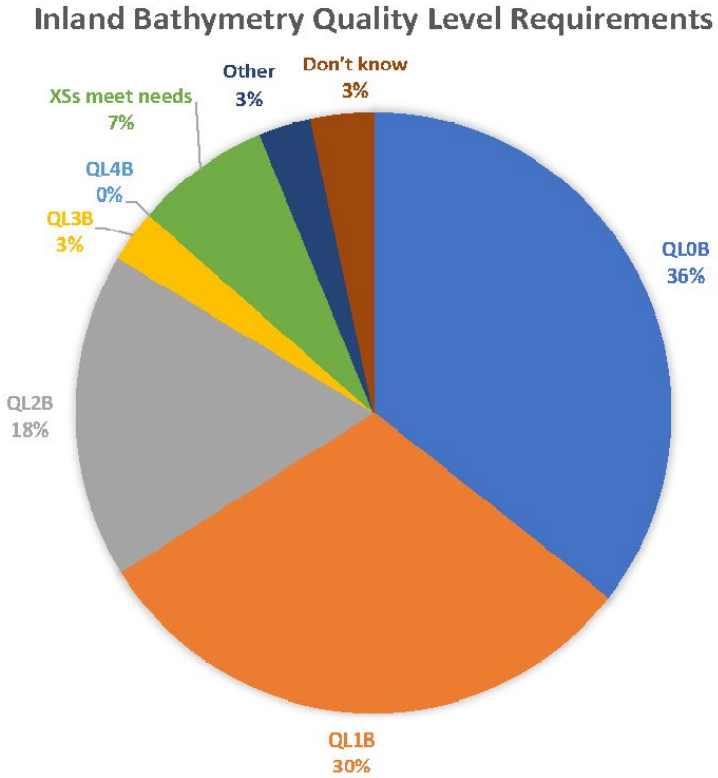
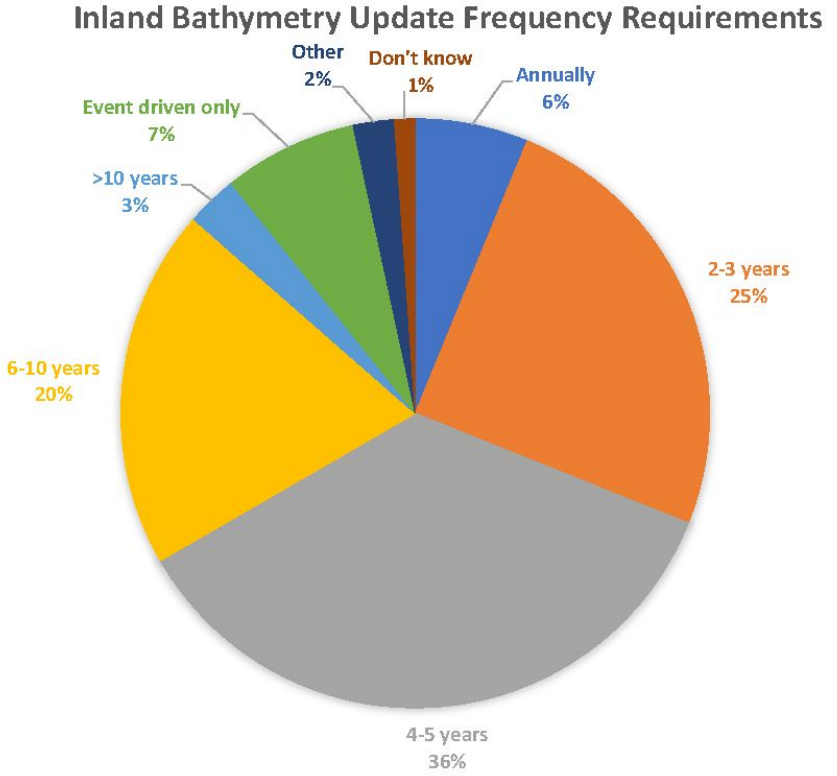
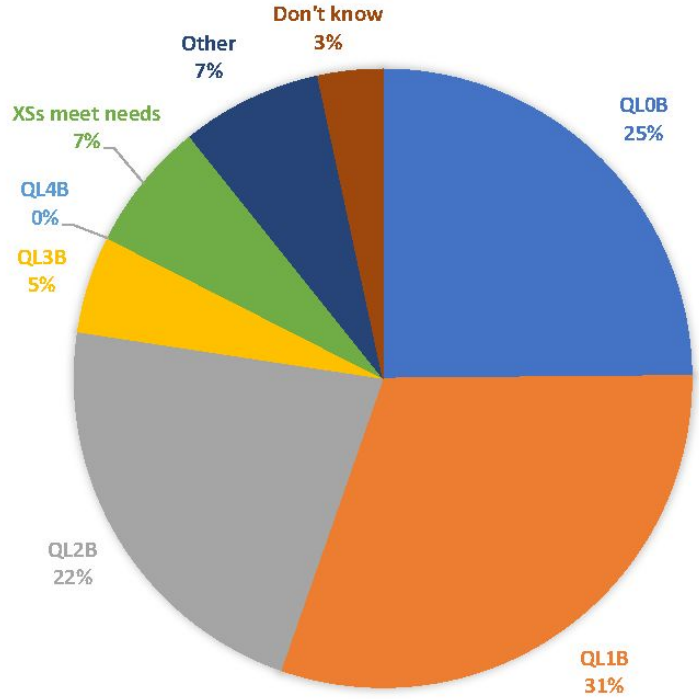
Alaska Inland Bathymetry Requirements



