

USA Country Report

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Chesapeake Biological Laboratory

University of Maryland Center for Environmental Science, Solomons, MD, USA

Pacific Arctic Group Meeting

Arkhangelsk, Russia

May 23, 2019

ASGARD: Arctic Shelf Growth, Advection, Respiration, and Deposition (ASGARD) Rate Measurements Project

CEO: Chukchi Environmental Observatory

DBO: Distributed Biological Observatory

Arctic EIS II: Arctic Ecosystem Integrated Study II

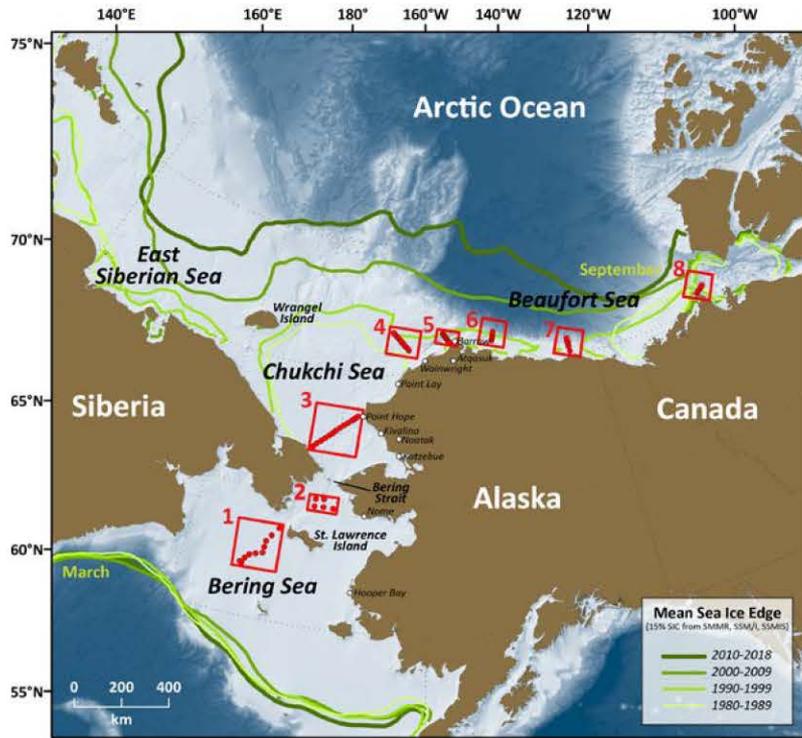
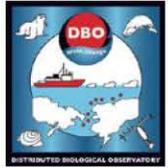
Bering Strait moorings

Beaufort Slope: The Importance of Shelf Break Upwelling to Upper Trophic Level Ecology in the Western Beaufort Sea

JOIS/AON-BGOS: Joint Ocean Ice Study/Arctic Observing Network-Beaufort Gyre Observing System (**Bill Williams talk**)

Saildrones and Gliders

Linking Physics to Biology: the Distributed Biological Observatory (DBO)



[Grebmeier, Moore, Cooper, Frey, 2019]

- **Ship-based sampling:**
 - CTD and ADCP
 - Chlorophyll, nutrients, carbon products
 - Plankton (size, biomass and composition)
 - Benthos (size, biomass and composition)
 - Seabird and marine mammal surveys
 - Fishery acoustics
 - Bottom trawling (every 3-5 years)

- **Autonomous sensor sampling:**
 - Gliders, moorings, saildrone
 - Satellite observations

- **DBO lines also embedded in process cruises**

- DBO sites (red boxes) are regional “hotspot” transect lines and stations, based on high productivity, biodiversity, and/or overall rates of change
- DBO serves as a **change detection array** for consistent monitoring of biophysical responses
- Sites occupied by **national and international entities** with shared data plan



2019 PAG and DBO Cruise Plan Table

2019 PAG and DBO Field Season (version 03_14_19): Sampling Contributors. Projects Key: AON=US Arctic Observing Network (National Science Foundation); ArCS=Arctic Challenge for Sustainability; ArcticEIS2=Arctic Ecosystem Integrated Survey, C30=Canada's Three Oceans; CHINARE=Chinese Arctic Research Expedition; DBO=Distributed Biological Observatory; EcoFOCI= JAMSTEC= Japan Agency for Marine-Earth Science and Technology; JOIS=KOPRI = Korea Polar Research Institute; MOSAiC= Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC); NIPR = National Institute of Polar Research; NOAA=National Oceanic and Atmospheric Administration; Office of Naval Research (ONR) Marginal Ice Zone (MIZ) project; PMEL=Pacific Marine Environmental Laboratory. **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.

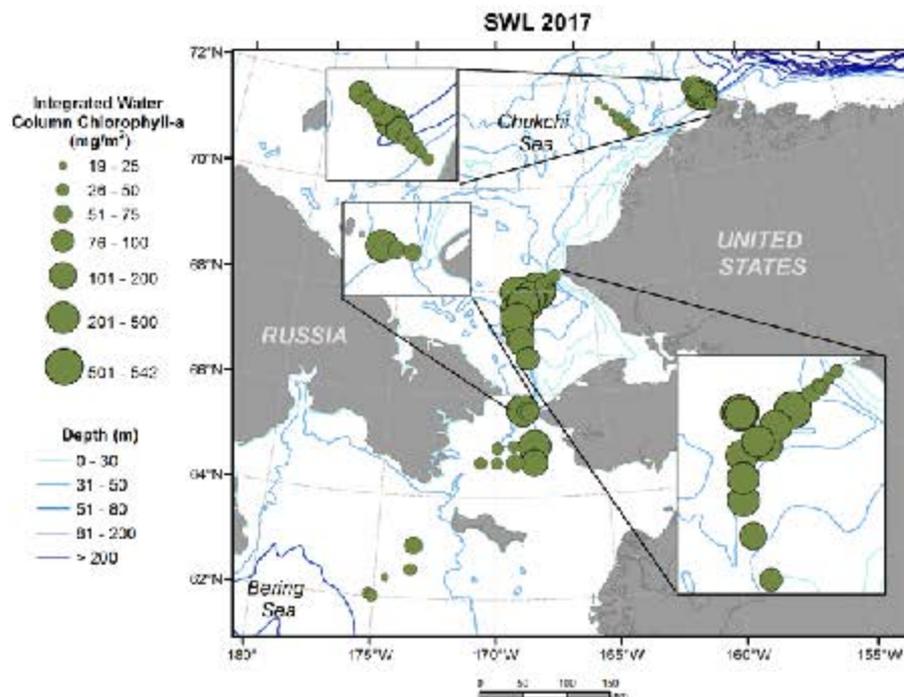
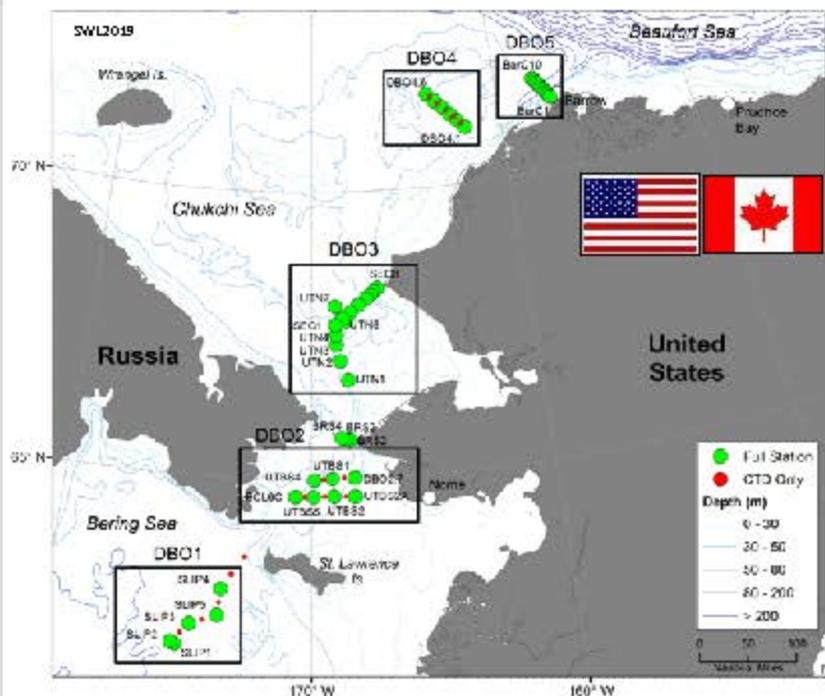
Dates 2019 (Port calls)	Ship	DBO Region	Projects	PAG contact	Chief Scientist
July 12-24 (Dutch Harbor-Utqiagvik)	Sir Wilfrid Laurier	1,2,3,4,5	C30/DBO (AON)	Jackie Grebmeier jgrebmei@umces.edu	John Nelson John.Nelson@dfo-mpo.gc.ca
June-Sept (Shanghai-Shanghai)	Xuelong	-	CHINARE/MOSAiC	Jianfeng He hejianfeng@pric.org.cn	Jianfeng He hejianfeng@pric.org.cn
Aug 1-Oct 2 (Dutch Harbor-Nome-Nome-Nome-Dutch Harbor)	R/V Ocean Starr	2,3,4,5	Arctic IES (Integrated Ecosystem Survey)	Ed.Farley@noaa.gov	Geoff Lebon, Geoff.t.lebon@noaa.gov Ed Farley, ed.farley@noaa.gov Kris Cieciel, Kristin.cieciel@noaa.gov
Aug 1-25 (Dutch Harbor-Utqiagvik)	Araon	1,2,3	K-AOOS (Korea-Arctic Ocean Observing System)	Sung-Ho Kang shkang@kopri.re.kr	Eun Jin Yang ejyang@kopri.re.kr
Aug 27 – Sept 20 (Dutch Harbor-Nome-Nome-Dutch Harbor)	F/V Northwest Explorer	2	Northern Bering Sea Assessment	Ed.Farley@noaa.gov	Jim Murphy, jim.murphy@noaa.gov
Aug 2-22 (Utqiagvik - Utqiagvik)	Healy	1,2,3,4,5	DBO/NCIS=Northern Chukchi Integrated System	Jackie Grebmeier jgrebmei@umces.edu	Robert Pickart rpickart@whoi.edu and Jackie Grebmeier jgrebmei@umces.edu
Sept (Nome-Nome)?	Norseman II	3	Bering Strait Mooring Project/AON	Rebecca Woodgate woodgate@apl.washington.edu	Rebecca Woodgate woodgate@apl.washington.edu
Sept 18-Oct 6 (Dutch Harbor-Kodiak)	Dyson	1 and M8	EcoFOCI	Phyllis Stabeno, Phyllis.stabeno@noaa.gov	Geoff Lebon geoffrey.t.lebon@noaa.gov
Sept -Oct?	Louis S. St-Laurent	-	JOIS/AON-BGOS	Bill.Williams@dfo-mpo.gc.ca	Bill.Williams@dfo-mpo.gc.ca
Sep 27- 10 Nov 2019 (Sekinehama, Japan, return Sekinehama, Japan)	Mirai	1,2,3	Japanese Atmospheric cruise; National Institute of Polar Research (NIPR)	Takashi Kikuchi takashik@jamstec.go.jp	Dr. Kazutoshi Sato satokazu@mail.kitami-it.ac.jp
Oct?	Sir Wilfrid Laurier	4,8	C30	Bill.Williams@dfo-mpo.gc.ca	Humfrey.Melling@dfo-mpo.gc.ca



Canada's Three Oceans (C3O) and the DBO: CCGS Sir Wilfrid Laurier, July 11-23, 2019



Focus: sampling along latitudinal transect lines developed as a “change detection array” for consistent monitoring of biophysical responses to changing environmental conditions



Contacts: John Nelson
John.Nelson@dfo-mpo.gc.ca and
Jackie Grebmeier
jgrebmei@umces.edu

DBO data collections

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



DBO Transects: CCGS Sir Wilfrid Laurier (July 14-July 24, 2018)

CTD/Rosette



Bongo nets



Incubation experiments



Laboratory filtrations



Over the side
150kHz ADCP



C-OPS

vanVeen grabs



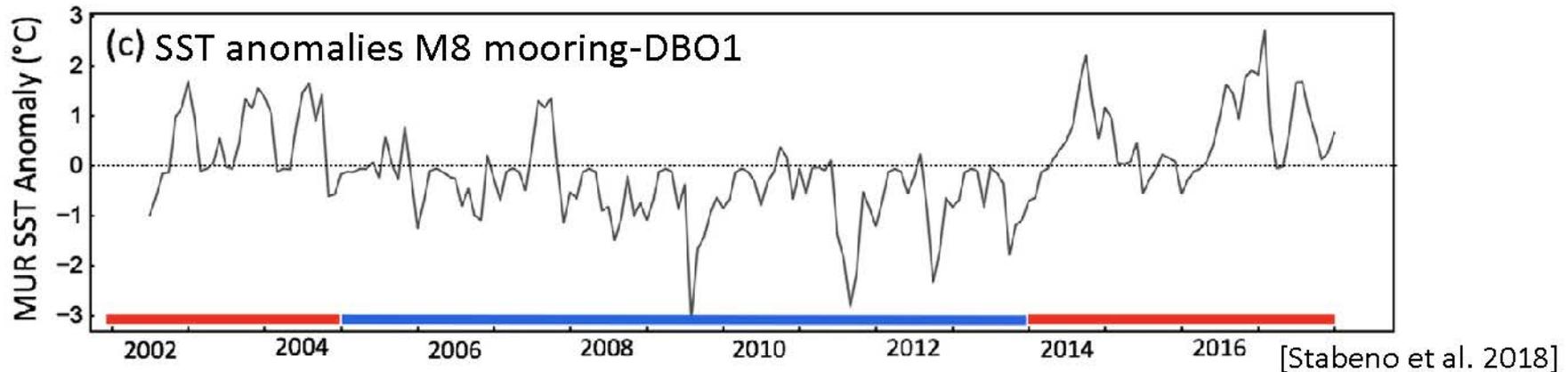
Bird observations



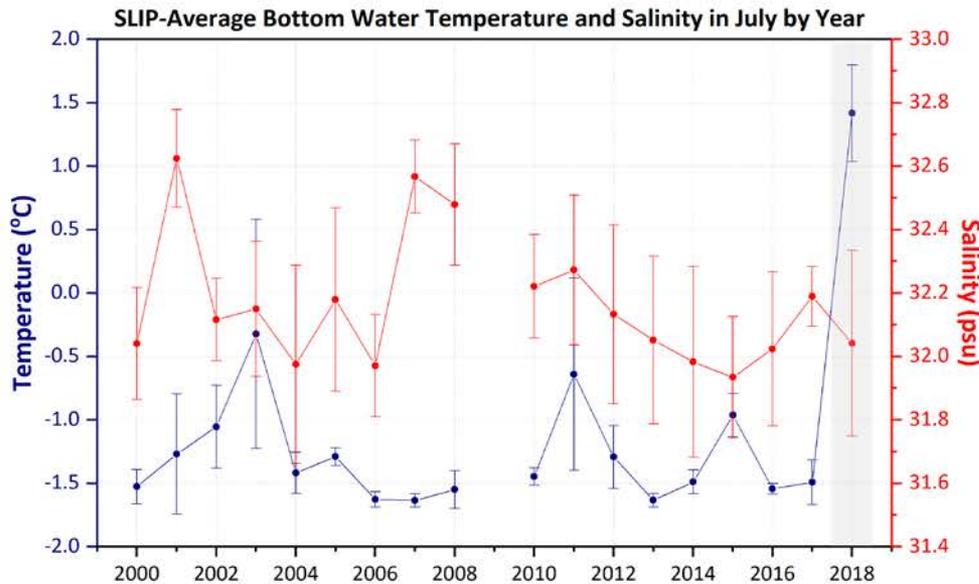
Science:

- CTD stations, most with Rosette sampling (chlorophyll, nutrients, phytoplankton)
- Bongo net hauls for zooplankton
- deployments of 150 kHz ADCP
- Benthic sampling stations with up to 5 vanVeen grabs at each station\
- Benthic Video-camera recordings
- stations where water was collected for methane and nitrous oxide analysis
- stations sampled for apparent optical properties
- Subset of stations were used for primary productivity incubation experiments
- Seabird and Marine Mammal observations
- Meteorological and position data from ship sensors

2018: A Tipping Point for the Northern Bering Sea (DBO1)?



- Time series of SST monthly mean anomalies. The colored lines at the bottom indicate periods of limited ice (red) and more extensive (blue) in December/January

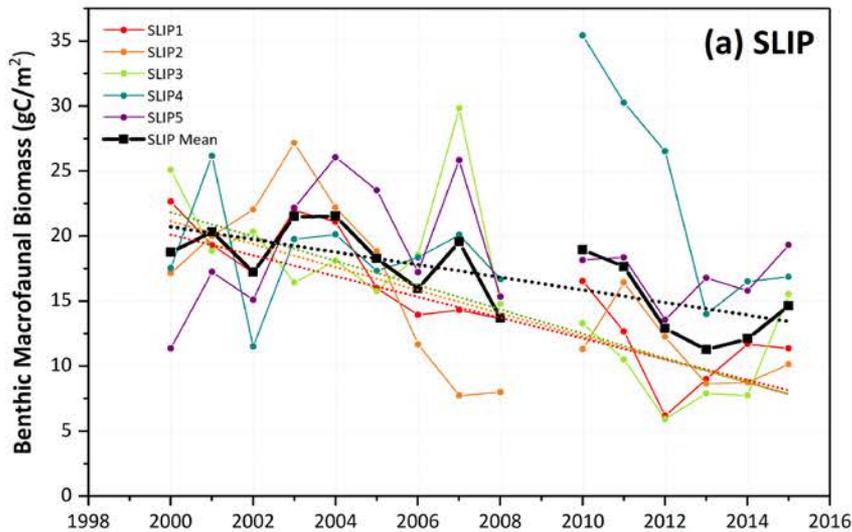


[Grebmeier et al., Oceanography, 2018]

- Gray shading: SLIP1-5 stations in 2018 had an average bottom water temperature that was a statistically significant outlier, without any SD bar overlap
- Although salinities becoming fresher in recent years, they still have overlapping SD bars

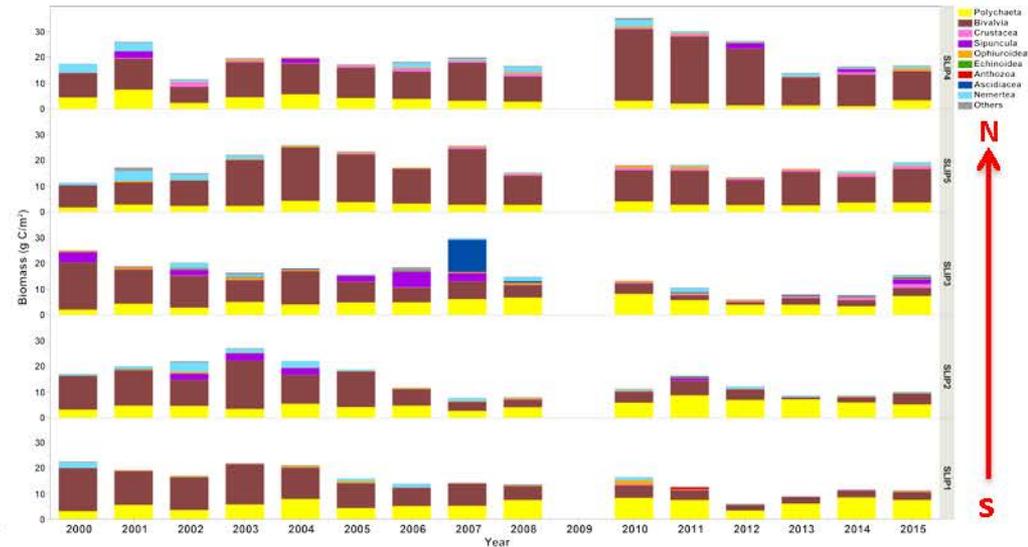
Macrofaunal biomass and composition at time series stations (DBO1: SLIP1-5) south of St. Lawrence Island, 2000-2015

Time series benthic biomass in the DBO1



- Significant declining trend in southern SLIP1-3 stations and average values using Mann-Kendall (Kendall's tau) trend analysis ($p < 0.0001$)

Macrofaunal composition for SLIP time series sites in DBO1



- Stations stacked from southern site (SLIP1) to northern site (SLIP4)
- Change in dominance from bivalve (brown) to polychaete (yellow) fauna in 2008 in southern sites

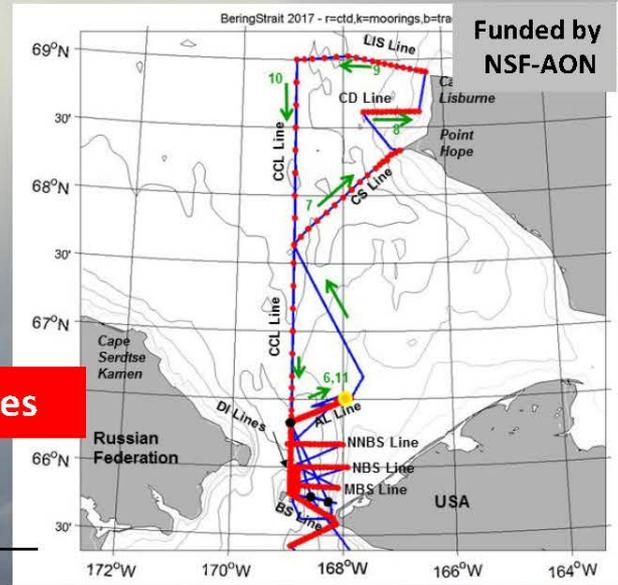
Bering Strait Mooring Program – Sept 2019 *Rebecca*

Woodgate University of Washington, Seattle, USA

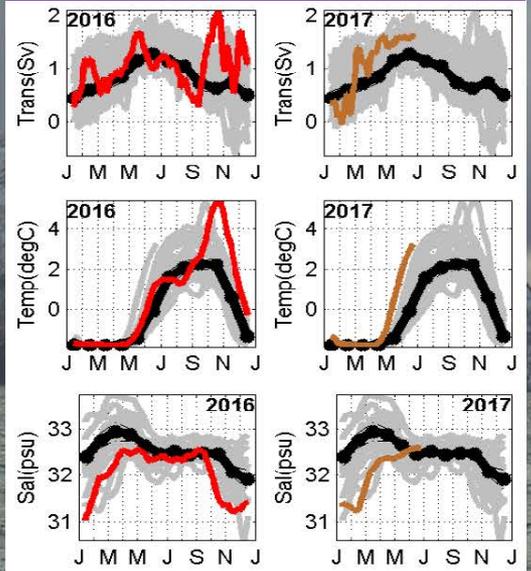


September 2018 Norseman 2 cruise recovered & redeployed the 3 Bering Strait moorings, and took CTD sections, finding the Chukchi remarkably warm.

Recovered data show:



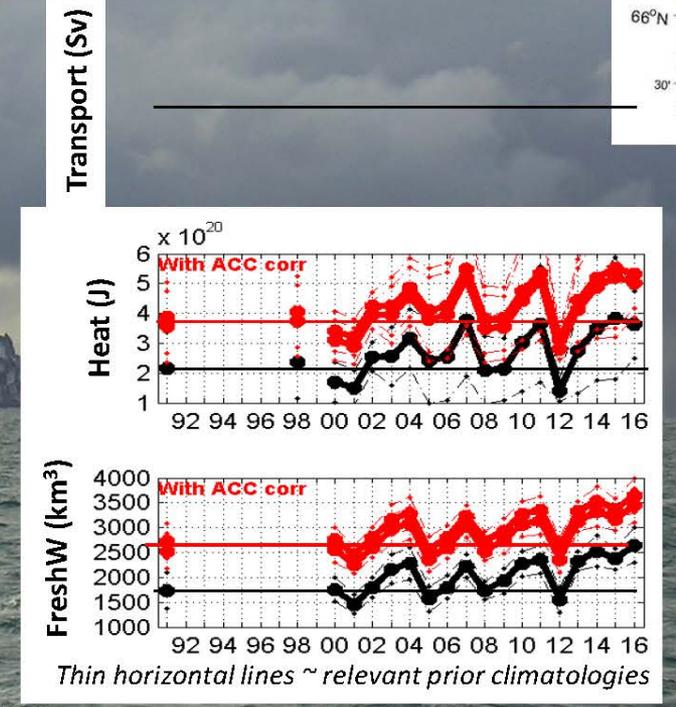
2016/2017 Remarkably warm & fresh



Color=2016 or 2017 30day smoothed data. Black = climatology; Grey=all past years

- * Oct 2016 & June 2017 both **3°C warmer** than climatology
- * ~20 day late cooling in 2016
- * ~15 day early warming in 2017
- * Salinities **0.5-1psu fresher** than climatology

Still Increasing annual mean fluxes



Trans $\geq 1\text{Sv}$; FW $\sim 3500\text{km}^3/\text{yr}$ (cf 34.8psu)
 Heat $\sim 5 \times 10^{20}\text{J}/\text{yr}$ $\sim 15\text{TW}$ (cf -1.9°C)

Recent papers document also:

- * trends in seasonal changes
- * flow increase driven by pressure head, far field forcing;
- * patterns of the pressure head forcing, finding **flow dominantly driven from the Arctic**

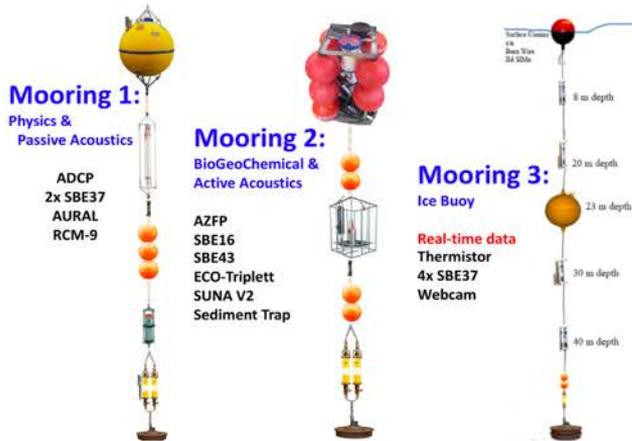
Woodgate 2017 in review PiO
Peralta-Ferriz & Woodgate 2017 GRL

Find data and papers at:
psc.apl.washington.edu/Bstrait.html

Chukchi Ecosystem Observatory (CEO)

71.6 °N
161.5 °W

September → August



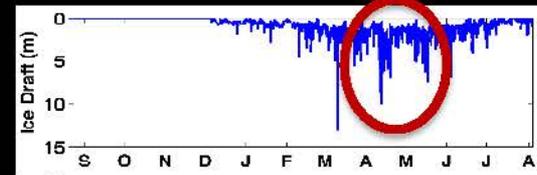
New in 2017-18
Discrete water sampler
for nutrients &
phytoplankton

- Developing a better mechanistic understanding of the Arctic marine ecosystem.
- Fostering coordination and cooperation among research programs: multiple site visits by research vessels each summer. **Let us know if you stop by!!**

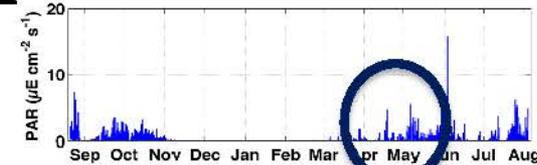
DATA AVAILABLE

sldanielson@alaska.edu

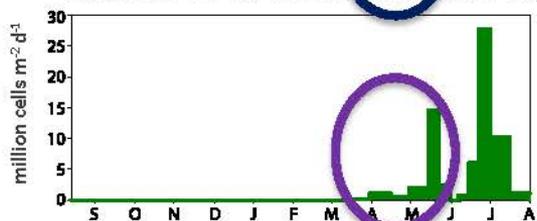
www.ChukchiEcosystemObservatory.org



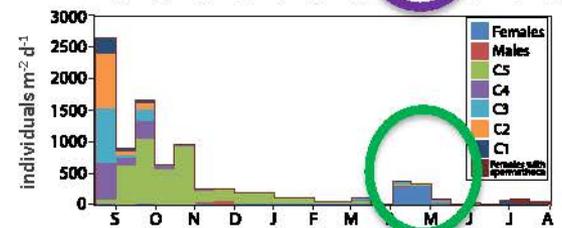
Ice Draft



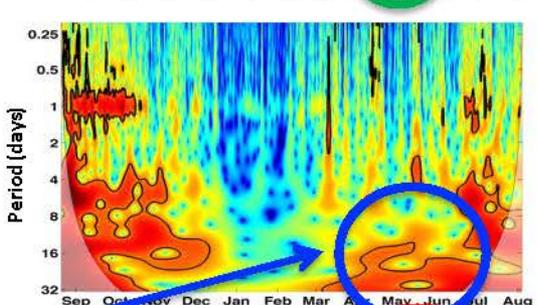
Light



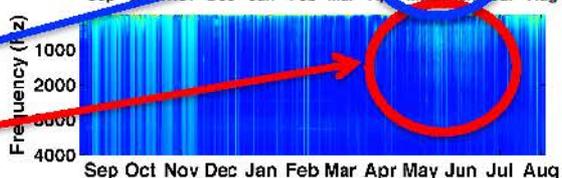
Ice Algae



Copepod
Zooplankton



Acoustic
Backscatter



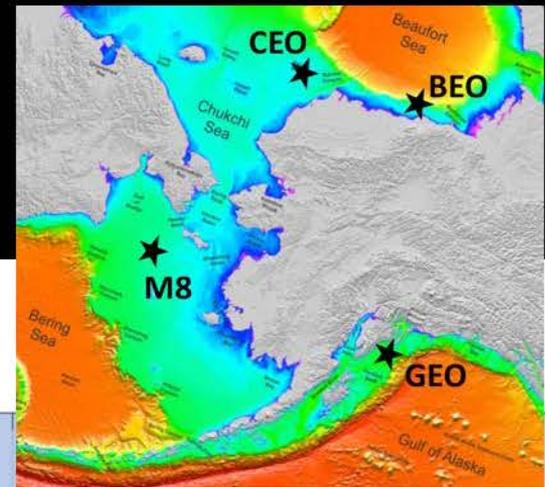
Acoustic
Sound
Recording

Arctic Cod

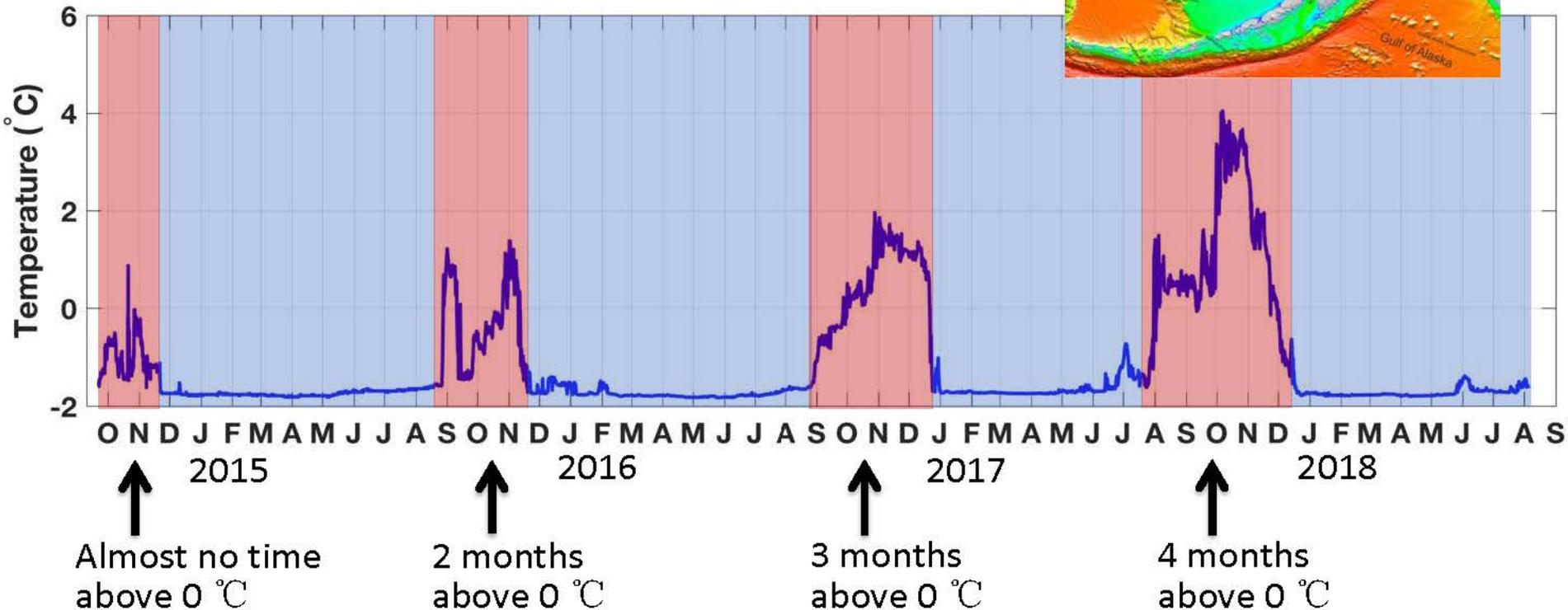
Bearded Seals

Chukchi Ecosystem Observatory (CEO)

New GEO site coming in 2019!



Near-Seafloor Temperature Sep. 2014 to Aug. 2018



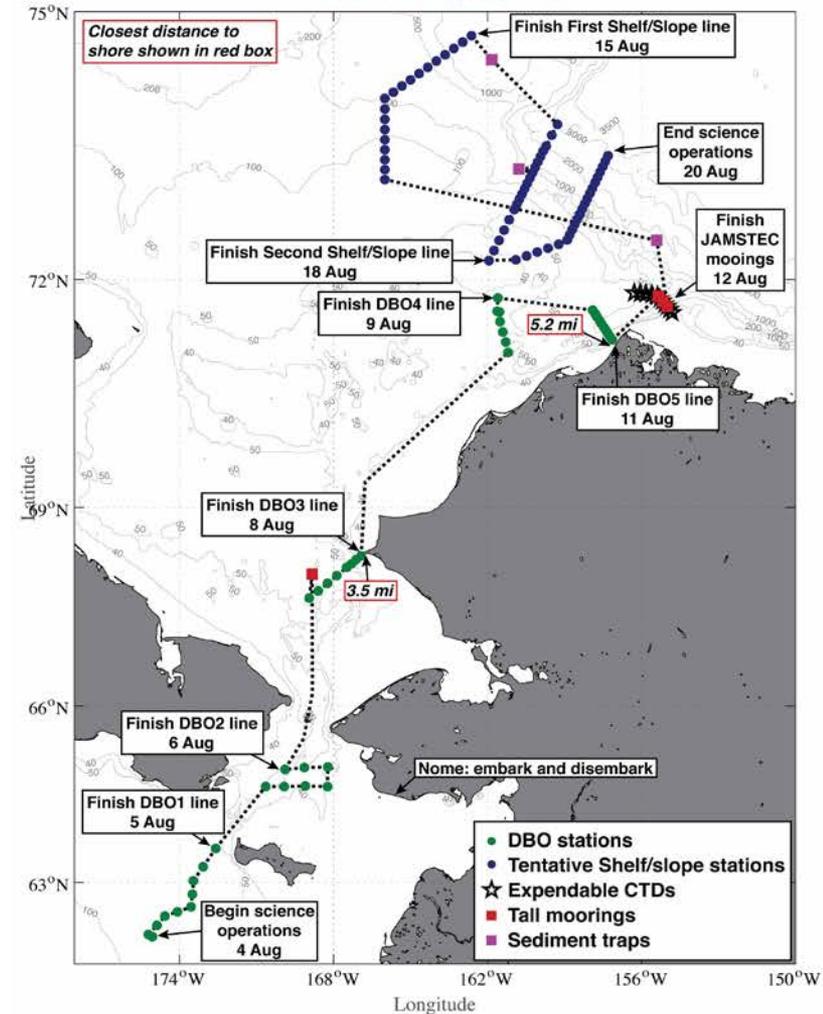
2019 DBO (Distributed Biological Observatory)-NCIS (Northern Chukchi Sea Integrated Study)

Aug 2-23, 2019 (Nome-Nome, Alaska)

Standard measurements and process studies (DBO1,2,3,4,5), Barrow Canyon,

- Physical: CTD and ADCP, mooring retrieval and replacement (JAMSTEC and NOAA)
- Chemical: nutrients, oxygen-18,
- Chlorophyll-a, carbon components, Harmful Algal Bloom (HAB) components
- Biological: Zooplankton and larval fish abundance and biomass
- Benthos: macrobenthos abundance, biomass and population structure
- Sediment: organic carbon/nitrogen content, chl-a content, grain size, radioisotopes, HABs
- Benthic oxygen uptake and nutrient exchange
- Marine mammal and seabird surveys

USCGC Healy cruise 1901
2 - 23 August, 2019
Draft as of April 1, 2019



Chief Scientist: Robert Pickart (WHOI)
and co: Jackie Grebmeier/UMCES:
jgrebmei@umces.edu

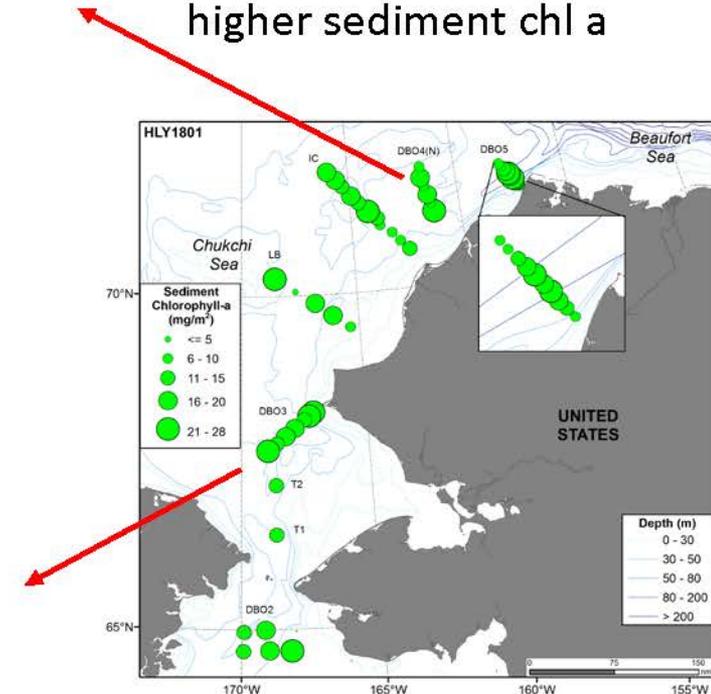


EcoFOCI
Ecosystems & Fisheries-Oceanography Coordinated Investigations

Contact: Phyllis Stabeno/NOAA:
phyllis.stabeno@noaa.gov

DBO-NCIS Hydrography and Sediment Chlorophyll a

DBO4: cold remnant winter water at bottom; higher sediment chl a



[R. Pickart]

[Grebmeier/Cooper]

DBO3: offshore colder, more saline Bering Sea water, nearshore warmer, less saline Alaska Coastal water; variable sediment chl a

BEAUFORT SHELF BREAK ECOLOGY – PLANKTON, FISH, AND BELUGAS

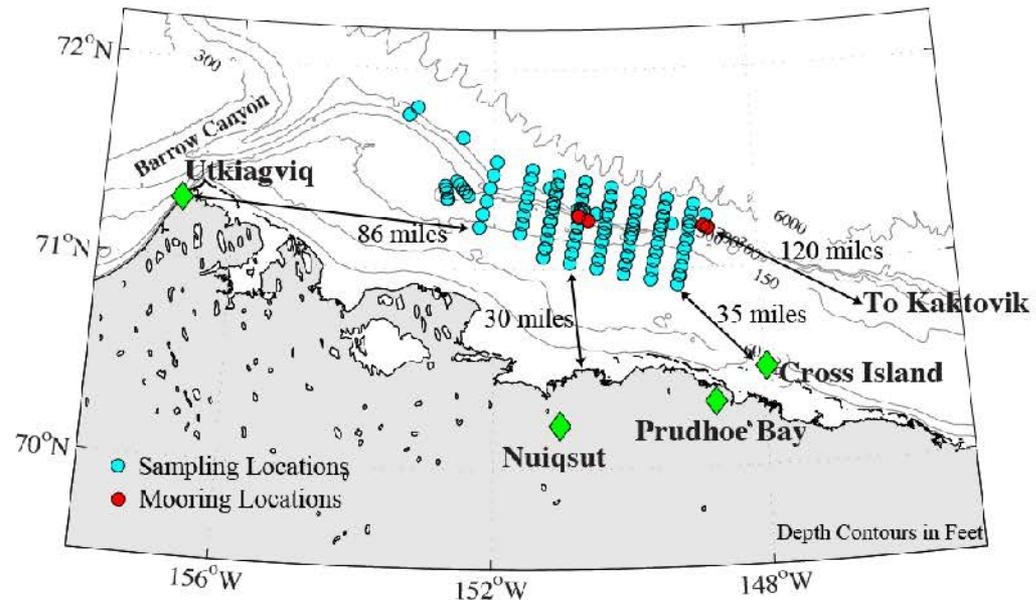
C. Ashjian, R. Campbell, M. Jech, K. Kuletz, J. Llopiz, M. Lowe, S. Okkonen, K. Stafford, J. Zhang

2019: retrieval two moorings only, no ship sampling



Potential Sampling Locations

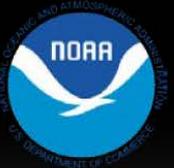
Aug. 3-27, 2018 (based on 2017 locations)



Cyan: station locations; Red: mooring locations

Arctic Integrated Ecosystem Survey II

Ed Farley, Carol Ladd, Kris Cieciel, Alex DeRobertis, Janet Duffy-Anderson, Lisa Eisner, Jeff Guyon, Dave Kimmel, Ron Heintz, Libby Logerwell, Phyllis Stabeno & Chris Wilson



Field sampling: Aug/Sep 2017 and 2019

Franz Mueter

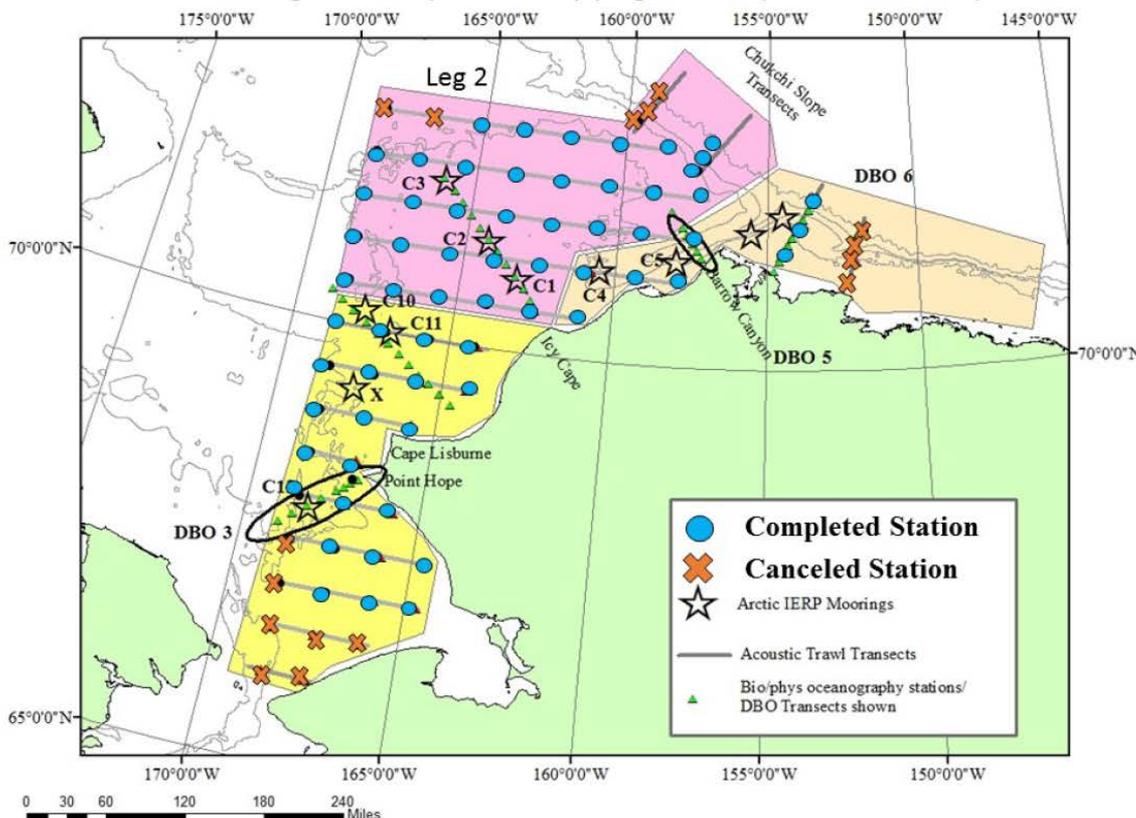
Louise Copeman

Ryan McCabe,
Calvin Mordy &
Danny Grunbaum

Kathy Kuletz



Arctic Integrated Ecosystem Survey (August 1 – September 28, 2017)



NORTH PACIFIC RESEARCH BOARD
Arctic
Program

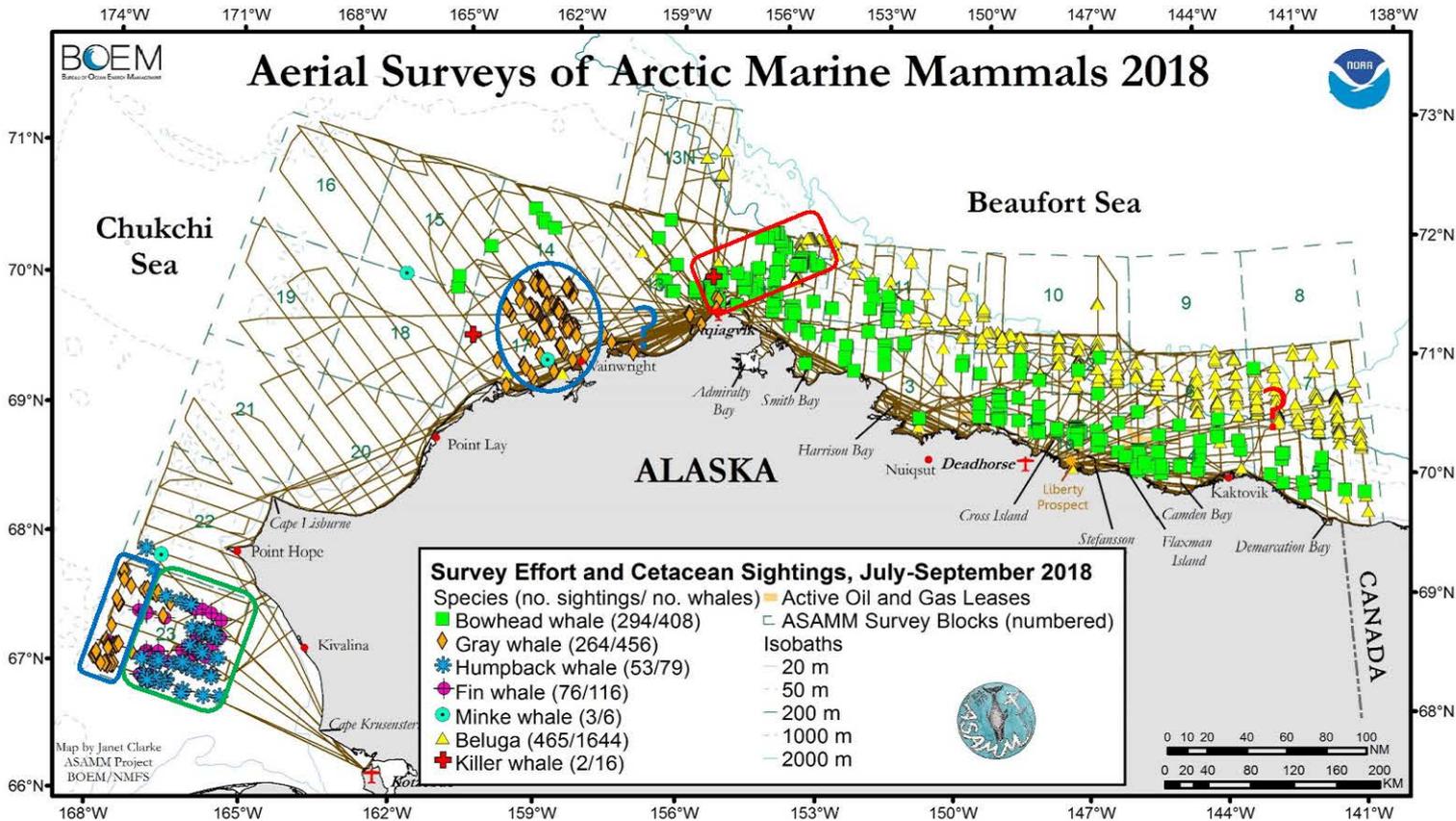
DBO 3, 4, 5, 6, and 7

2018

Bowhead whales – missing in summer (red question mark), when they have normally been found well offshore in deep water from July through early August*; lots of use of Barrow Canyon (red box); lowest calf count since summer surveys started in 2012.

Gray whales – continuing to show love for the area between Hanna Shoal and Wainwright (blue oval) and sustaining use of that area well into fall; pretty much abandoned the area between Pt. Franklin and Pt. Barrow; benthic hotspot in southern Chukchi (blue box) still active in summer but not much in fall; moderately low calf ratio compared to past years*.

Subarctics – the southern Chukchi continues to be quite attractive to fin whales and humpback whales (green box)*, although distribution was somewhat more limited than that observed in previous years.



DBO-3 – gray whale hot spot, humpbacks and other subarctic cetaceans

DBO-4 and DBO-5 – bowhead whales, gray whales, belugas nearshore

DBO-6 and DBO-7 – bowhead whales, belugas



<http://www.afsc.noaa.gov/NMML/cetacean/bwasp/>



BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

[Janet Clark]

Innovative Technology for Arctic Exploration



Jessica Cross, NOAA/PMEL, Seattle, Washington, USA



[DBO-NCIS August 2018, C. Wright]

2018 Saildrone Projects; now in water for 2019

Two Projects in the Pacific Arctic in 2018

Bering Strait & Chukchi Sea

July through September 2018

Ocean Acidification

- No active acoustics
- Assess important questions about physical circulation, ice melt, ecosystems, and ocean acidification in the region

Fisheries Survey

- Active acoustics
- Understand the fate of the age-0 Arctic cod and other pelagic fish species on the Chukchi shelf

FOR INFORMATION

Notice of Operations

<https://www.pmel.noaa.gov/itae/mariner-and-public-notice-research-platforms>

Saildrone Research Blog

<https://www.pmel.noaa.gov/itae/follow-saildrone-2018>

Email Updates – sign-up using

<https://goo.gl/forms/4fBQkg2GXp3obCn42>

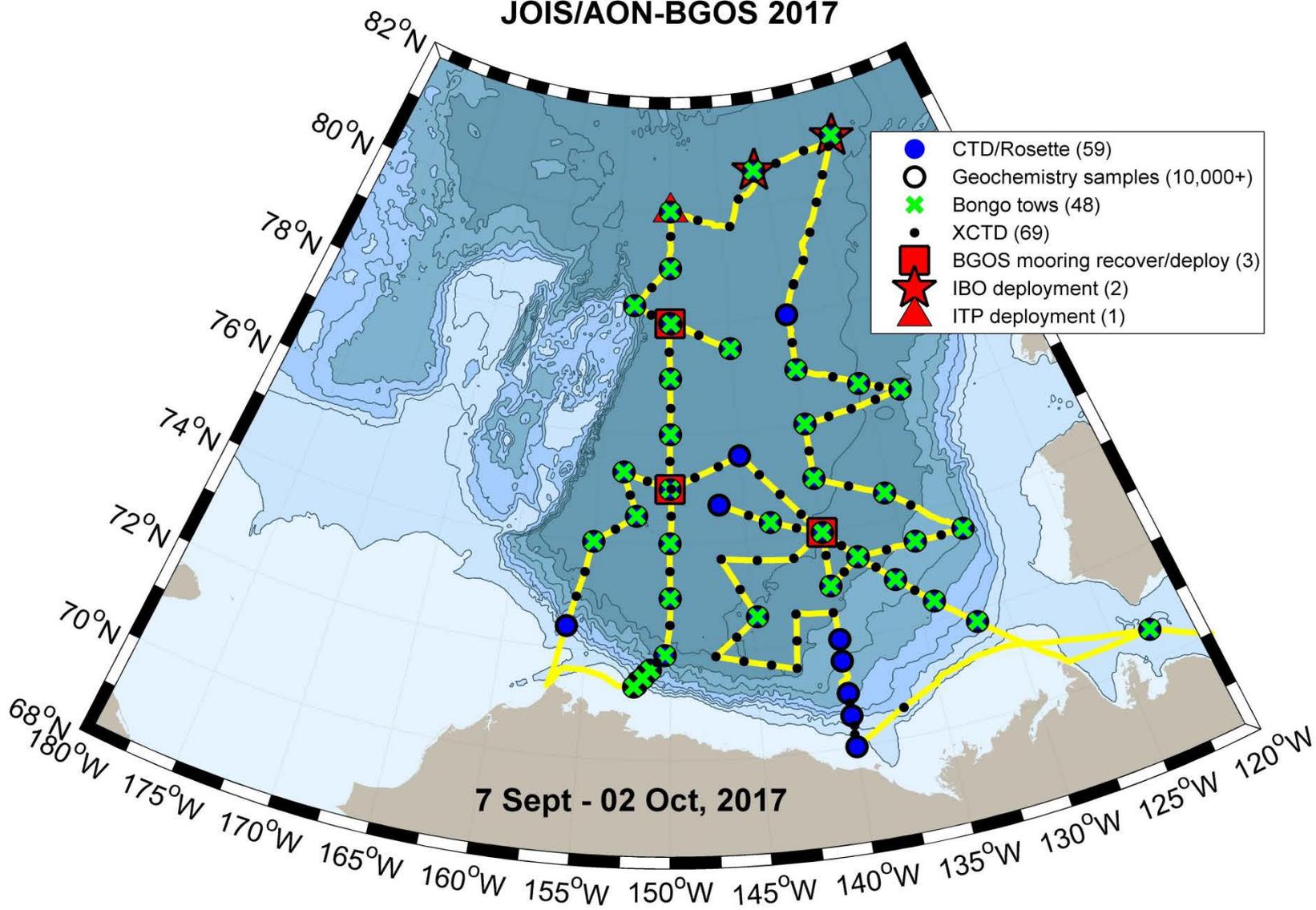
Contact

Heather Tabisola, Research Coordinator

heather.tabisola@noaa.gov, 206.526.6662



JOIS/AON-BGOS 2017

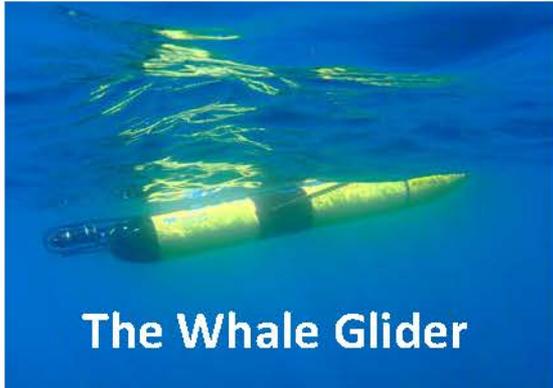


Beaufort Gyre Observing System: Canada and USA

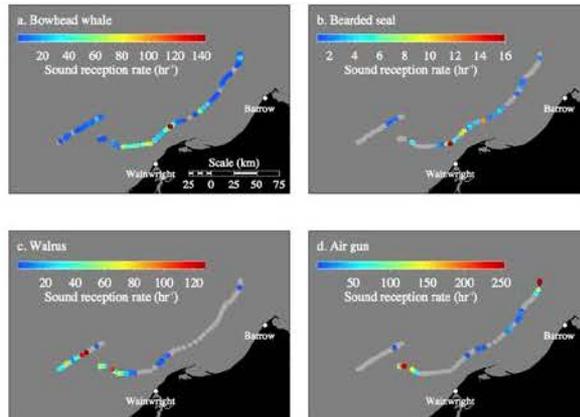
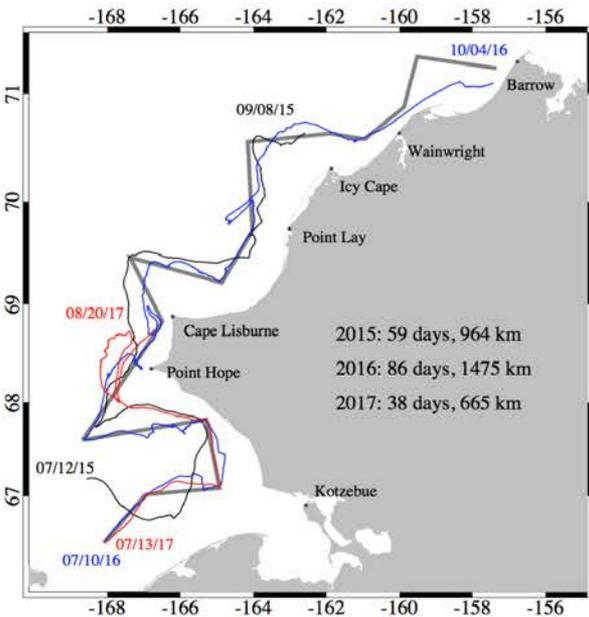
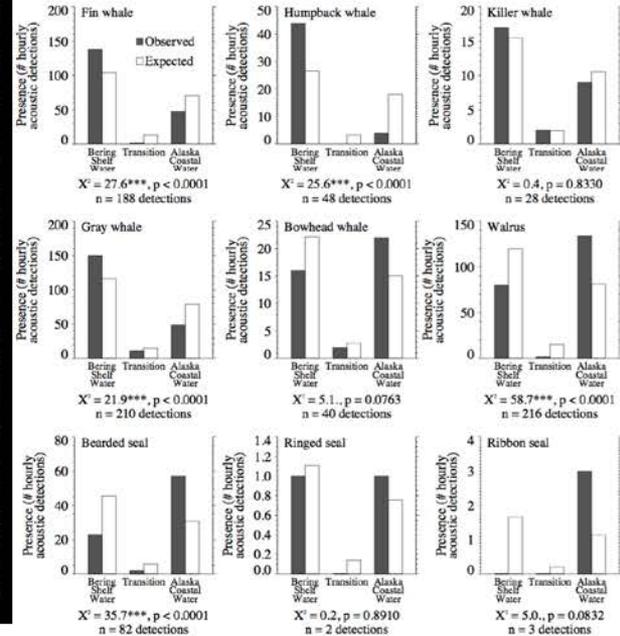
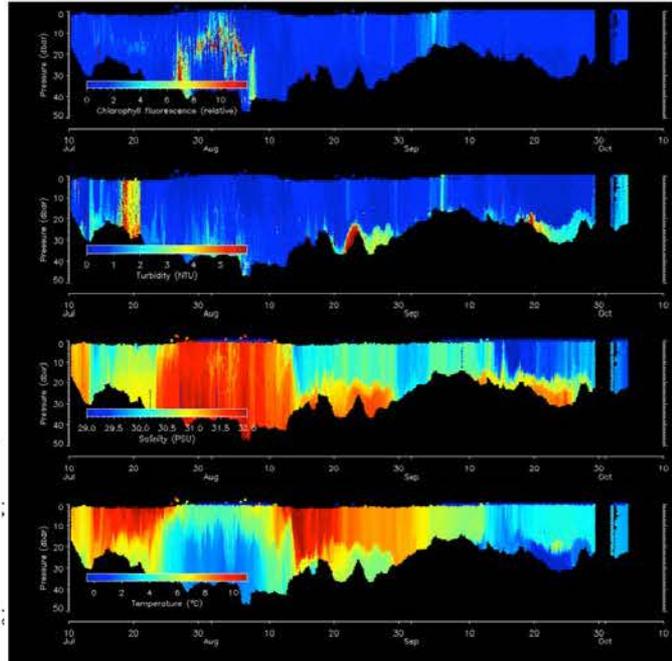
[see Bill Williams PAG 2018 talk for update]

Glider-Based Passive Acoustic Monitoring in the Arctic

Peter Winsor, Kate Stafford and Mark Baumgartner



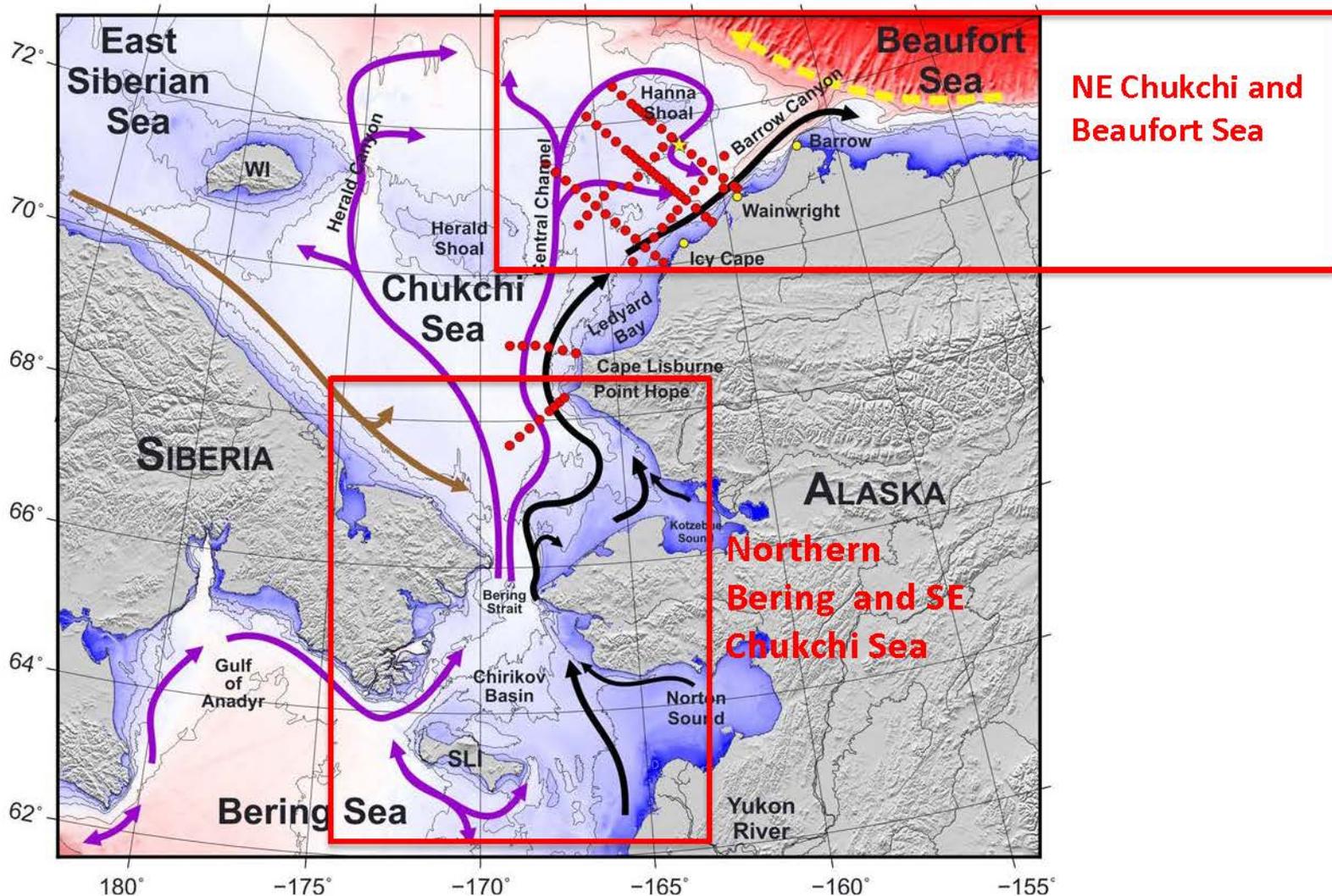
The Whale Glider



- 90+ days of Autonomous Measurements in Real-Time
- Passive Acoustics, CTD and Bio-optics in a single package

Science access during subsistence whaling: April-May and Sept-Oct periods

- need to interface with coastal communities through new Arctic Waterways Safety Committee to interface with Alaska Eskimo Whaling Commission, Eskimo Walrus Commission, and other parties; see <http://www.arcticwaterways.org/>



[modified from S. Danielsen map 2015]

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, and ongoing national and international science partners in the Pacific Arctic Group.

<http://arctic.cbl.umces.edu> , <http://www.arctic.noaa.gov/dbo>

<http://pag.arcticportal.org>

<http://neptune.gsfc.nasa.gov/csb/index.php?section=270>

<http://arcticdata.io> (*Arctic Data Center, then use DBO as search term*)

<http://ambon-us.org/>, <https://mbon.ioos.us/>

<http://www.ChukchiEcosystemObservatory>

