

# The Pacific Distributed Biological Observatory: A Change Detection Array in the Arctic

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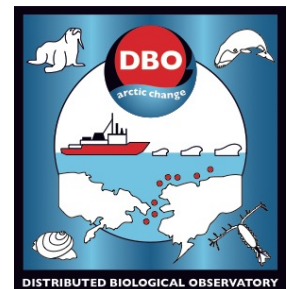
Solomons, Maryland, USA

**Pacific Arctic Group**

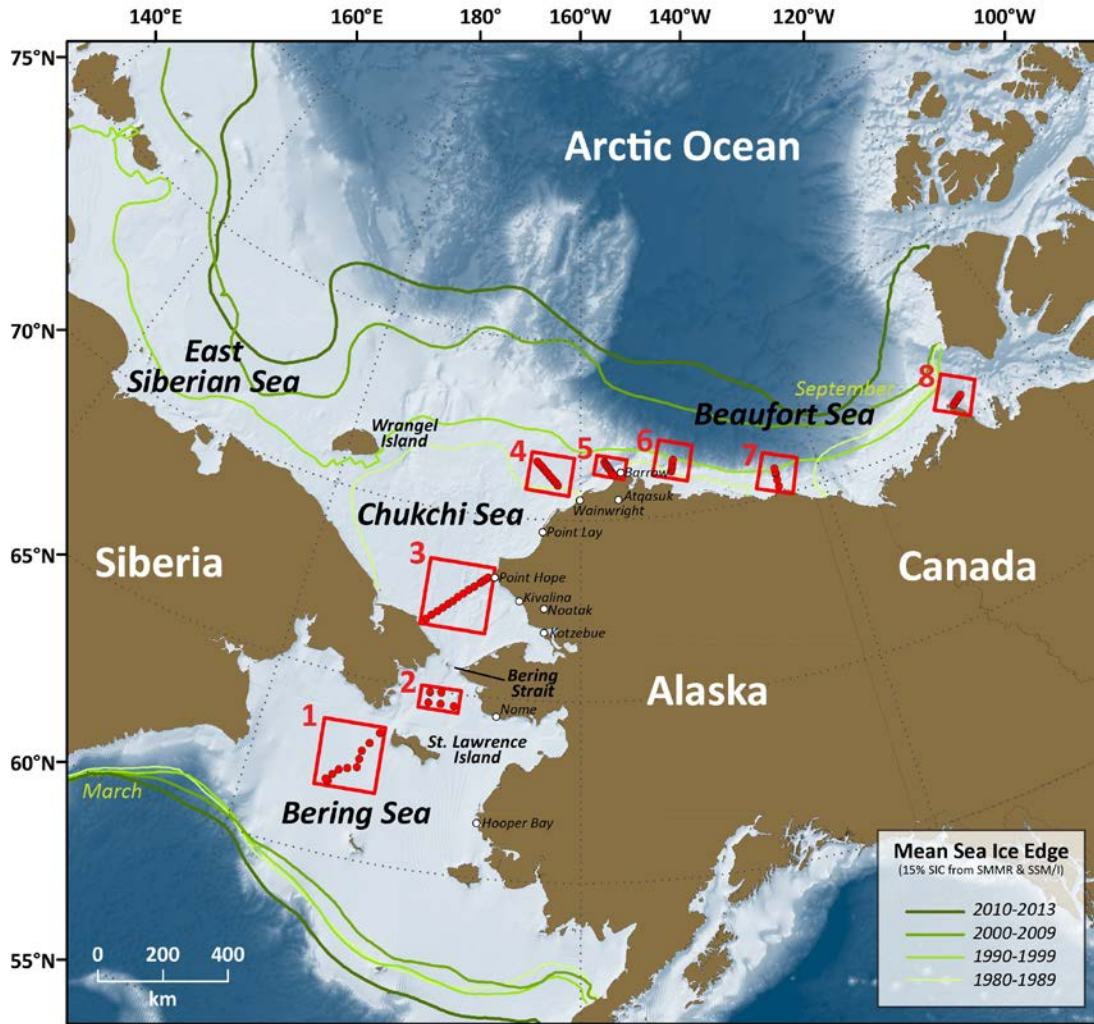
**Arctic Science Summit Week**

**Davos, Switzerland**

**June 18, 2018**



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



- DBO sites (red boxes) are regional “hotspot” transect lines and stations located along a latitudinal gradient
- DBO sites are considered to exhibit high productivity, biodiversity, and overall rates of change
- DBO sites serve as a change detection array for the identification and consistent monitoring of biophysical responses
- Sites occupied by national and international entities with shared data plan

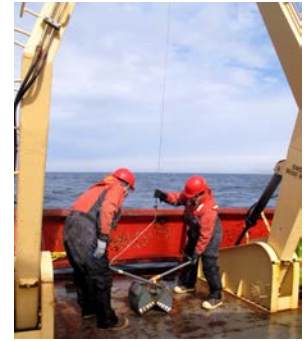
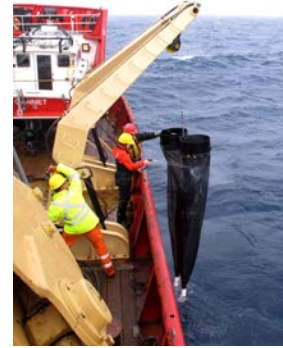
[updated by Karen Frey from Grebmeier et al. 2010, EOS 91]



# Distributed Biological Observatory Standardized Sampling

## Core ship-based sampling:

- CTD and ADCP
- Chlorophyll
- Nutrients
- Ice algae/Phytoplankton (size, biomass and composition)
- Zooplankton (size, biomass and composition)
- Benthos (size, biomass and composition)
- Seabird standard surveys (no additional ship time)
- Marine mammal watches & surveys (no additional ship time)



## Second tier ship-based sampling:

- Fishery acoustics (less effort than standardized bottom trawling)
- Bottom trawling (every 3-5 years)

## Shipboard measurements

- Record underway measurements from the seawater loop, meteorological sensors, sounder, and navigation information

# Distributed Biological Observatory Additional Sampling

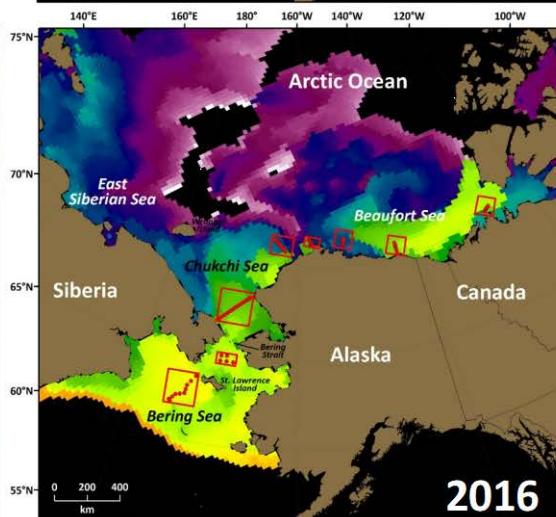
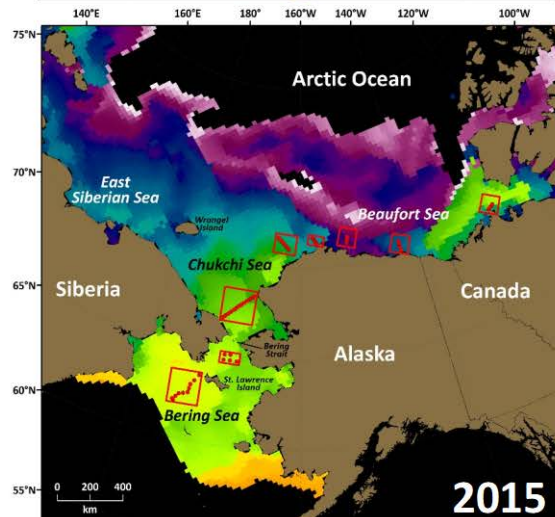
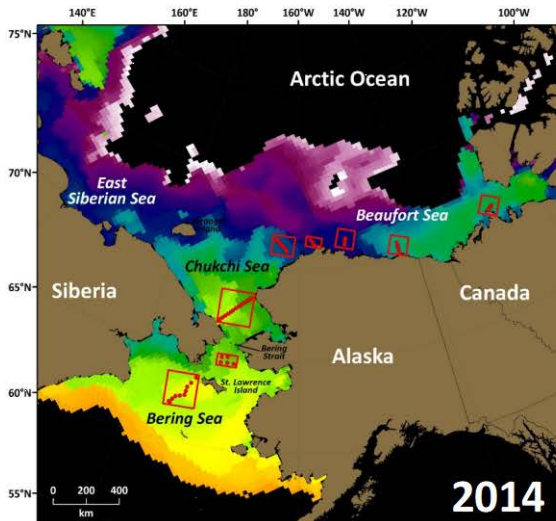
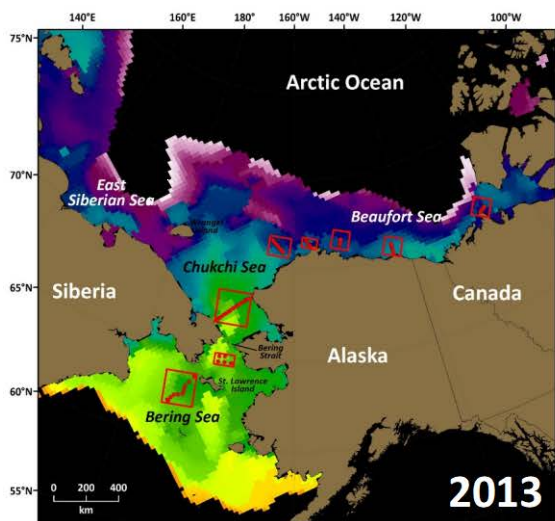
## Examples of additional sampling on various DBO cruises in 2017 (national and international):