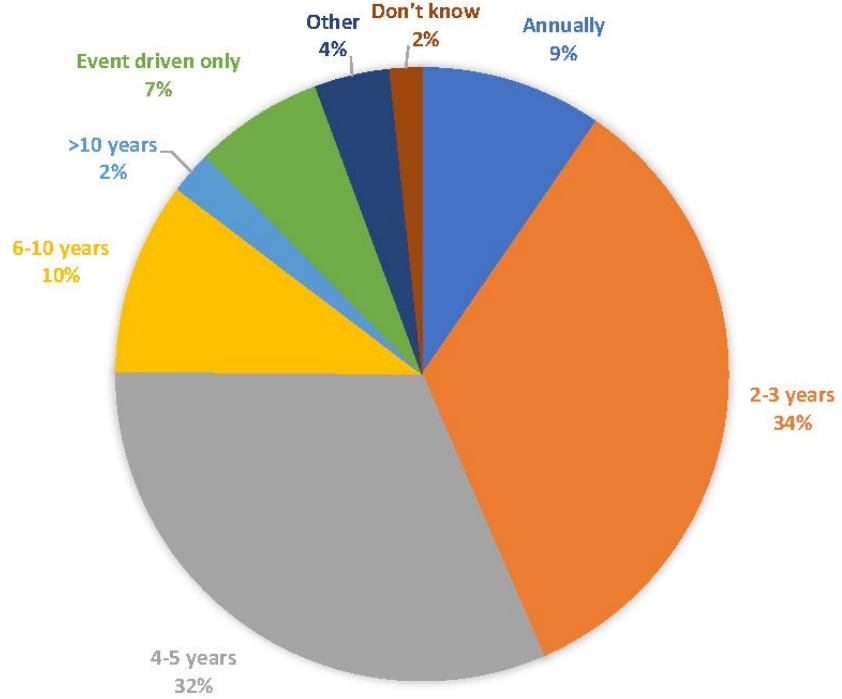


Alaska Nearshore Bathymetry Requirements

Nearshore Bathymetry Quality Level Requirements



Nearshore Bathymetry Update Frequency Requirements



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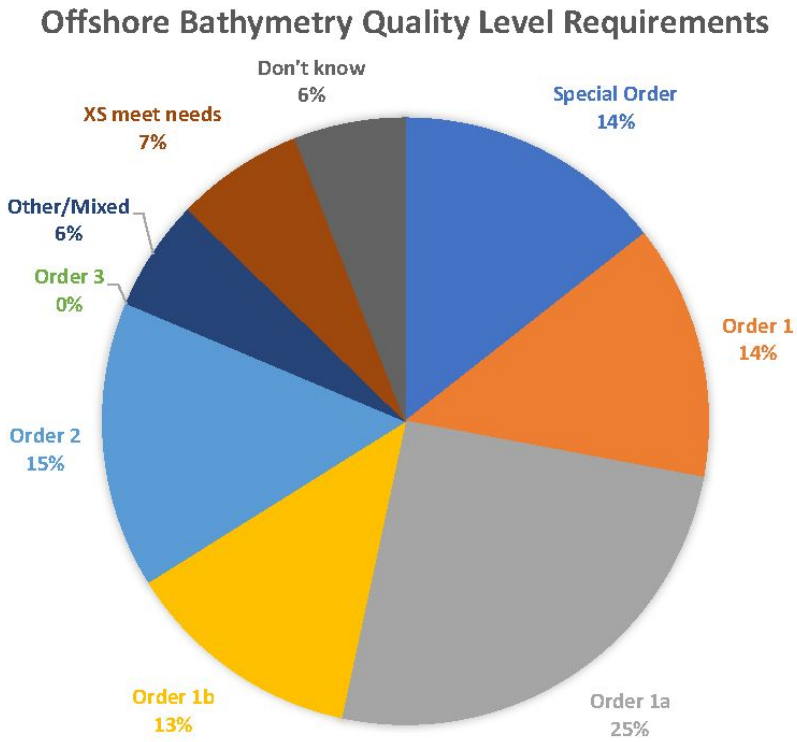
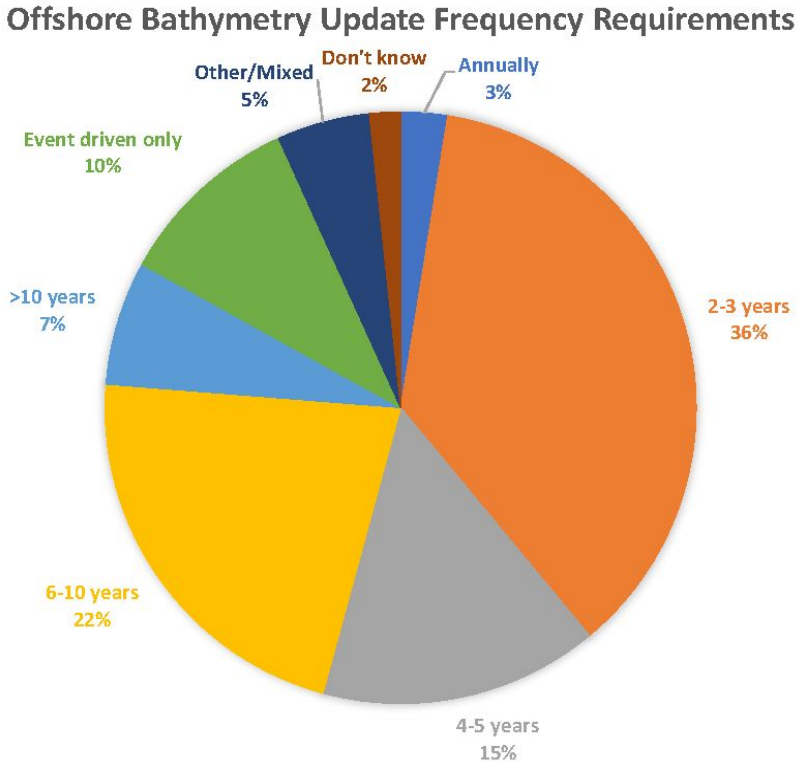
Alaska Offshore Bathymetry Requirements





