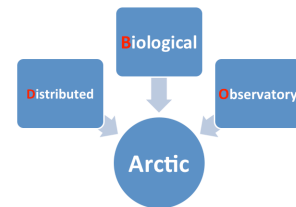


The Distributed Biological Observatory: An International Change Detection Array in the Pacific Arctic

Jacqueline M. Grebmeier¹, Sue E. Moore², Lee W. Cooper¹

¹*University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, Maryland, USA*

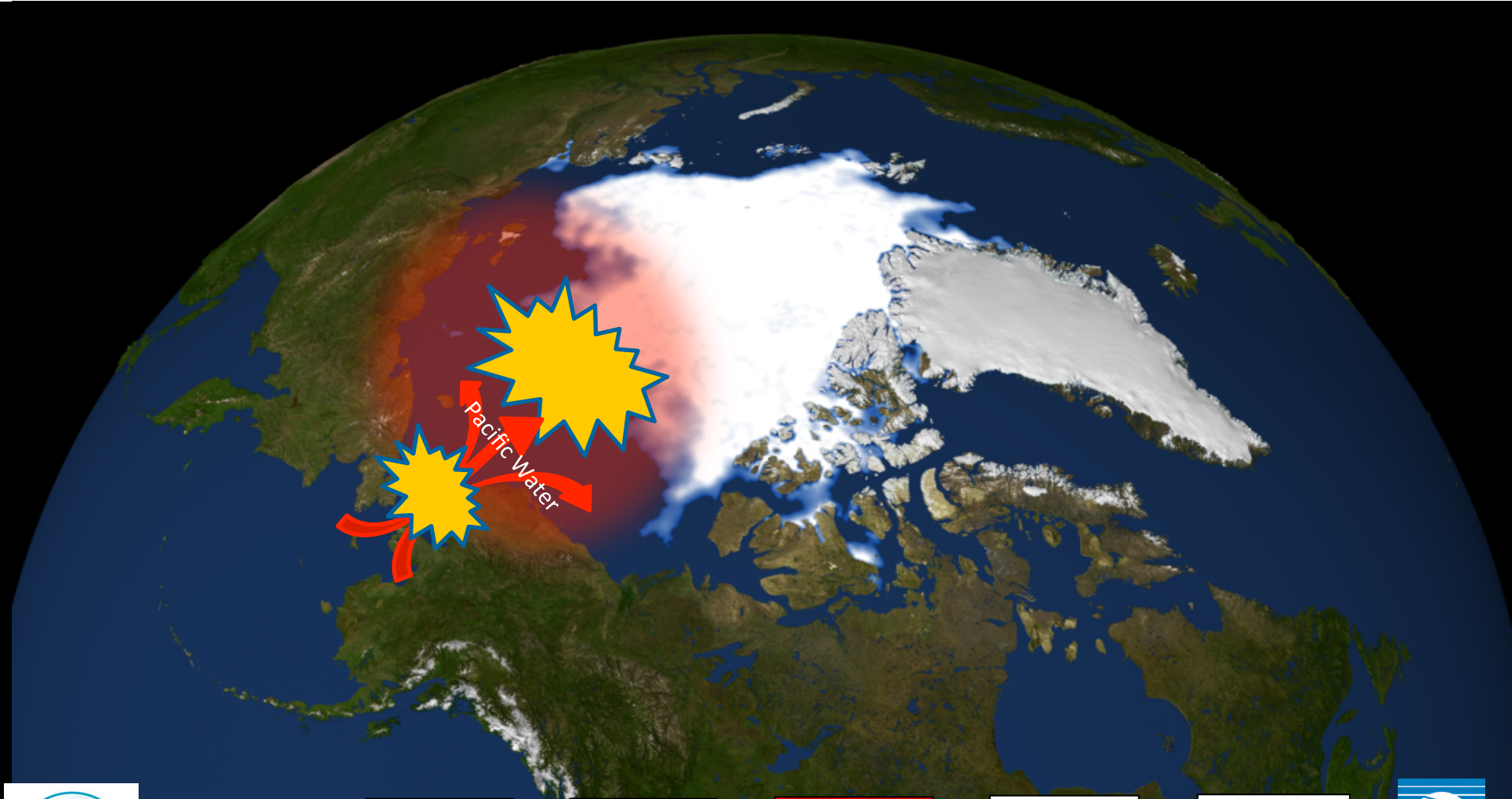
²*NOAA Fisheries, Office Science & Technology, Seattle, Washington, USA*



Key Points of Presentation

- Overview of key stressors with climate change influence biological processes, prey-predator interactions, and ecosystem dynamics
- Repeat sampling on both temporal and spatial scales facilitates evaluation of the seasonality of ecosystem status and trends through the international Distributed Biological Observatory (DBO)
- Many developing observation systems in the Arctic are focused on physical sensors, but biological sampling across a range of spatio-temporal scales is required to detect ecological shifts in response to environmental forcing
- Coordinated ship-based sampling, coincident with data streams from satellites and moorings, will provide an early detection system for biological shifts in the Arctic

The international Pacific Arctic Group (PAG) is engaged in **project development and sampling in the Pacific Arctic region** that is in rapid transition with seawater warming and sea ice retreat

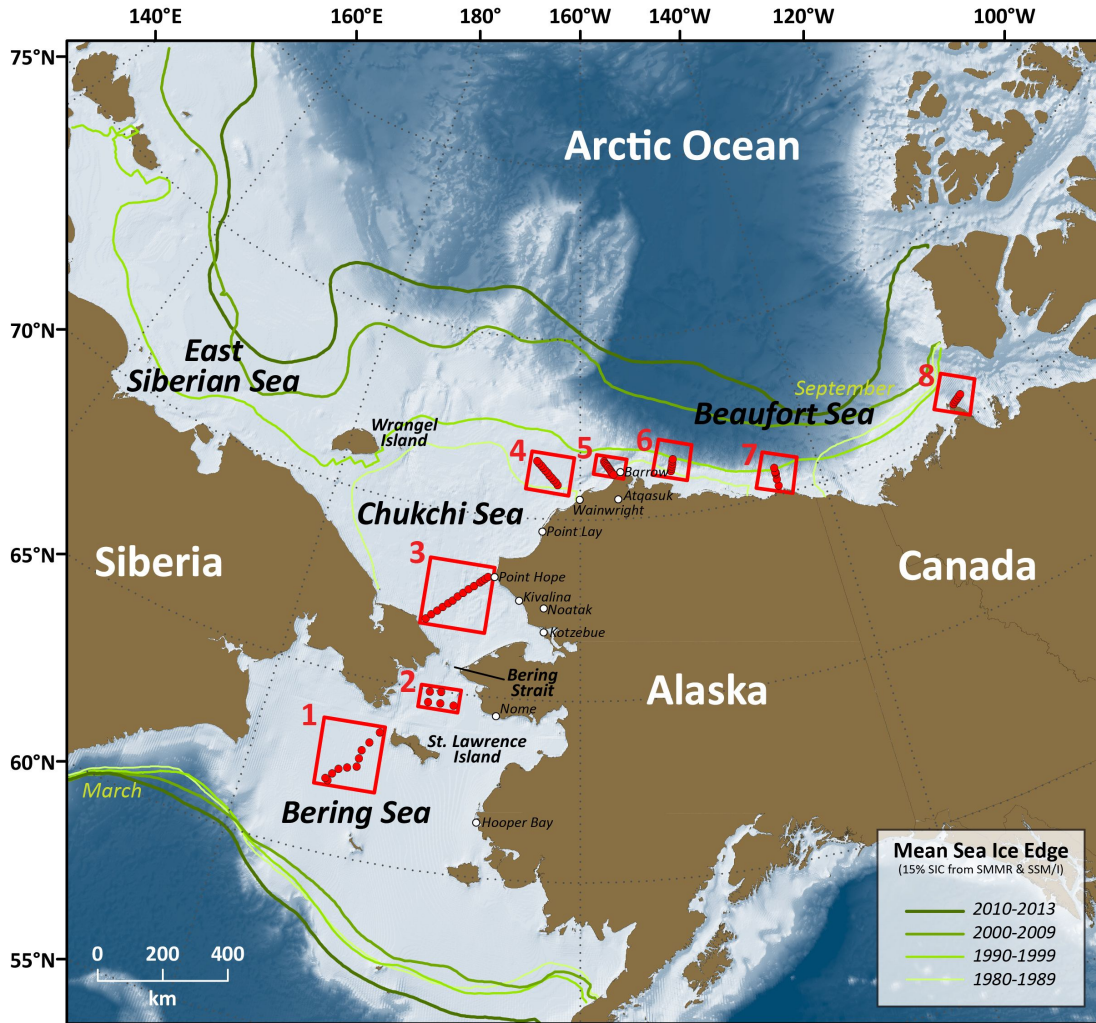


The international Pacific Arctic Group (PAG) is engaged in **project development and sampling in the Pacific Arctic region** that is in rapid transition with seawater warming and sea ice retreat

- Key stressors:
 - Decrease in sea ice extent and duration
 - Increasing seawater temperatures
 - Change in prey concentrations
 - Acidification
 - Northward species movement

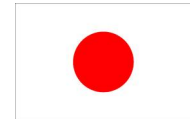


Linking Physics to Biology: the Distributed Biological Observatory (DBO)