- Optical studies for satellite calibration
- Colored dissolved organic matter (CDOM) and dissolved organic carbon (DOC), alkalinity
- Sea ice tracers (e.g., Oxygen-18)
- Ocean acidification and carbon cycling
- Phytoplankton growth rates (primary production)
- Lower trophic production studies
- Epifaunal and fish biodiversity studies
- Benthic camera for videos of benthos
- Genetics for microbial, meiofaunal, macrofaunal, and epifaunal studies
- Moorings and saildrones, gliders
- Contaminants and potential Harmful Algal Blooms (HABs) impacting various trophic levels

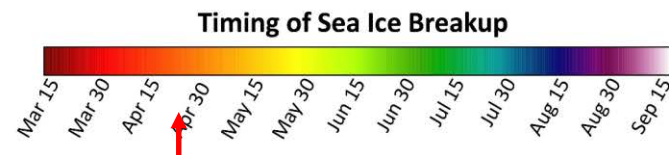
**Notably, DBO sampling often embedded in larger process-study cruises**

# Satellite Products for DBO-NASA and Academics

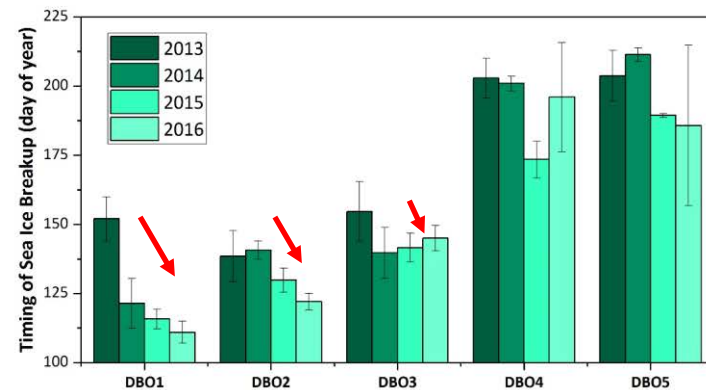


## Timing of Sea Ice Breakup 2013- 2016

based on SSM/I satellite data



\*2018: Northern Bering Sea ice free by end of April



- Focus on DBO1-5

- earlier sea ice retreat in spring
- later sea ice return in fall
- Influences phenology of annual primary production

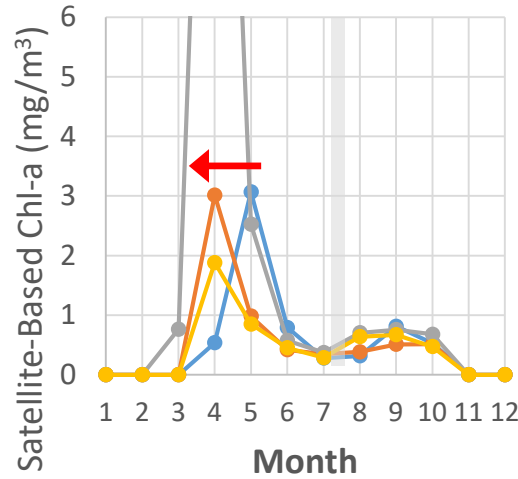
[courtesy Karen Frey]

# Monthly and Interannual Variability of Chlorophyll a (Chl-a)

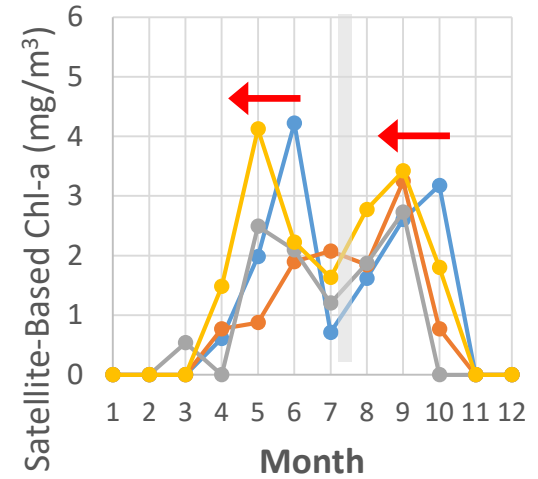
*based on MODIS-Aqua satellite data*

- DBO1-2: Earlier spring blooms
- DBO2-5: Increasing observation of fall blooms
- Interannual variability relative to advection of nutrients into system

