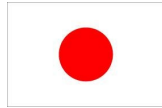


PACIFIC ARCTIC GROUP (PAG)



US Country Report-Research Cruises

Jackie Grebmeier

University of Maryland Center for Environmental Science
Chesapeake Biological Laboratory, Solomons, Maryland, USA

December 5, 2022

Pacific Arctic Group Meeting

Victoria, B.C. Canada

<http://pag.arcticportal.org>

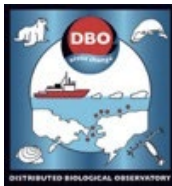
2022 PAG and DBO Cruise Plan Table (12-01-22)

[will build 2023 PAG and DBO table during the meeting]

2022 PAG and DBO Field Season (version 12_1_22): Sampling Contributors. Projects Key: AON=Arctic Observing Network; ArCS II=Arctic Challenge for Sustainability (JAMSTEC=Japan Agency for Marine-Earth Science and Technology); AMOS=Arctic Mobile Observing System; C30=Canada's Three Oceans (DFO=Department of Fisheries and Oceans Canada); DBO=Distributed Biological Observatory; EcoFOCI=Ecosystem & Fisheries Oceanography Coordinated Investigations; JOIS=Joint Ocean Ice Study/BGOS = Beaufort Gyre Observatory System (DFO); K-AWARE (KOPRI)=Korea- Arctic ocean WArming & Ecosystem study (Korea Polar Research Institute).

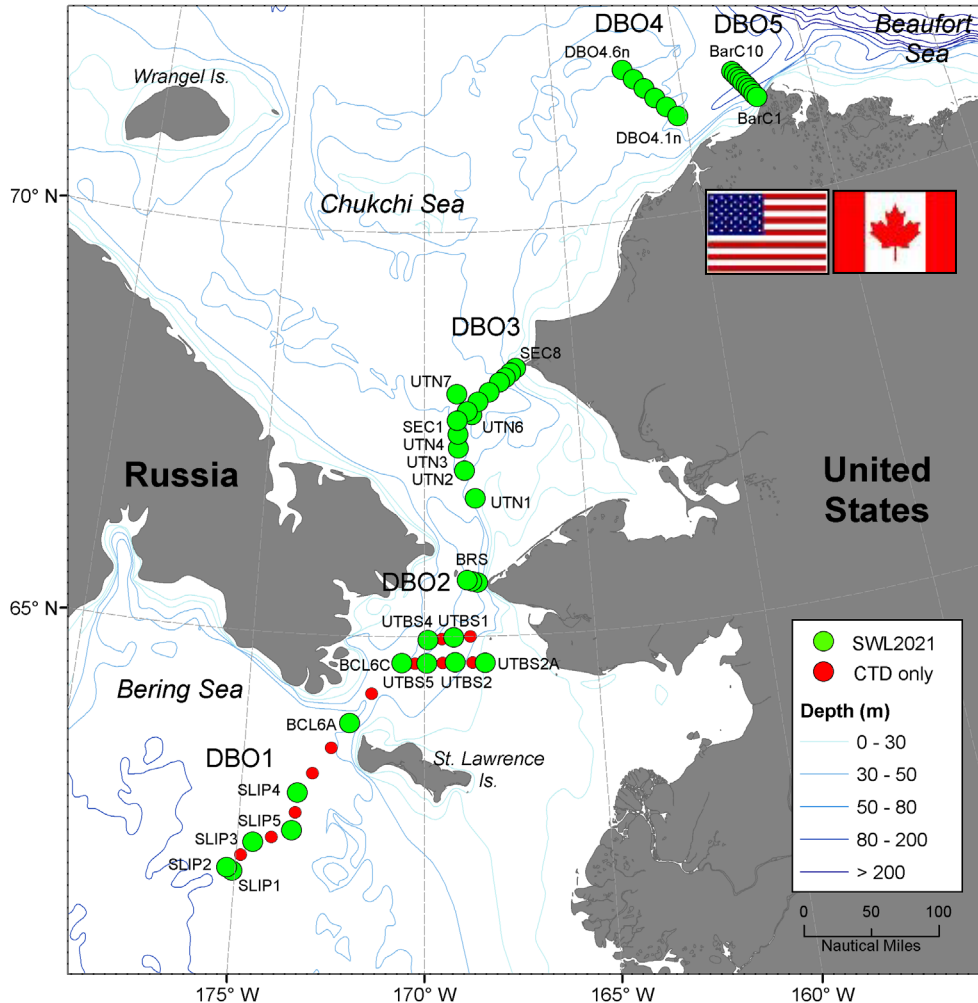
DBO Region Key: DBO1=So. St. Lawrence Is., DBO2=Chirikov Basin, DBO3=So Chukchi Sea, DBO4=NE Chukchi Sea, DBO5=Barrow Canyon, DBO6=East Beaufort Sea, DBO7=Beaufort Sea Central, DBO8=Bathurst polynya region.

Dates 2022 (Port calls)	Ship	DBO Region	Projects	PAG contact	Chief Scientist
July 6-26 (Victoria, BC-Utqiagvik, AK)	Sir Wilfrid Laurier	1,2,3,4,5	DBO/C30 (AON/NSF)	Jackie Grebmeier jgrebmei@umces.edu	John Nelson John.Nelson@dfo-mpo.gc.ca
July 14-Aug 30 (Dutch-Dutch)	Healy	-	AMOS	Craig Lee craig@apl.washington.edu	Craig Lee craig@apl.washington.edu
July 19-Aug 15, 2022 Leg 1: Nome-Nome)	Norseman II	3,5,6	Harmful Algae Blooms	Robert Pickart rpickart@whoi.edu	Robert Pickart rpickart@whoi.edu
July 4-Oct 4 (Incheon-Incheon, stops in Dutch Harbor and Utqiagvik)	Araon	3, Chukchi Borderland, Beaufort Sea	K-AWARE (KOPRI)	Eun Jin Yang ejyang@kopri.re.kr	Eun Jin Yang ejyang@kopri.re.kr
July 19-Aug 15, 2022 Leg 1: Nome-Nome)	Norseman II	3,5,6	Harmful Algae Blooms	Robert Pickart rpickart@whoi.edu	Robert Pickart rpickart@whoi.edu
Aug 12-31 (Utqiagvik-Utqiagvik)	Annika Marie	5	Bio-physical drivers of bowhead whales	Carin Ashjian cashjian@whoi.edu	Carin Ashjian cashjian@whoi.edu
<i>Sept 15-25 (Dutch-Kodiak); cancelled early, engine issues</i>	<i>Dyson</i>	<i>1,2,3,4,5</i>	<i>DBO-EcoFOCI</i>	<i>Jackie Grebmeier</i> jgrebmei@umces.edu	<i>Ryan McCabe</i> ryan.mccabe@noaa.gov
Aug 12-Oct 6 (Japan-Dutch Harbor-Japan)	Mirai	3,5,6,7	ArCS II (JAMSTEC)	Shigeto Nishino nishinos@jamstec.go.jp	Motoyo Itoh motoyo@jamstec.go.jp
Aug 17-Sept 6, 2022 (Leg 2: Nome-Nome)	Norseman II	3,5,6	Harmful Algae Blooms	Robert Pickart rpickart@whoi.edu	Robert Pickart rpickart@whoi.edu
Sept 4-Oct 28 (Dutch-Dutch)	Healy	4 (CEO mooring only)	SAS	Jackie Grebmeier jgrebmei@umces.edu	Carin Ashjian cashjian@whoi.edu
Sept 8-18, 2022 (Nome-Nome)	Norseman II	3; moorings; CTDs	Bering Strait Mooring Project (AON/NSF)	Rebecca Woodgate woodgate@uw.edu	Rebecca Woodgate woodgate@uw.edu
Sept 14-Oct 28 (Nome-Nome)	Sikuliaq	-	AMOS	Craig Lee craig@apl.washington.edu	Craig Lee craig@apl.washington.edu
Sept 1-29 or Sept 15-Oct 11 (Kugluktuk, Canada-return)	Louis S. St-Laurent	-	JOIS/BGOS (DFO/NSF)	Bill.Williams@dfo-mpo.gc.ca	Sarah.Zimmermann@dfo-mpo.gc.ca
Sept 25-Oct 28	Sir Wilfrid Laurier	-	Moorings	Bill.Williams@dfo-mpo.gc.ca	Bill.Williams@dfo-mpo.gc.ca
Nov 1-28, 2022 (Nome-Nome)	RV Sikuliaq	3,5,6	Beaufort Gyre Shelf - Edge Current	Robert Pickart rpickart@whoi.edu	Robert Pickart rpickart@whoi.edu



July 2022 CCGC Sir Wilfrid Laurier

Canada's Three Oceans (C3O) and the DBO: *CCGS Sir Wilfrid Laurier*, July 6-25, 2022 (**planned 2023**); Victoria, BC, Canada or Dutch Harbor, Alaska to Utqiagvik, Alaska [**Jackie Grebmeier: PAG DBO talk/DBO data workshop**]



DBO data collections

- Seawater temperature and salinity; currents
- Nutrients, chlorophyll, carbon products, dissolved carbon
- Phytoplankton, zooplankton and macrobenthic abundance, biomass, community structure
- Marine mammal and seabird surveys



Contacts: John Nelson

John.Nelson@dfo-mpo.gc.ca

and Jackie Grebmeier

jgrebmei@umces.edu

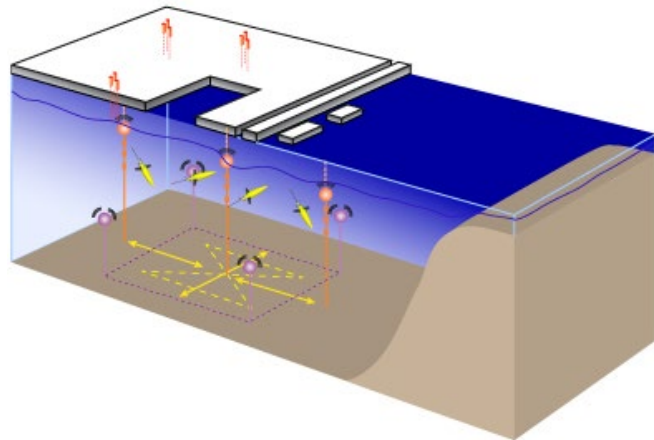
Craig Lee, University of Washington

[will give PAG talks on these projects]

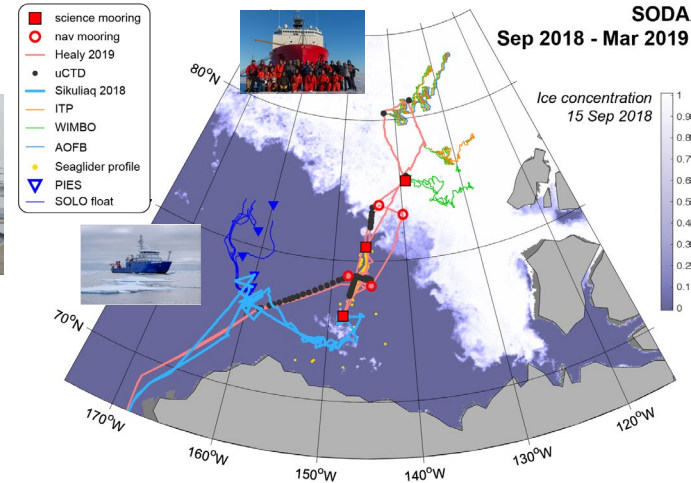
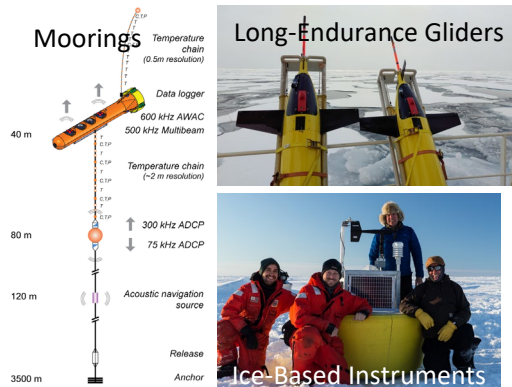


Stratified Ocean Dynamics of the Arctic (SODA)

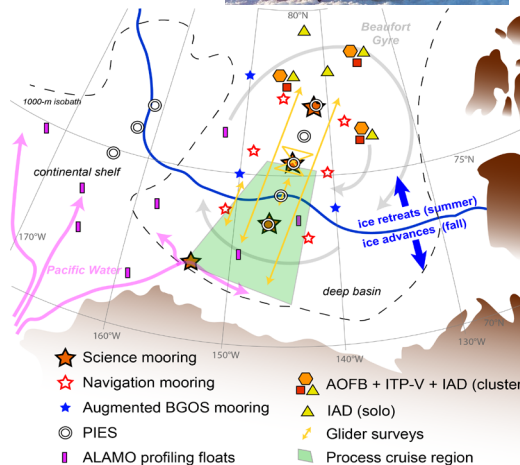
<https://apl.uw.edu/project/project.php?id=soda>



Moored and Mobile Instruments Maintain Focus on Fixed Domain



- Understand how the upper Beaufort Sea, particularly stratification and sea ice, responds to changes in inflow and surface forcing.
- Mobile instruments operate within broad field of moored (fixed) assets that provide acoustic infrastructure and sampling.
- Ice-based instruments deployed to drift through mooring array.
- Good for sustained focus on fixed geographic sites.



Results include new understanding of...

- Ice-ocean drag parameterizations.
- Role of sea ice melt water in modulating freeze-up.
- Seasonal modulation of near-inertial motions within mixed layer.
- Episodic offshore heat transport within filaments.

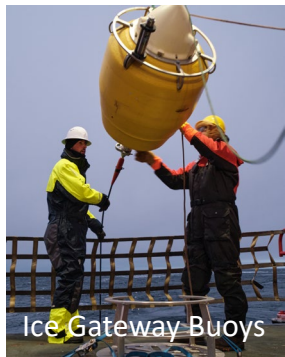
Ongoing-completed 2022 and planned for 2023

Arctic Mobile Observing System (AMOS)

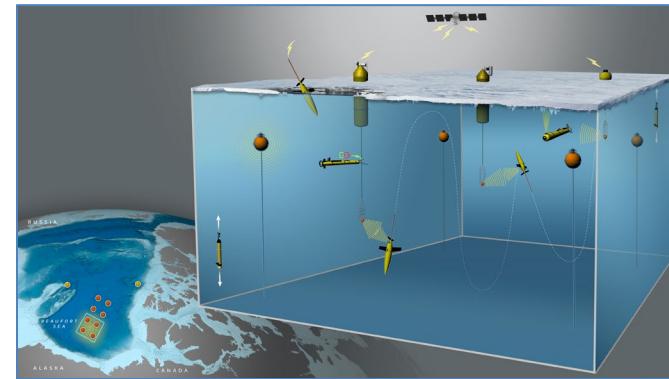


Persistent, year-round monitoring, event-driven sampling/response

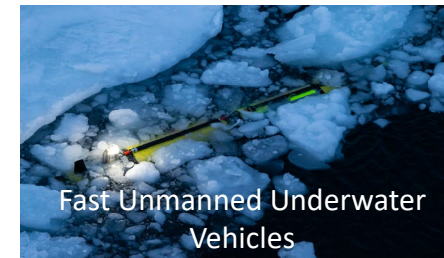
- Data exfiltration and control for instruments operating under ice through 'gateway' buoys that bridge ice-ocean interface.
- Store and forward network of mobile instruments.
- Persistent presence, multi-scale sampling – gliders, floats & fast UUVs operating with 'gateway' buoys.



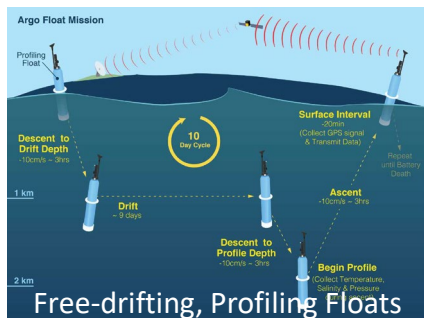
Ice Gateway Buoys



Long-Endurance Gliders



Fast Unmanned Underwater Vehicles



Free-drifting, Profiling Floats

- Robust, broad acoustic navigation:
 - Long-range (trans-basin) very low frequency (35 Hz) beacons – 'underwater GPS.'
 - 900 Hz broadband beacons.
- Situational awareness and control center – in situ environmental data, remote sensing, numerical predictions inform decisions.

[Bob Pickart: PAG and DBO workshop talks]

Phytoplankton Blooms in the warming Chukchi Sea: Two cruises on R/V *Norseman II*-2022

Team of Investigators: Donald Anderson, Robert Pickart, *Woods Hole Oceanographic Institution*
Miguel Goni, Lauren Juranek, *Oregon State University*
Dean Stockwell, *University of Alaska, Fairbanks*

Funded by: the National Science Foundation – Office of Polar Programs

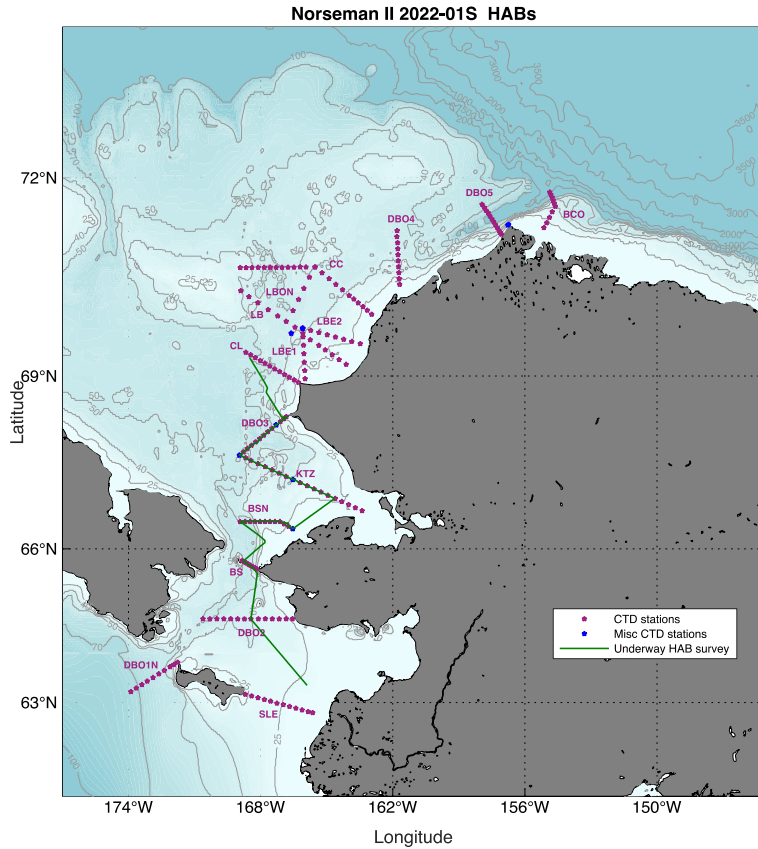


Goals of the project

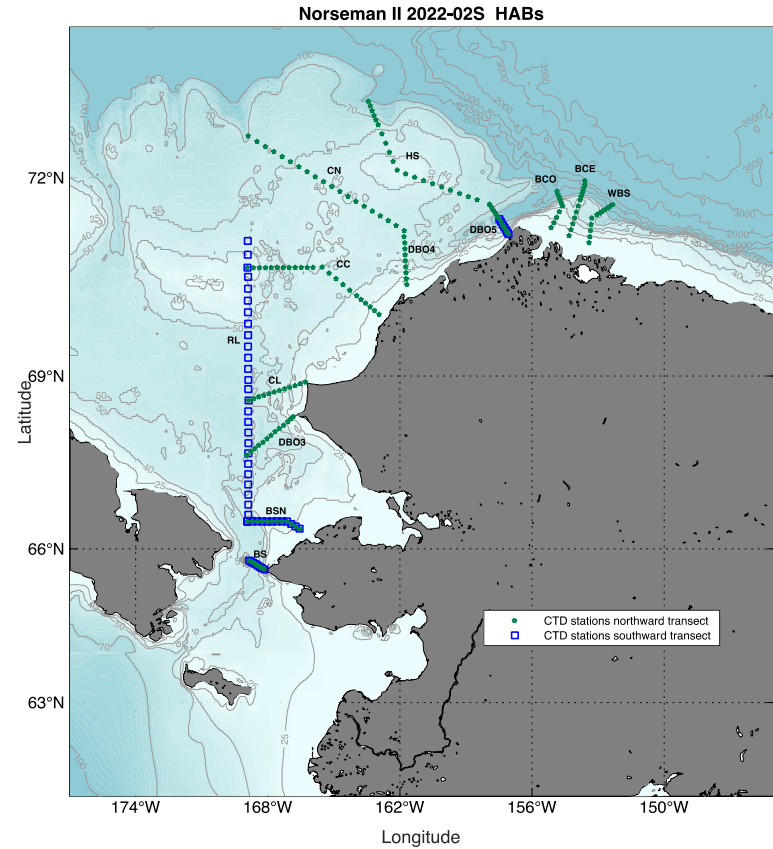
- Improve our understanding of phytoplankton dynamics in the Chukchi Sea
- Identify locations and quantify the magnitude of harmful algal blooms (HABs)
- Map the distribution of HAB cysts in the sediments
- Understand how the circulation and water properties influence these things

Extensive physical and biogeochemical sampling of the water column and sediments, including 435 CTD stations, 120 surface sediment grabs, 15 multi-cores, and 47 phytoplankton net tows

Hydrographic stations on Leg 1: 19 Jul – 15 Aug 2022



Hydrographic stations on Leg 2: 17 Aug – 6 Sep 2022



[will give talk during DBO workshop]

Bio-physical drivers of bowhead whale distribution on the Alaskan Beaufort Shelf during a period of rapid environmental change

Carin Ashjian (WHOI), Bob Campbell (URI), Steve Okkonen (UAF), Mei Sato (WHOI), Kate Stafford (UW)

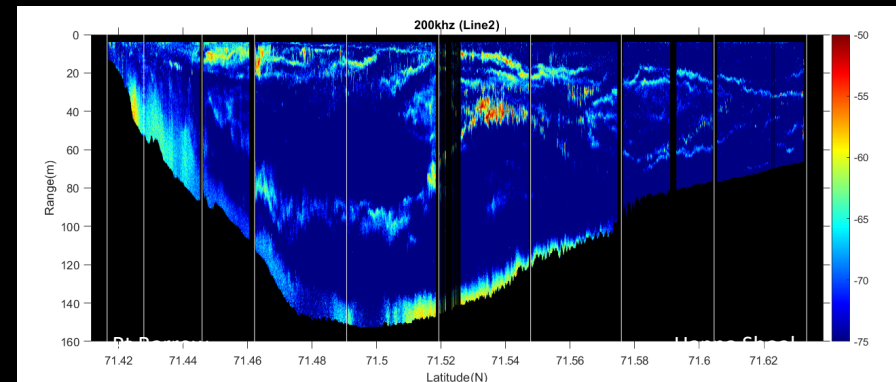
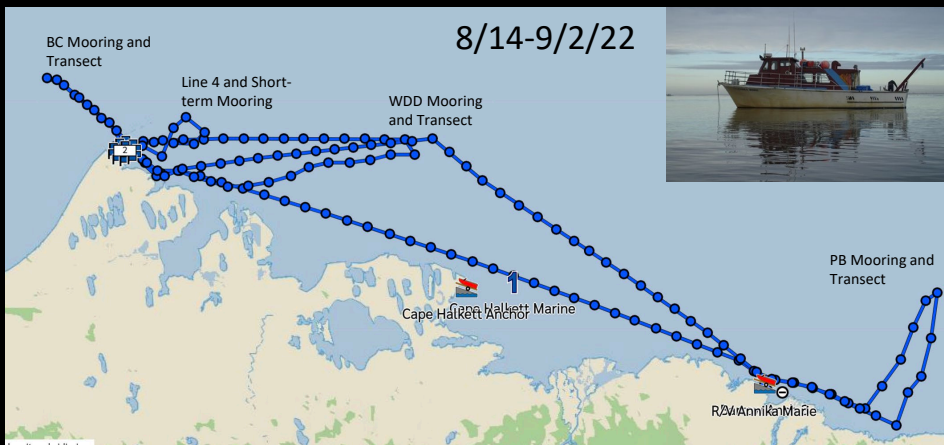
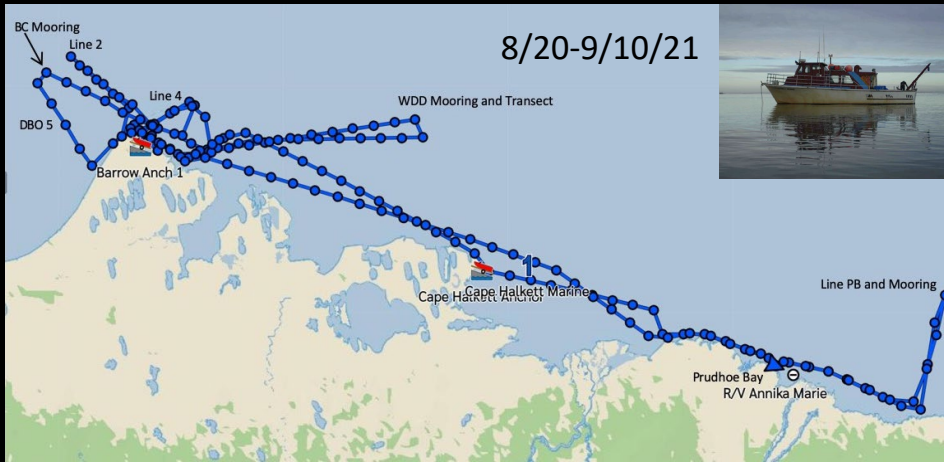


Funded by the US Bureau of Ocean Energy
Management Award M21AC00015 to the
University of Alaska Fairbanks

Photo: Kate Stafford

Data collection

- Vessel-based sampling of currents (2021; ADCP), hydrography (CTD), zooplankton (nets), bioacoustics (2022)
- 3 year-round moorings at Prudhoe, WDD, Barrow Canyon equipped with ADCP, CTD, acoustic recorders (2021 and 2022)
- 2 year round moorings at WDD and Barrow Canyon equipped with AZFP (2022)
- 1 short-term (~2 weeks) mooring deployed (20-m isobath)
- Krill/copepods collected for C:N, morphometrics, genetics
- Marine mammal and bird distributions



200 kHz backscatter across Barrow Canyon -8/19/22

Bering Strait Mooring Project

PIs: Rebecca Woodgate & Cecilia Peralta-Ferriz

woodgate@uw.edu

psc.apl.washington.edu/BeringStrait.html

1990 – present (32+ years)

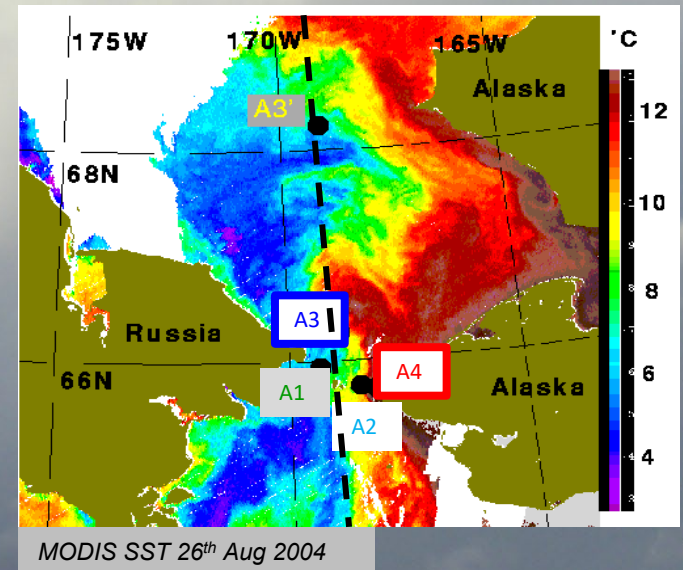
== year-round moorings

mid channel (e.g., A1, A2, A3, A3')

== mostly near bottom

== 2001 started measuring the Alaskan Coastal Current with A4

[will give PAG and DBO workshop talks]



To 2022: Physical data:

- hourly (or better)

- temperature (T)

- salinity (S)

- velocity (ADCP)

after 2007 also

- ice

- upper "ISCAT" TS

New NSF-OPP-AON funding:

- Continues moorings from 2022-2026

- Adds

Biooptics on moorings (A3 and A2):

- hourly

- SUNA nitrate

- Fluorescence

- Dissolved Oxygen

- Turbidity

SUNA nitrate & nutrient sampling to annual cruises

Thanks to Seth Danielson (UAF) and
Sinhue Torres-Valdes & Daniel Scholz
(AWI) for SUNA
discussions

Interested in having a
SUNA user group?
Email Rebecca

We are interested in
collaborations on all
these – please get in touch

Bering Strait Mooring Project

2022 Cruise

8th – 19th Sept 2022 (Nome to Nome)

-recovered moorings (other than A2-21)

A3-21 dragged 1nm SEward by ice

A2-21 still missing

*(Thanks to ** for helping in search)*

- deployed new moorings with biooptics

- water sampling (on some lines)

nutrients (green)

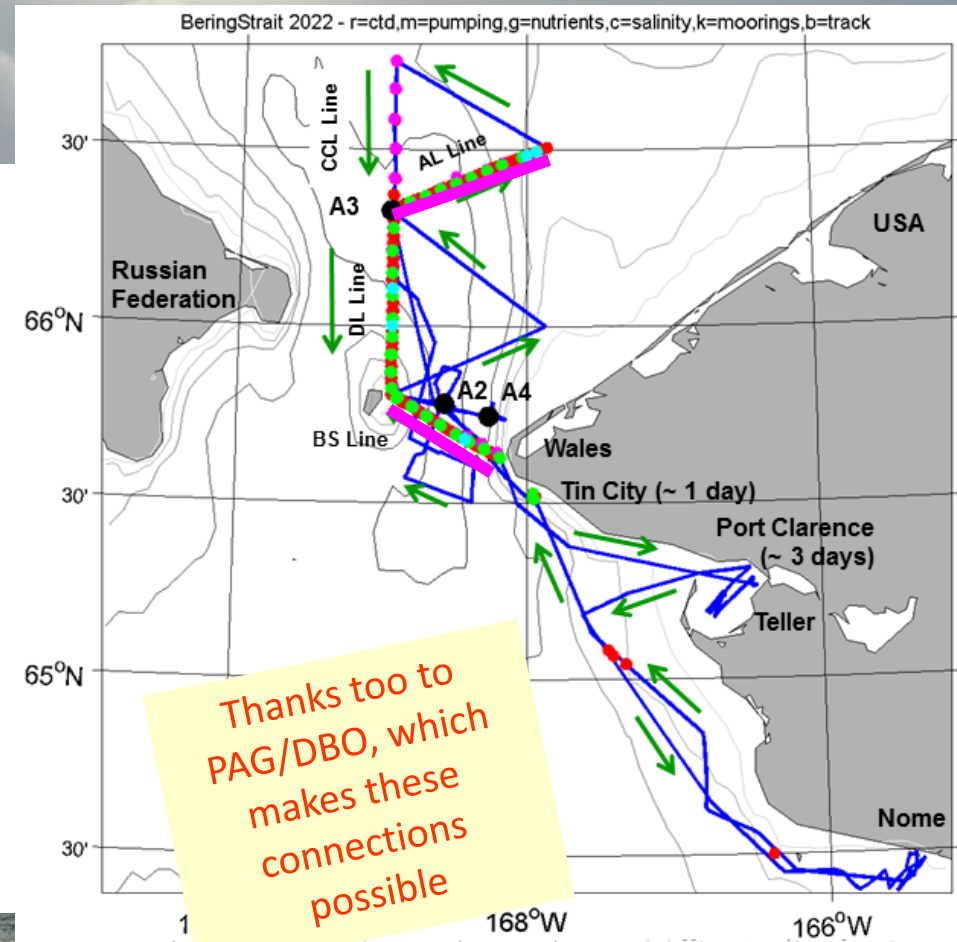
salinity (cyan)

trace metals (pink) (PI Laramie Jensen)

- sections with profiling SUNA for nitrate

All despite - 1 weather day Tin City

- 3(!) weather days Port Clarence

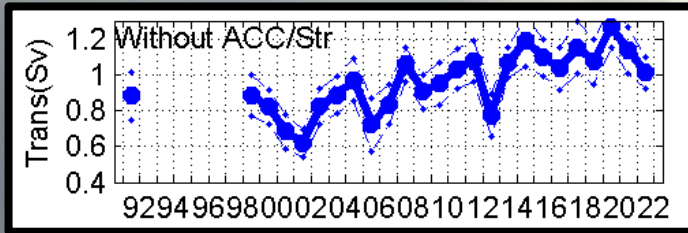


** Steven Roberts, Bob Pickart, Ethan Roth on the Sikuliaq
Luc Rainville, Ben Jokinen on the Sikuliaq
Motoyo Itoh on the Mirai
Ryan McCabe, Catherine Berchok, Phyllis Stabeno on the Dyson
Carin Ashjian, Seth Danielson, Jackie Grebmeier on the Healy
Mike Dempsey on the Laurier
Robert Levine, Erica Escajeda, UW students

2023 current planning:
~4th-14th July Norseman2,
Nome to Nome

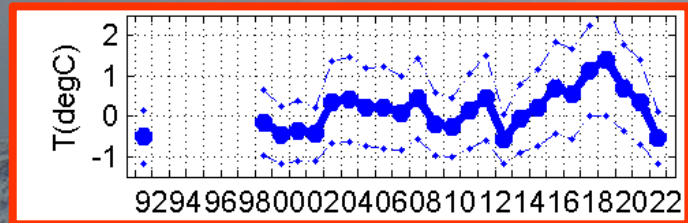
Bering Strait Mooring Project

- Science update at DBO on Wed, but annual mean results are

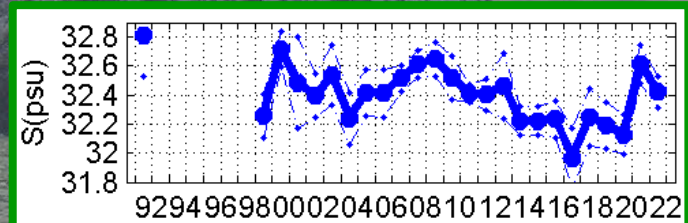


Annual mean transports still have increasing trend,
 - 2020 and 2021 still high, though less than 2019
 (Still no significant trend in Alaskan Coastal Current)

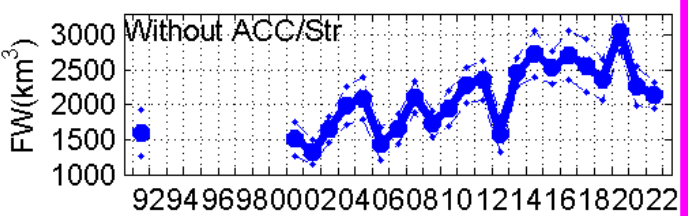
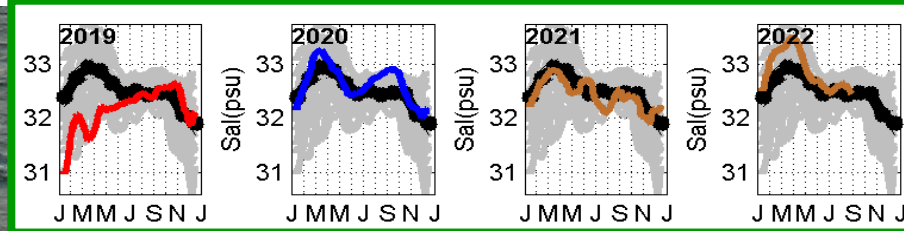
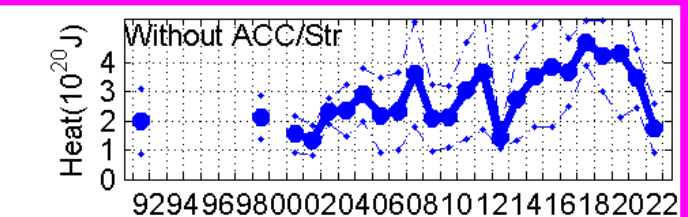
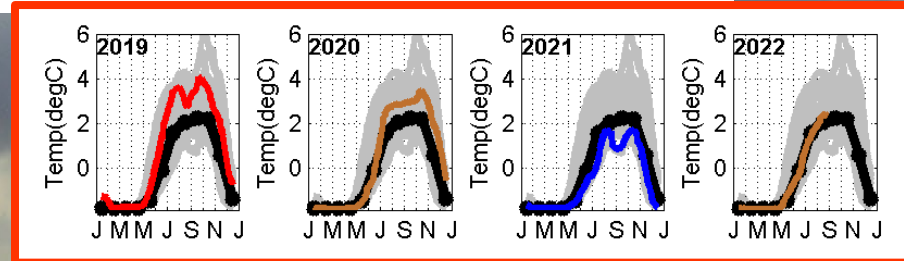
Dark blue = total from A3, without ACC



2021 remarkably COLD (2018 was warmest),
 - 2021 annual mean as cold as any in the record



2021 & 2020 remarkably SALTY, though still < early 90s
 - 2020, 2021 & 2022 show return of winter high salinities

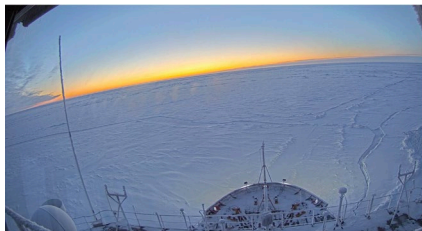
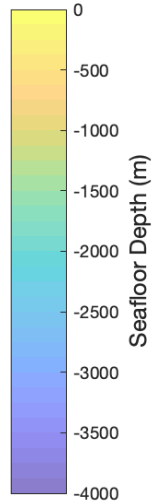
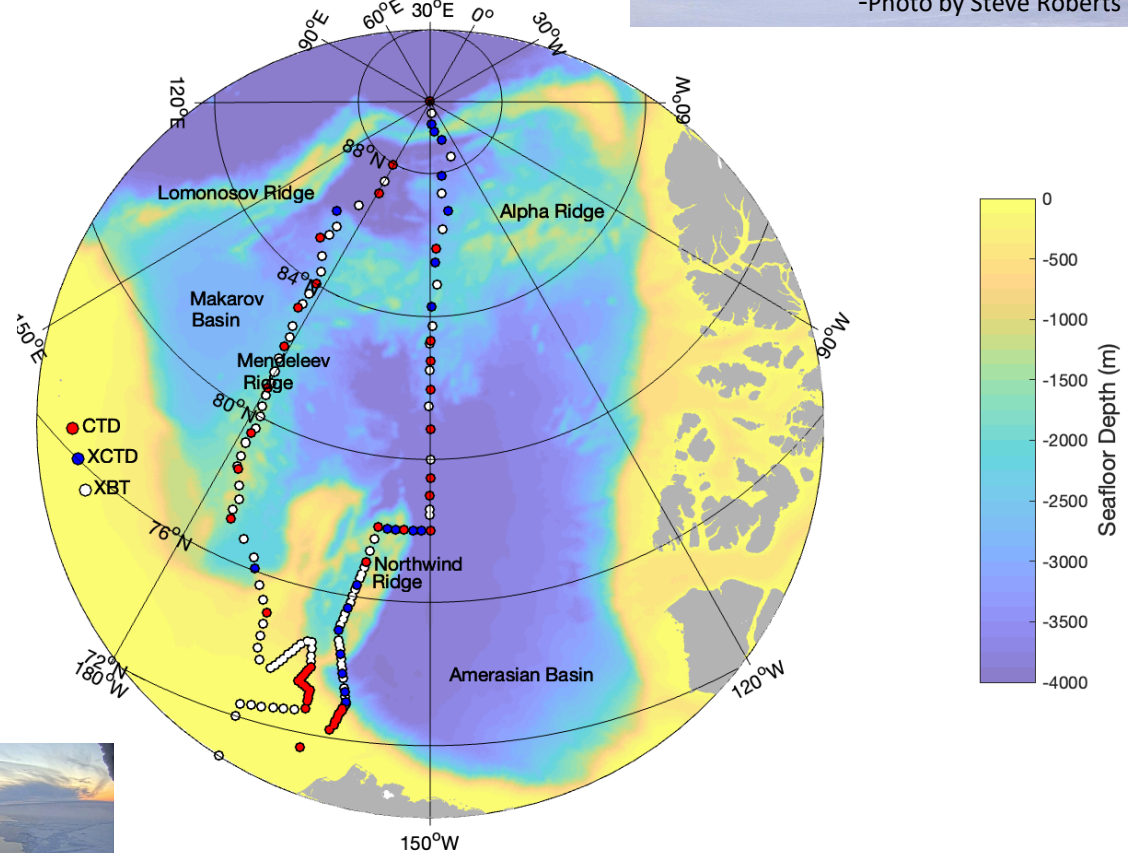
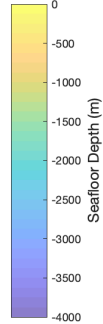
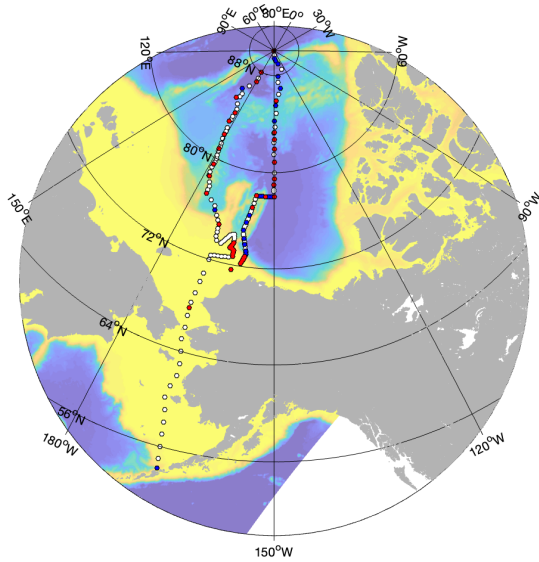


Combined:
 - heat flux down, as low as prior lowest years
 - freshwater flux down, though still higher than 2000s



Synoptic Arctic Survey Cruise on USCGC Healy: Sept 4-Oct 28, 2022

- To/from Dutch Harbor
- ~60 days in length



Transit north of
82°N

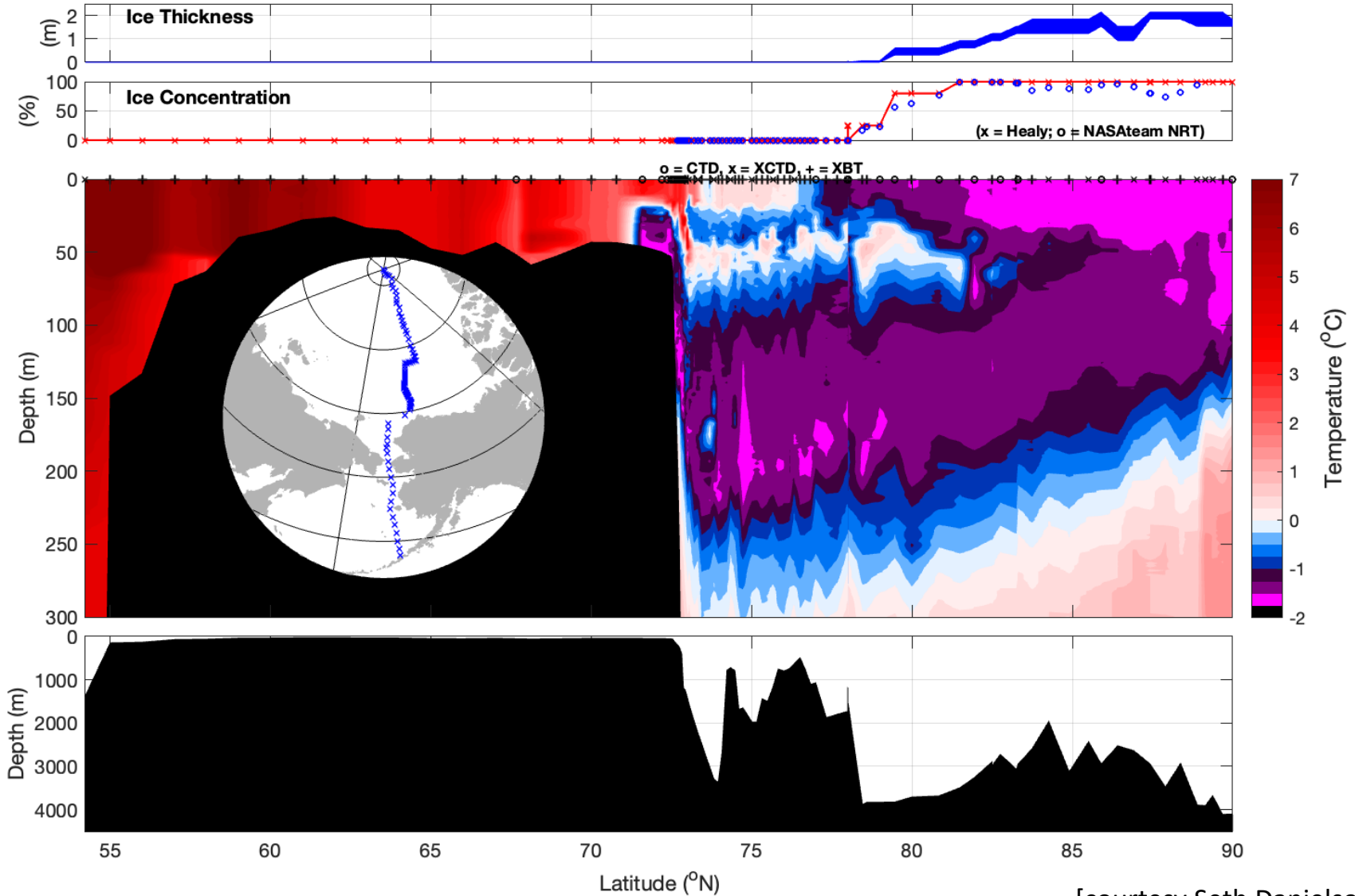


[Carin Ashjian: PAG SAS talk]



Synoptic Arctic Survey Cruise on USCGC Healy: Sept 4-Oct 28, 2022

Synoptic Arctic Survey 9/9/2022 to 10/25/2022

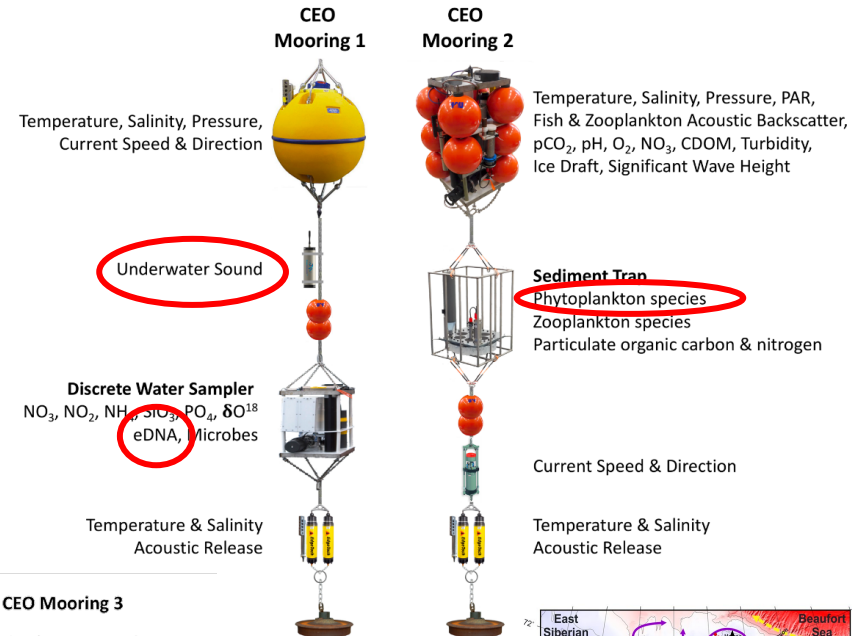


[courtesy Seth Danielson]

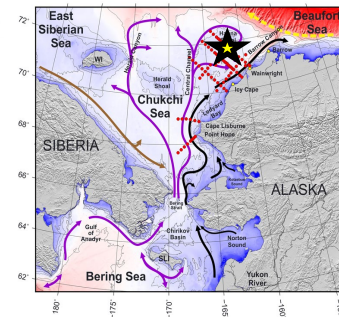
Arctic Marine Biodiversity Observing Network: Aug-Sept 2022 collaboration for field collections (field program facilitated on NSF funded HLY2202)

Chukchi Ecosystem Observatory (CEO)

- Year-round data collection in one location
- Long-term environmental context
- AMBON-supported instrumentation:
 - Marine mammal sound
 - eDNA water collections
 - Phytoplankton species (sediment traps)
- **New AMBON-leveraged instrumentation from AOOs:** Benthic time-lapse camera
 - Year-round benthic biodiversity
 - Migration patterns of benthic fisheries species, e.g., snow crab



CEO Mooring 3
Tripod Bottom Lander
Benthic Camera



[Seth Danielson: PAG and DBO workshop talks]

[courtesy Seth Danielson and Katrin Iken, UAF]

[Bob Pickart: PAG and DBO talks]

Monitoring the Western Arctic Boundary Current in a Changing Climate: A late-season cruise on R/V *Sikuliaq*

Principal Investigator: Robert Pickart, *Woods Hole Oceanographic Institution*



Funded by: the National Science Foundation – Office of Polar Programs, Arctic Observing Network

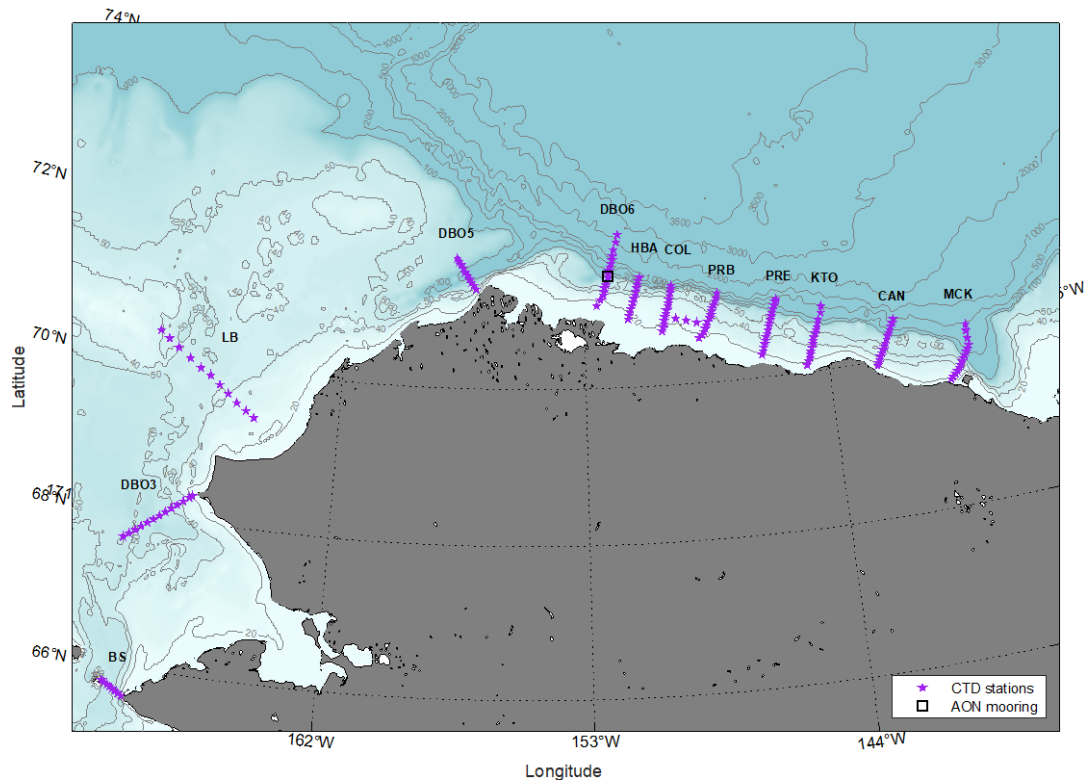
Goals of the project

- Service the long-term mooring located in the Beaufort Sea boundary current east of Pt Barrow
- Carry out a hydrographic/velocity/tracer survey of the boundary current system from Bering Strait to the Canadian Beaufort
- Provide a platform for ancillary programs, including underway biogeochemistry, HABs, oxygen isotopes in the water column and air, sediment coring, and black carbon

Beaufort Sea in November (photo by A. Pacini)

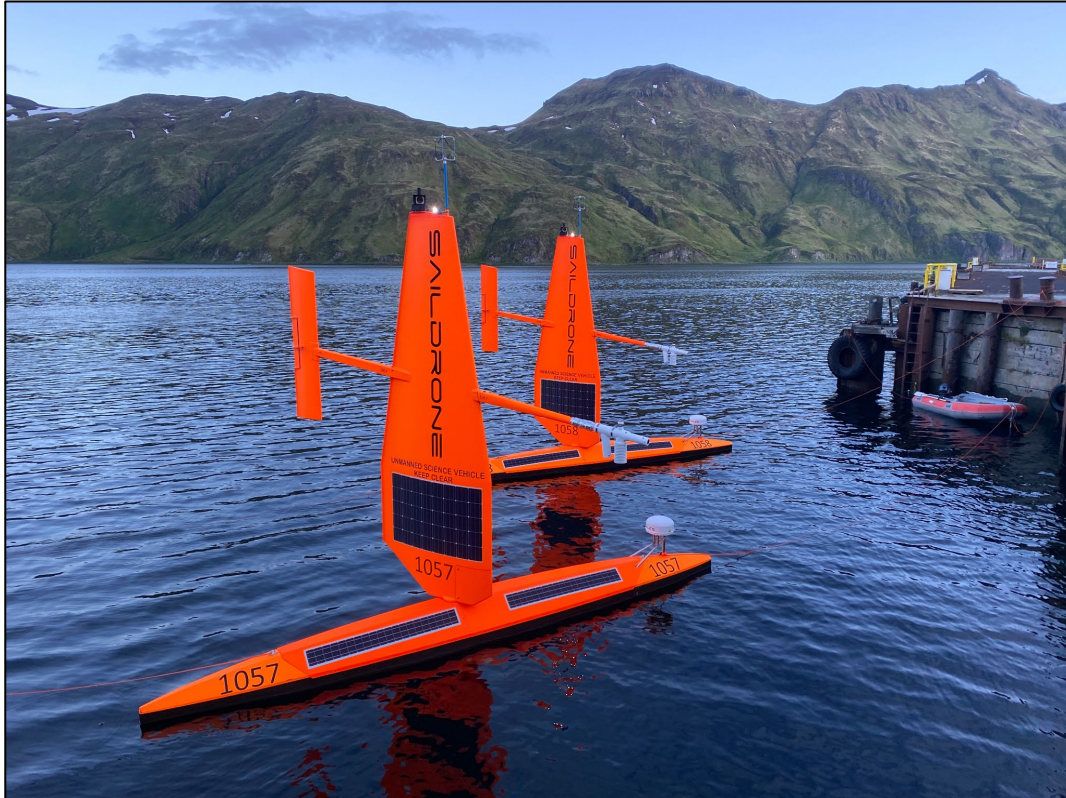
- The AON DBO6 mooring was successfully turned around
- Physical/biogeochemical sampling of the water column and sediments
- 169 CTD stations, 69 surface sediment grabs, and 10 long cores
- Most of the sampling in the Beaufort was done in 90-100% ice cover (newly-forming ice)

Hydrographic stations occupied on R/V Sikuliaq 1 Nov – 3 Dec 2022



[PAG and DBO workshop talks]

MISST3, Sailyrones, and DBO 2022: July-August



Michael Steele
University of Washington

- Sailyrones sampled across DBOs in the Pacific Arctic: July-August 2022



R/V Sikuliaq

Planned 2023 Arctic cruise



Jackie Grebmeier, chief scientist
Seth Danielson, co-chief scientist
Distributed Biological Observatory:
Ecosystems & Fisheries Oceanography
Investigations

September 10-October 4, 2023

**[collaborative with Arctic Marine Biodiversity
Observing Network (AMBON) and Chukchi
Ecosystem Observatory (CEO)]**

Seawater warming and declining sea ice cover are impacting ecosystem components, from prey in the water and sediments to marine mammal and seabird consumers. Food security, harmful algal blooms, and ocean acidification are impacted by changing environmental conditions that influence the health of the marine ecosystem.

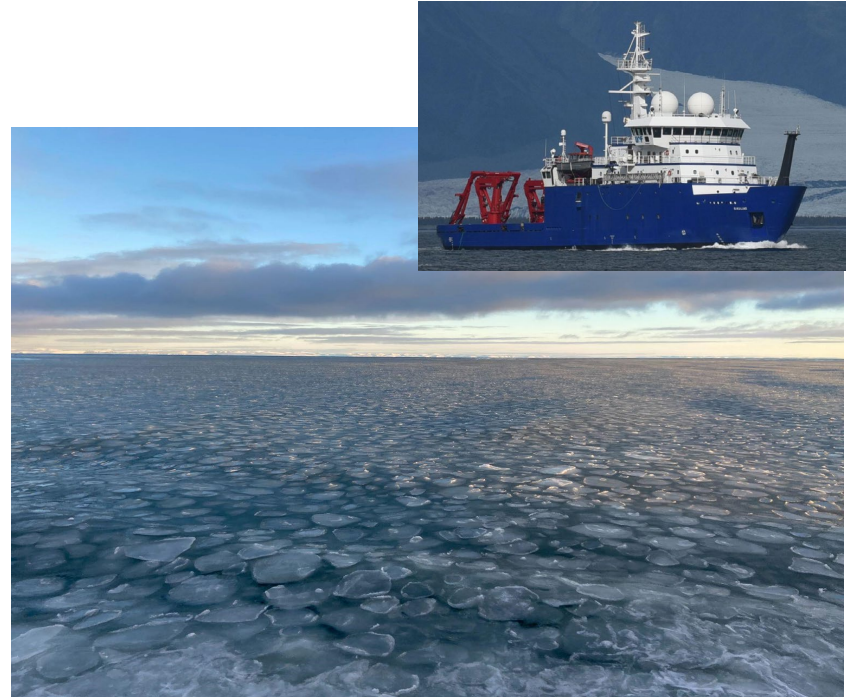


Photo by Seth Danielson, November 2021.

Research questions:

- What ecosystem changes are occurring in the northern Bering and Chukchi seas?
- What conditions cause marine animal populations to vary?



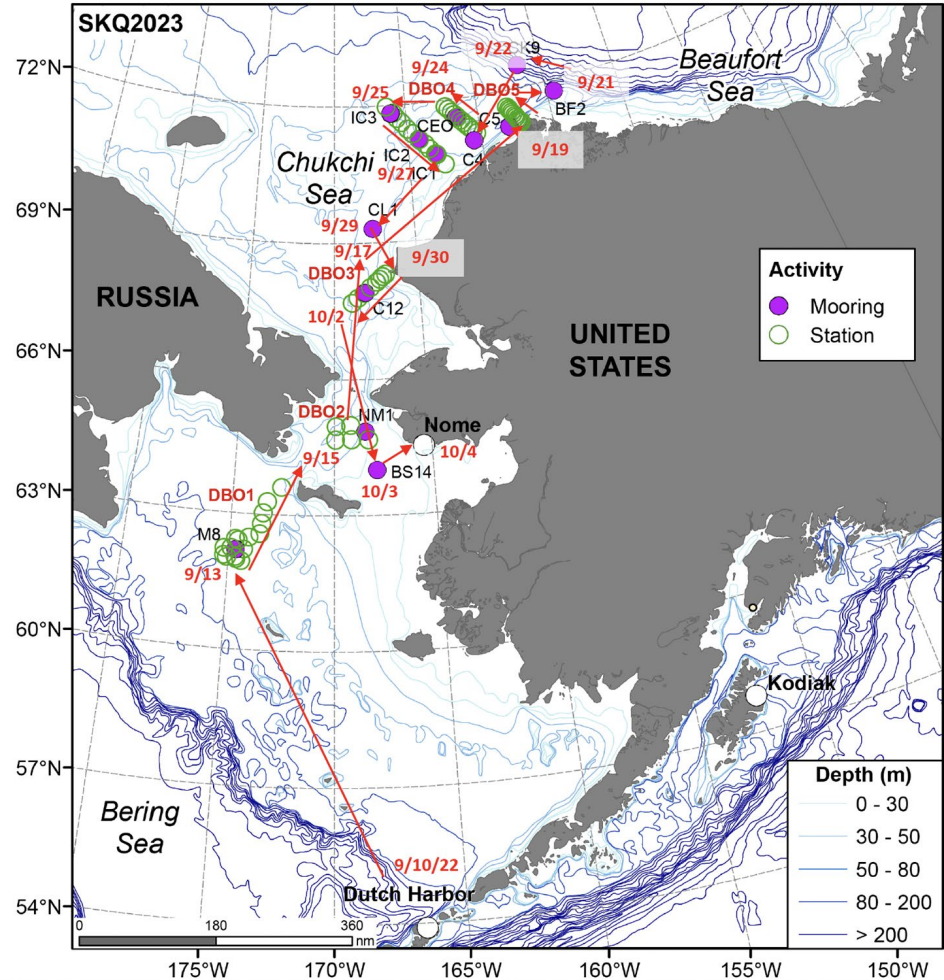
R/V Sikuliaq

Planned 2023 Arctic cruise

The NOAA annual research cruise, collaborative with AMBON and CEO, will occupy five DBO and EcoFOCI time series stations, along with turning moorings.

Measurements will include:

- Seawater temperature and salinity, currents
- Water column measurements: chlorophyll, nutrients, eDNA, phytoplankton type, organic carbon
- Zooplankton and larval fish type
- Harmful algal bloom collections
- Bottom sediments and animals living on and in the sediments
- Seabird and Marine mammal surveys





RV Sikuliaq

Planned 2023 Arctic cruises

Kevin Arrigo, PI; “The Tale of Three Systems: Primary production in the Chukchi Sea”; **June 16-July 30, 2023**

Microalgae generate most of the food that supports Arctic Ocean food webs

- How abundant are these organisms around sea ice and in open water?
- How do microalgae and sediments move in Arctic Ocean environments?
- Understanding this behavior will help us better understand Arctic food webs as sea ice decreases



Photo courtesy of Kevin Arrigo.



Core measurements

- Temperature, salinity, chlorophyll - water mass characteristics
- Fast repetition rate fluorometer - measures phytoplankton health
- HAPS corer - collects seafloor samples of hard and soft sediments
- Sediment traps - measures sinking particles
- FlowCAM - takes images and counts individual algal cells
- Standard suite of oceanographic instruments

Thank you for your attention.

Questions and comments?

Thank you to all Pacific Arctic Region science colleagues and DBO collaborators, field and laboratory technicians over the years for the time series efforts. Financial support for the science provided by the US NOAA, NSF, BOEM, NASA, NPRB, and ongoing national and international science partners in the Pacific Arctic Group.

<http://pag.arcticportal.org>, <https://dbo.cbl.umces.edu/>,

<https://arcticdata.io/catalog/portals/DBO>

<https://earth.gsfc.nasa.gov/cryo/data/distributed-biological-observatory>

<http://ambon-us.org/>, <http://www.ChukchiEcosystemObservatory>

<https://www.ncdc.noaa.gov/data-access>