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

- 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



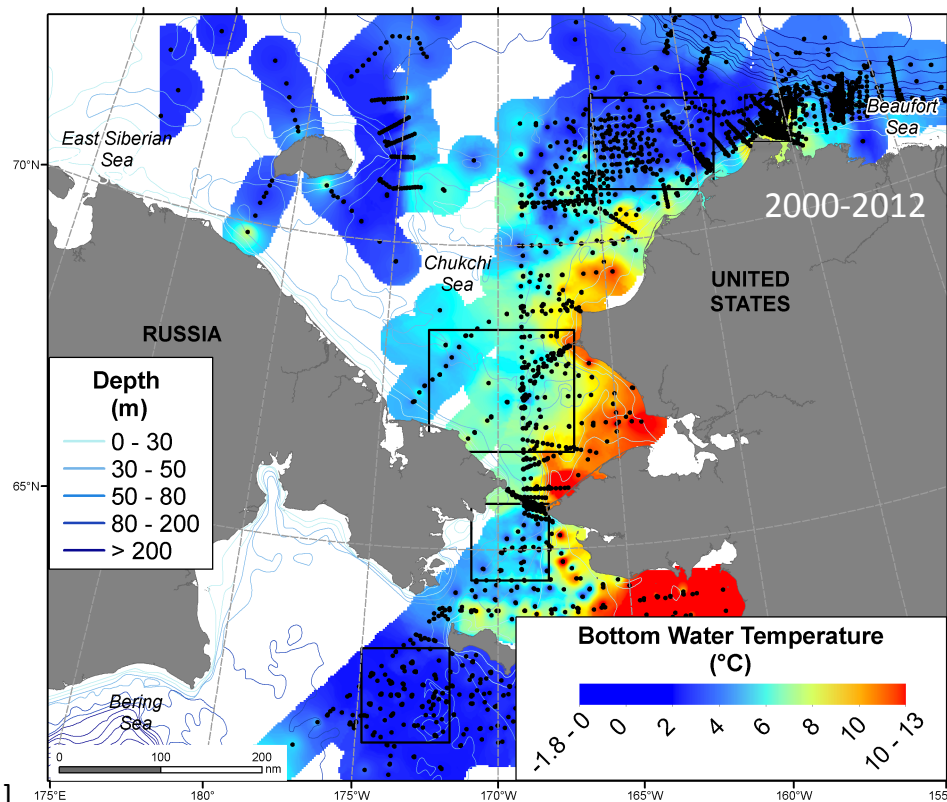
Current flow and bottom water temperatures from March-October



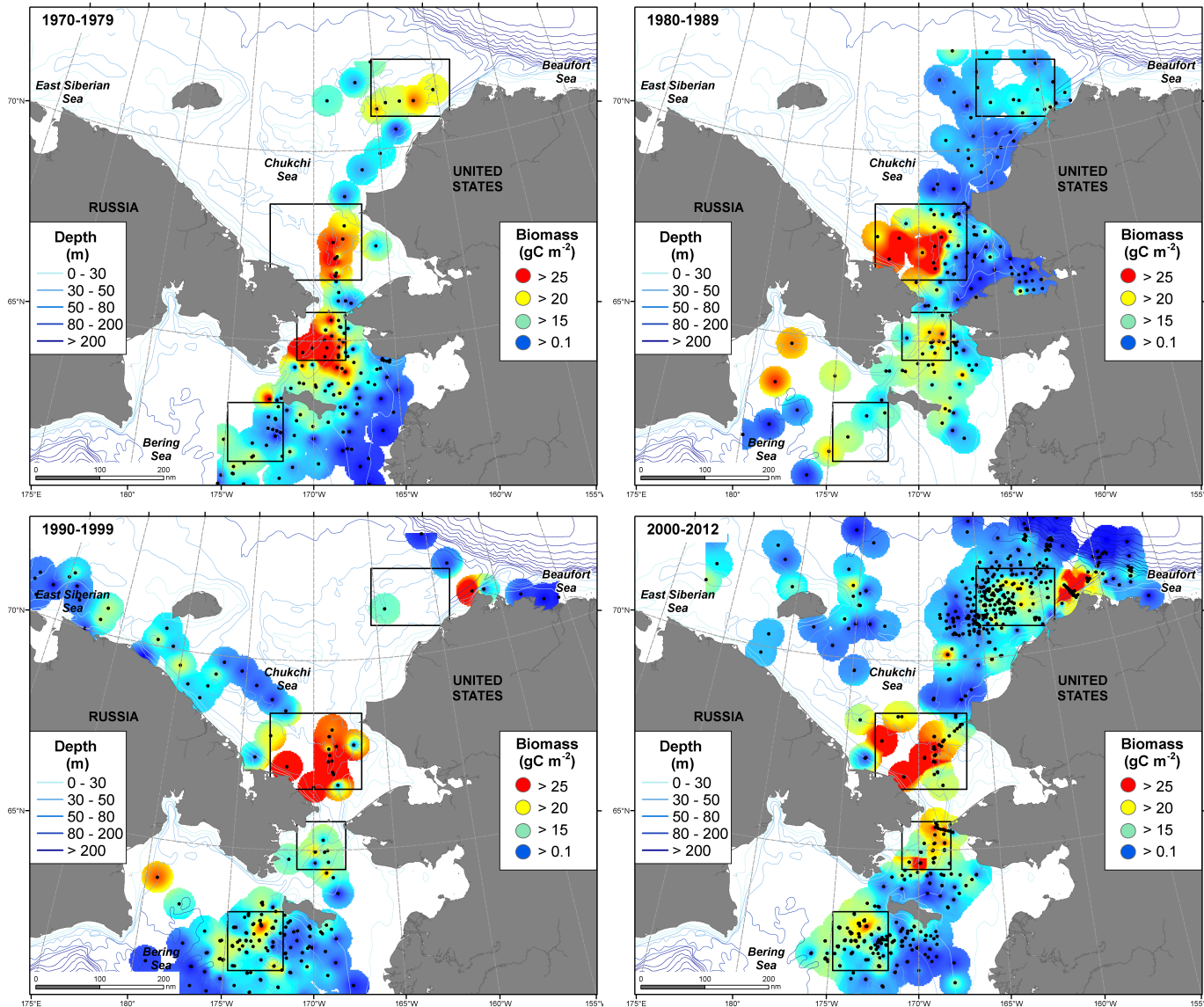
- Advective regime
- High nutrients western side
- Increasing volume of warm Pacific water through Bering Strait in recent years (Woodgate et al. 2012)

- Latitudinal warming bottom water temperatures March to October
- Coldest: Northern Bering Sea south of St. Lawrence Island & Northeast Chukchi Sea, plus downslope western Chukchi Sea

[Grebmeier+17 co-authors, 2015 SOAR Prog. Oceangr.]

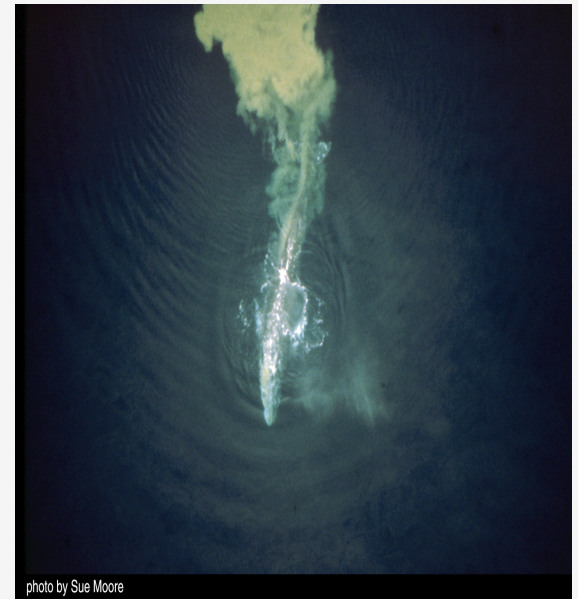
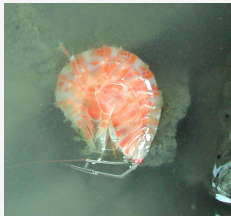


Persistent biological hotspots maintained by deposition of *in situ* and advected carbon to the benthos



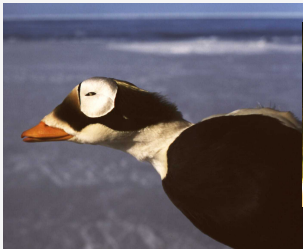
Benthic Foragers: Response to Changes in Sea Ice

Gray whales = shifts in distribution reflects sea-ice related prey decrease (amphipods: time and space), plus opportunity feed on euphausiids and staying longer north near Barrow to feed



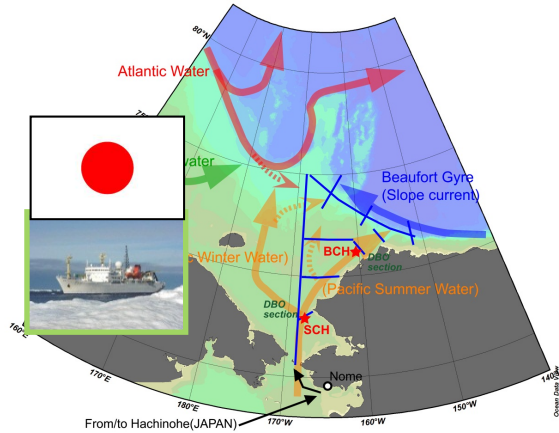
Walrus = loss of sea ice platform for riding, resting, nursing calves & access to Chukchi shelf feeding areas