DBO1



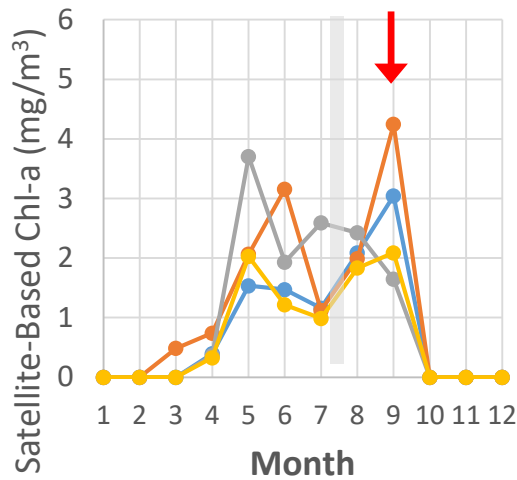
DBO2



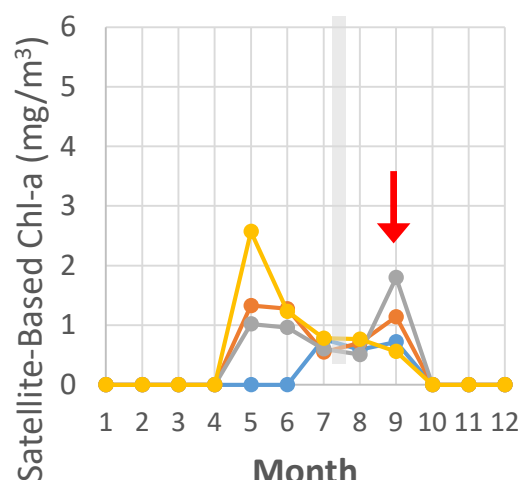
● 2013 ● 2014 ● 2015 ● 2016

● 2013 ● 2014 ● 2015 ● 2016

DBO3

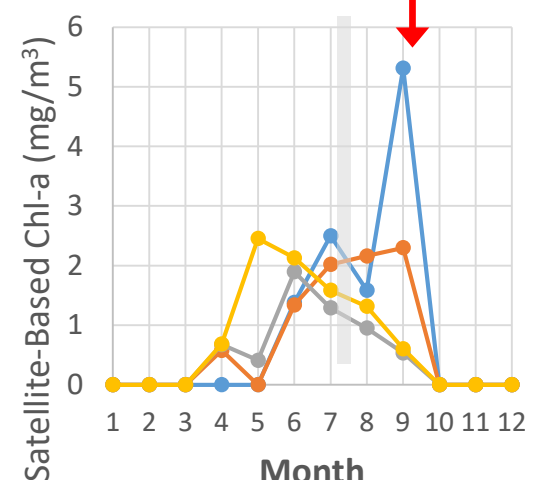


DBO4



● 2013 ● 2014 ● 2015 ● 2016

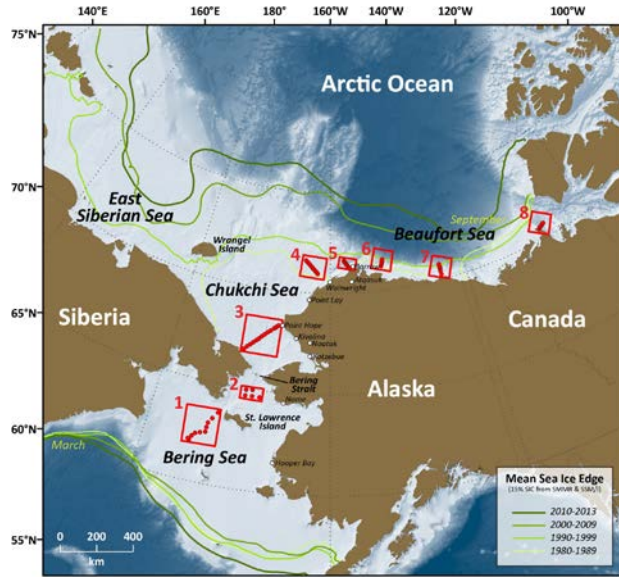
DBO5



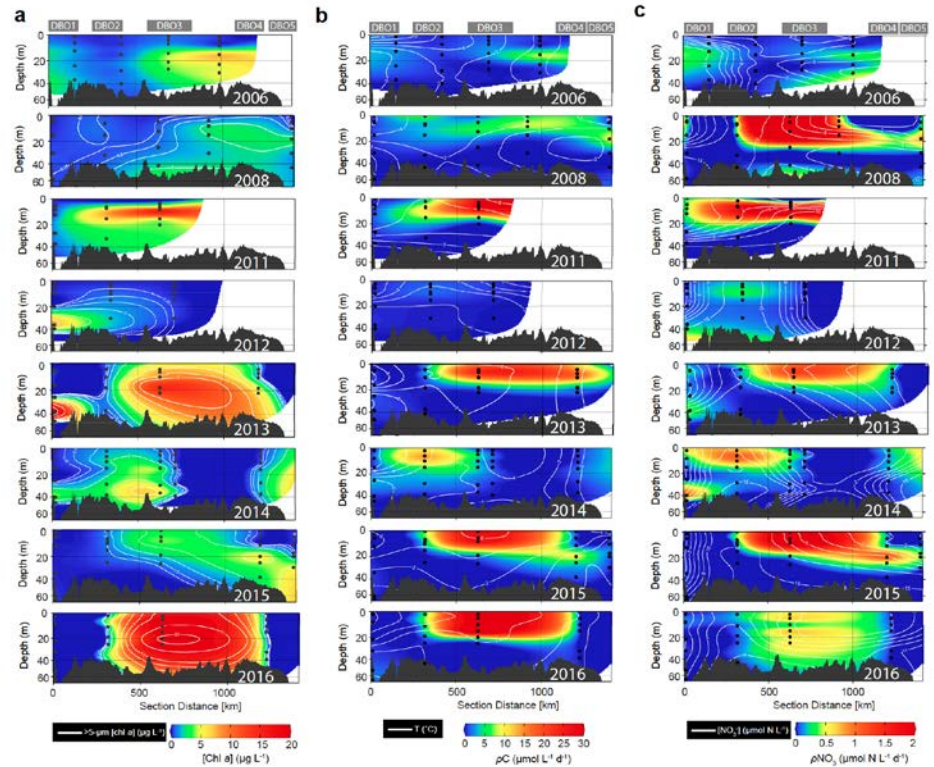
● 2013 ● 2014 ● 2015 ● 2016

[modified from Karen Frey]

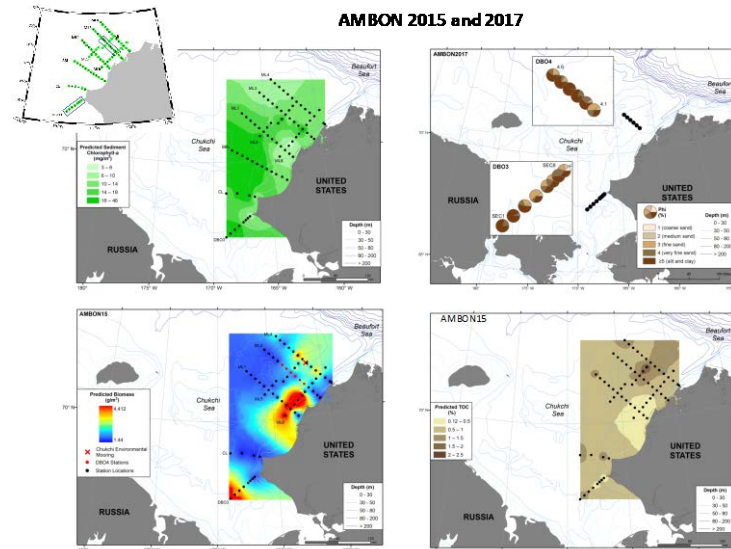
# Examples of DBO Data Products



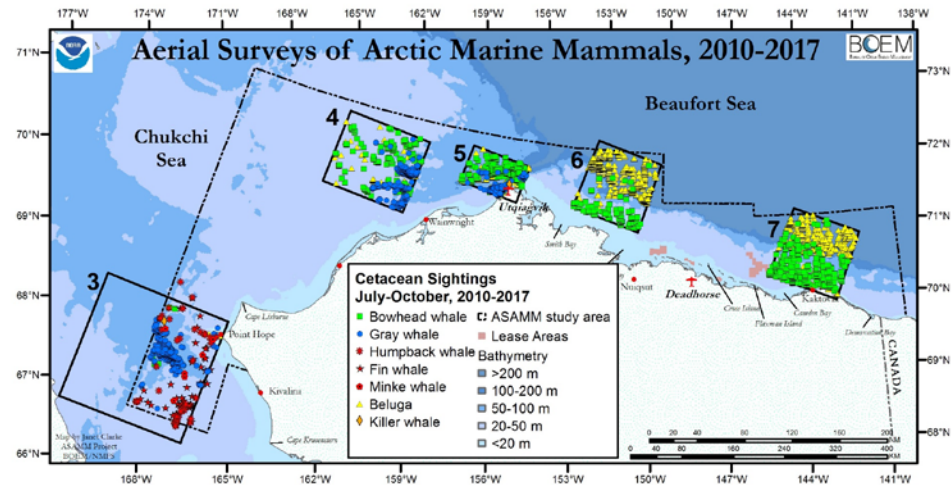
[Moore and Grebmeier 2018]



[Giesbrecht et al.]



[Grebmeier and Cooper, AMBON]



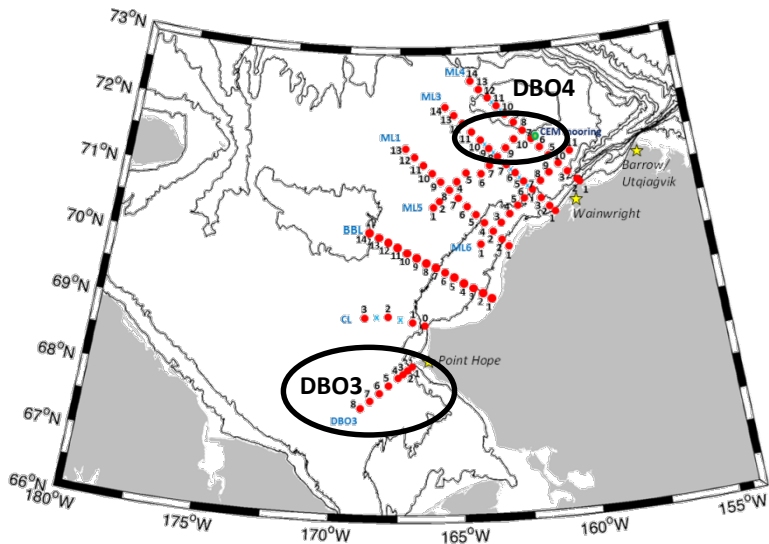
[Janet Clark]

# AMBON: Arctic Marine Biodiversity Observing Network



Iken K<sup>1</sup>, Cooper L<sup>2</sup>, Danielson S<sup>1</sup>, Grebmeier J<sup>2</sup>, Mueter F<sup>1</sup>, Hopcroft R<sup>1</sup>, Stafford K<sup>3</sup>, Kuletz K<sup>4</sup>, Collins E<sup>1</sup>, Kavanaugh M<sup>8</sup>, Bluhm B<sup>1,5</sup>, Moore S<sup>6</sup>, Buckelew S<sup>7</sup>, Bochenek R<sup>7</sup>

(1) University of Alaska Fairbanks; USA; (2) University of Maryland, USA; (3) University of Washington, USA; (4) US Fish and Wildlife Service, USA; (5) University of Tromsø, Norway; (6) National Oceanographic and Atmospheric Administration, USA; (7) Alaska Ocean Observing System/AXIOM, USA; (8) Oregon State University



**Focus area:** Chukchi Sea shelf

**Field work:** 2015 and 2017

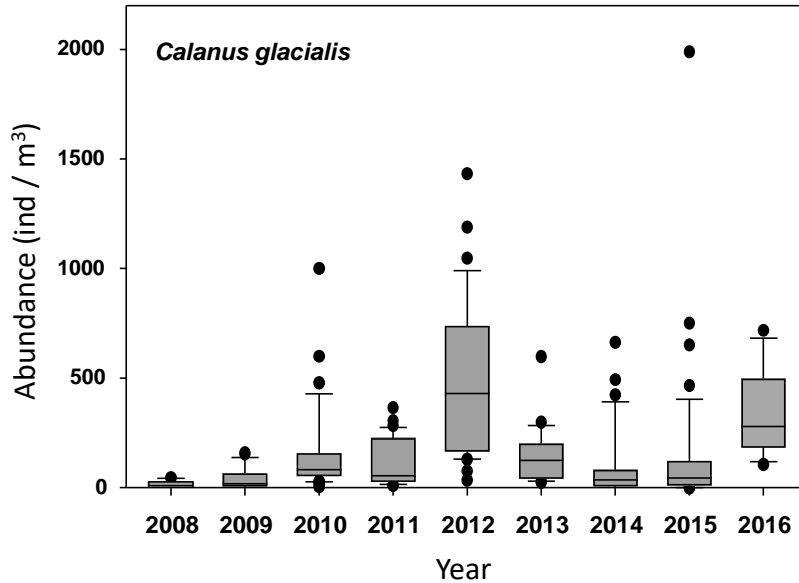
**Disciplines:** hydrography, microbes, zooplankton, benthos, fish, seabirds, marine mammals, seascapes

**Intent:** Provide biodiversity data  
Fill gaps (e.g., microbes)  
Continue long-term time series  
Providing publicly accessible data



# Adding to long-term time series

## Zooplankton



Relate copepod abundance to hydrographic conditions

= warm years dominated by small *Pseudocalanus*

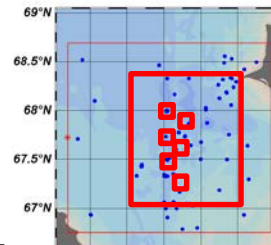
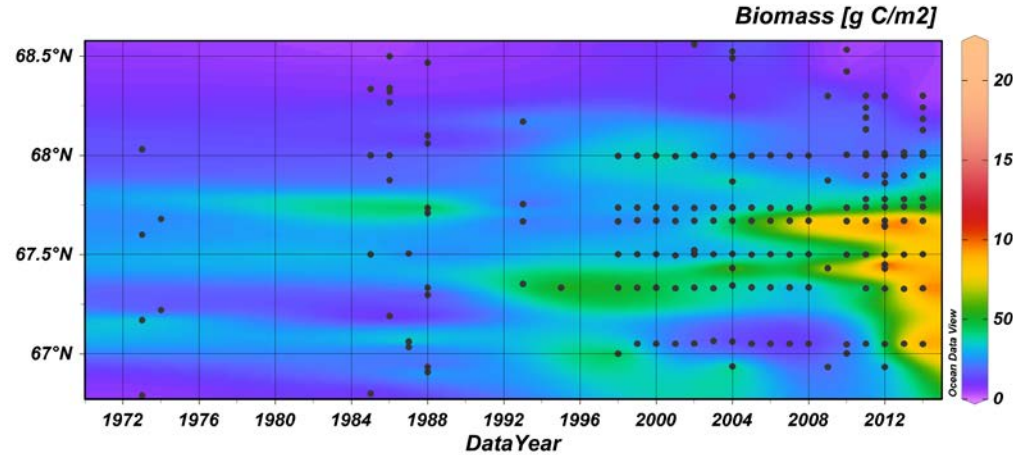


= lipid-rich *Calanus* more abundant in cold years



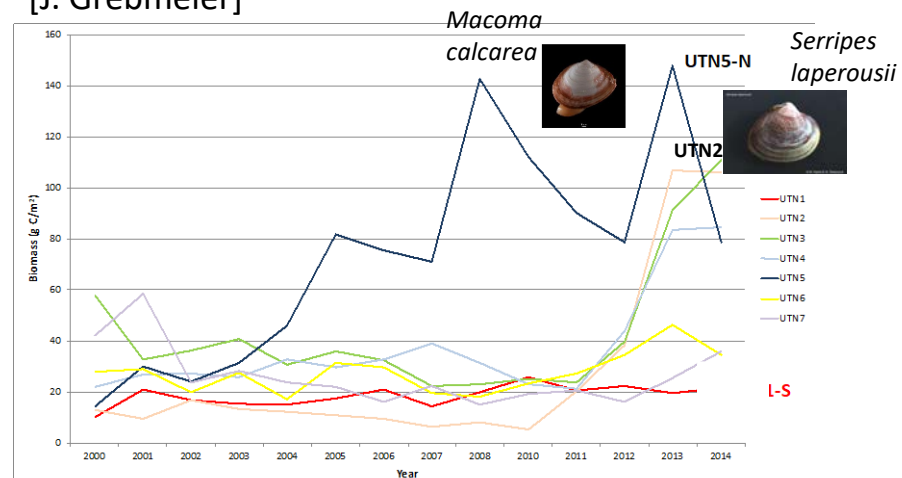
[R. Hopcroft]

## Macrofaunal Biomass



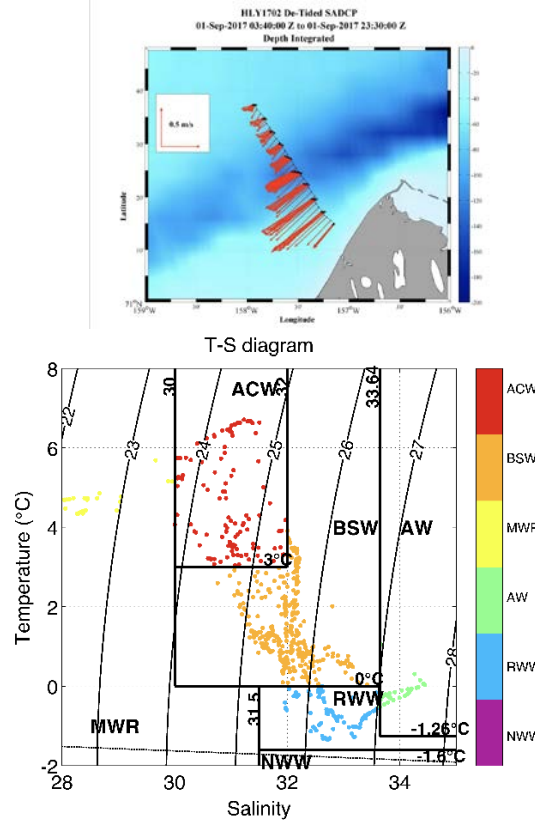
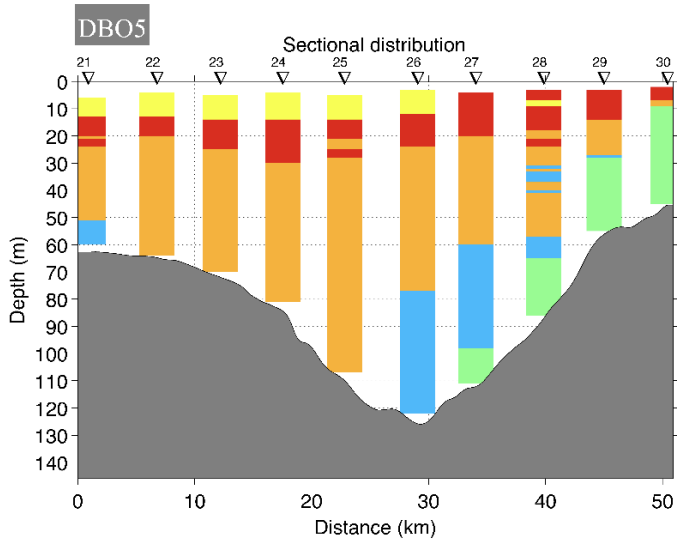
Dominated by two species of bivalves

[J. Grebmeier]

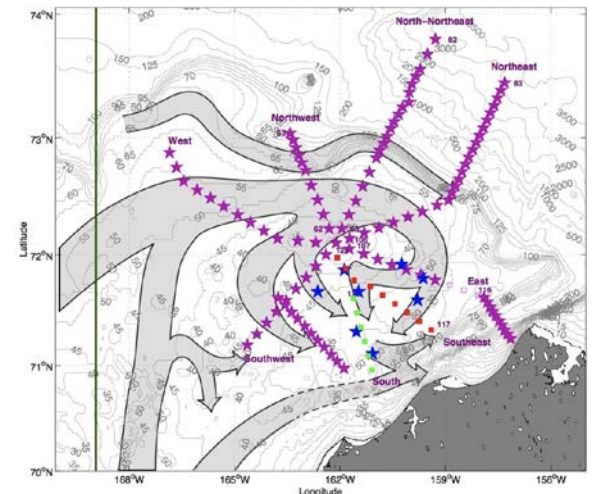


# 2017 DBO-NCIS: Preliminary Results

**Below.** Water mass type across DBO5, upper Barrow Canyon

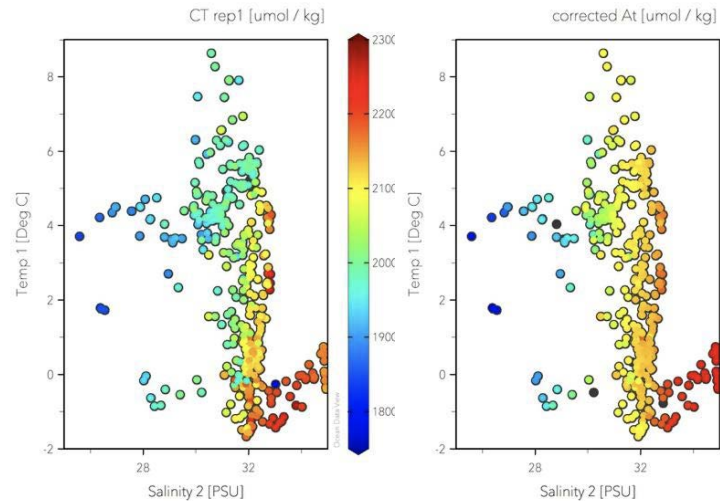
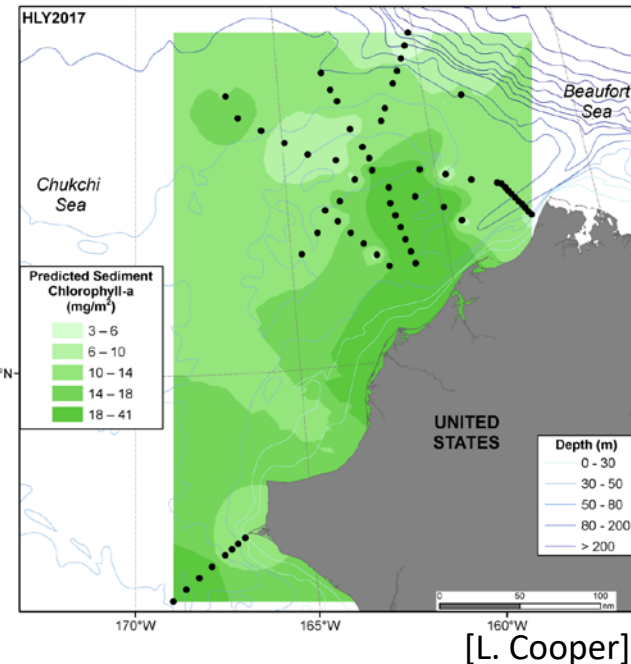


ACW: Alaskan coastal water; BSW: Bering summer water; MWR: Melt water/river water  
AW: Atlantic water; NWW: Newly ventilated winter water; RWW: Remnant winter water



**Above.** Revised sampling SECS in benthic hotspots.

**Below.** Surface sediment chlorophyll a (mg/m<sup>2</sup>)



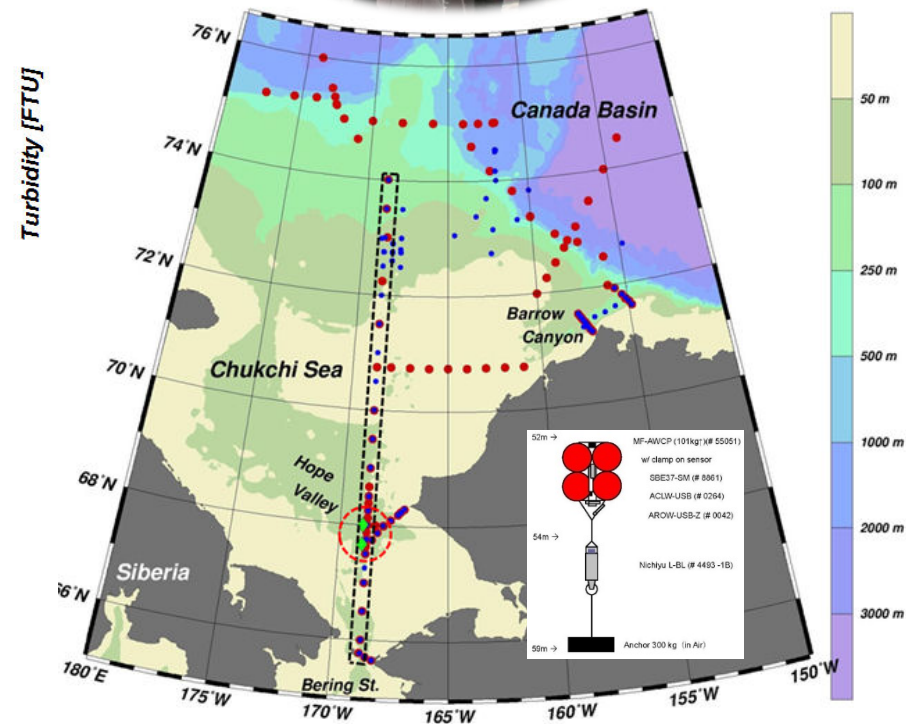
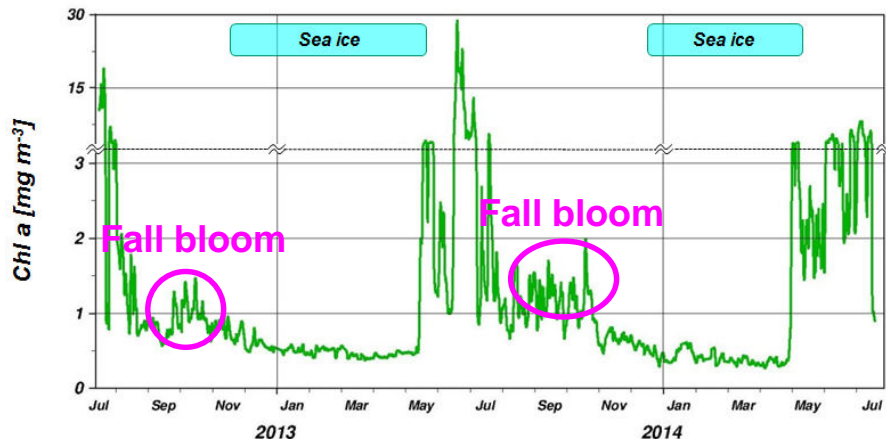
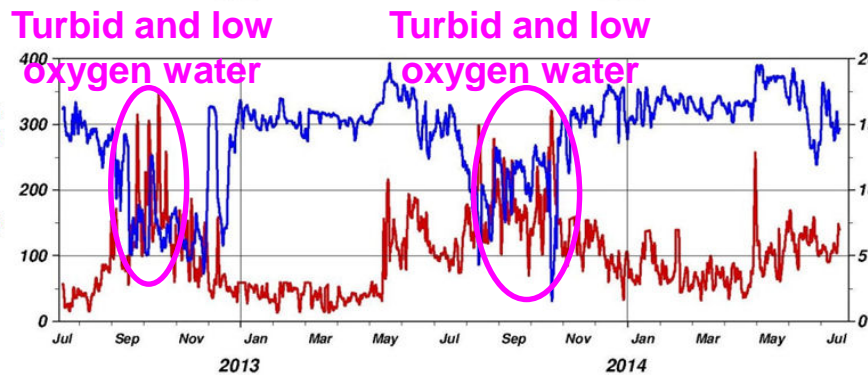
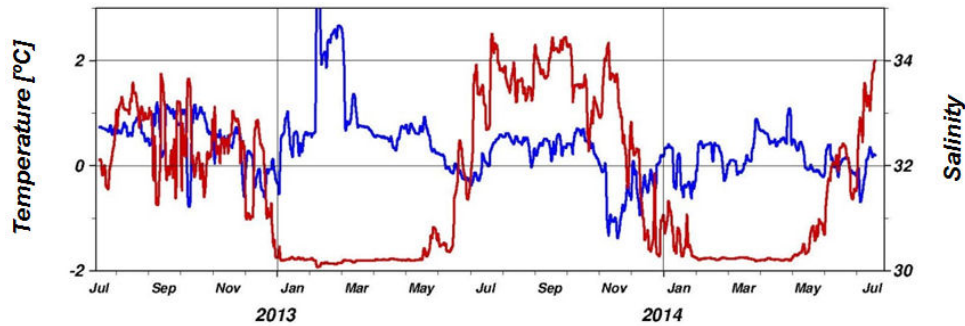
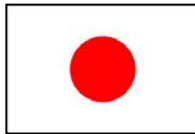
**Left.** Scatter plots showing the distribution of total inorganic carbon (CT,  $\mu\text{mol kg}^{-1}$ , left) and total alkalinity (AT,  $\mu\text{mol kg}^{-1}$ , right)

[R. Pickart]

[L. Cooper]

# DBO3 moorings during July 2012 to July 2014

\* In 2016: DBO1-5 each has a mooring array

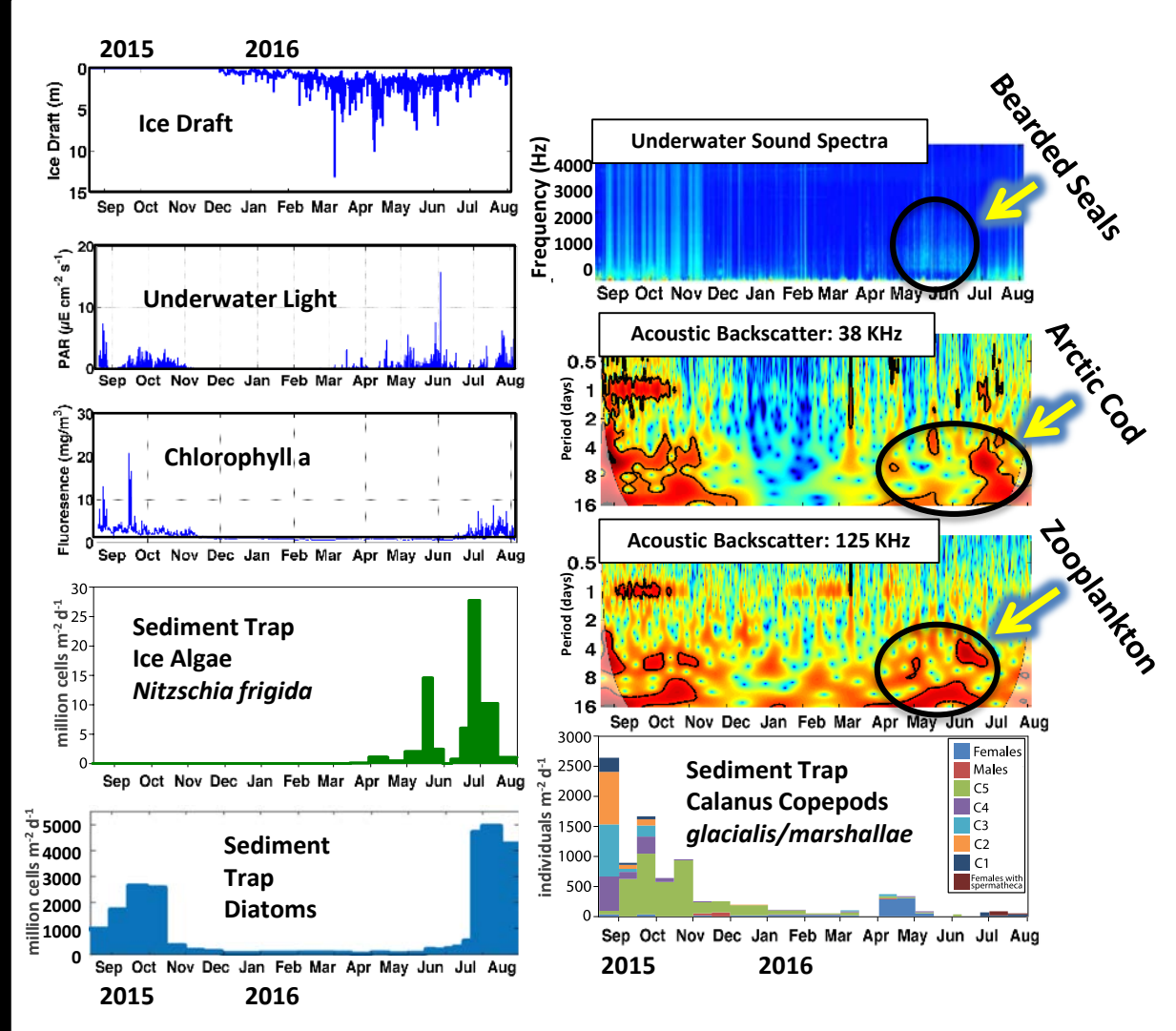


# Views into event timing, magnitude and co-variability

(Seth Danielson/UAF)

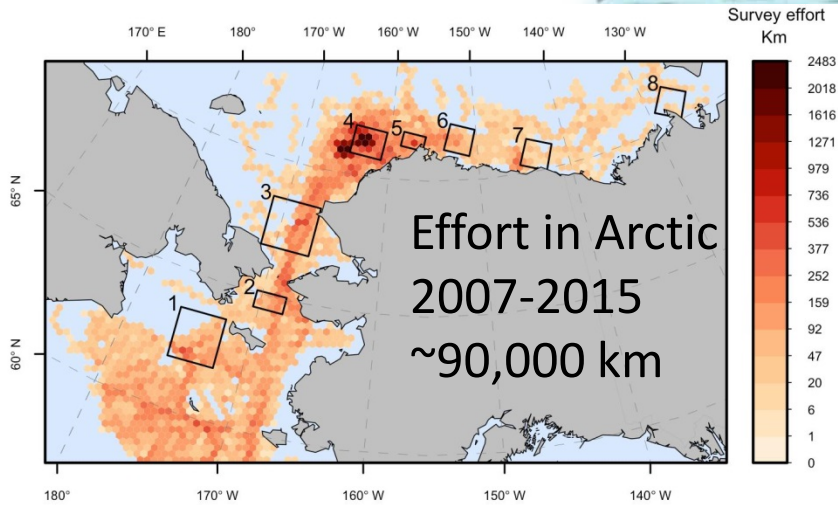


- Ship-of-opportunity visits to the mooring site that enable us to recover and redeploy the mooring each year are CRITICAL to this project's success.
- DBO4 region in NE Chukchi Sea

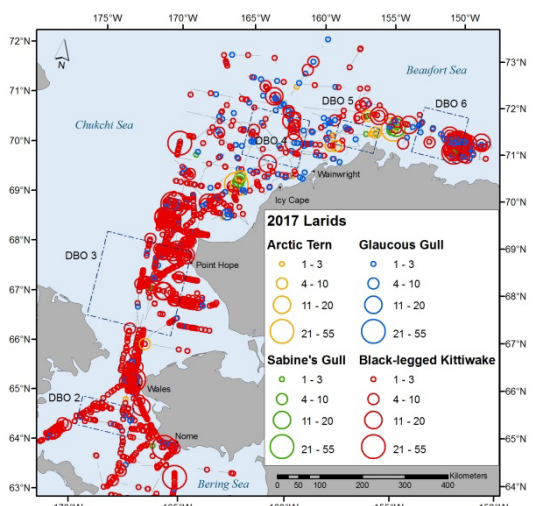
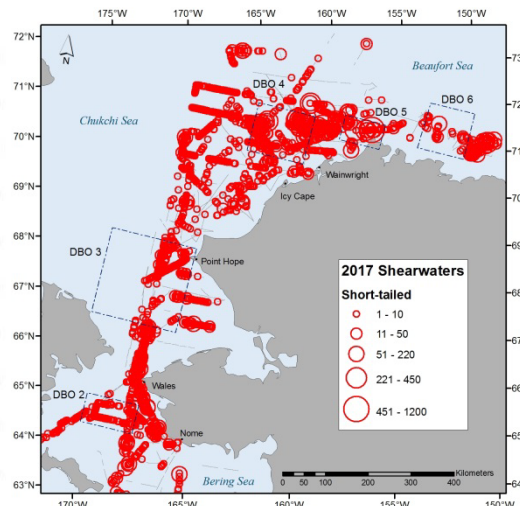
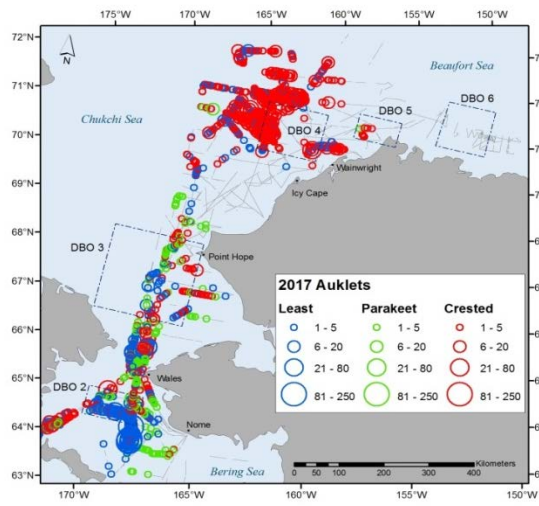


[www.ChukchiEcosystemObservatory](http://www.ChukchiEcosystemObservatory) for more information

# Seabird Surveys in the Pacific Arctic

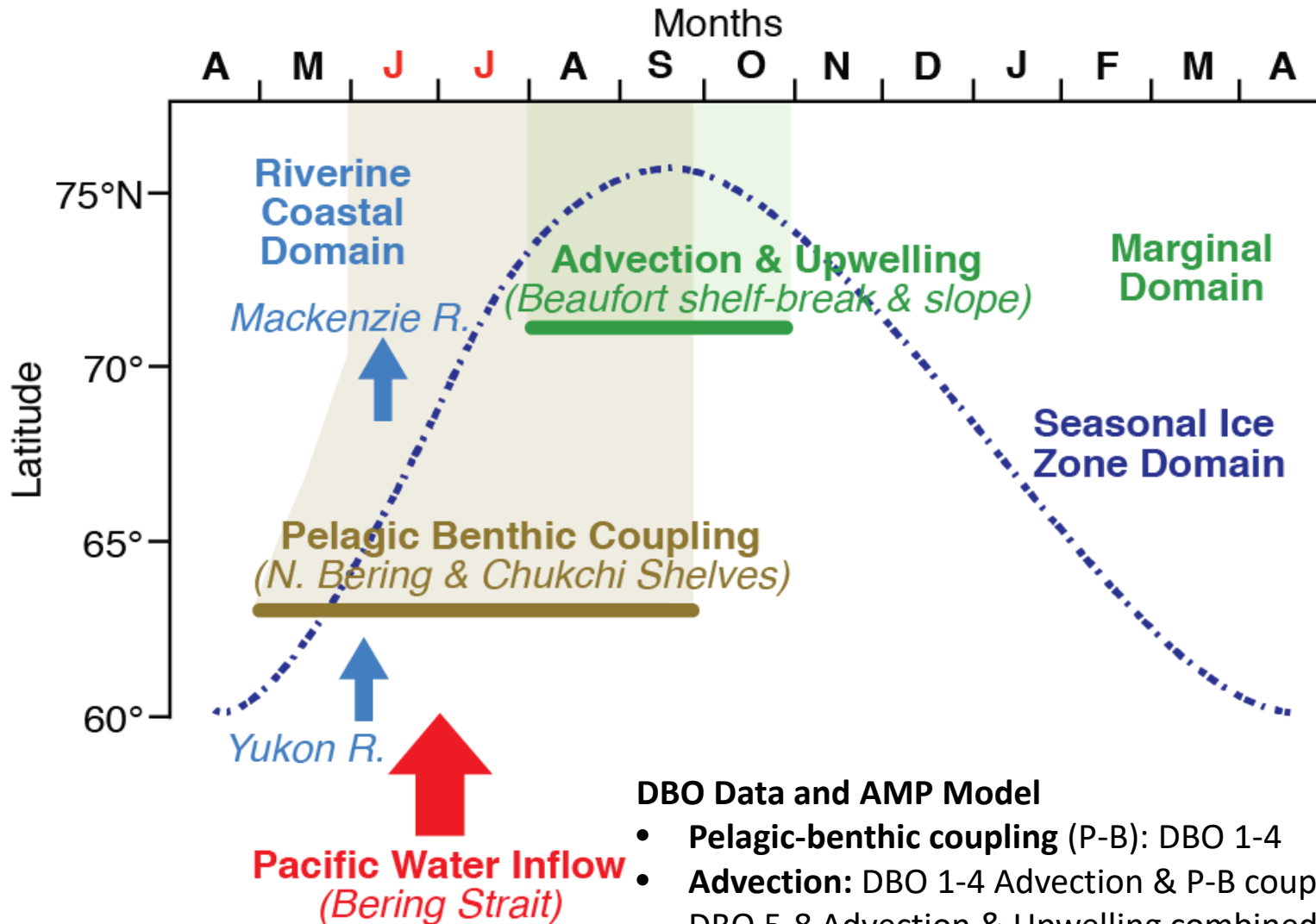


**In 2017**  
**~ 19,700 km surveyed in**  
**North Bering, Chukchi, Beaufort**



2017 Distribution of Auklets (3 spp), Short-tailed shearwaters, Larids (4 spp)

# Arctic Marine Pulses (AMP) Model: *the Pacific Arctic Domain*



## DBO Data and AMP Model

- **Pelagic-benthic coupling (P-B):** DBO 1-4
- **Advection:** DBO 1-4 Advection & P-B coupling combined; DBO 5-8 Advection & Upwelling combined, also eddies
- **DBO data being used to further develop the AMP model** with an aim to predict seasonal variability in ocean processes in the Pacific Arctic over an annual cycle.

[Moore et al. 2016]

## Distributed Biological Observatory

! Group

Group Id: DBO

4 years, 2 months Contributor since April 17, 2014

1,096 contributions

4,505 downloads

1 members

★ Matthew B. Jones  
<http://orcid.org/0000-0003-0...>

**DBO International Data Policy, approved by partners within PAG in 2015**

- DBO data contributions since April 17, 2014
- 1,096 contributions DBO data
- 4,505 downloads of DBO data


DATASETS 11 TO 15 OF 122

Prev 1 2 3 4 5 ... 25 Next

Sort by Most recent

Jacqueline Grebmeier. 2017. **Collaborative Research: The Distributed Biological Observatory (DBO)-A Change Detection Array in the Pacific Arctic Region**. Arctic Data Center. urn:uuid:e09c44d9-96b3-4dac-a340-f757e69f3118.

\$ ([https://arcticdata.io/metacat/d1/mn/v2/object/resource\\_map\\_urn:uuid:e09c44d9-96b3-4dac-a340-f757e69f3118](https://arcticdata.io/metacat/d1/mn/v2/object/resource_map_urn:uuid:e09c44d9-96b3-4dac-a340-f757e69f3118))

23 % & 

Jacqueline Grebmeier. 2017. **The Distributed Biological Observatory (DBO) Conductivity-Temperature-Depth (CTD) data from 2010**. Arctic Data Center. doi:10.18739/A2Q24W.

\$ ([https://arcticdata.io/metacat/d1/mn/v2/object/resource\\_map\\_doi:10.18739/A2Q24W](https://arcticdata.io/metacat/d1/mn/v2/object/resource_map_doi:10.18739/A2Q24W))

18 % & 

Carin Ashjian. 2017. **Distributed Biological Observatory (DBO), Conductivity-Temperature-Depth (CTD) data along DBO5, from 2010 BOWFEST on R/V Annika Marie**. Arctic Data Center. doi:10.18739/A2TV6H.

\$ ([https://arcticdata.io/metacat/d1/mn/v2/object/resource\\_map\\_doi:10.18739/A2TV6H](https://arcticdata.io/metacat/d1/mn/v2/object/resource_map_doi:10.18739/A2TV6H))

17 % & 

Robert Pickart. 2017. **Distributed Biological Observatory (DBO), Conductivity-Temperature-Depth (CTD) data along DBO5, from 2010 ICESCAPE on the USCGC Healy (HLY1001)**. Arctic Data Center. doi:10.18739/A2ZJ9S.

\$ ([https://arcticdata.io/metacat/d1/mn/v2/object/resource\\_map\\_doi:10.18739/A2ZJ9S](https://arcticdata.io/metacat/d1/mn/v2/object/resource_map_doi:10.18739/A2ZJ9S))

18 % & 

Kevin Arrigo. 2017. **Distributed Biological Observatory (DBO), Conductivity-Temperature-Depth (CTD) data along DBO3, from 2010 ICESCAPE on the USCGC Healy (HLY1001)**. Arctic Data Center. doi:10.18739/A23C2N.

\$ ([https://arcticdata.io/metacat/d1/mn/v2/object/resource\\_map\\_doi:10.18739/A23C2N](https://arcticdata.io/metacat/d1/mn/v2/object/resource_map_doi:10.18739/A23C2N))

17 % & 

Prev 1 2 3 4 5 ... 25 Next



2017 ASSW

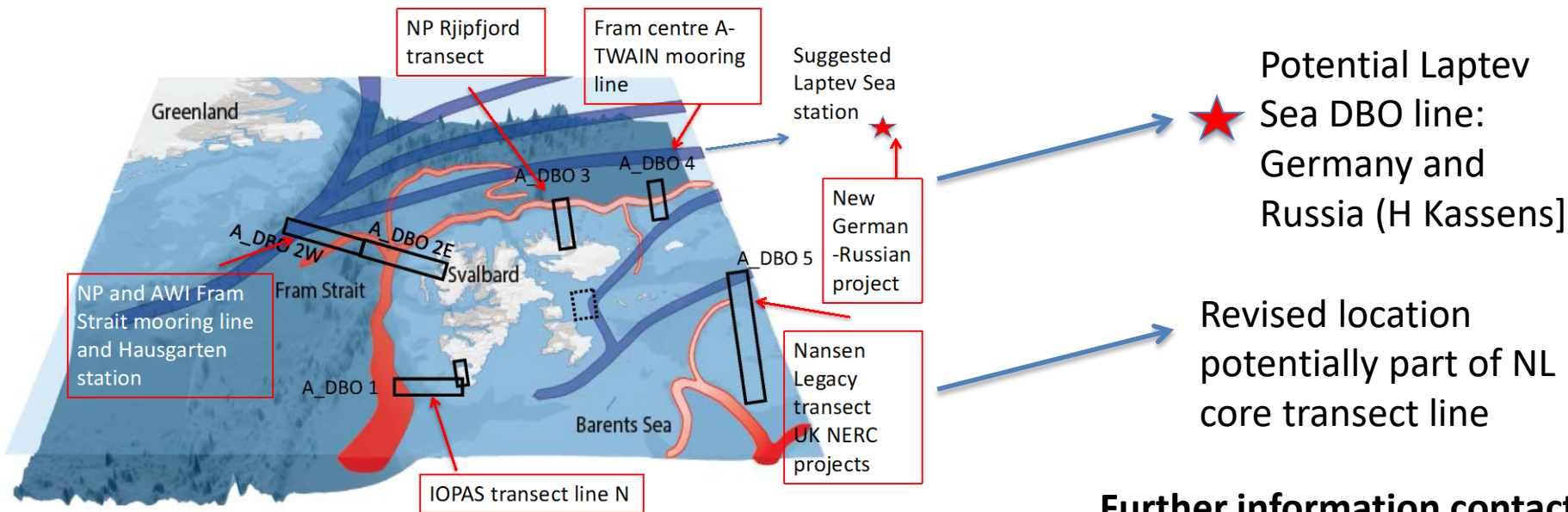
## Working Towards an International Pan-Arctic DBO

Ex. Atlantic DBO Workshop, November 2016



- Norway, Germany, Poland, UK, France, USA
- Physical oceanography, plankton, benthos, vertical flux, molecular studies
- moorings, time series, coordinating initiatives, planned initiatives
- Updated at the 2017 4th DBO data workshop

### Suggest five A-DBO transect lines



In addition to moorings in Kongsfjord and Rjipfjord operated by SAMS/UiT

Further information contact:  
marit.reigstad@uit.no



# Summary

- Biological sampling across a range of **spatio-temporal scales** is required to detect ecological shifts in response to environmental forcing
- **Repeat time and space collections** of various environmental and biological parameters, coincident with process studies, is allowing us to evaluate seasonality and interannual Arctic ecosystem status and trends
- Strong need for **time series analyses** in multiple components of the biological and biogeochemical system in relation to changes in physical forcing factors
- **Biological time series data indicating shifts due to timing of sea ice retreat**, warming seawater temperatures, and changing current speeds impacting habitats
- **Tracking lower trophic level prey base with associated upper trophic level** feeding and movement providing insight of ecosystem status and trends at the subarctic-arctic interface in both the Pacific and Atlantic Arctic

# 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, IASC Marine Working Group, 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>