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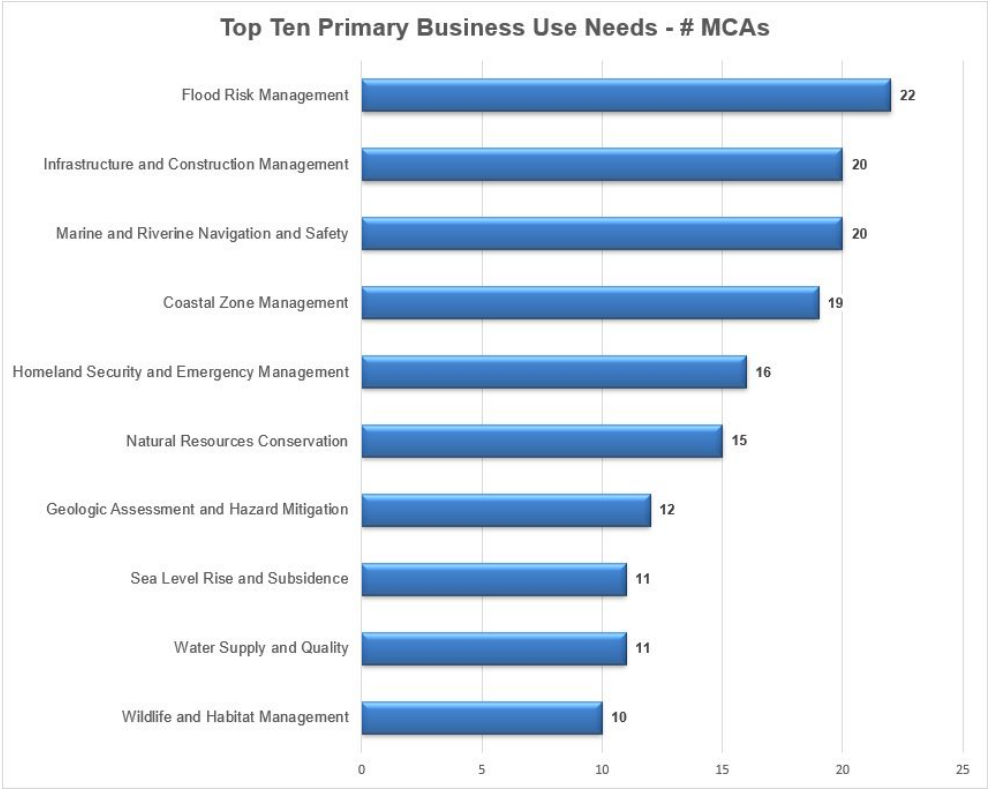
Alaska Top 10 Business Uses



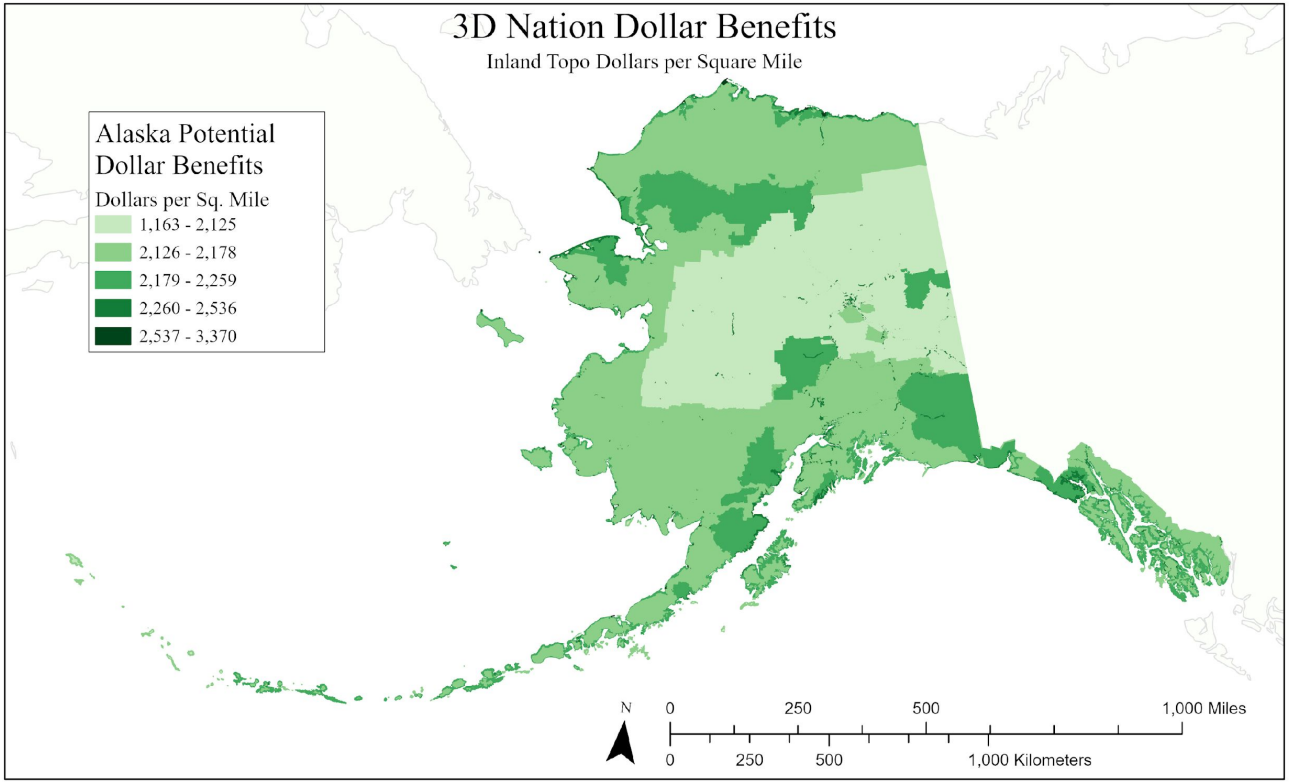
Future Annual Benefits

Annual Dollar Benefits by Organization and Geography Type

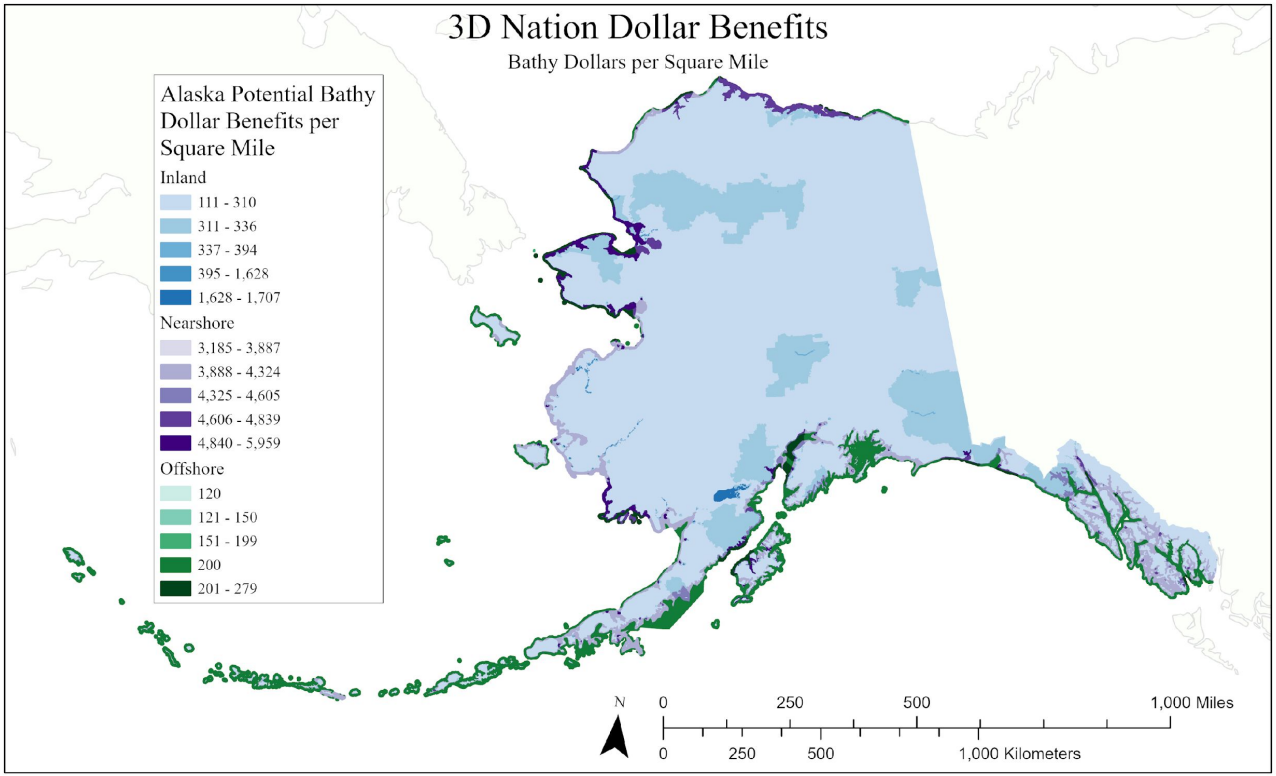
Organization Type	Future Annual Benefits
Federal agencies	$5.84B
State, regional, county, local, and tribal government	$7.68B
Not-for-profit and private entities	$0.04B
Total	**$13.56B**

Geography Type	Future Annual Benefits
Inland topography	$9.99B
Inland bathymetry	$0.86B
Nearshore bathymetry	$2.55B
Offshore bathymetry	$0.16B
Total	**$13.56B**

Alaska Dollar Benefits – Inland Topography



Alaska Dollar Benefits – Bathymetry

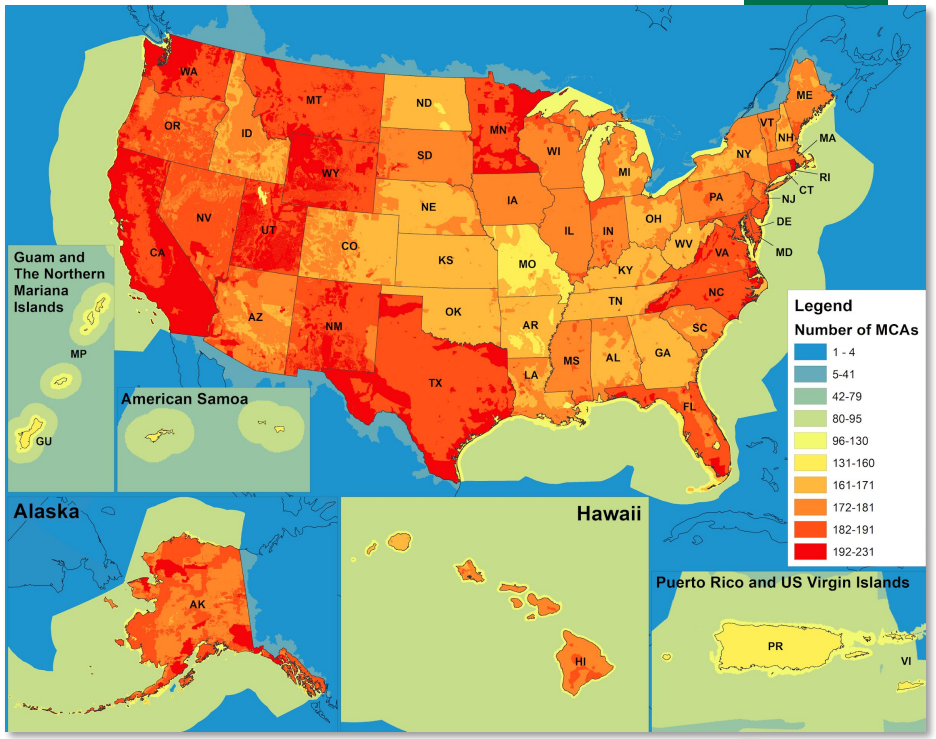


Benefits are Likely Underestimated

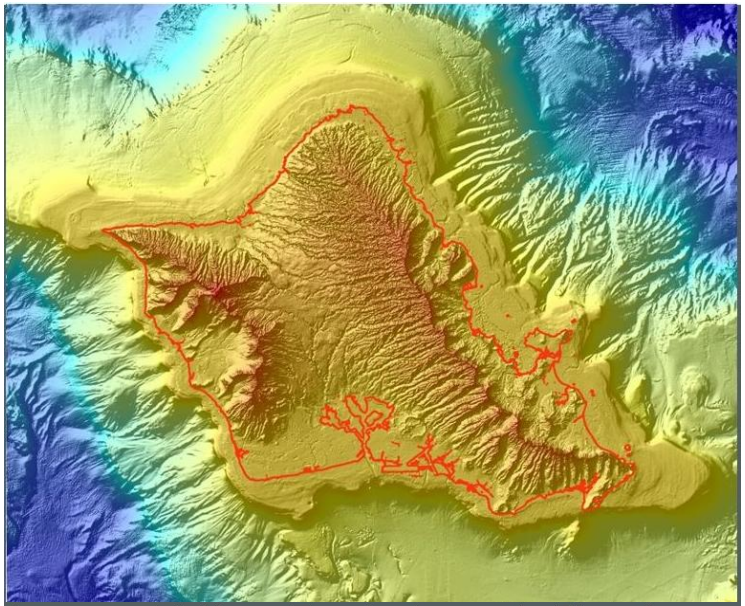
- Respondents were hesitant to estimate benefits from data they do not have yet or use regularly. 3DEP data are better known and understood than bathymetry.
- Missing input from smaller private firms and individual users:
  - Only one small engineering firm responded to the 3D Nation Study, indicating millions of dollars in annual savings from the availability of public domain elevation data. If many of the 24,000 other engineering firms and 16,000 land survey firms had similarly responded, the annual benefits would have been billions of dollars higher.
- Missing future annual dollar benefits from key industries:
  - Commercial timber
  - Precision agriculture
  - Fish and seafood aquaculture
  - Mining
  - Wind energy
  - Oil and gas
  - Motor vehicle manufacturers
  - Shipping, boating, fishing, and cruise lines
  - Port and harbor managers
  - Engineering and surveying
  - Real estate, banking, mortgage, and insurance
  - Telecommunications

Geospatial Benefit Cost Analyses

- All user requirements and benefits are tied to geospatial AOIs
- 1km grid overlaid on land and water areas
- Requirements, benefits, and costs are calculated per grid cell and aggregated to HUC, state, and national scales
- Cost information derived from data provided by the Government
- Reduced Value Multipliers applied
- Scenarios were run for all combinations of QL and update frequency plus some mixed QLs/update frequencies

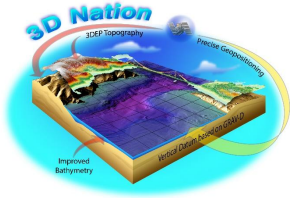


Thank You



Integrated 1-Meter Topobathymetric Elevation Model (TBDEM) for Oahu, Hawaii (USGS CoNED)

Image: Coastal National Elevation Database (CoNED)



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Study Report

https://usgs.gov/3DEP/3DNationStudy

Whole study: shoegberg@dewberry.com

Topography & Inland Bathymetry: 3dep@usgs.gov

Nearshore & Offshore Bathymetry: iwgocm.staff@noaa.gov

What's next?

- **Determine** program direction using study results

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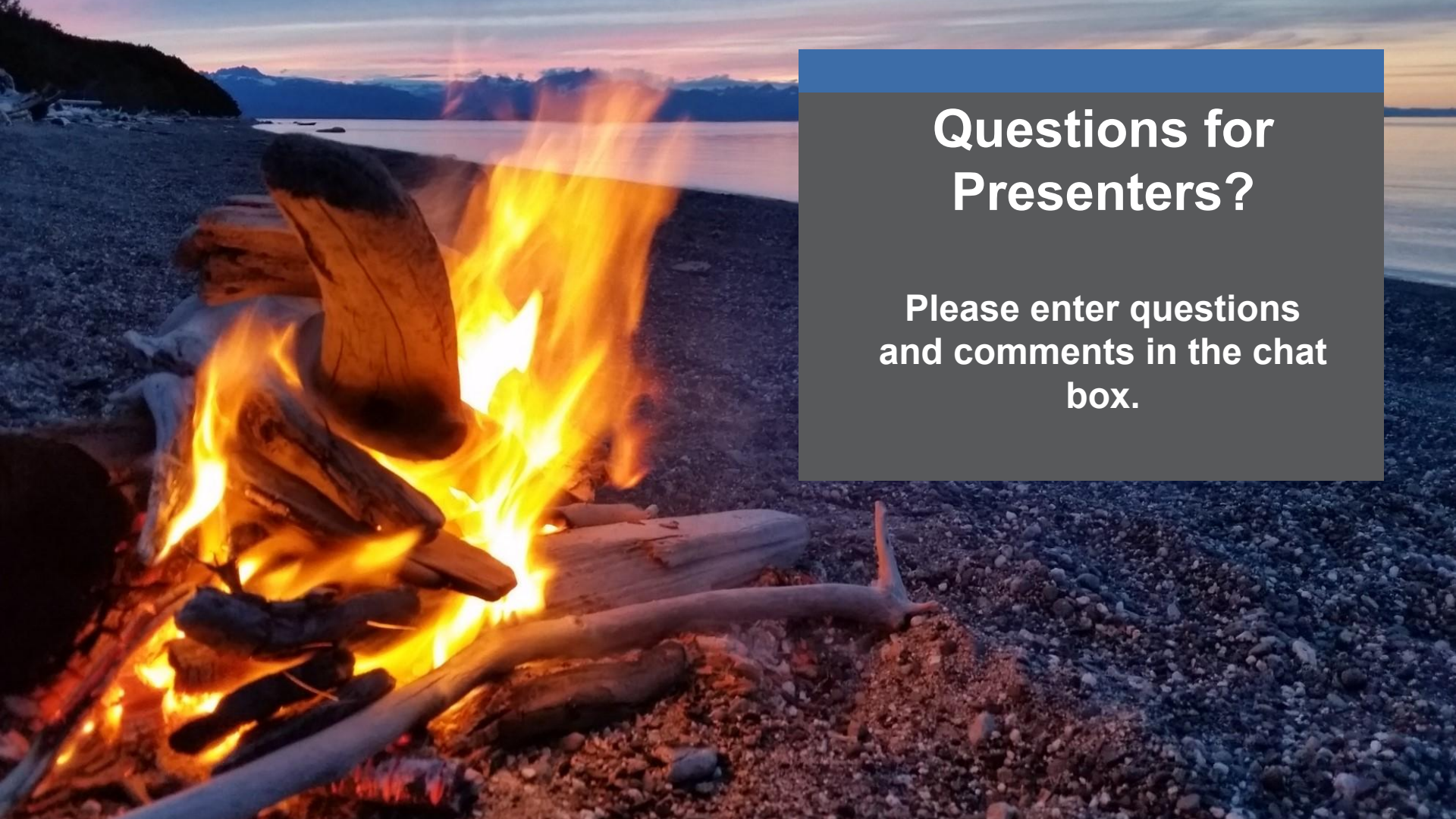

Questions for Presenters?

Please enter questions and comments in the chat box.