Diving seabirds = changing sea ice location as resting platform

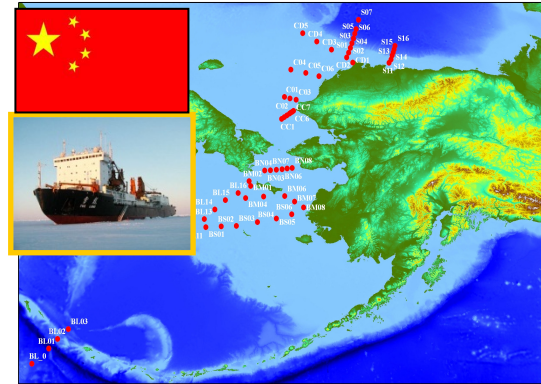


PAG research cruises in the Pacific Arctic Region with DBO sampling efforts

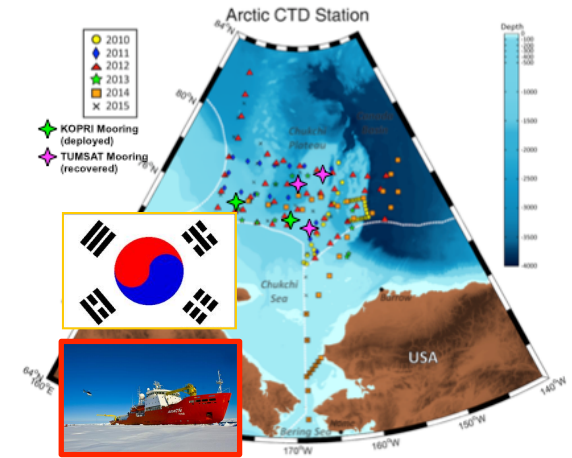
Japan: RV Mirai



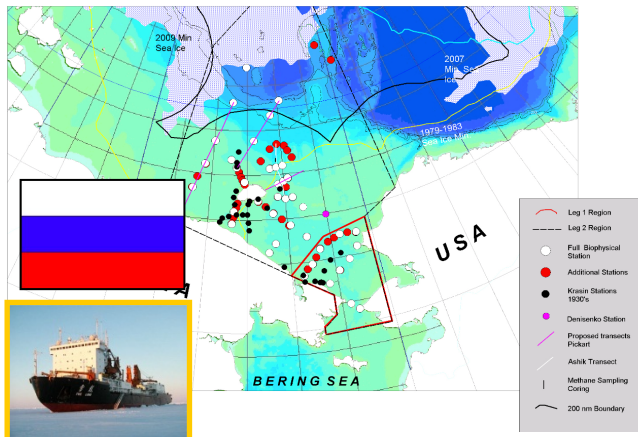
China: RV Xuelong



Korea: RV Araon

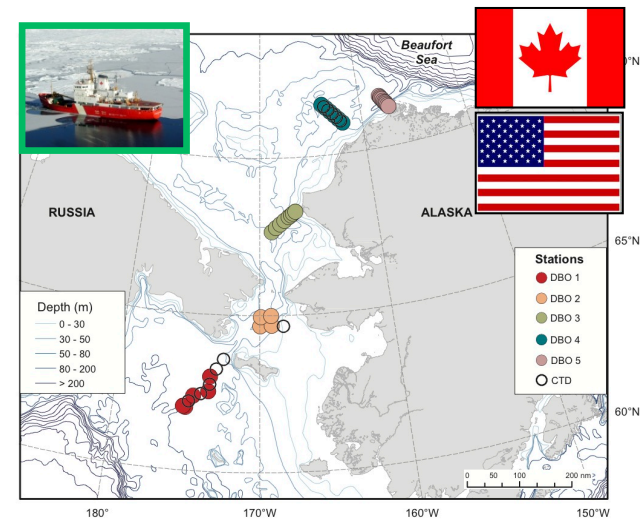


Russia-USA: RV Khromov



Canada: CCGS Sir Wilfrid Laurier, Louis St. Laurent

USA: Healy, RV Aquila, Brown etc.



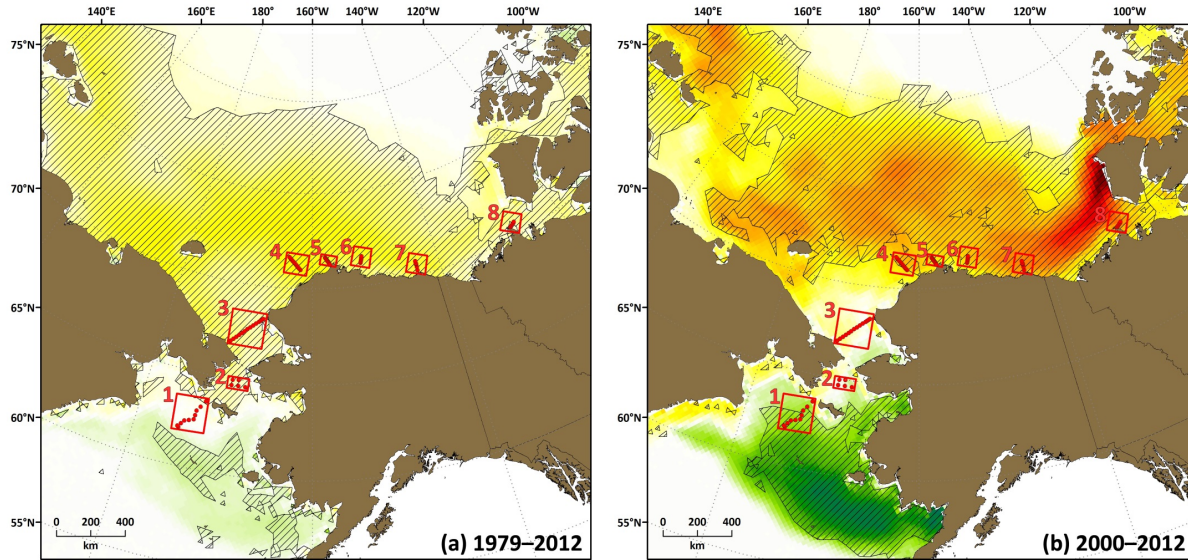
Distributed Biological Observatory Standardized Sampling Protocols

- Conductivity, Temperature, Depth (CTD), Acoustic Doppler Current Profiler (ADCP) data
- Bottle data for chlorophyll and nutrients
- Abundance, biomass and composition of ice algae, phytoplankton, zooplankton, benthic fauna (both infauna and epifauna), and fish
- Sediment parameters (grain size, organic carbon content, chlorophyll *a* content)
- Seabird and marine mammal surveys
- Mooring data (temperature (T), salinity (S), currents, fluorescence, nutrients, sediment traps)
- Satellite data (data presented are weekly averages of most recent data on: (1) chlorophyll pigment concentration; (2) sea surface temperature (SST); (3) sea ice concentration; (4) cloud fraction, and (5) winds and sea level pressure)

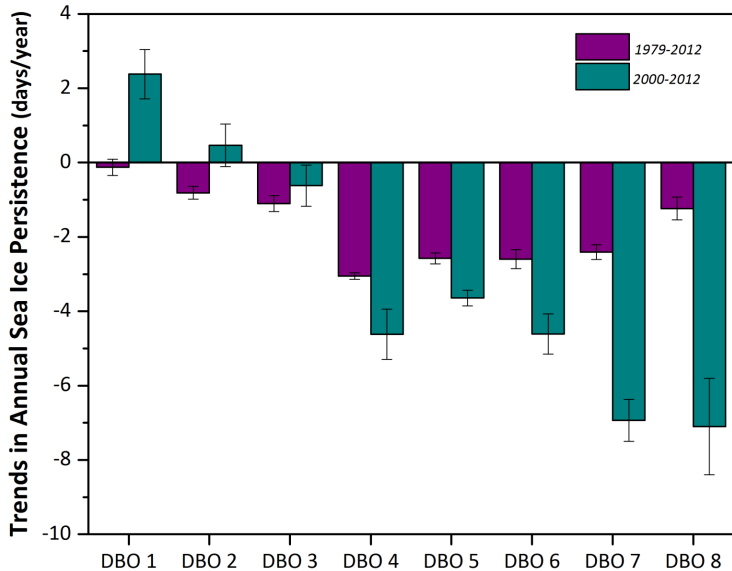
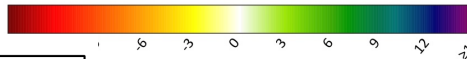
Trends in Annual Sea Ice Persistence (DBO 1–8)

Hatching indicates statistically significant trends (Mann-Kendall $p < 0.1$)

Trends in annual sea ice persistence have accelerated since 2000



Trends in Annual Sea Ice Persistence (days/year)



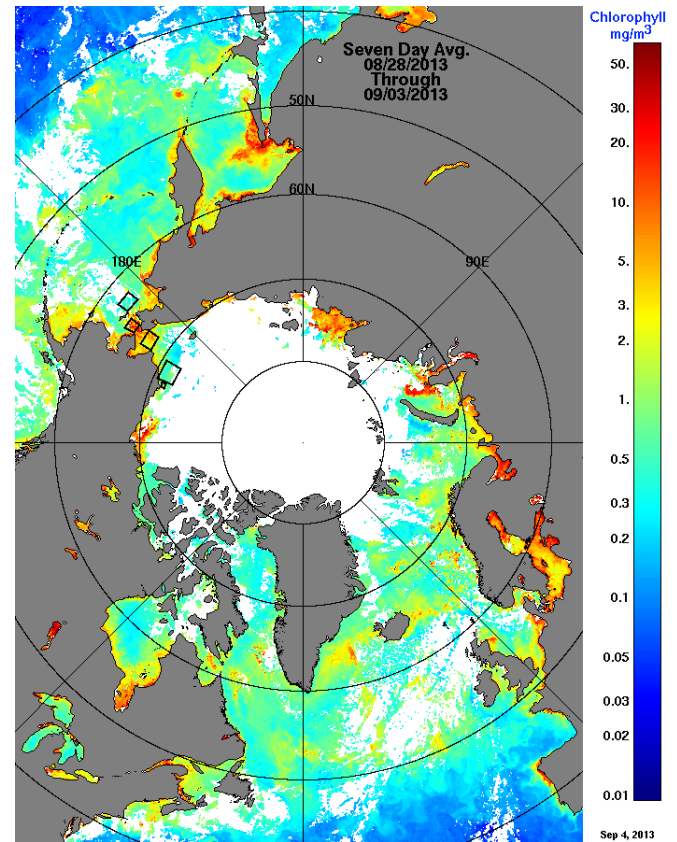
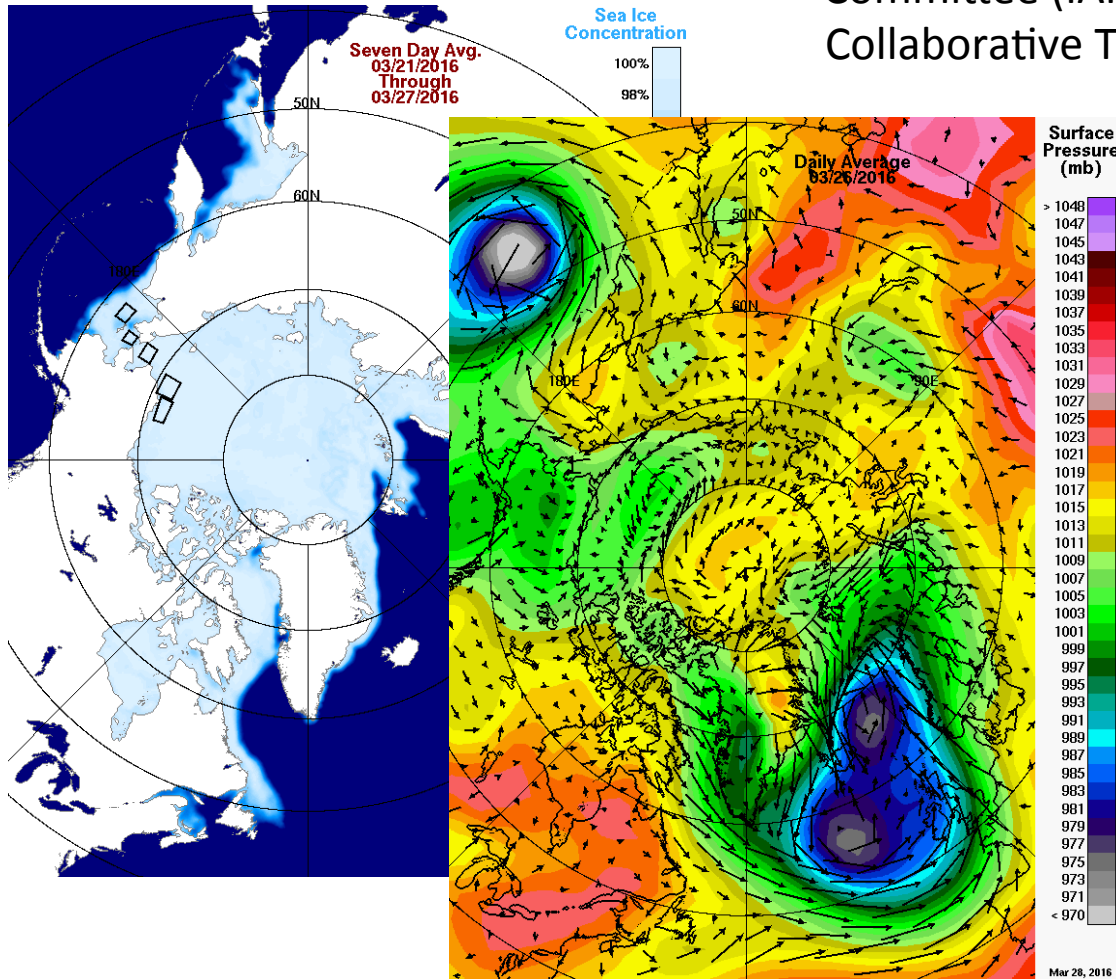
- *Trends in annual sea ice persistence have accelerated since 2000*
- *Recent gains in annual sea ice persistence in the south (DBO 1–2) transition to losses in the north (DBO 3–8)*

[Karen Frey, Clark University]

Satellite Visualization Data for the Distributed Biological Observatory (DBO)

J. C. Comiso, Karen Frey, L. V. Stock, R. A. Gersten, and H. Mitchell.
NASA Goddard Space Flight Center

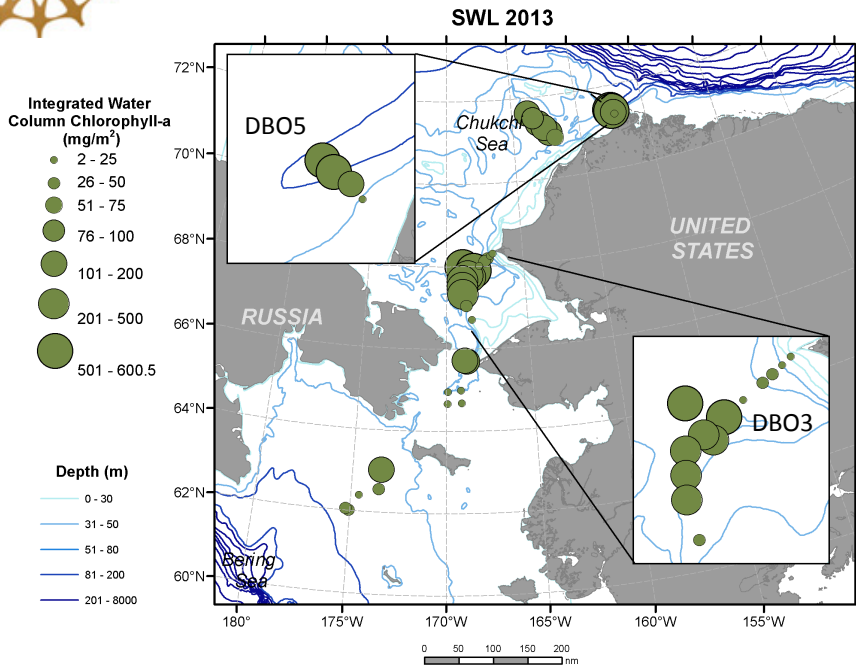
US Interagency Arctic
Research Policy
Committee (IARPC) DBO
Collaborative Team (CT)



<http://neptune.gsfc.nasa.gov/csb/index.php?section=270> (courtesy Joey Comiso)



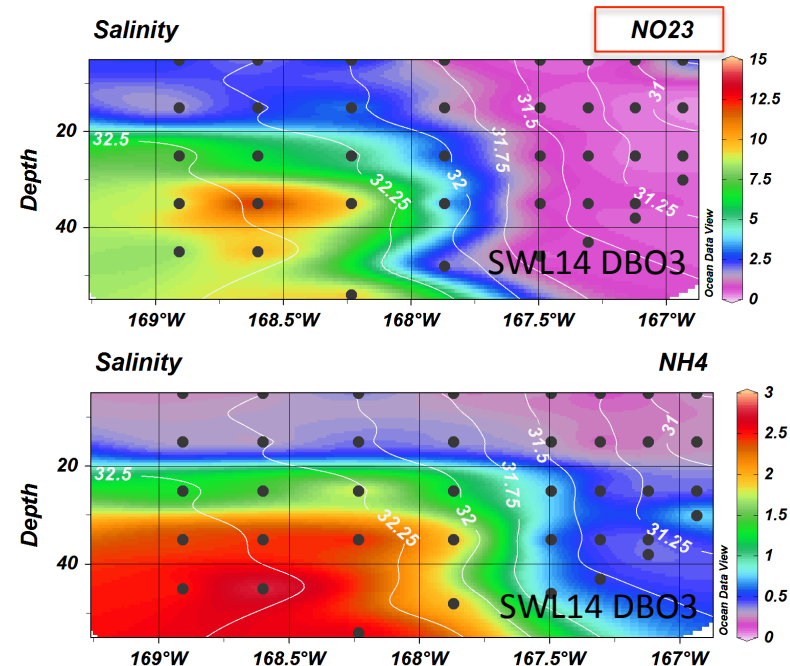
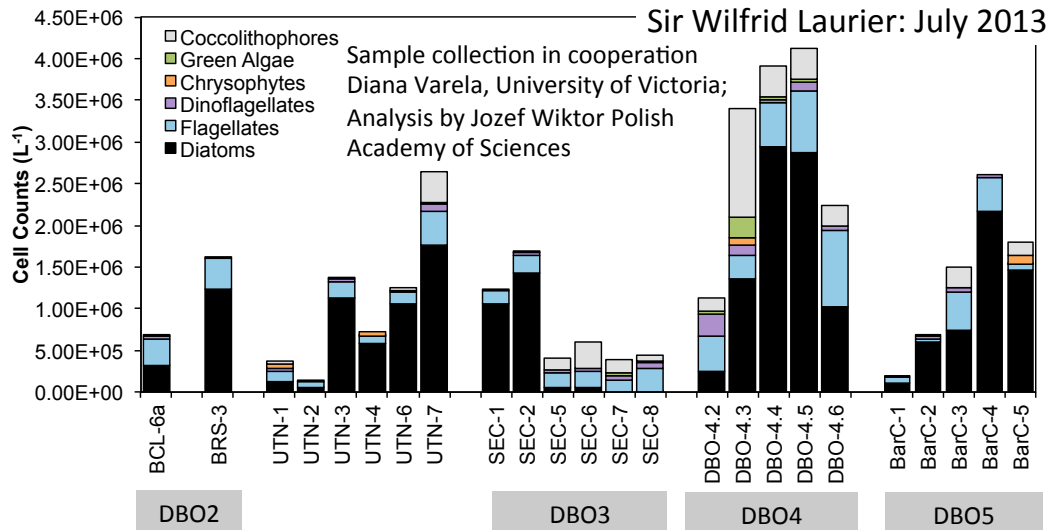
Examples of DBO Data Products



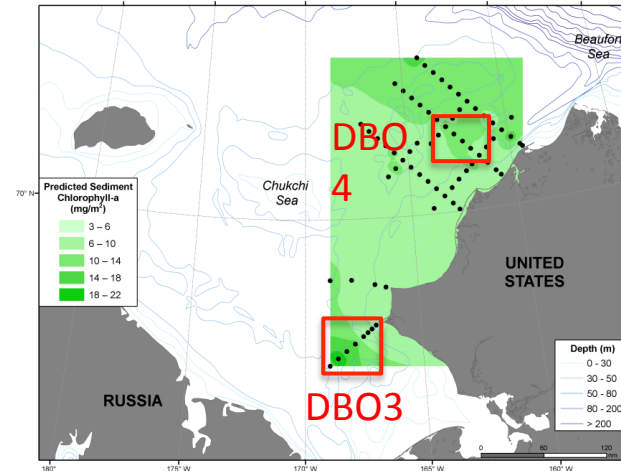
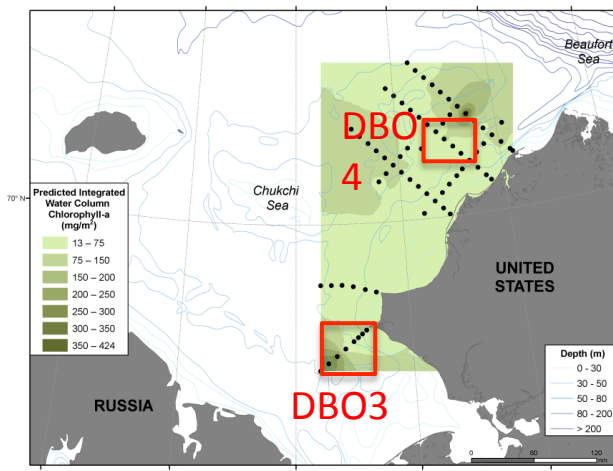
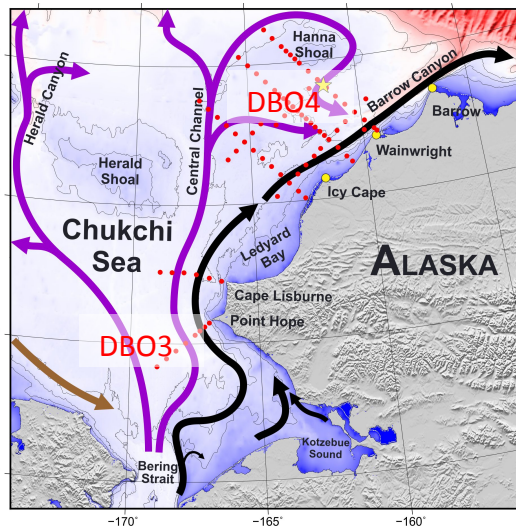
Top Left: Integrated Chlorophyll *a* during annual DBO cruise

Bottom left: Phytoplankton taxonomy, with dominance by diatoms in western side maintained by nutrient rich Anadyr and Bering Shelf waters

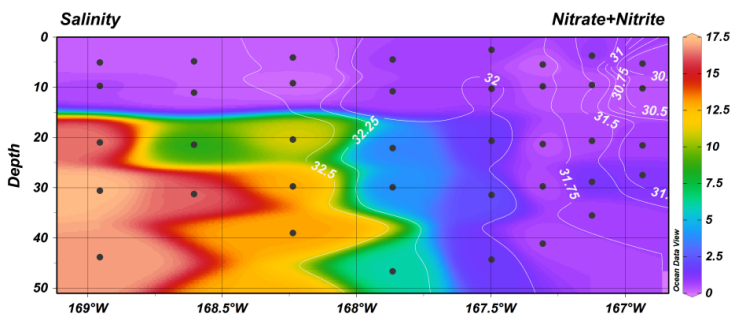
Bottom right: nitrate/nitrite (top panel) and ammonium (bottom panel) (μM)



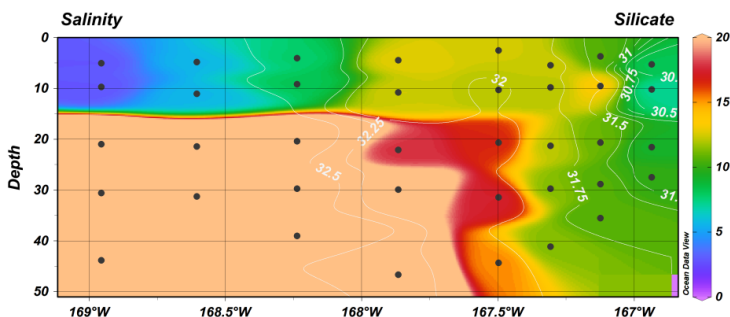
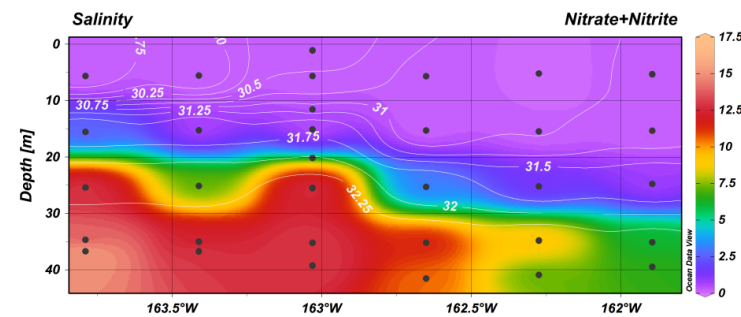
Goal: Evaluate faunal biodiversity and environmental drivers to understand Chukchi Sea ecosystem dynamics



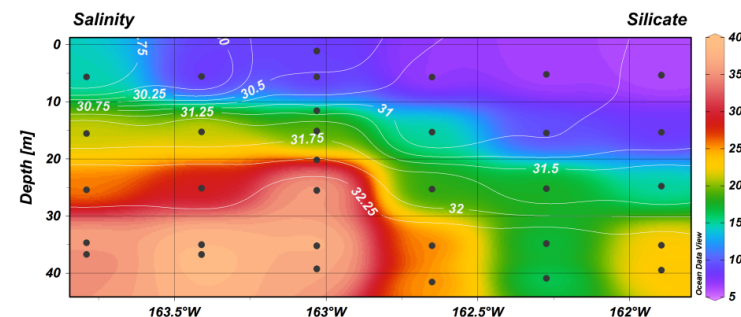
- Integrated water column chl α (left) and sediment chl α (right)



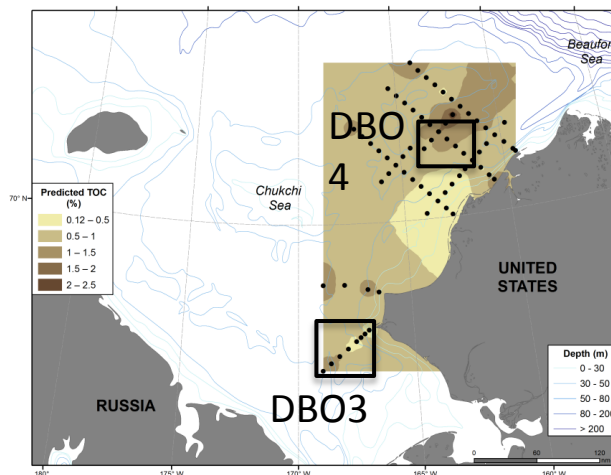
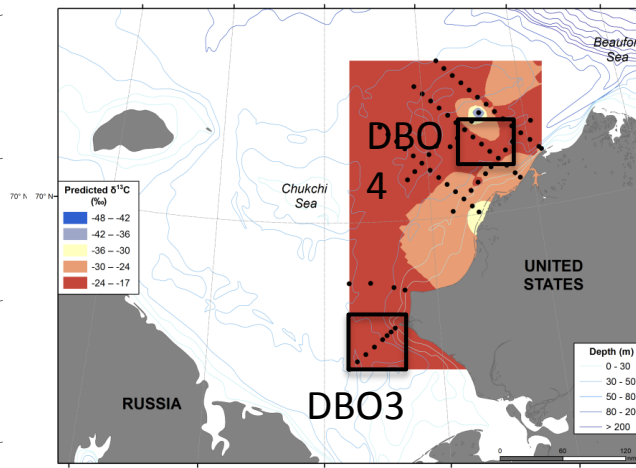
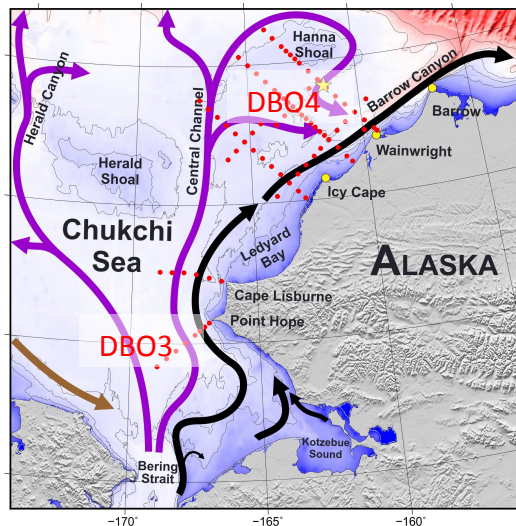
- Water column nutrients at DBO3 (left) and DBO4 (right)- August 2015



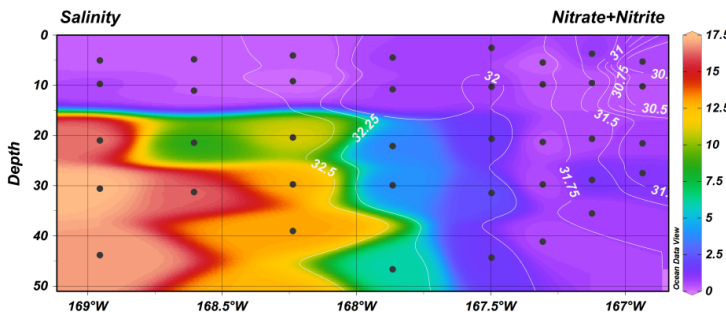
[funding through NOPP from NOAA, BOEM and Shell Oil]



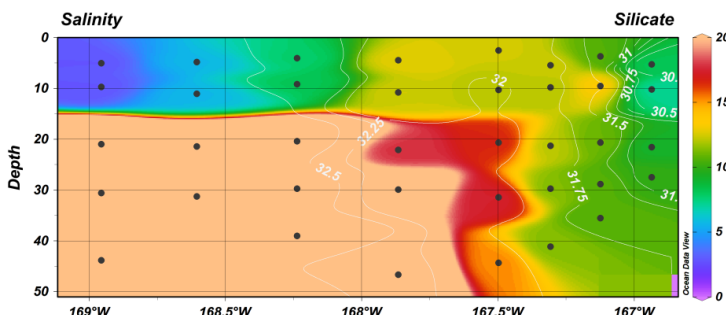
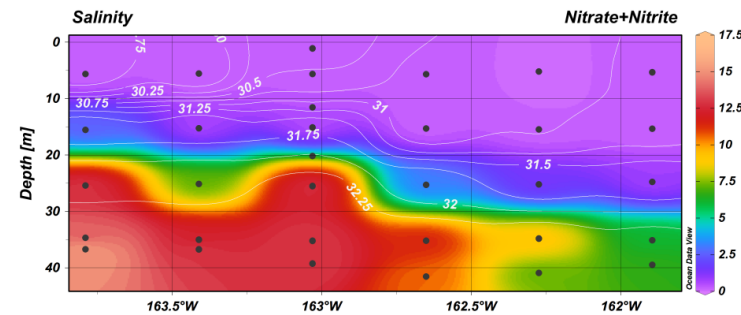
Goal: Evaluate faunal biodiversity and environmental drivers to understand Chukchi Sea ecosystem dynamics



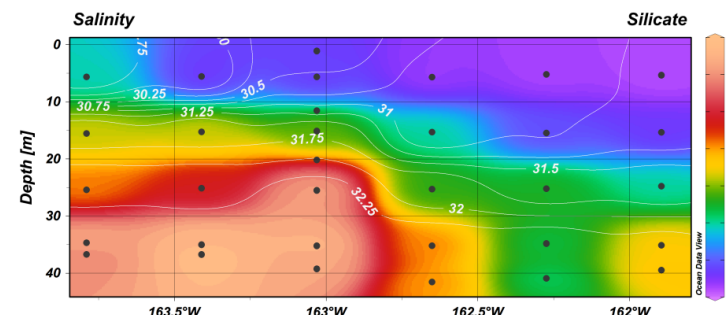
- Surface sediment $\delta^{13}\text{C}$ (left) and total organic carbon (right)



- Water column nutrients at DBO3 (left) and DBO4 (right)- August 2015



[funding through NOPP from NOAA, BOEM and Shell Oil]



Mooring observations at DBO-5

[Takashi Kikuchi]

● Publication

Itoh et al. (2015, DSR-I)



Water properties, heat and volume
 Canyon during summer 2010

Motoyo Itoh ^{a,*}, Robert S. Pickart ^b, Takashi Kikuchi ^{c,d},
 Daisuke Simizu ^{c,d}, Kevin R. Arrigo ^e, Svein Val
 Jeremy T. Mathis ^h, Shigeto Nishino ^a, Carolin

^a Japan Agency for Marine-Earth Science and Technology, Yokosuka, Kanagawa
^b Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA
^c Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan
^d National Institute of Polar Research, Tachikawa, Japan
^e Department of Environmental Earth System Science, Stanford University, Sta
^f Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, British Col
^g Polar Research Institute of China, Shanghai, China
^h NOAA Pacific Marine Laboratory, Seattle, WA 98115, USA

ARTICLE INFO

Article history:

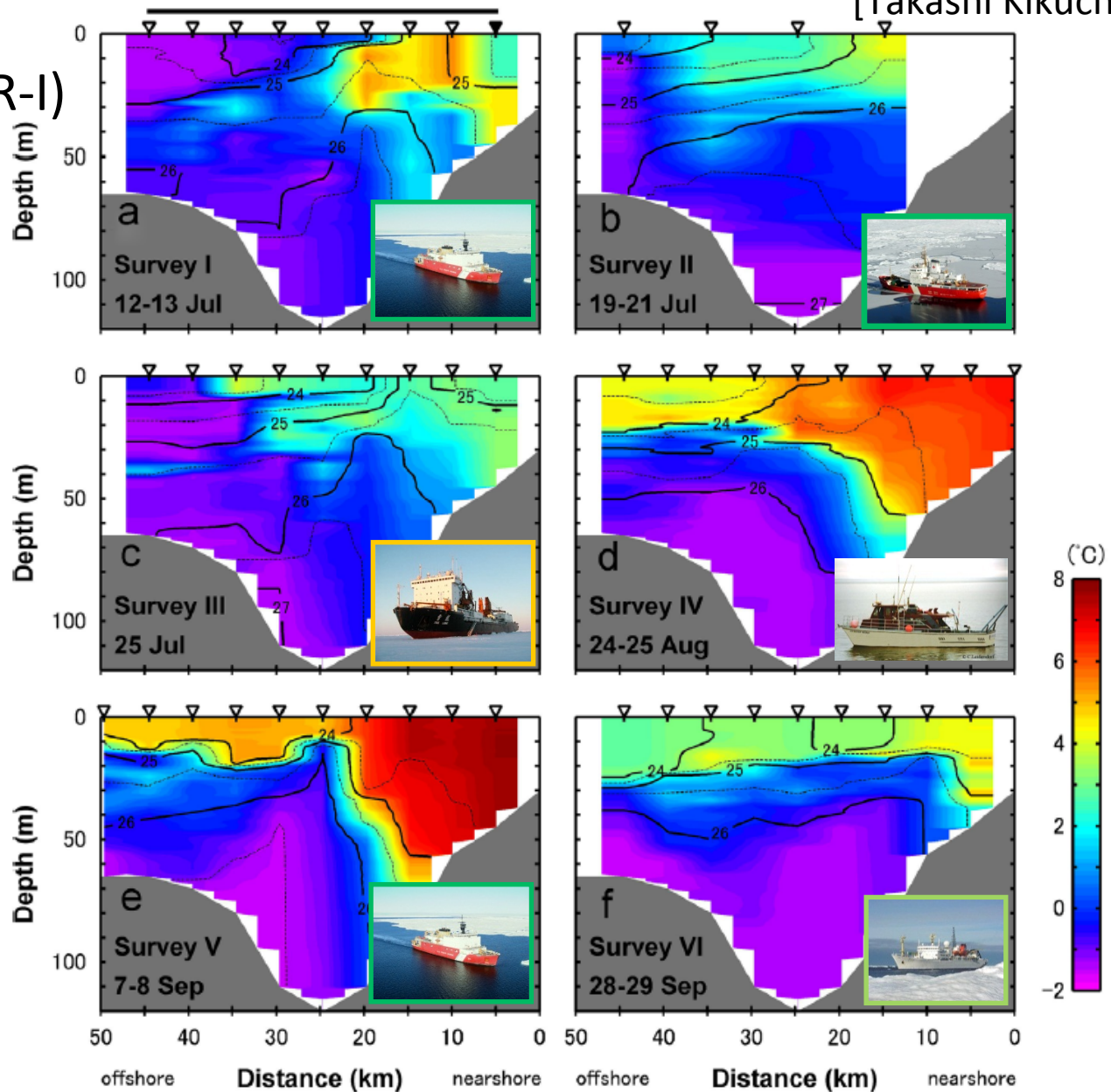
Received 16 July 2014
 Received in revised form
 9 April 2015
 Accepted 11 April 2015
 Available online 25 April 2015

Keywords:

Polar oceanography
 Arctic Ocean
 Chukchi Sea
 Heat fluxes
 Volume transports
 Water properties

ABSTRACT

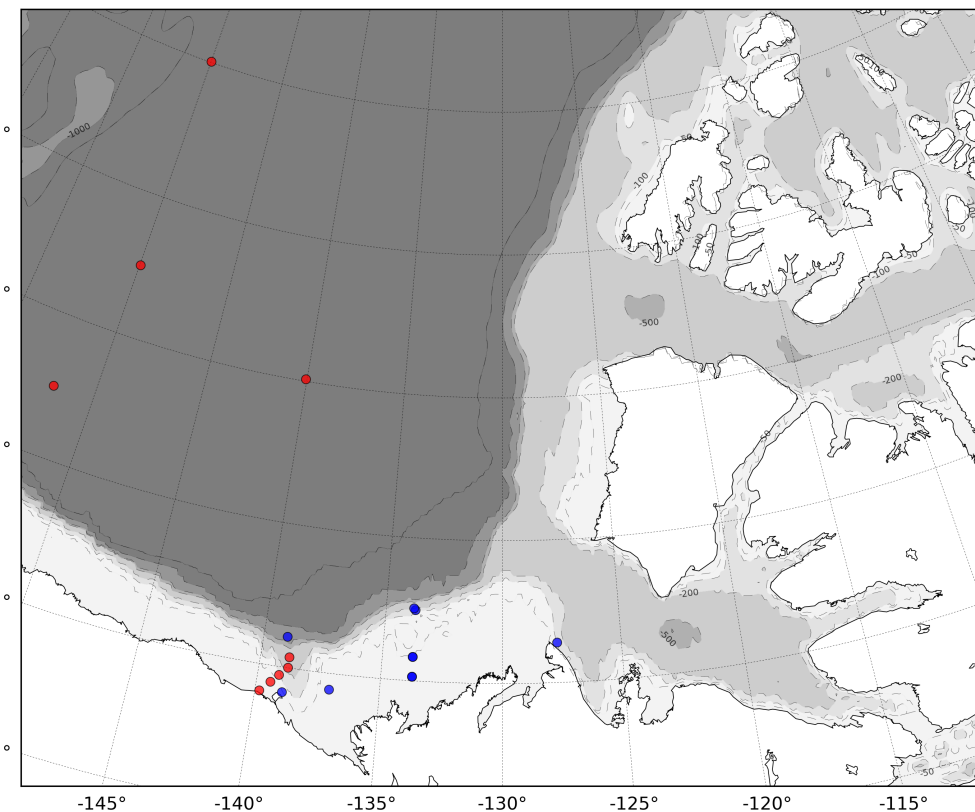
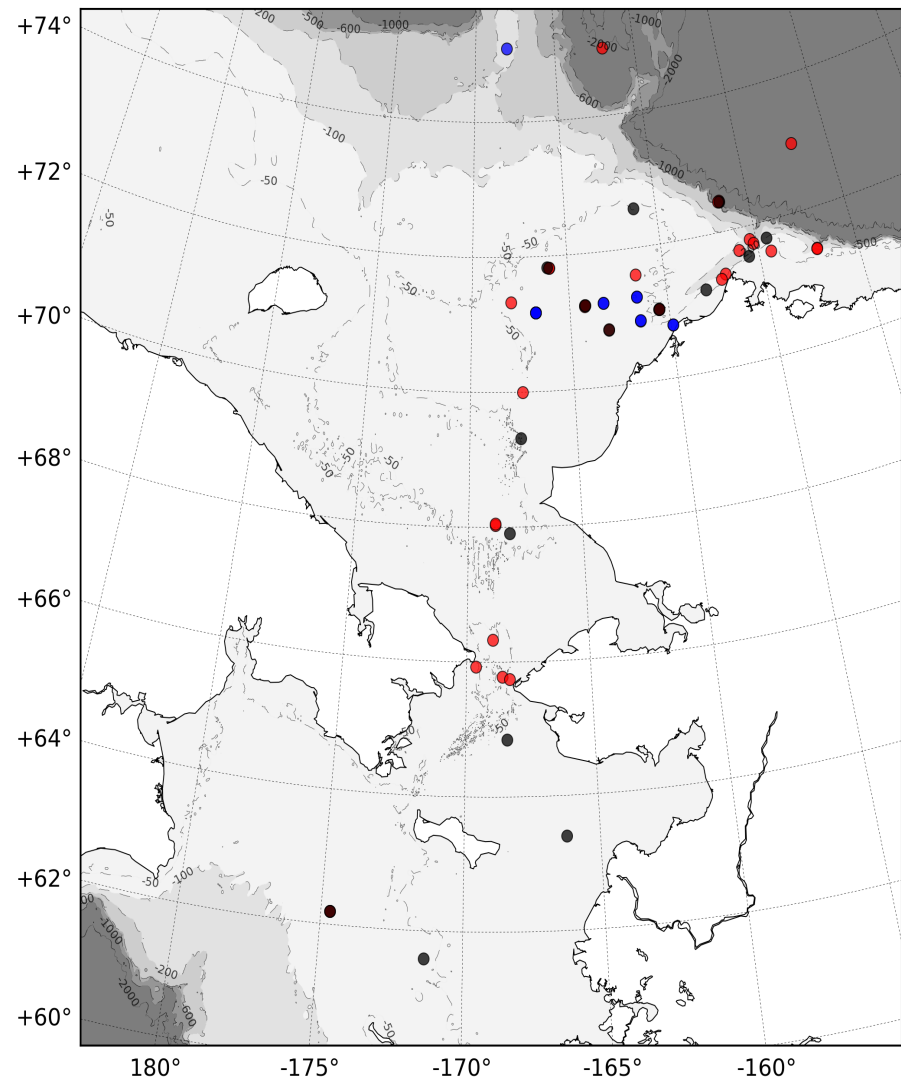
Over the past few
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 © 2015 The Auth



Arctic Moorings - 2016

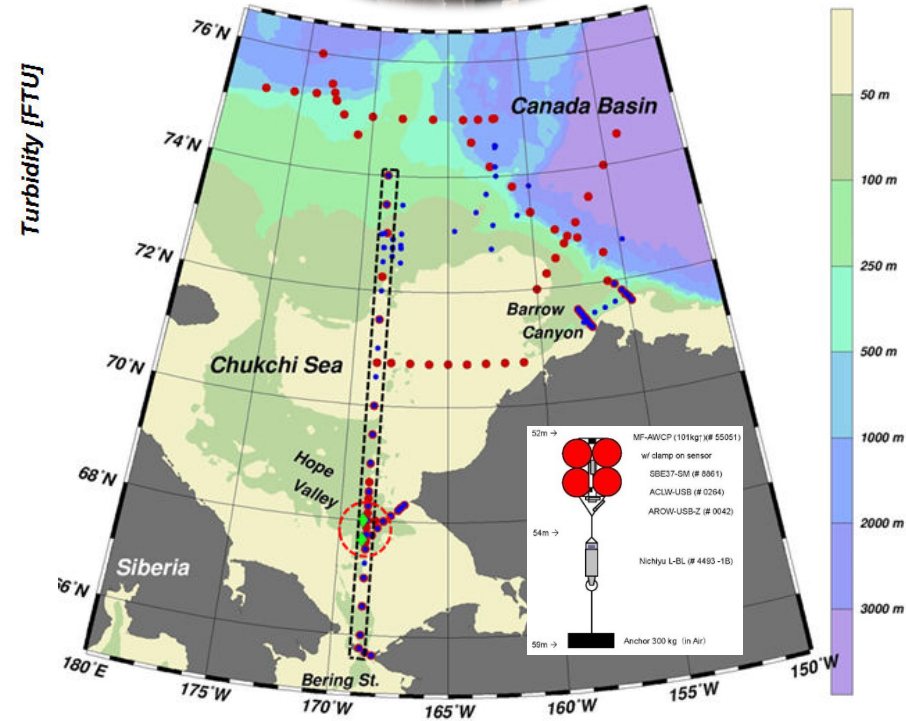
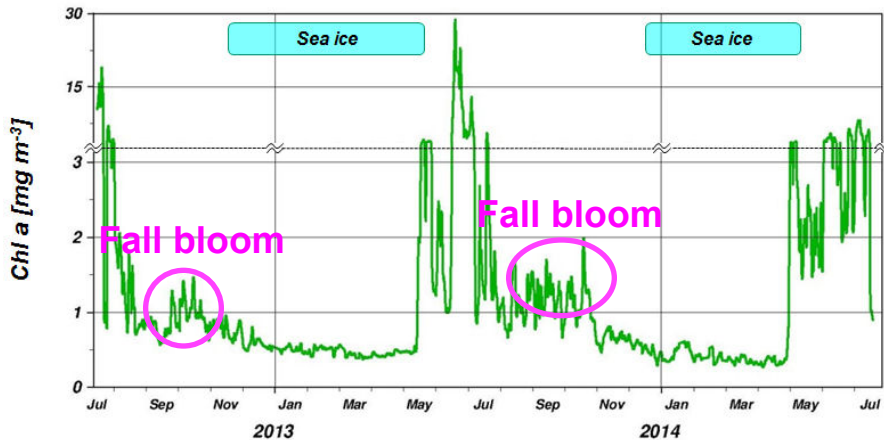
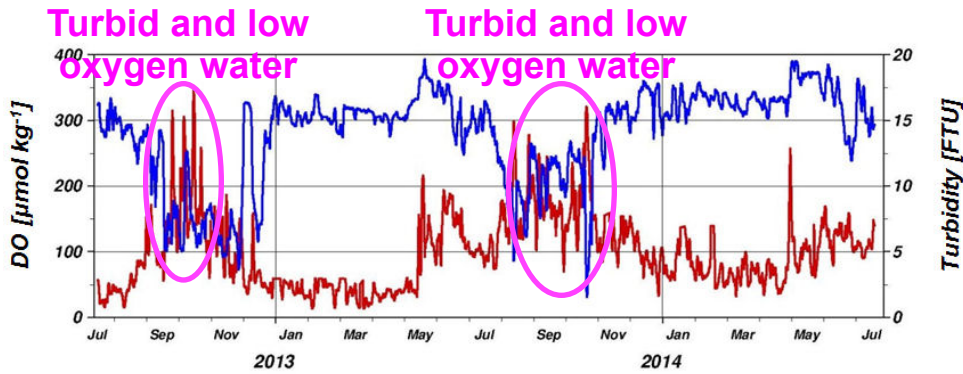
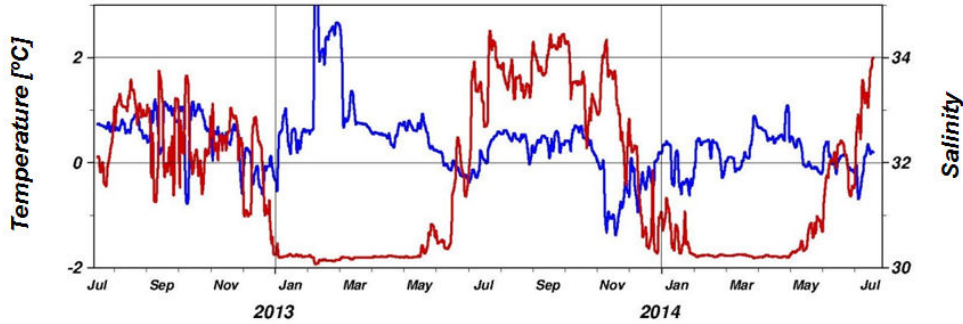
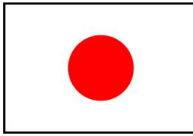
Number of moorings: ~80

- Different dot color=various projects
- Further details and excel sheet via PAG website

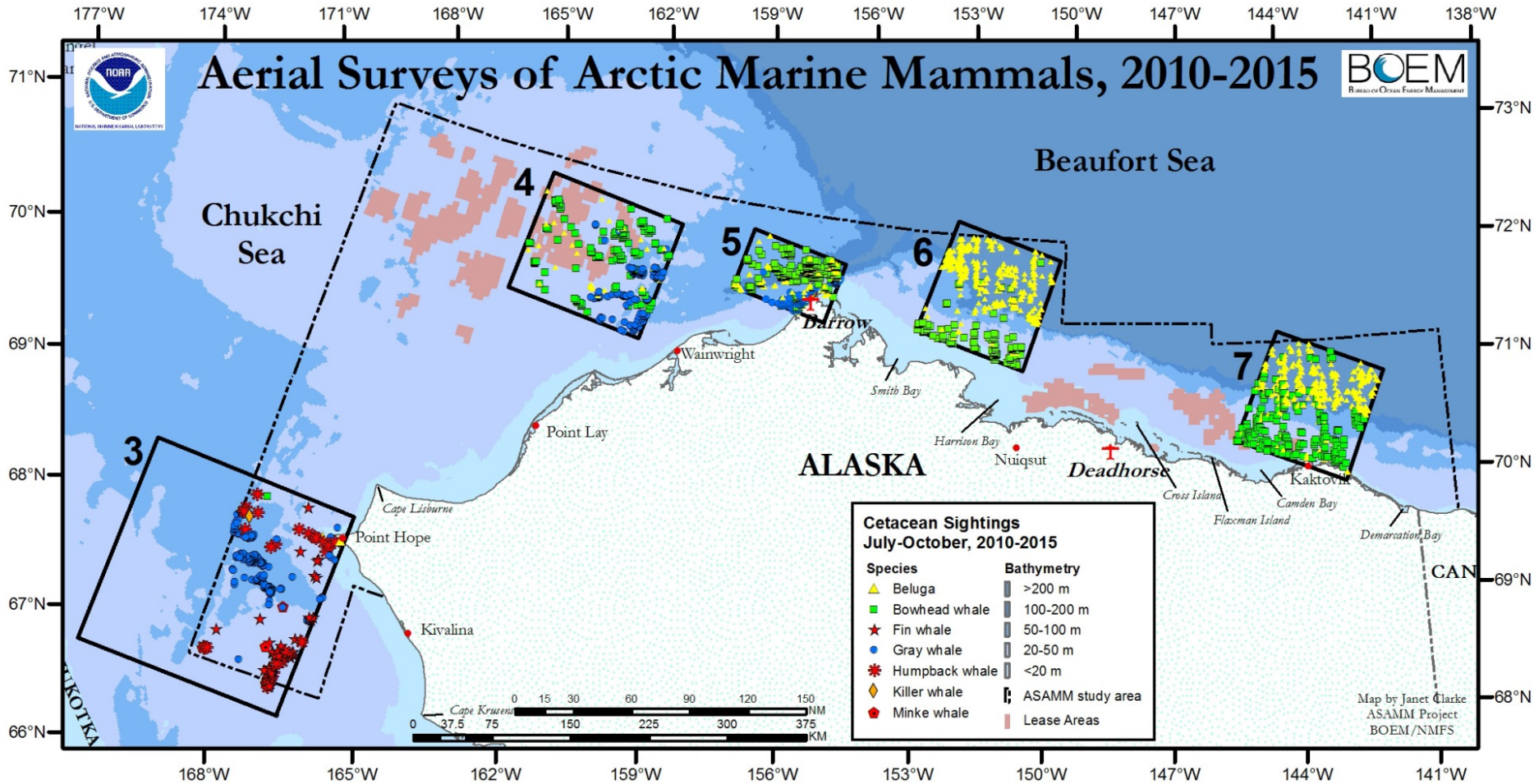


[courtesy Phyllis Stabeno/NOAA]

DBO3 moorings during July 2012 to July 2014



DBO 3, 4, 5, 6, and 7



DBO-3 – gray whale hot spot, subarctic cetaceans

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

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



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



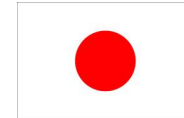
[Janet Clark]

DBO Data Sharing Protocols



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

- Data Sharing Site Established and Supported Through NSF at Earth Observations Laboratory, UCAR: dbo.eol.ucar.edu
- Data Policy Protocol Approved by International Partners in 2015 http://dbo.eol.ucar.edu/data_policy-dbo.html
- US Collaboration Team chaired by Sue Moore and Jackie Grebmeier through US IARPC to facilitate US agency DBO <http://www.iarpcollaborations.org/teams/Distributed-Biological-Observatory>



Distributed Biological Observatory

An Arctic Data Archive Linking Physics & Biology



June 1, 2010

Project Description:

The **Distributed Biological Observatory (DBO)** is an international effort spanning seven countries, including Canada, China, Japan, the Republic of Korea, Russia, Sweden, the United States, and many agencies within those countries. Sampling for the DBO is focused on transects centered on locations of high productivity, biodiversity and rates of biological change. The DBO is now focused on bringing together data from 2010-2014 sampling efforts.

Those looking to access DBO data should follow the link in the top right menu.

Principal Investigators of the DBO and Pacific Arctic Group (PAG) are asked to submit parameter information for data collected in the DBO regions using the form below. Click here for the [Mobile version](#), and here for [Instructions](#) for this form.



PARAMETERS FOR DBO STATIONS AND BOUNDING BOXES

Choose the type of data, the DBO line or bounding box, and the parameters collected.

1 Contact and cruise information

Name of Principal Investigator *

First Last

Affiliation *

Email *

Completed metadata will be sent to primary and cc email addresses.

cc on email

Mode of collection *

Collection Date Range (begin)

3/7/2016

This is an updated version for these data.

Yes No

Select "Yes" if you are updating a previous submission.

Collection Date Range (end)

3/7/2016

Name of project for these data

URL to project web site

Please provide link to project's home page

URL to dataset if not at EOL DBO Data Archive

Maps of DBO Stations and Bounding Boxes for reference:

[Regions 1-5](#)
[Regions 6-8](#)

If not submitting data to the EOL DBO Data Archive, and dataset is presently online, please provide link to the dataset.

Comments

DATA ACCESS

Data Access

DATA DOCUMENTATION

- About
- How to Submit Data
- