

# 21<sup>st</sup> Century Oceanography in the Last Frontier

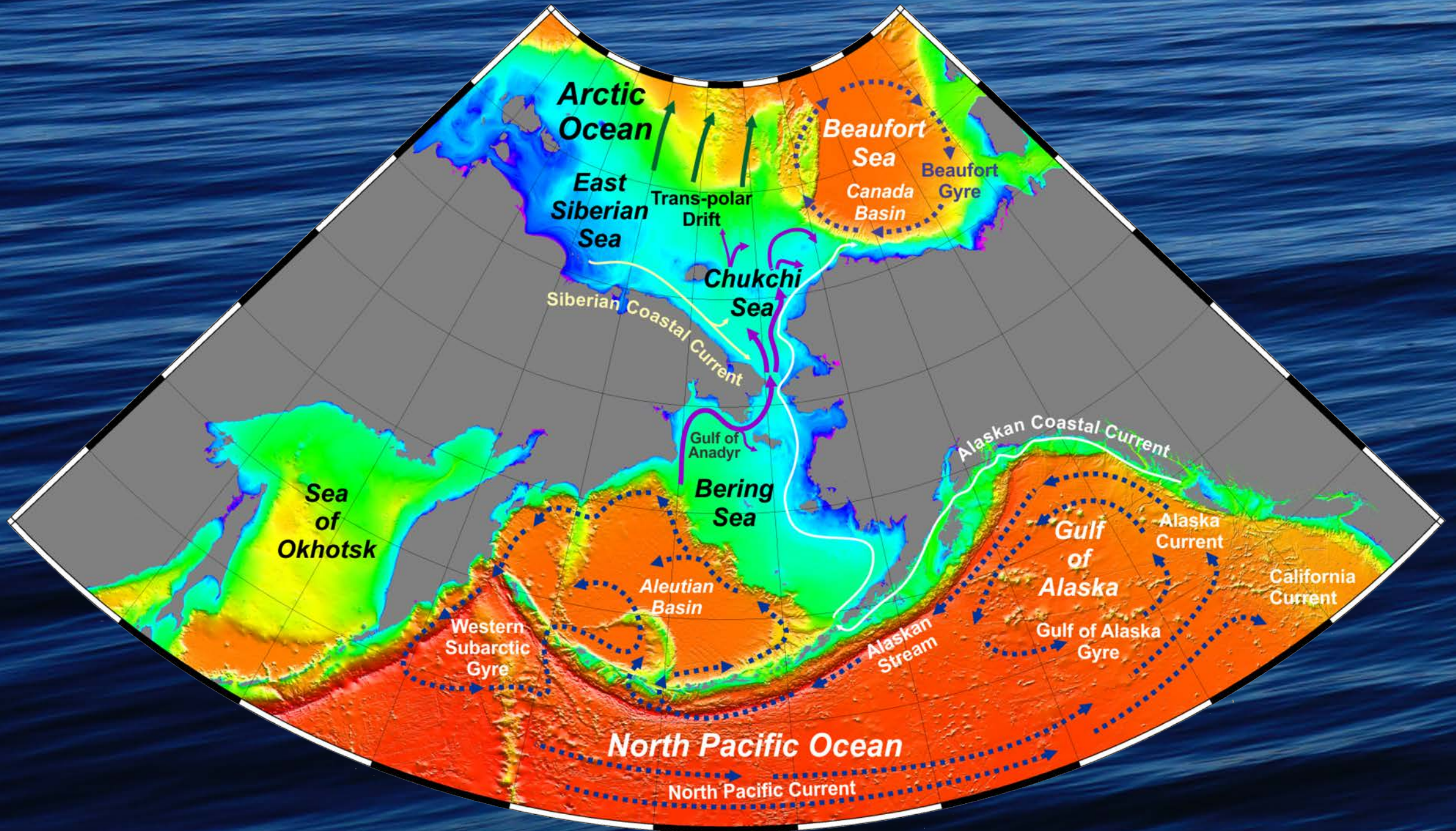


**RVTEC 2019**

**Seth Danielson**

**University of Alaska Fairbanks**





# Alaska region research

- Relevant Scales:
  - Local
  - Regional
  - Global
- Issues relating to:
  - Climate
  - Social Justice
  - Economics
  - Politics & Geopolitics

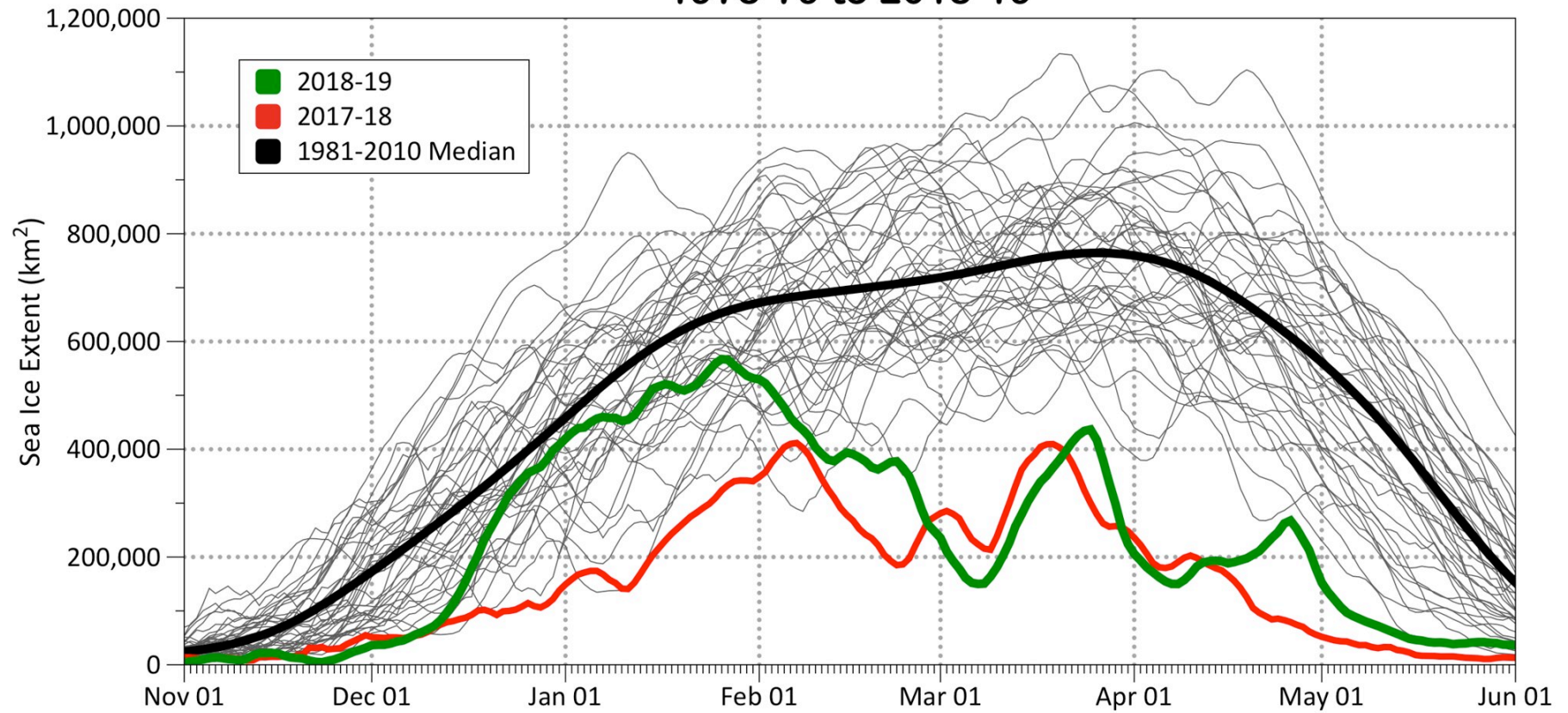


# Ongoing changes affecting extreme storm hazard events

- Rising sea level
- Warming temperatures
- Thawing permafrost
- Coastal Erosion
- Reduced sea ice cover
- Ice run-up on shore
- Increased fetch
- Increased wave heights
- Changing storm frequency
- Changes in wind direction
- Altered hydrological cycles



# Bering Sea Daily Ice Extent 1978-79 to 2018-19



Data source: NSIDC Sea Ice Index, Version 3  
Graphic by Rick Thoman, @AlaskaWx  
Updated through June 01, 2019

