

Update on Pacific Arctic Group (PAG) activities

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FARO Meeting

June 18, 2018

Arctic Science Summit Week 2018

Davos, Switzerland



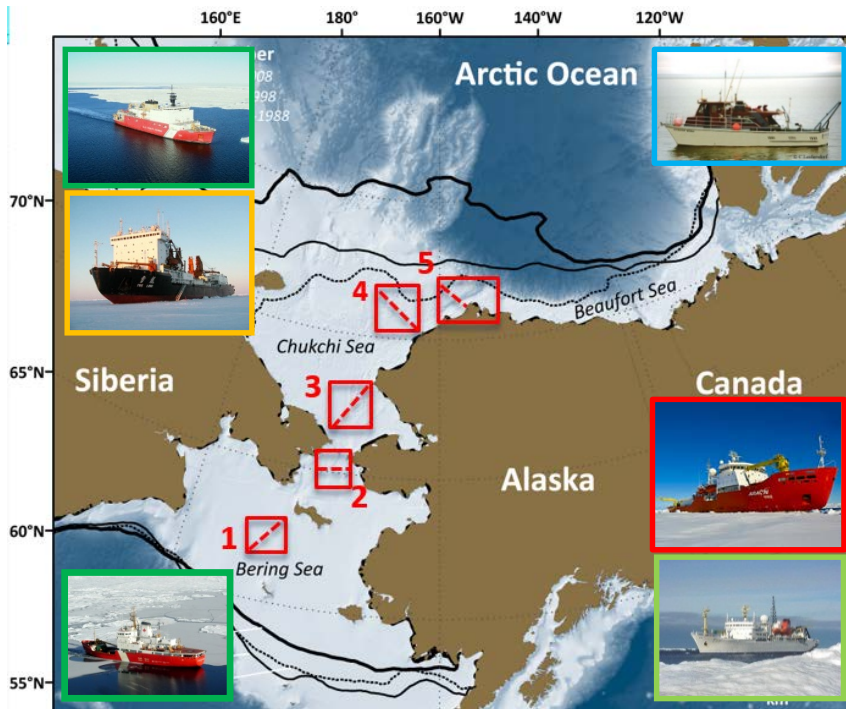
<http://pag.arcticportal.org/>



Pacific Arctic Group (PAG) joint activities

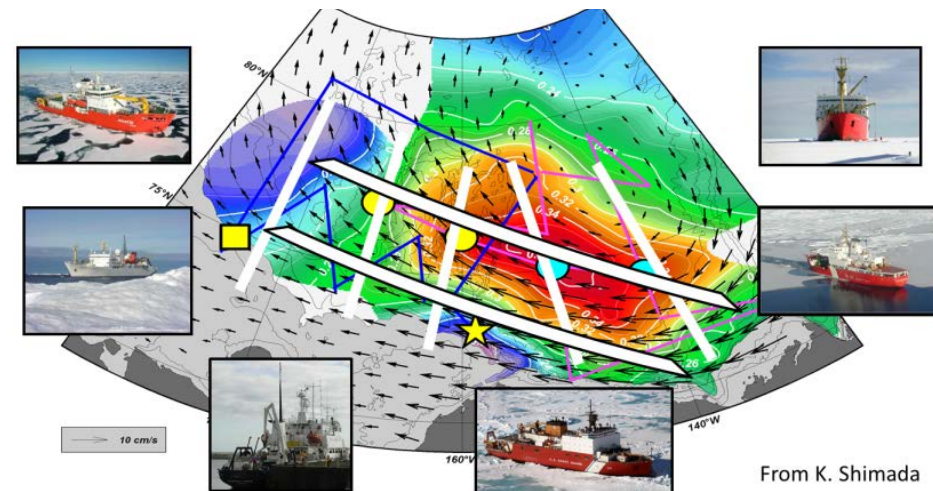
- PAG continues to develop and implement long-term monitoring activities such as
 - ✓ Distributed Biological Observatory (DBO) and
 - ✓ Pacific Arctic Climate Ecosystem Observatory (PACEO)

Distributed Biological Observatory (DBO)



[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]

Pacific Arctic Climate Ecosystem Observatory (PACEO)



From K. Shimada

Background color: dynamic height at 100dbar relative to 800dbar from Mirai and Louis S. St-Laurent 2008 cruises (Oceanic Beaufort Gyre)

Black vectors: average sea ice motion vectors for Nov. 2007- Apr. 2008 (Sea Ice Beaufort Gyre)

Symbols: Mooring array in 2012-2013 (TUMSAT/KOPRI/NIPR & WHOI)

2018 PAG and DBO Cruise Plan Table (06-17-18)

2018 PAG and DBO Field Season (version 06_17_18): Sampling Contributors. Projects Key: AON=US Arctic Observing Network (National Science Foundation); ArCS=Arctic Challenge for Sustainability; ArcticEIS2=Arctic Ecosystem Integrated Survey, ASGARD=Arctic Shelf Growth, Advection, Respiration and Deposition Rate Experiment, C30=Canada's Three Oceans; CHINARE=Chinese Arctic Research Expedition; DBO=Distributed Biological Observatory, JAMSTEC= Japan Agency for Marine-Earth Science and Technology; KOPRI = Korea Polar Research Institute; NOAA=National Oceanic and Atmospheric Administration; Office of Naval Research (ONR) Marginal Ice Zone (MIZ) project; PMEL=Pacific Marine Environmental Laboratory; RUSALCA=Russian-American Long-term Census of the Arctic. **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 2018 (Port calls) | Ship | DBO Region | Projects | PAG contact | Chief Scientist |
|--|------------------------|------------|--|---|--|
| June 1-25 (Seward-Nome) | Sikuliaq | 2, 3 | ASGARD | Seth Danielson sldanielson@alaska.edu | Seth Danielson sldanielson@alaska.edu |
| June 25-July 15 (Dutch Harbor-Dutch Harbor) | Oshoro-maruru | 1,2,3 | ArCS project | Toru Hirawake hirawake@salmon.fish.hokudai.ac.jp | Toru Hirawake hirawake@salmon.fish.hokudai.ac.jp |
| July 12-24 (Dutch-Barrow) | Sir Wilfrid Laurier | 1,2,3,4,5 | C30/DBO (AON) | Jackie Grebmeier jgrebmei@umces.edu | John Nelson John.Nelson@dfo-mpo.gc.ca |
| July-Sept (Shanghai-Shanghai) | Xuelong | 3 | CHINARE | Jianfeng He hejianfeng@pric.org.cn | Jianfeng He hejianfeng@pric.org.cn |
| Aug 3-27 (Nome-Nome) | Sikuliaq | 6 | Shelf Break Ecology | Frank Rack frack@nsf.gov | Carin Ashjian cashjian@whoi.edu |
| Aug 27 – Sept 20 (Dutch-Nome-Nome-Dutch) | F/V Northwest Explorer | 1,2 | Northern Bering Sea Assessment | Ed.Farley@noaa.gov | Kris Ciciel, kristin.ciciel@noaa.gov (Leg 1); Ed Farley, ed.farley@noaa.gov (Leg 2) |
| Late August (Nome-Barrow) | Araon | | K-AOOS (Korea-Arctic Ocean Observing System) | Sung-Ho Kang shkang@kopri.re.kr | Sung-Ho Kang shkang@kopri.re.kr |
| Aug 7-24 (Nome-Nome) | Healy | 2,3,4,5 | Eco-FOCI-DBO/NCIS | 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 22-Oct 6 (Dutch Harbor-Kodiak) | Dyson | 1 and M8 | EcoFOCI | Phyllis Staben, Phyllis.staben@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 |
| Oct | Sir Wilfrid Laurier | 4,8 | C30 | Bill.Williams@dfo-mpo.gc.ca | Humfrey.Melling@dfo-mpo.gc.ca |
| Late Oct-Nov | Healy | 5,6 | Western Arctic boundary current in a warming climate | Robert Pickart rpickart@whoi.edu | Robert Pickart rpickart@whoi.edu |
| Oct 25-Dec 7 (Sekinehama, Japan, return Shimizue, Japan) | Mirai | - | Japanese Atmospheric cruise; National Institute of Polar Research (NIPR) | Takashi Kikuchi takashik@jamstec.go.jp | Dr. Inoue inoue.jun@nipr.ac.jp |

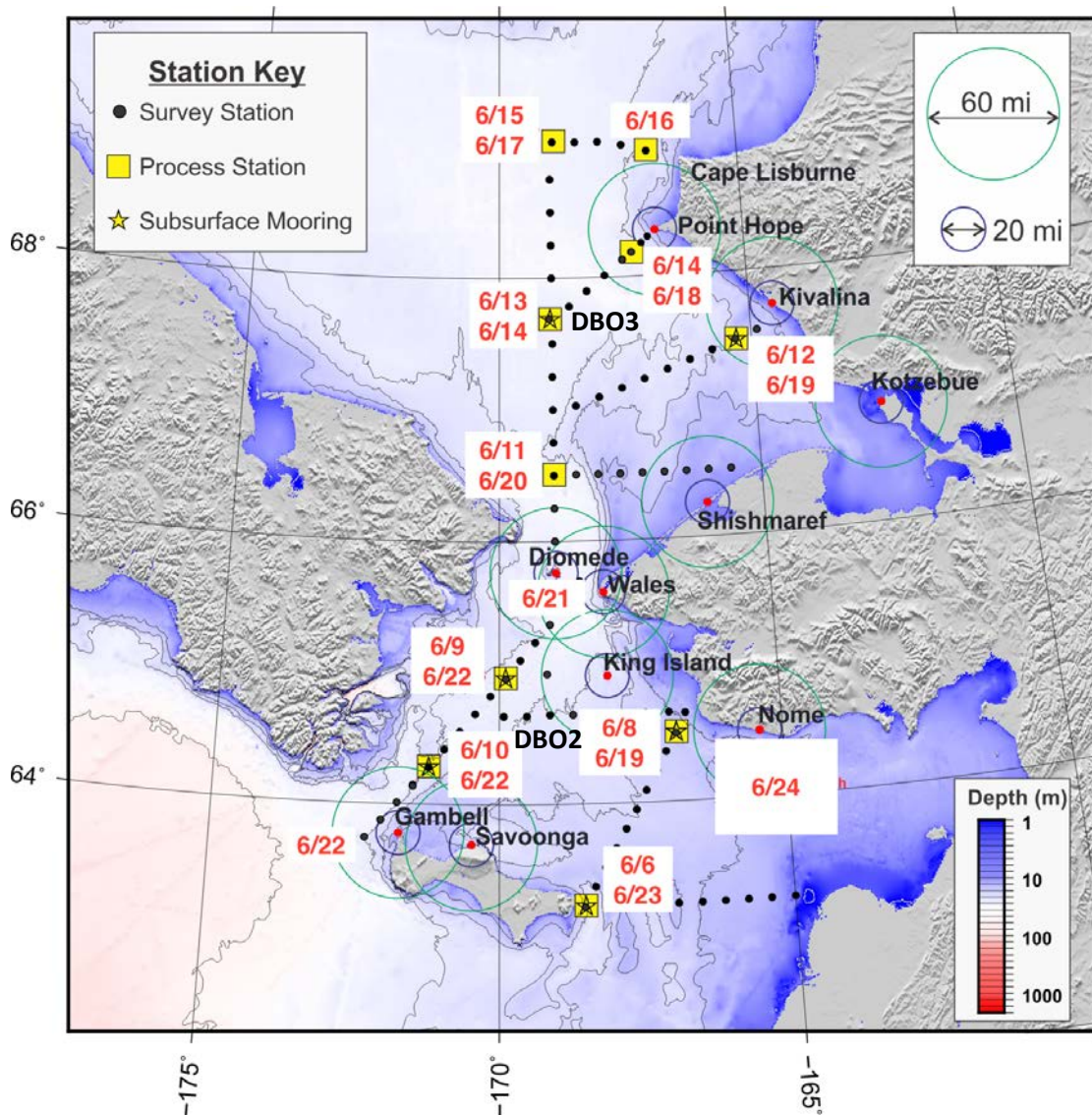
ASGARD Project

1st: Process Studies

Set up experiments that require multi-day incubations. Deploy moorings. Epibenthic fish sampling.

2nd: Synoptic Surveys

Multi-station transects that cross biogeographical domains. More fishing.



- June 2017 and 2018 on R/V Sikuliaq
- 2017/18 and 2018/19 moorings

[Seth Danielson, UAF]

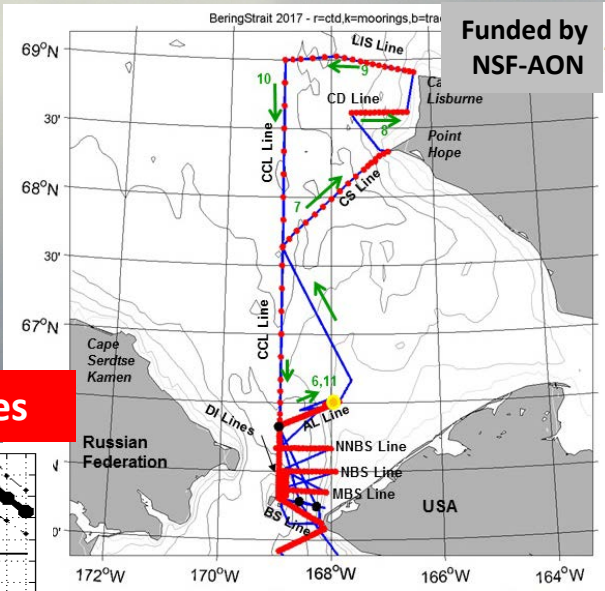
Bering Strait Mooring Program – July 2017/Sept 2018

Rebecca Woodgate University of Washington, Seattle, USA

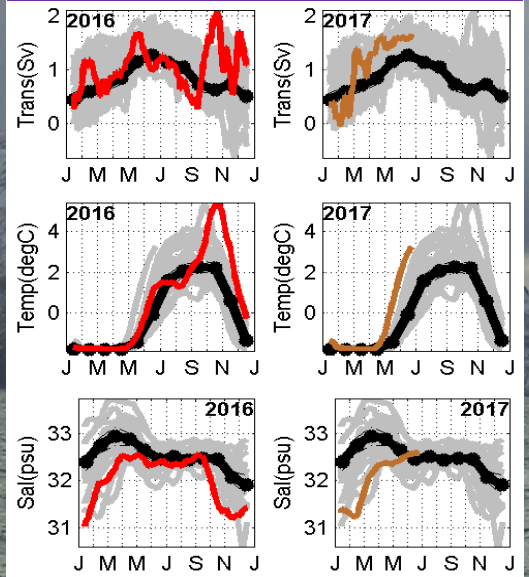


Our July 2017 Norseman 2 cruise recovered & redeployed the 3 Bering Strait moorings, and took CTD sections, finding the Chukchi remarkably warm.

Recovered data show:

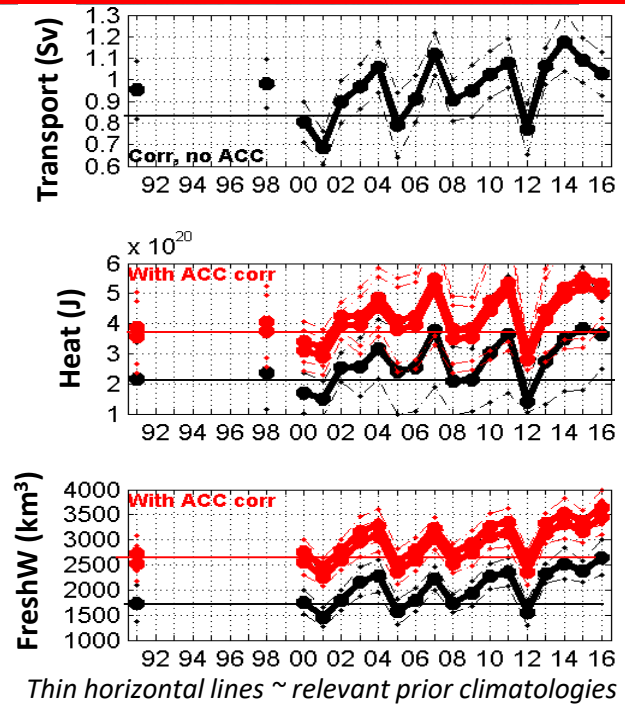


2016/2017 Remarkably warm & fresh



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

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)

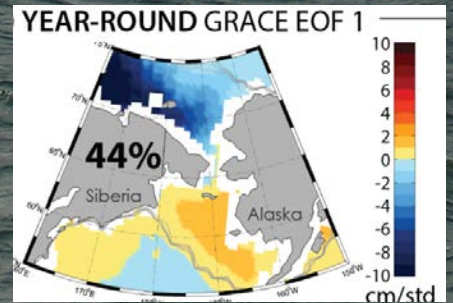
Recent papers document also:

- * 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

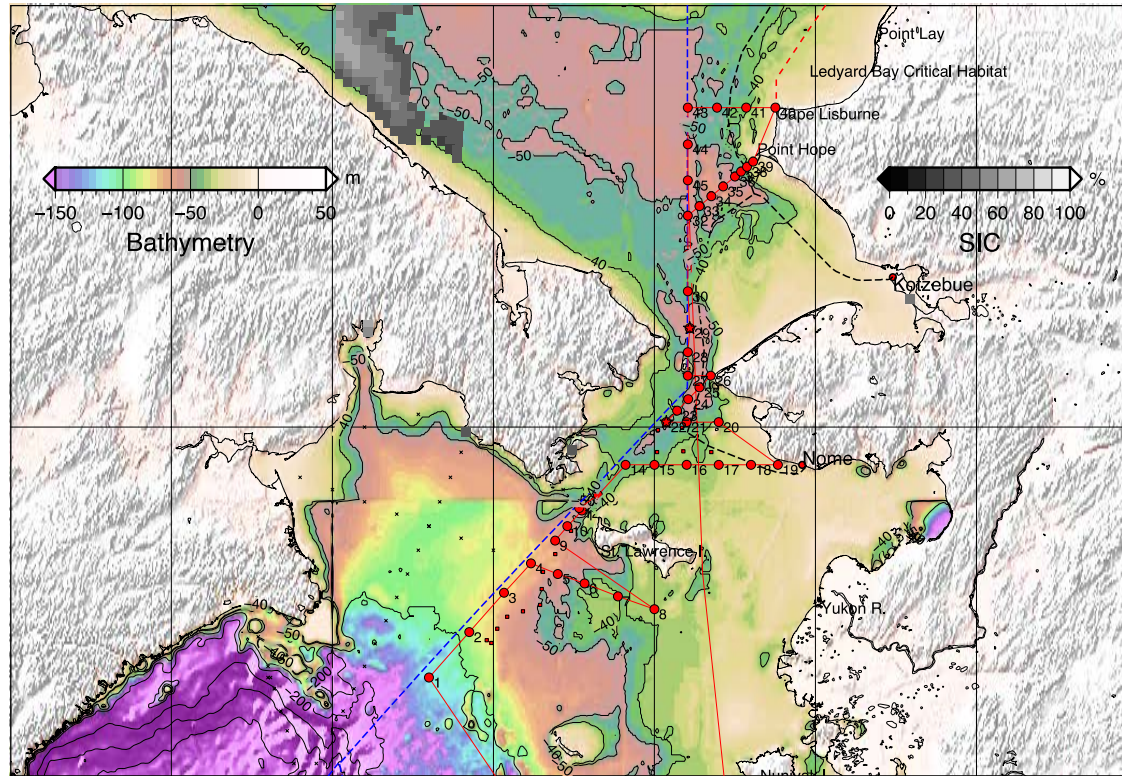
Woodgate 2017 in review PiO
Peralta-Ferriz & Woodgate 2017 GRL

- * 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

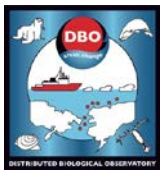
Find data and papers at:
psc.apl.washington.edu/Bstrait.html



T/S Oshoro-Maru 2018 (ArCS project)



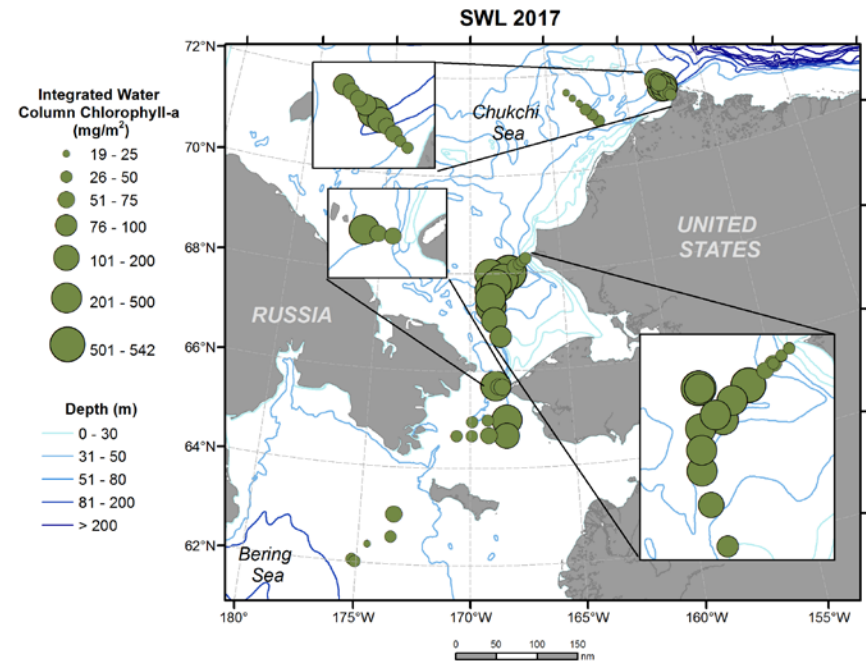
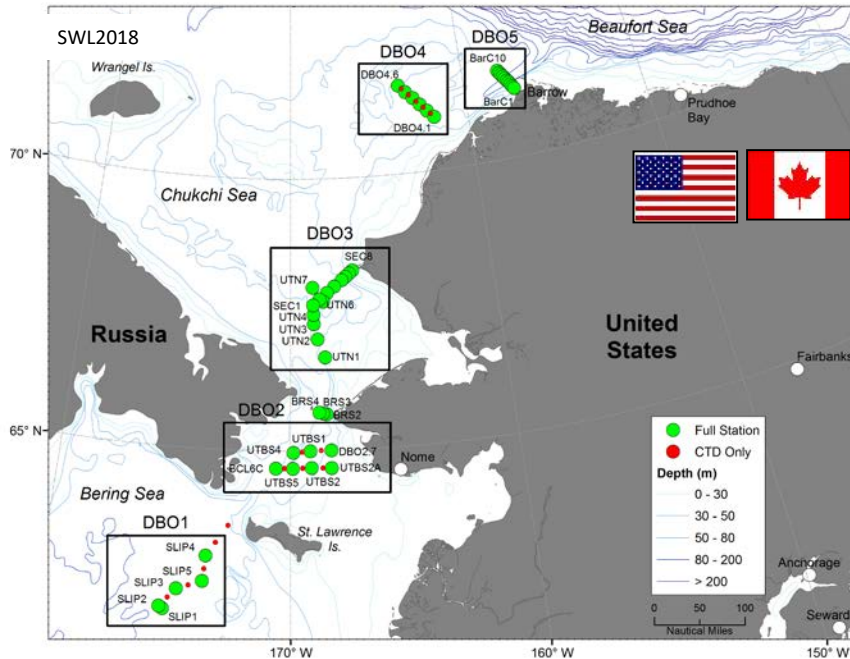
- June 29–July 15, Dutch Harbor - Chukchi Sea - Dutch Harbor
- Chief Scientist: Toru Hirawake hirawake@salmon.fish.hokudai.ac.jp
- Objectives: (1) To reveal mechanism and processes of high primary production in the Northern Bering and Southern Chukchi Seas and impact on higher trophic levels. To investigate pollutant materials in biology and sediments.
- <https://www.arcs-pro.jp/en/project/collaborated/06.html>



Canada's Three Oceans (C30) and the DBO: *CCGS Sir Wilfrid Laurier*, July 12-24, 2018



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



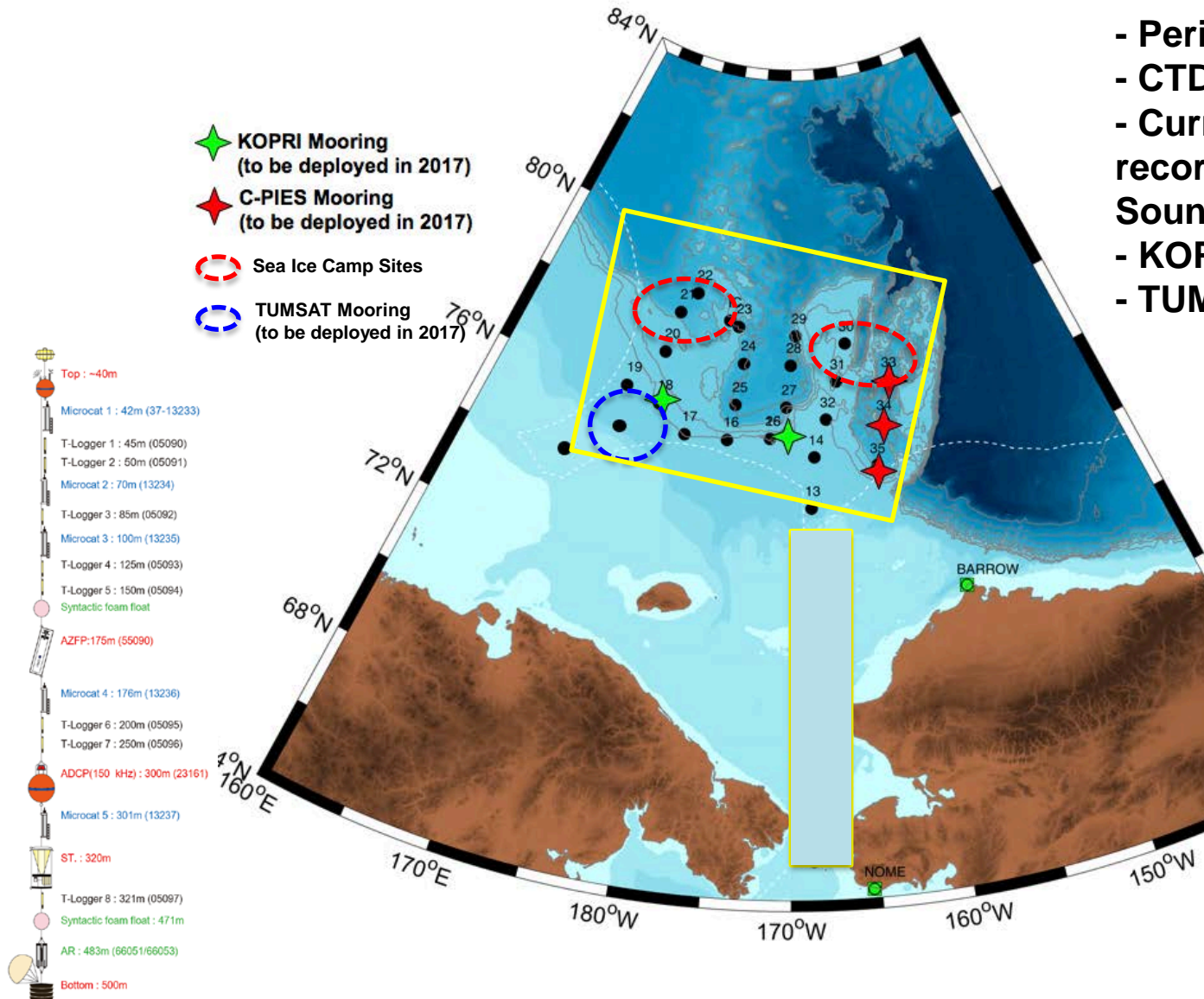
DBO data collections

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

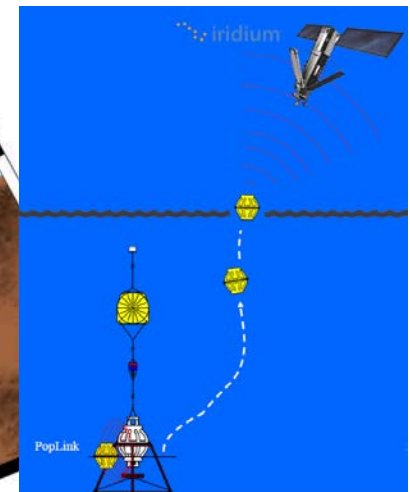
Contacts: John Nelson
John.Nelson@dfo-mpo.gc.ca and
 Jackie Grebmeier
jgrebmei@umces.edu



2018 ARAON Cruise Plan: Station Map



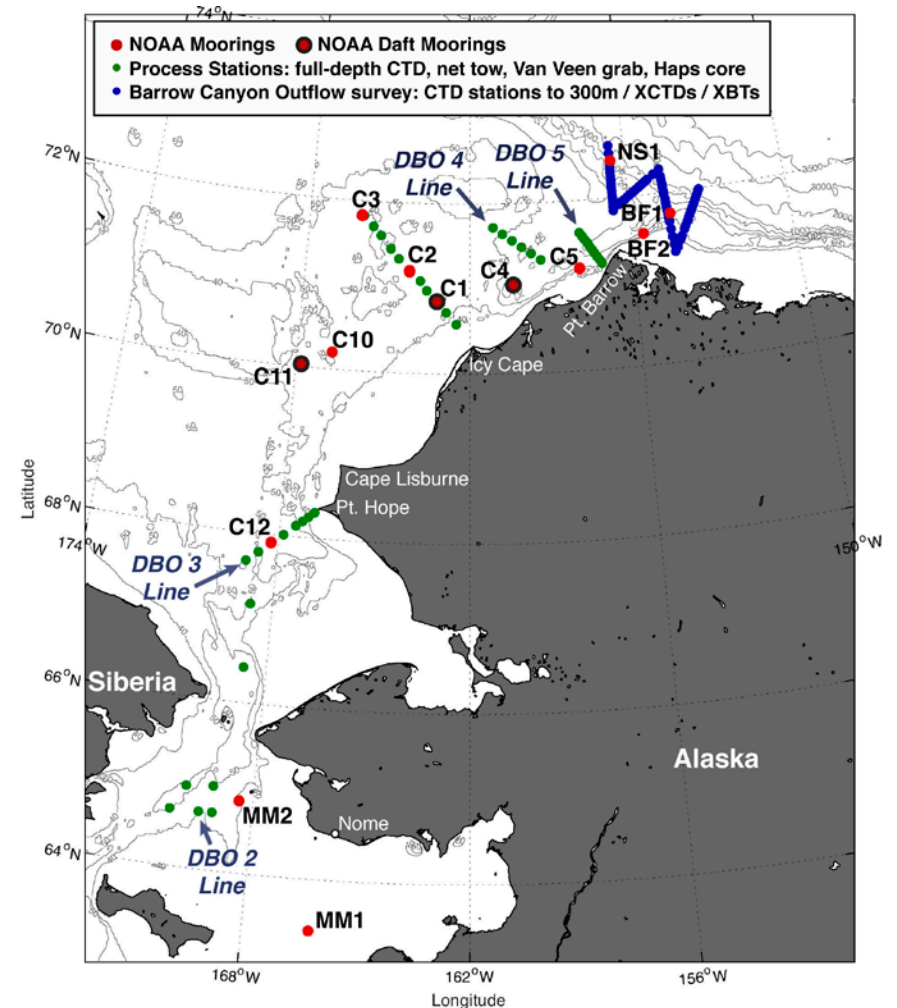
- Period: Aug to Sep
- CTD stations: 35~40
- Current & Pressure-recording Inverted Echo Sounder (C-PIES): 3
- KOPRI mooring: 4-5
- TUMSAT mooring: 2



2018 EcoFOCI & DBO-NCIS (Northern Chukchi Sea Integrated Study) (NOAA PMEL, UMCES, WHOI) Aug 7-24, 2018 (Nome-Nome, Alaska)

Standard measurements and process studies (DBO 2,3,4,5), Barrow Canyon, and EcoFOCI mooring array

- Physical: CTD and ADCP, mooring retrieval and replacement
- Chemical: nutrients, oxygen-18, Chlorophyll-a, carbon components
- Biological: Zooplankton abundance and biomass
- Benthos: macrobenthos abundance, biomass and population structure
- Sediment: organic carbon/nitrogen content, chl-a content, grain size, radioisotopes
- Benthic oxygen uptake and nutrient exchange
- Marine mammal and seabird surveys



EcoFOCI

Ecosystems & Fisheries-Oceanography Coordinated Investigations

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



DBO: Distributed Biological Observatory

Contact: Jackie Grebmeier/UMCES:
jgrebmei@umces.edu



Moored Chukchi Ecosystem Observatory (CEO) near Hanna Shoal

Year-round high-resolution time series

Current Speed & Direction

Pressure

Temperature

Salinity

PAR

Chlorophyll *a* fluorescence

Directional Wave Spectra

Acoustic Backscatter

@ 38, 125, 200, & 455 KHz

Ice Draft (level ice & keels)

Significant Wave Height & Direction

CDOM

Nitrate

Dissolved Oxygen

Optical Backscatter

Passive acoustic recordings

pH

pCO₂

Particle size spectra & concentrations

Water Sampler:

Nutrients

Phytoplankton identification

Sediment Trap:

Chlorophyll *a*

Phytoplankton identification

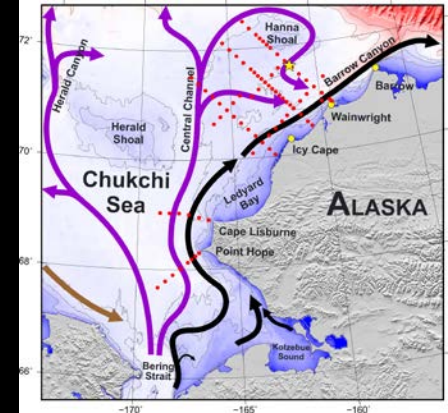
Total particulate matter (dry wt.)

Particulate organic carbon

Particulate nitrogen

Zooplankton species

Zooplankton fecal pellets



CEO Relevance

- Developing a better mechanistic understanding of the Arctic marine ecosystem.
- Fostering coordination and cooperation among research programs.
- Enhancing information availability with scientific data, analyses, and products tailored to public stakeholders.

CEO-affiliate scientists: Seth Danielson, Carin Ashjian, Lee Cooper, Jackie Grebmeier, Claudine Hauri, Russ Hopcroft, John Horne, Katrin Iken, Catherine Lalande, Andy Mahoney, Andrew McDonnell, Kate Stafford, Peter Winsor

www.ChukchiEcosystemObservatory for more information

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

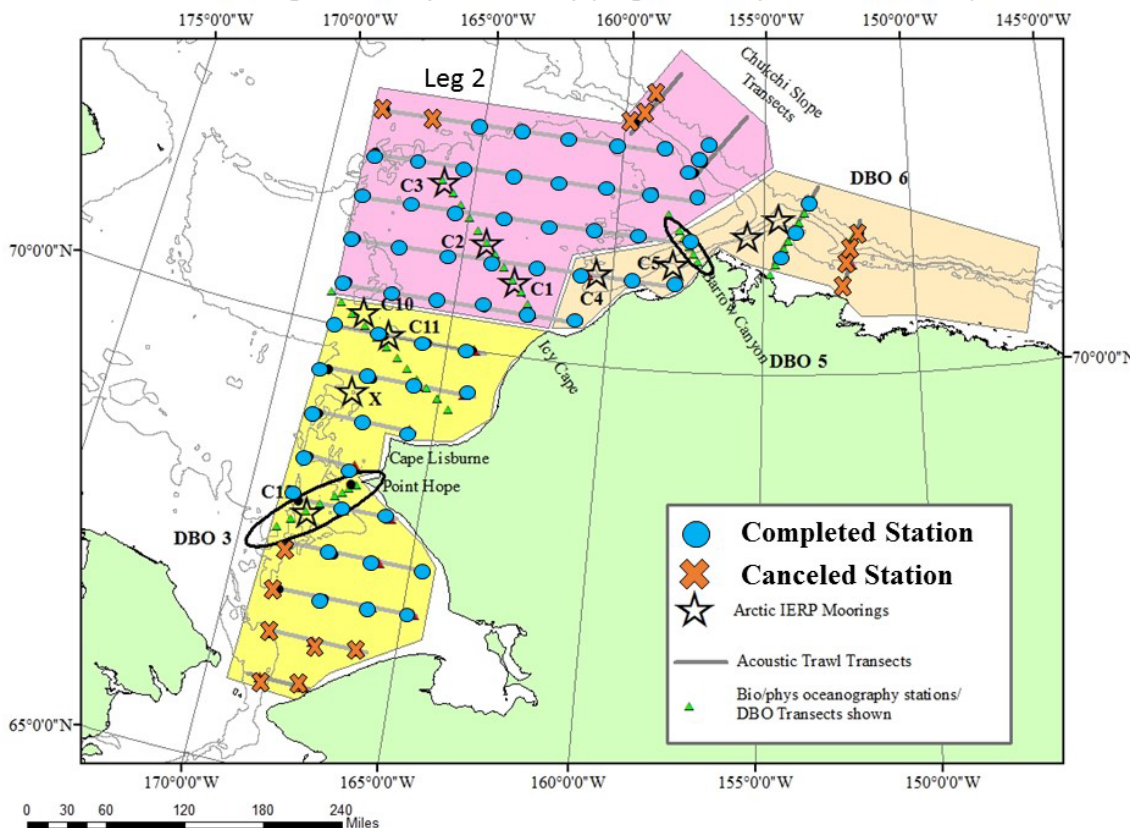
Louise Copeman

Ryan McCabe,
Calvin Mordy &
Danny Grunbaum

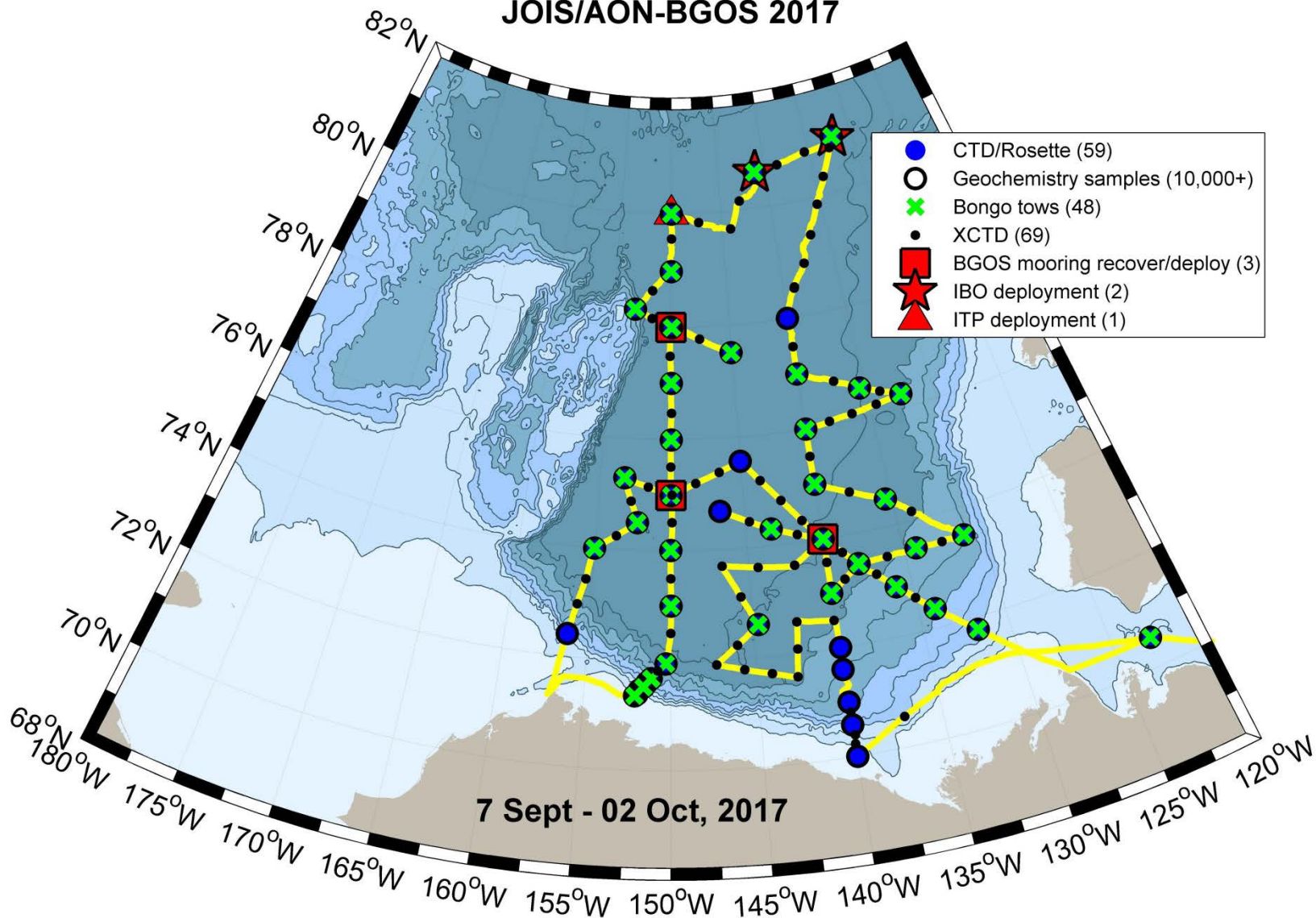
Kathy Kuletz



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

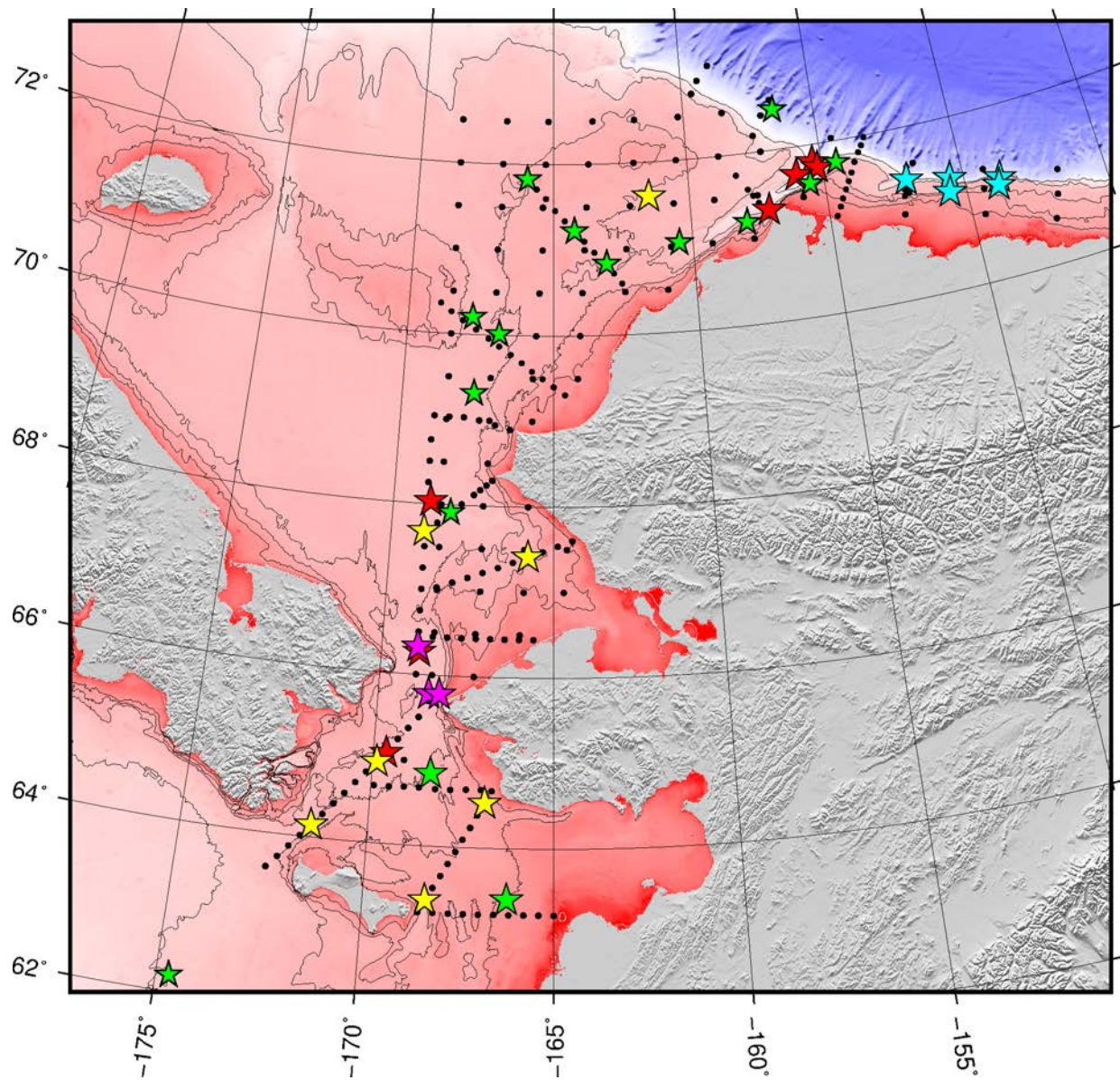


JOIS/AON-BGOS 2017



JOIS=Joint Ocean-Ice Study; AON=Arctic Observing Network;
BGOS=Beaufort Gyre Observing System

(courtesy Bill Williams, IOS/DFO)



AIERP & Other 2017-2018 Moorings

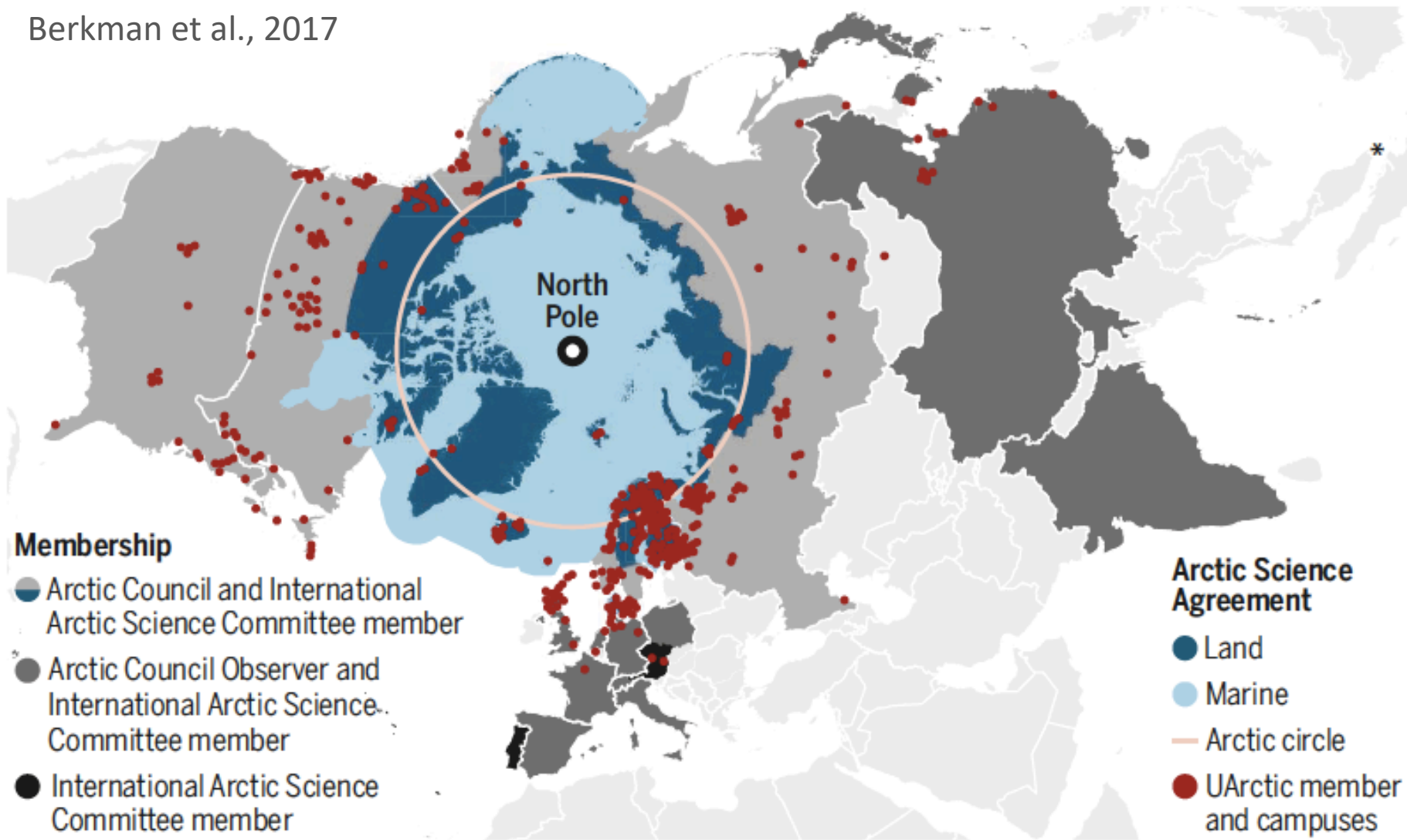
- UAF
- NOAA PMEL & NMML
- UW-APL
- ArCS & JAMSTEC
- WHOI & WHOI/UAF

[courtesy Seth
Danielson/UAF]



Agreement

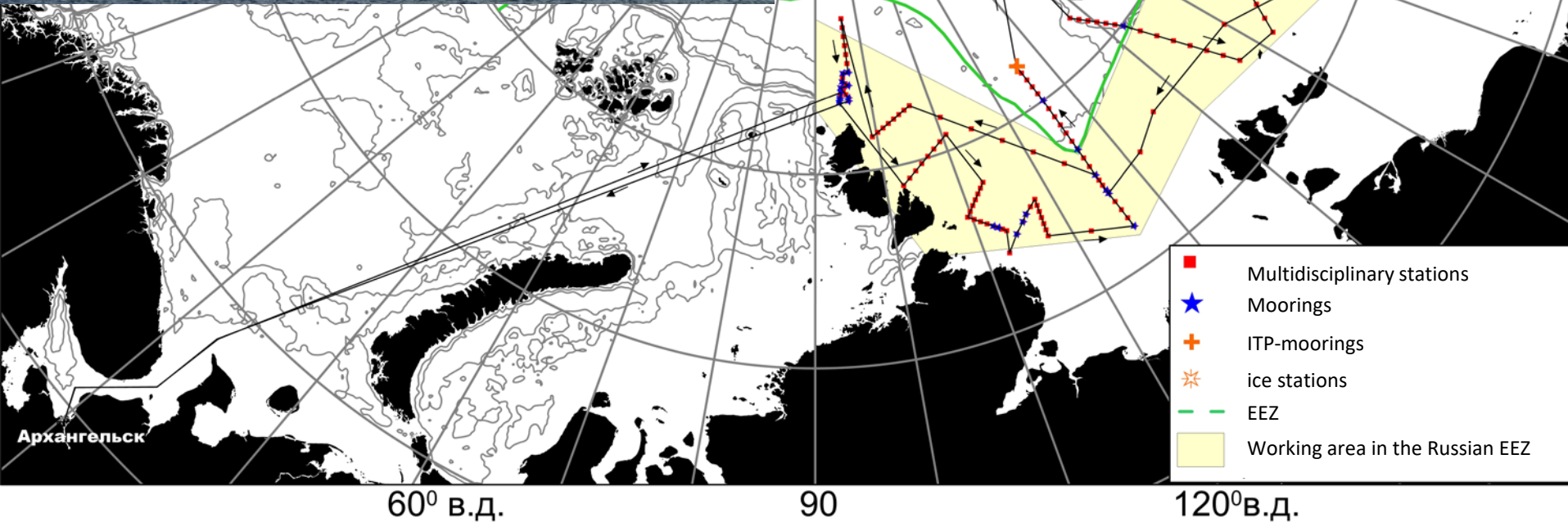
Berkman et al., 2017



*Singapore is an Arctic Council Observer State.

Land and ocean areas covered by the Arctic Science Agreement

Expedition ARCTIC 2018 (10.8.- 06.10.18)



In cooperation with the international projects
CATS – The Changing Arctic Transpolar System , NABOS and TICE (AWI)

Thank you for your attention.

Questions and comments?

Financial support from the NOAA, NSF, and international partners within
the Pacific Arctic Group

<http://www.arctic.noaa.gov/dbo/>

<http://pag.arcticportal.org/>