# Views from Little Diomedede Island

Mid-Late May 1993



Photo: G. Sheffield

Views  
from  
Little  
Diomedede  
Island

7 December 2017



Photo: O. Ahkinga

# Views from Little Diomedede Island

20 January 2018



Photo: O. Ahkinga



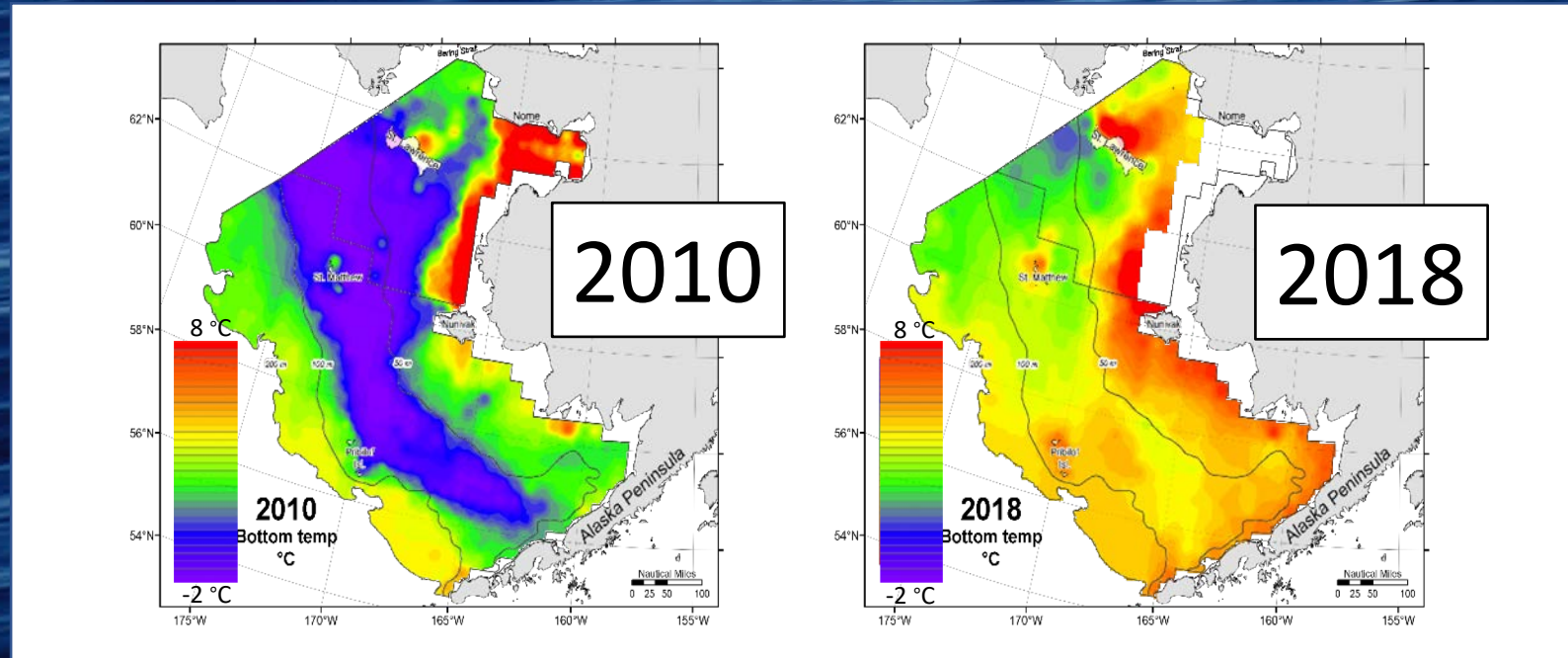
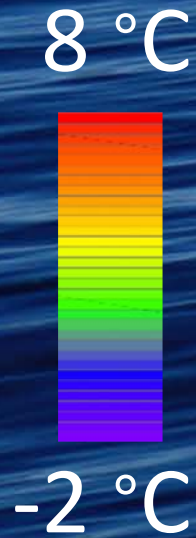
**20 February 2018**

**Views  
from  
Little  
Diomedede  
Island**



**Photo: F. Ozenna**

# Bering Sea Near-Bottom Temperature



## Percent Change from 2010

2017

2018

Arctic Cod

- 88%

-100%

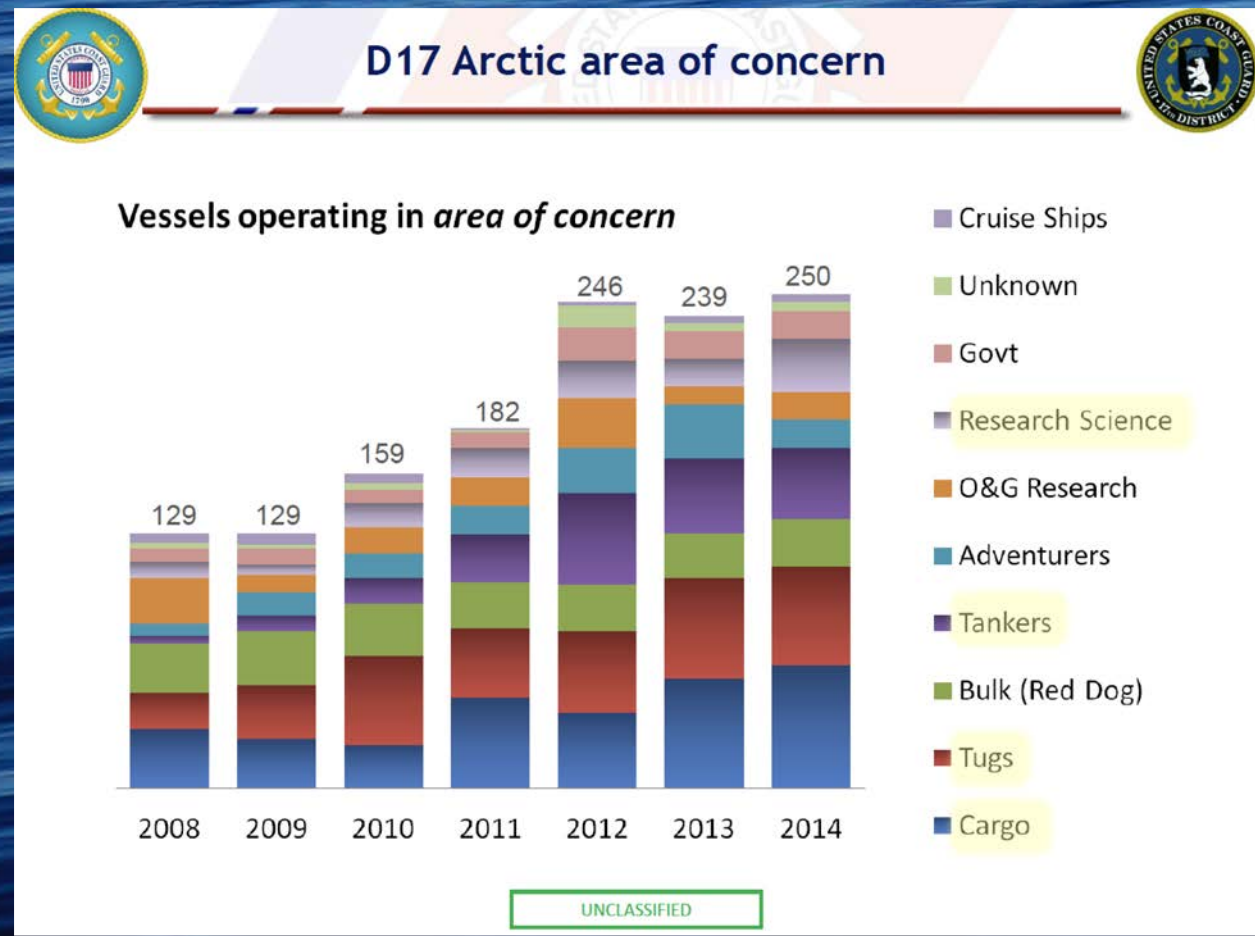
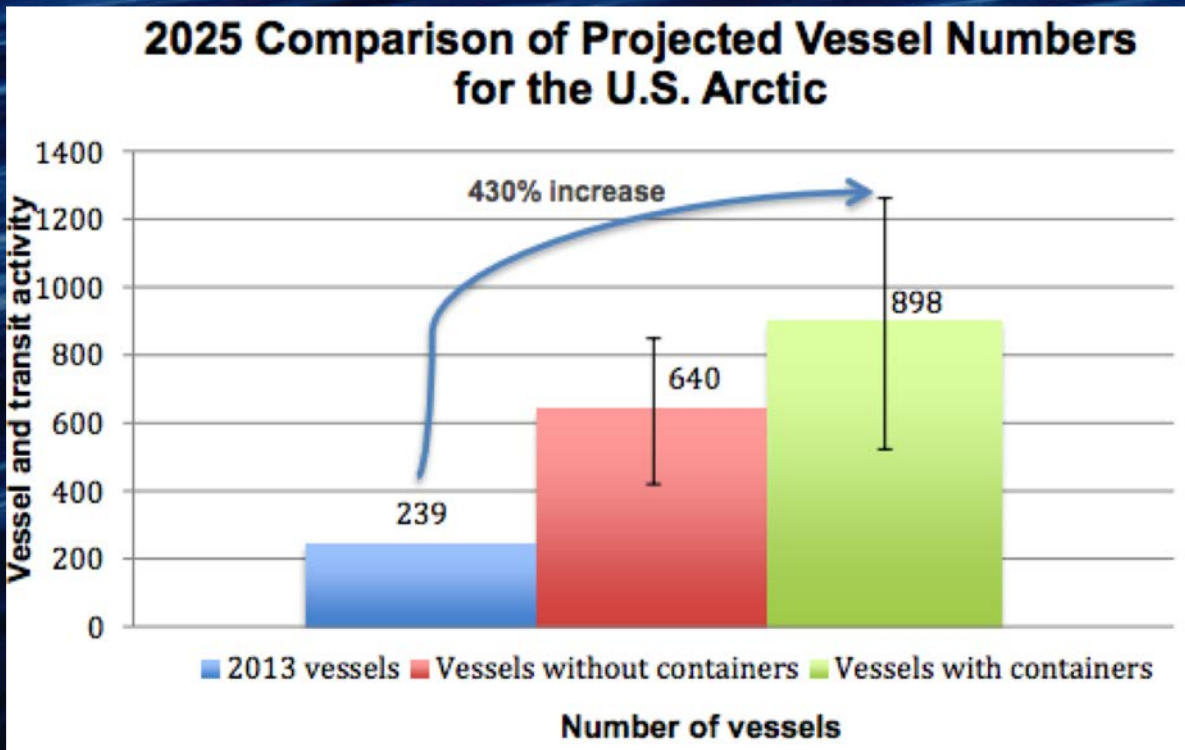
Pacific Cod

+900%

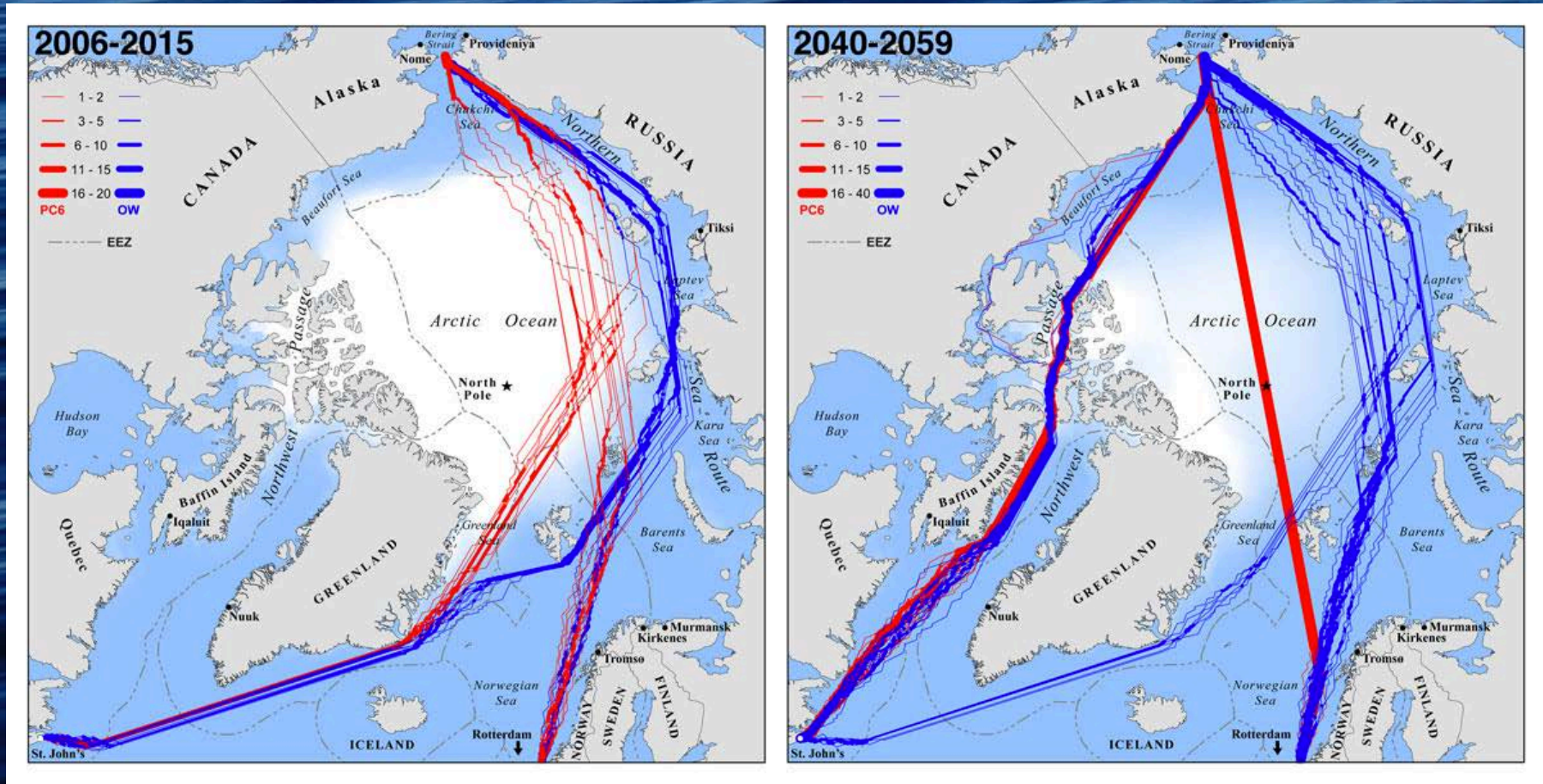
+2000%

[L. Britt &  
NOAA AFSC RACE  
Division, 2018]

# Alaskan Arctic Open Water Season Vessel Activity



# Arctic Shipping



Red: PC6 Ice Strengthened  
Blue: Open Water

[Smith & Stephenson, 2013]

# Arctic Shipping

5 July 2019

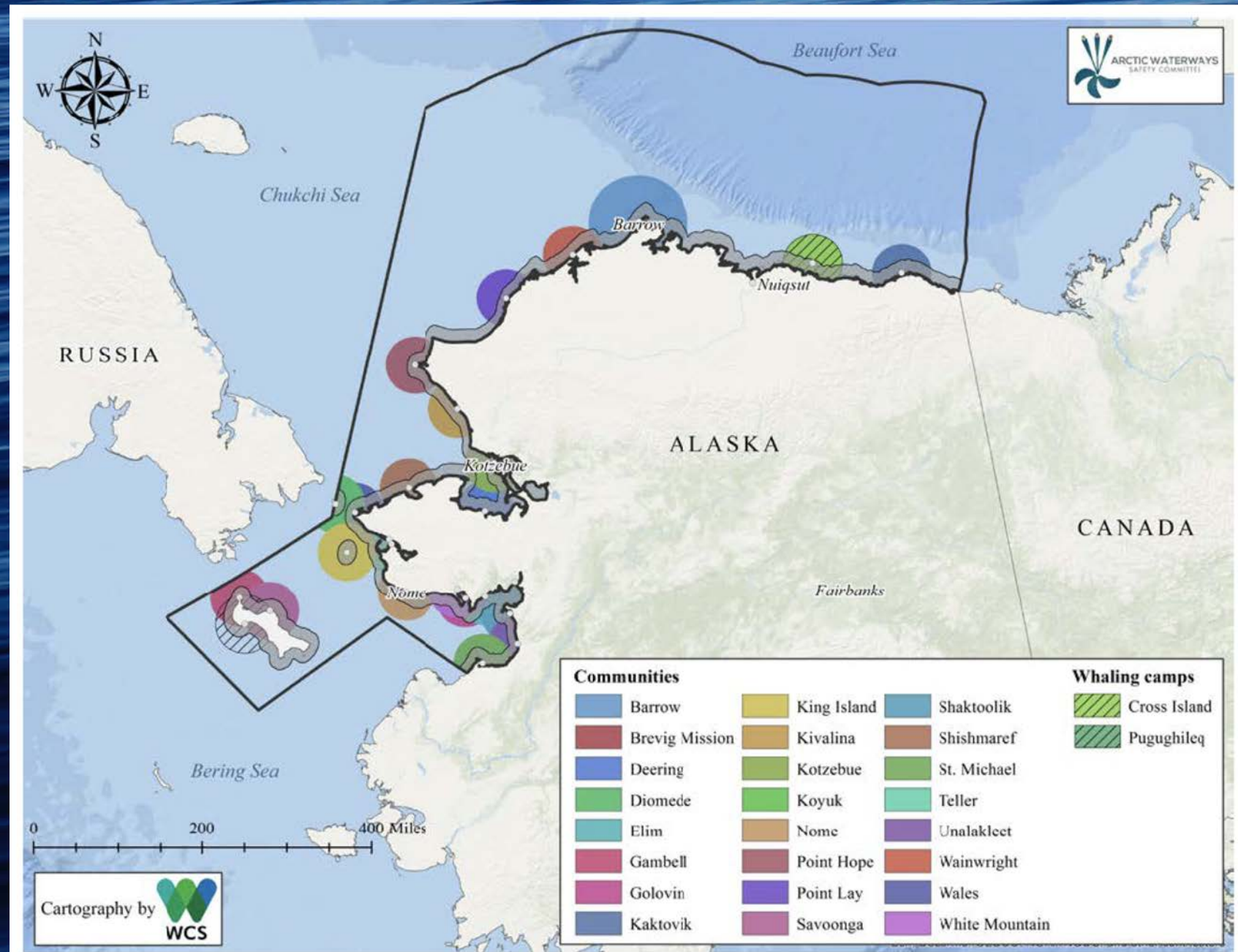


© D. Lobusov  
MarineTraffic.com



4 September 2019

# Avoiding conflict in marine operating areas

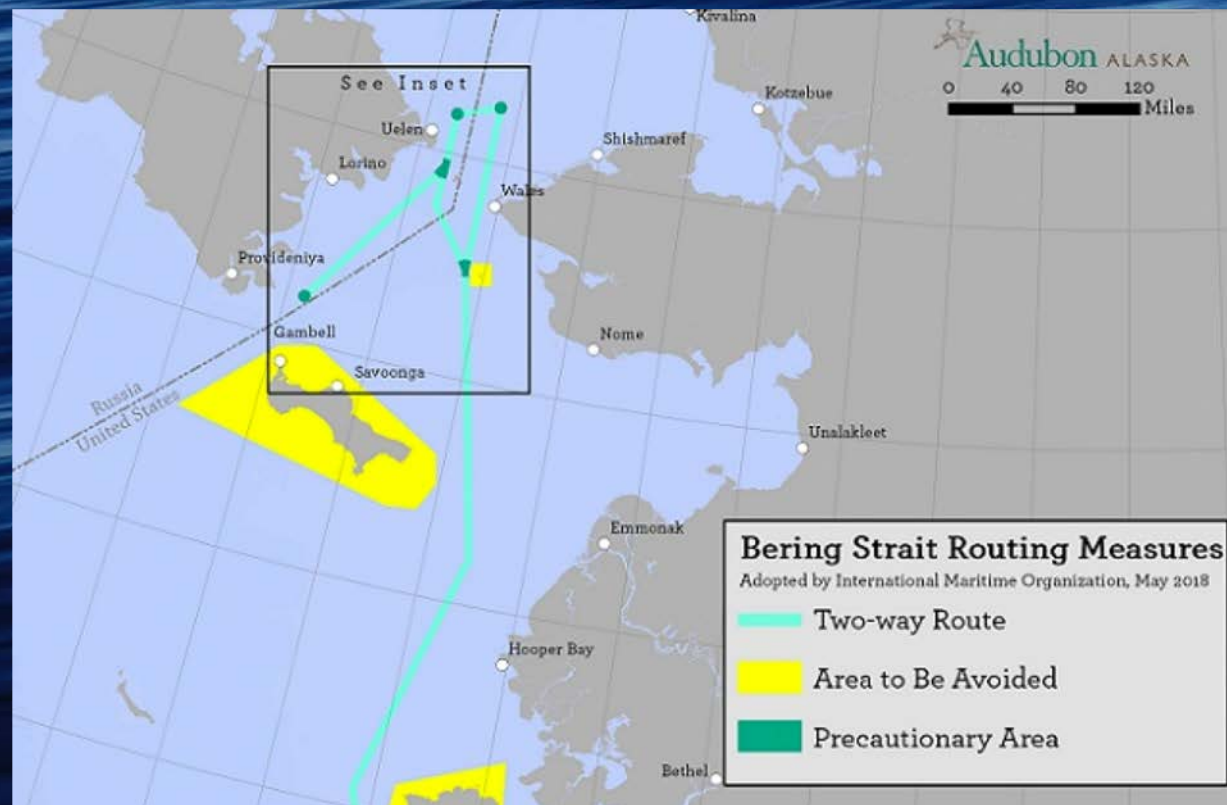


# Community & Environmental Compliance Standard Operating Procedures (CECSOP) for R/V *Sikuliaq* Research Operations

## For interfacing with the Arctic Waterways Safety Committee:

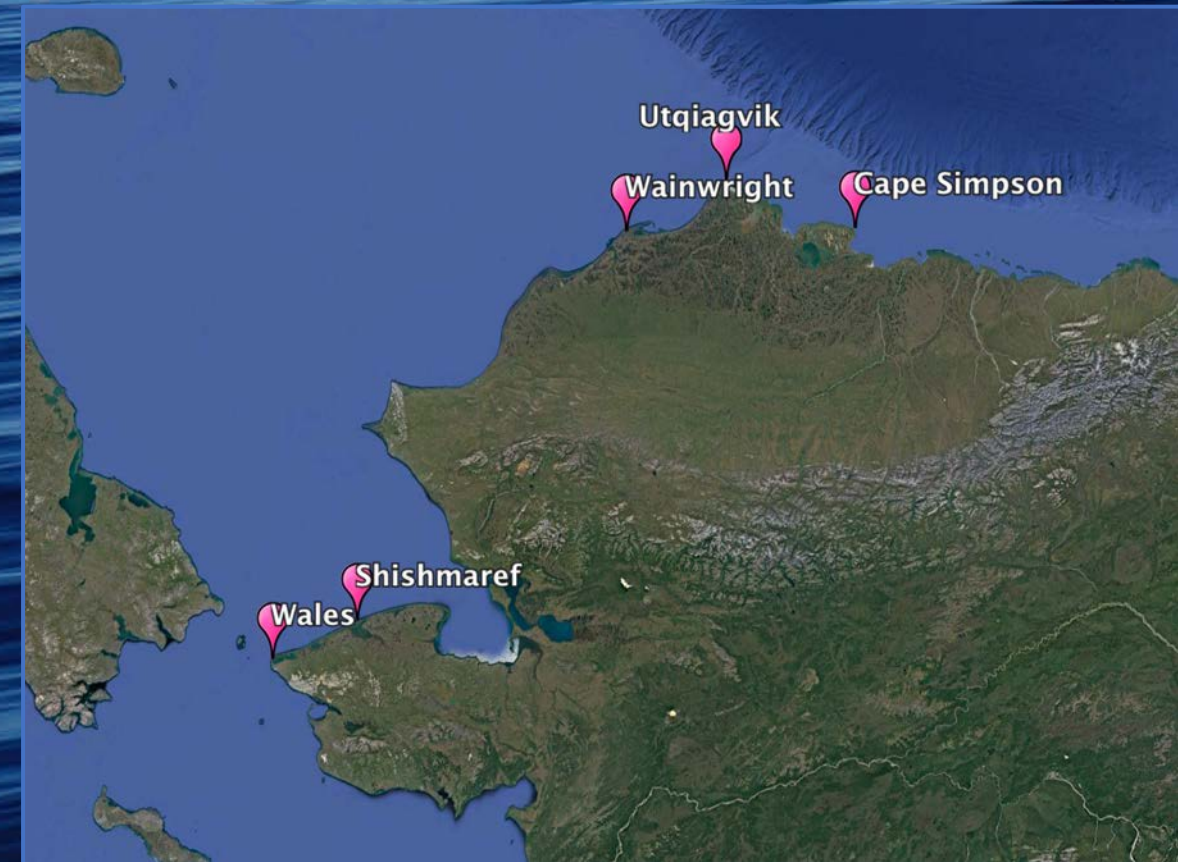
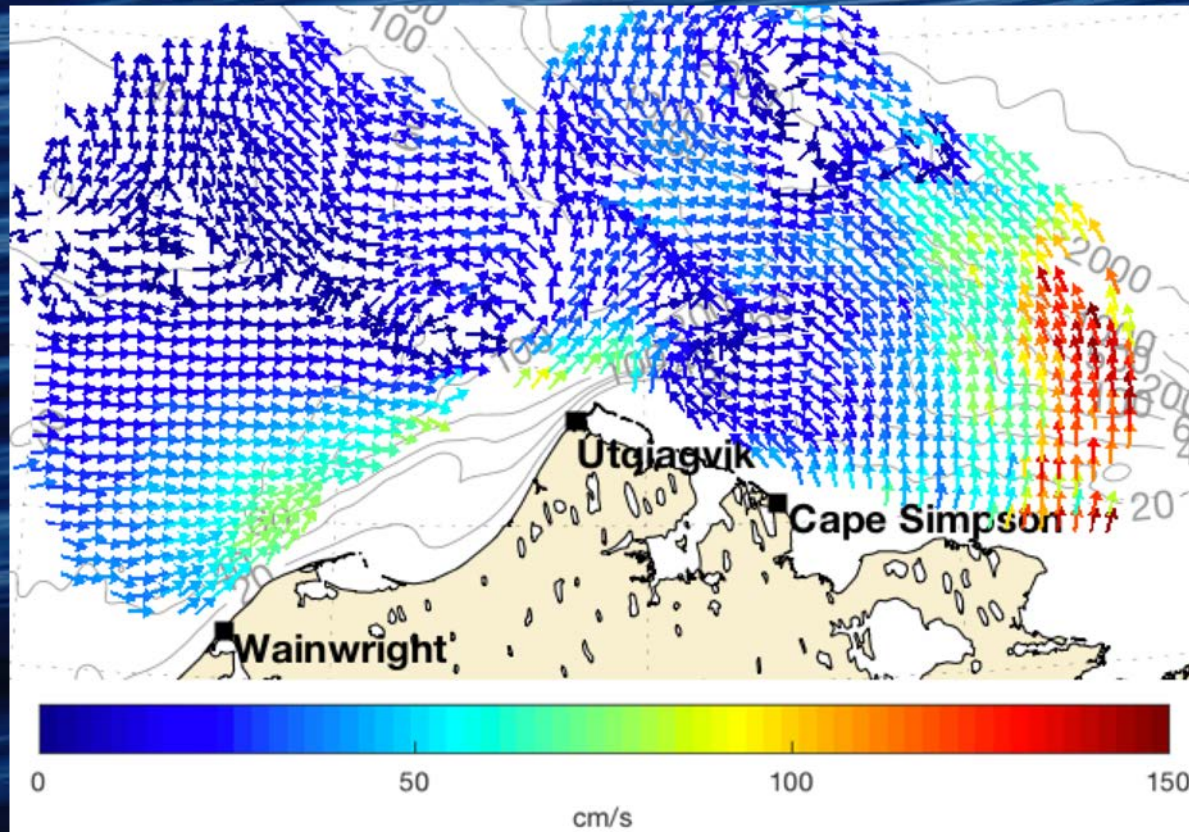
- Alaska Beluga Whale Committee
- Alaska Eskimo Whaling Commission
- Eskimo Walrus Commission
- Alaska Nanuuq Commission
- Ice Seal Committee
- Oil / Gas / Mining
- Tugs (Barges & Cargo)
- Research
- Tourism
- Fishing
- Alaska Marine Pilots
- Municipality of Nome
- Northwest Arctic Borough
- North Slope Borough

# 2018: IMO Authorization for new vessel routing in Bering Strait region





# High Frequency Radar (HFR) Installations



## Real-Time Maps of Ocean Currents

NE Chukchi: Since 2009  
Western Beaufort: Since 2014  
Bering Strait: Since 2019

[www.chukchicurrents.com](http://www.chukchicurrents.com)

[www.straitcurrents.com](http://www.straitcurrents.com)

# Remote Power Module (RPM)

- Insulated instrument shelter
- Trussed aluminum foundation
- Adjustable feet!
- Four wind turbines
- Six solar panels
- Battery Bank
- Monitoring and control electronics
- HughesNet satellite
- WiFi Router



Photo: H. Statscewich

# Cape Simpson: Summer 2014



Photo: H. Statscewich

# Cape Simpson: Summer 2018



Photo: H. Statscewich

# Cape Simpson: Summer 2018



Photo: H. Statscewich

# Operation Swamp Buggy



Photo: H. Statscewich

# Cambridge Bay Nunavut



DIY Boat Lift



Photo: A. Schimnowski

# Bering Strait HFR: Wales

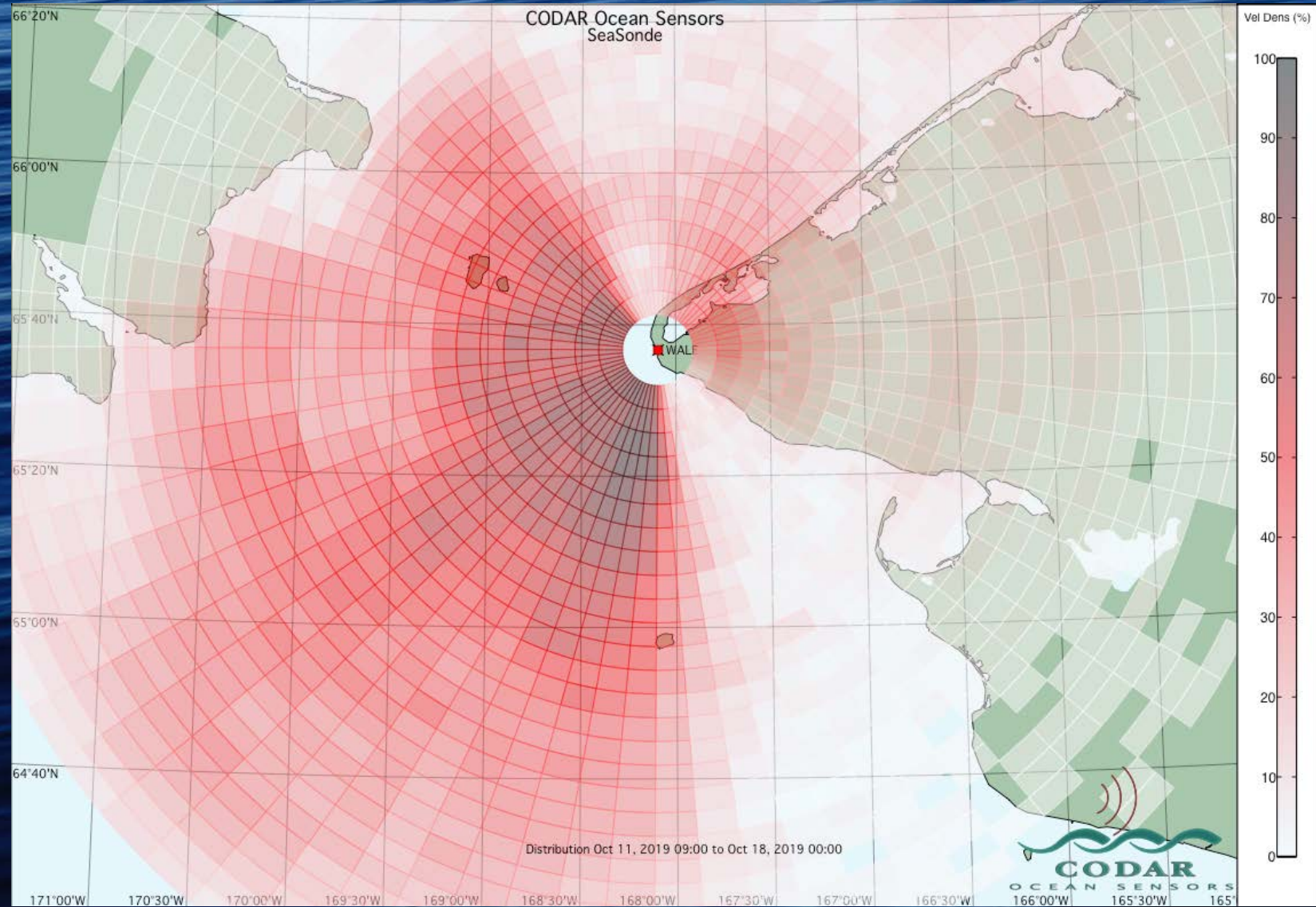
September 2019



Photos: H. Statscewich



# Wales HFR Radial Velocity Coverage Map



When your ocean is not liquid:  
Make your moorings short.



17. 8. 2006



# Mooring 1

Physics &  
Passive Acoustics

Currents  
Waves  
Temperature  
Salinity  
Pressure  
Underwater Sound  
Water Sampler



45 m water depth  
12 m mooring height

# Mooring 2

BioGeoChemical &  
Active Acoustics

Temperature  
Salinity  
Pressure  
Ice Draft  
Dissolved Oxygen  
PAR  
CDOM  
NO<sub>3</sub>  
δ<sup>18</sup>O  
pH  
pCO<sub>2</sub>  
Chl-a Fluorescence  
Optical Backscatter  
Acoustic Backscatter  
Particle Size Spectra  
Sediment Trap

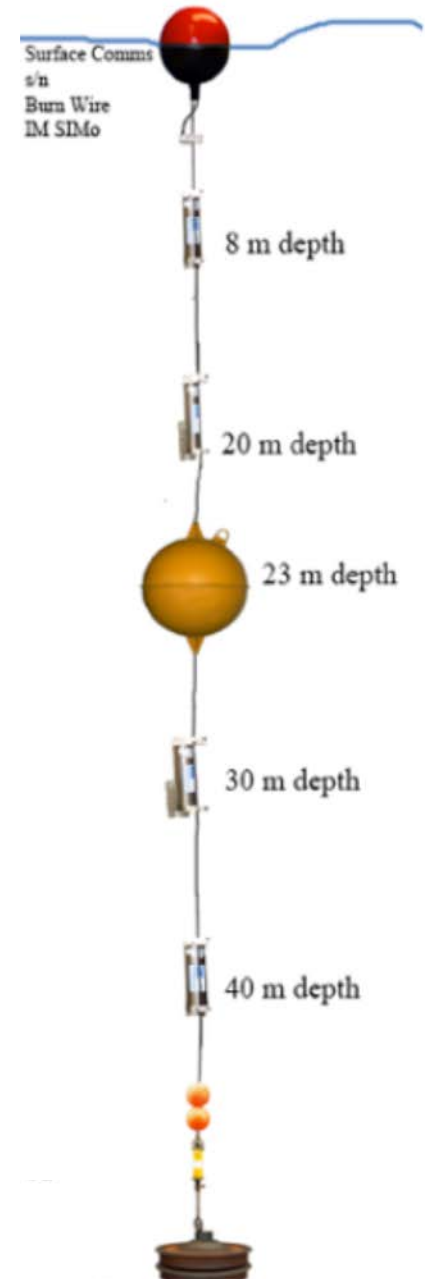


# Mooring 3

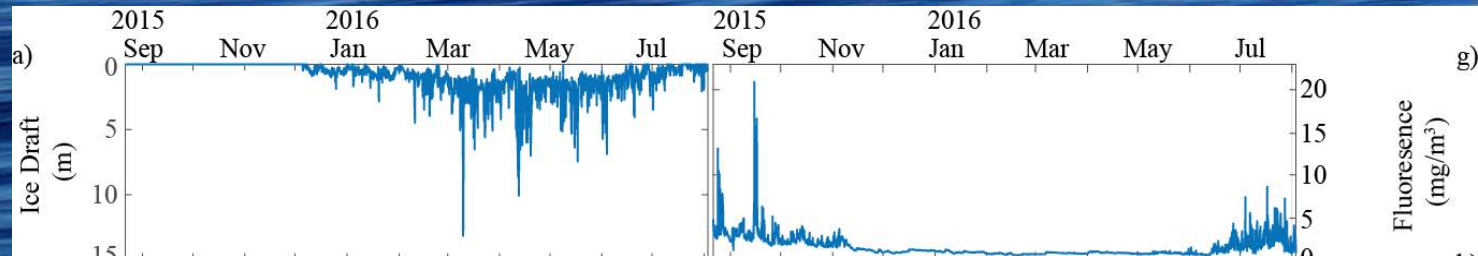
Freeze-Up Buoy

Real-time data  
through freeze-up

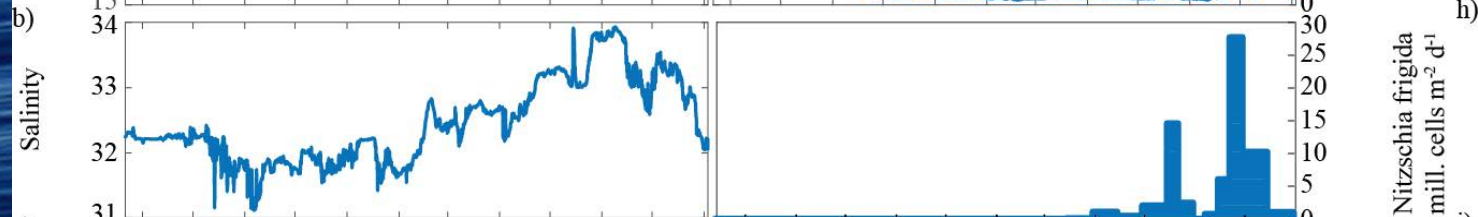
Temperature  
Salinity  
Pressure  
Webcam



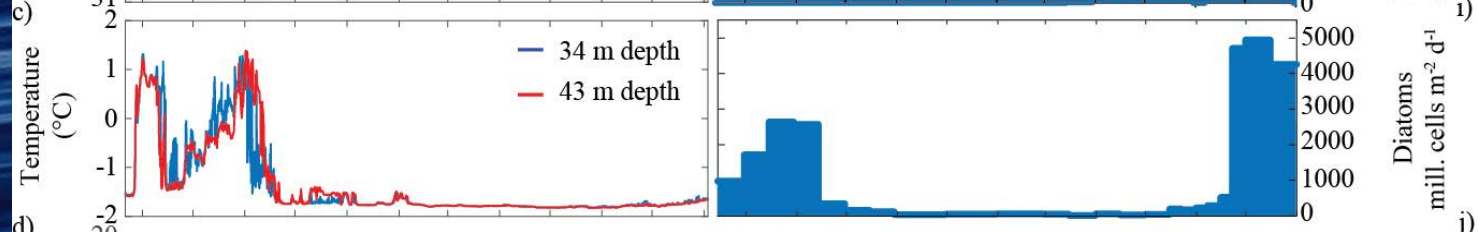
Ice Draft



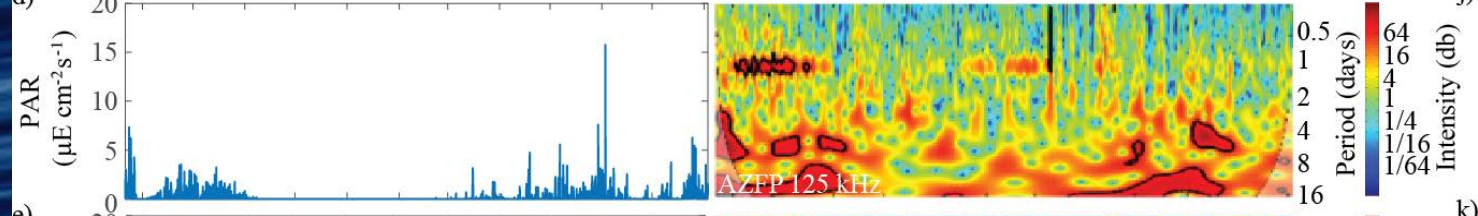
Salinity



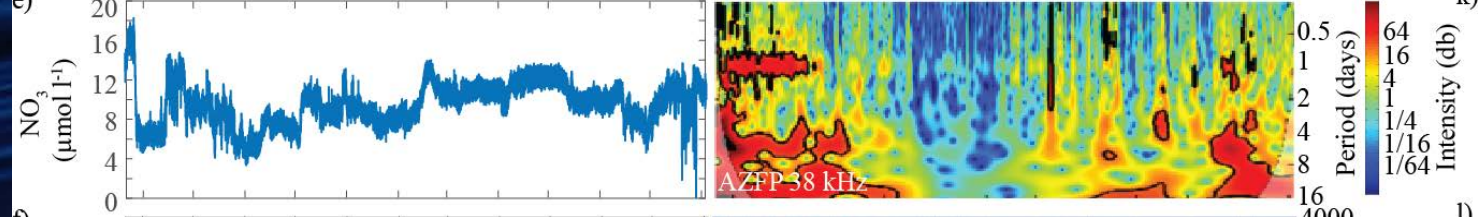
Temperature



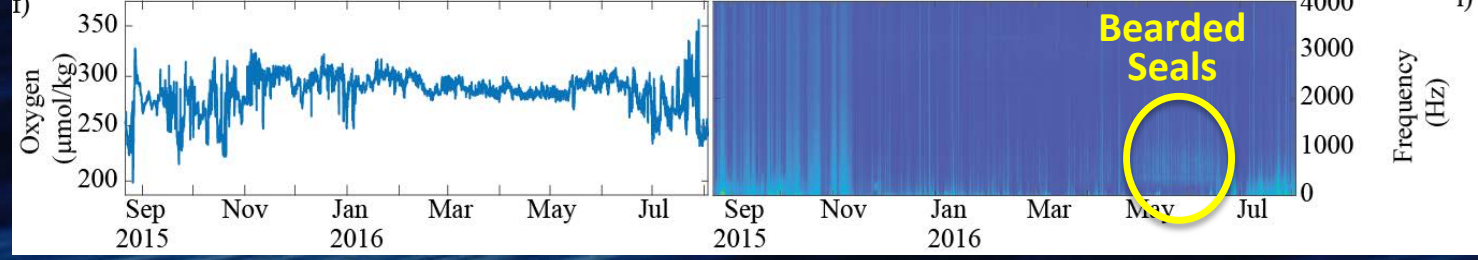
PAR



NO3



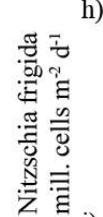
DO



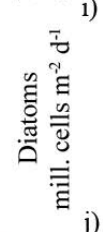
Chlorophyll a



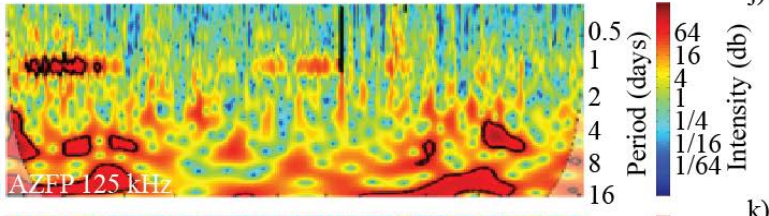
*Nitzschia frigida*



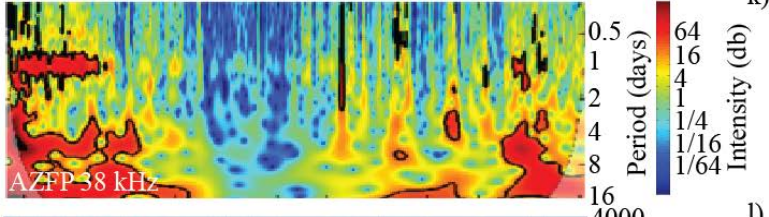
Diatoms



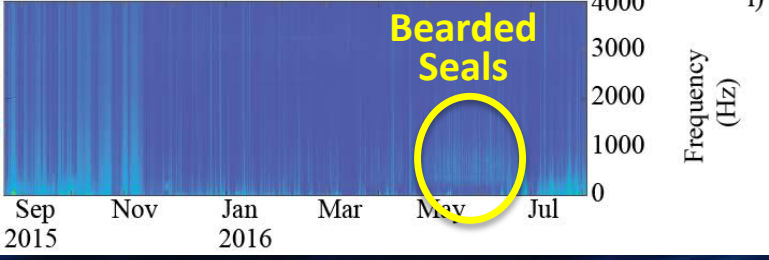
38 KHz  
20 m



125 KHz  
20 m



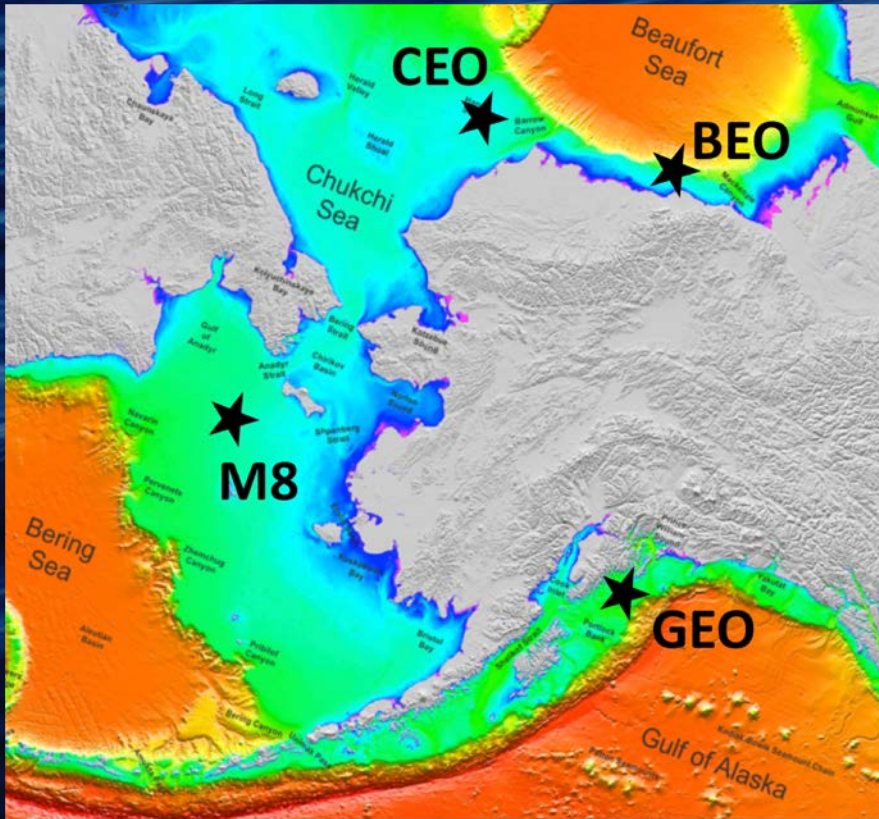
Underwater  
Sound





# Chukchi Ecosystem Observatory

# Alaska Region Marine Ecosystem Mooring Network



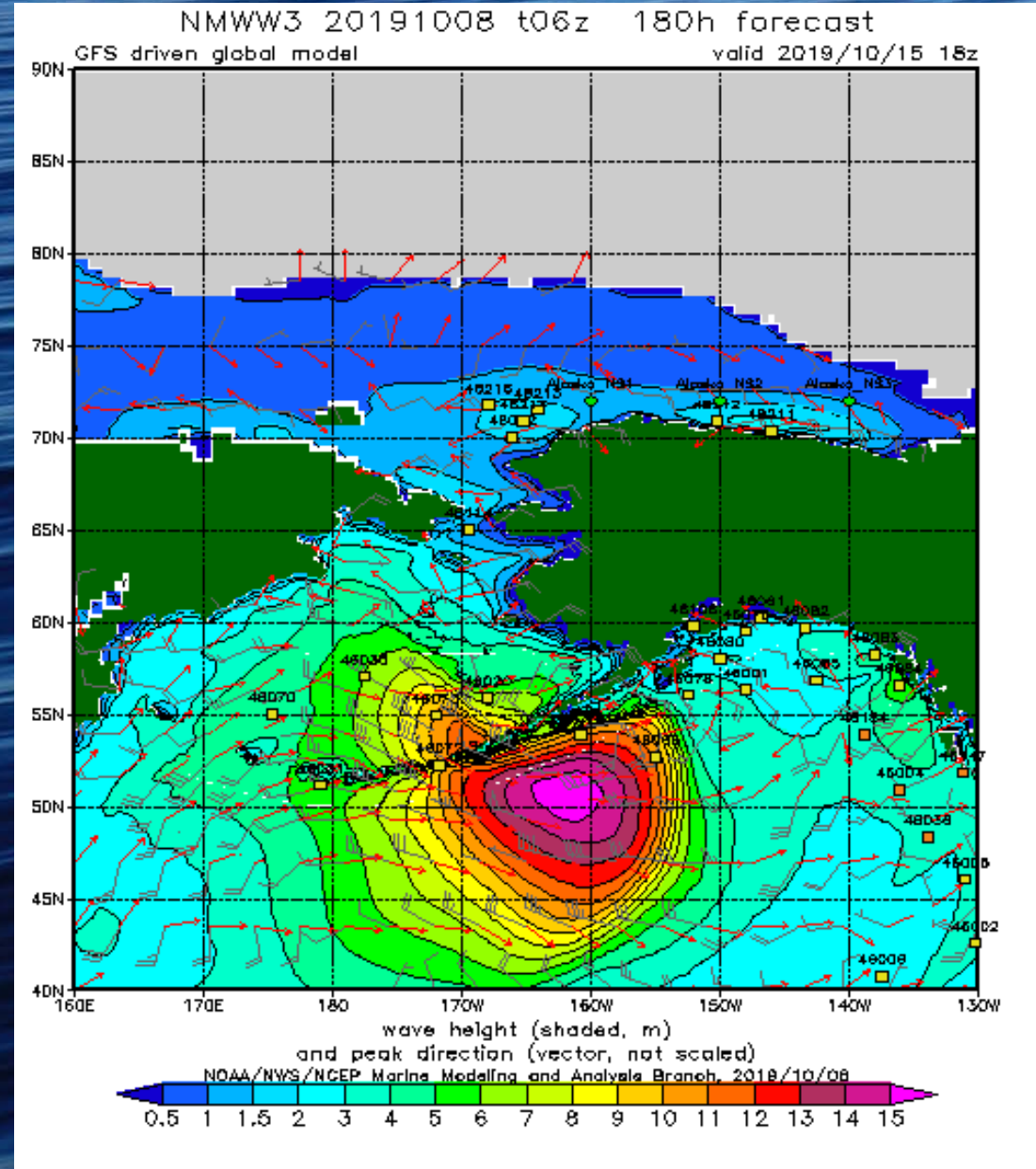
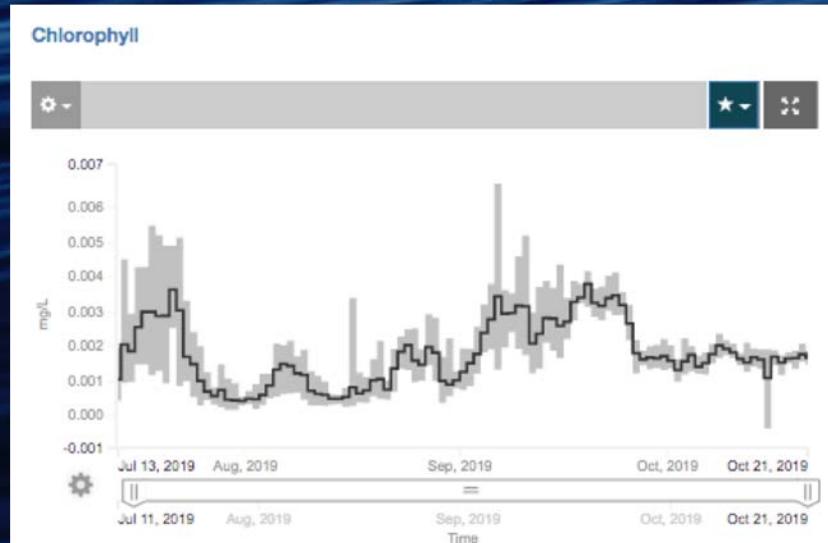
2014: CEO  
2019: GEO

# Gulf of Alaska Ecosystem Observatory (GEO) Mooring Cluster

- McLane Ice-Tethered Profiler
- 2 Surface Buoys w/real-time data
- Active Acoustics
- Passive Acoustics
- Sediment Trap
- Particle Camera
- Chl\_a, CDOM, OBS
- NO<sub>3</sub>, DO, pH, pCO<sub>2</sub>
- Currents
- Wind, Sea Level Pressure, Air Temp

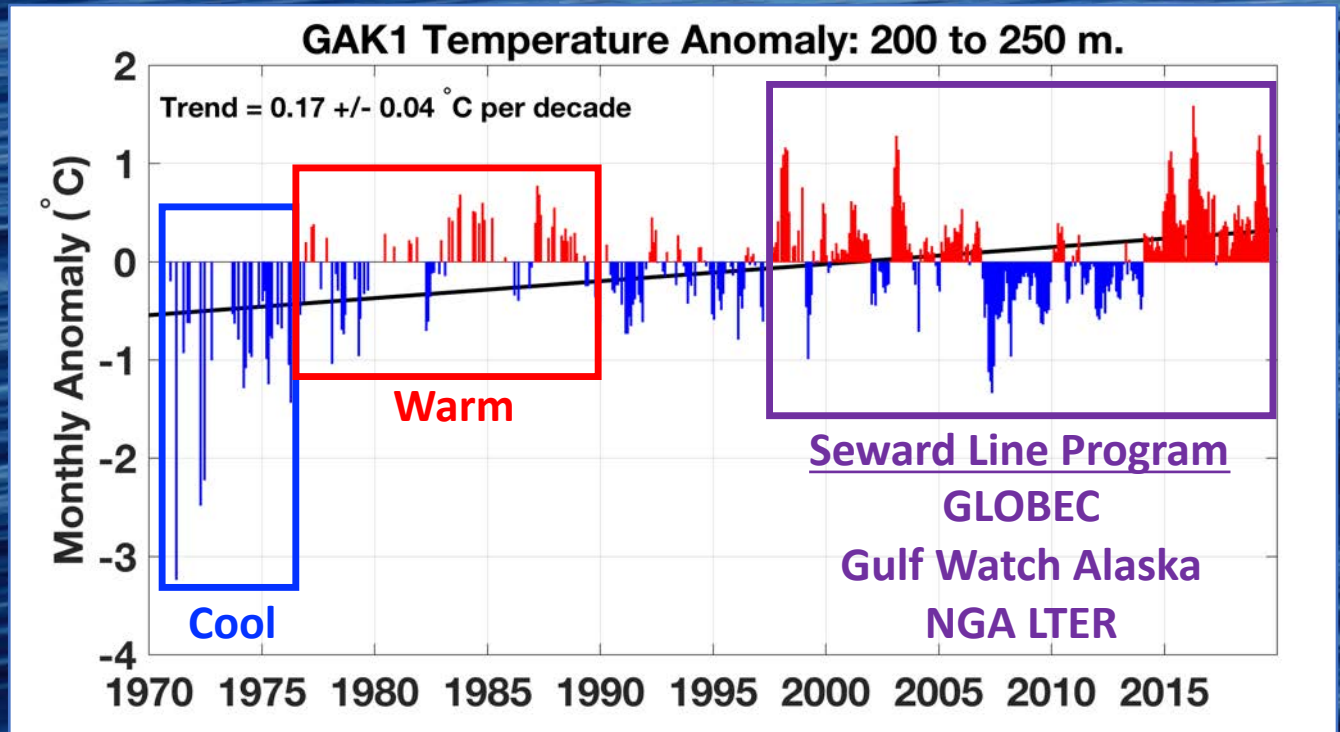
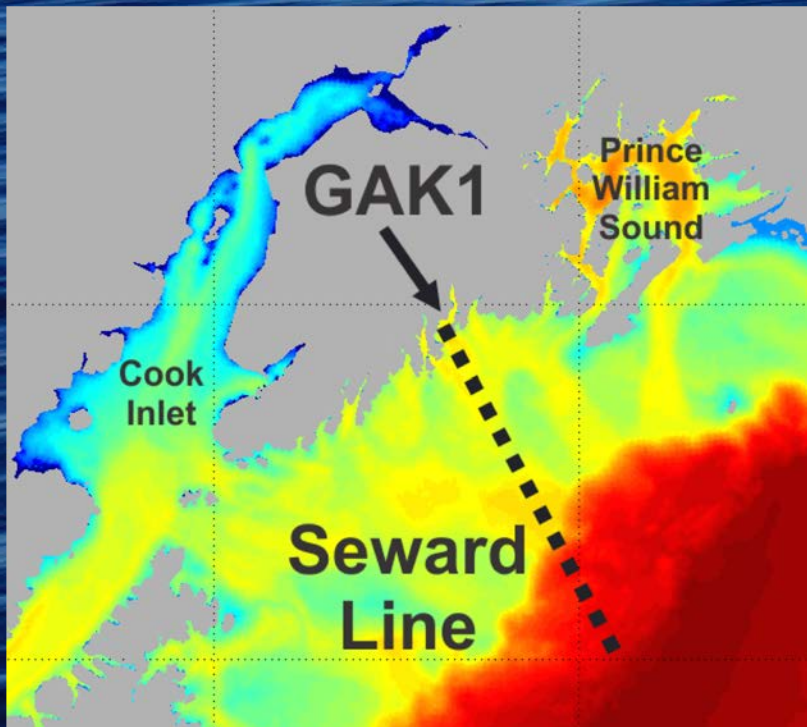


# GEO Data





Taking stock as we enter 2020



Anderson & Piatt 1997

Spring 2015  
Sikuliaq Ice Trials

June 2018  
Chukchi Sea



# Summer 2019 R/V Nanuq









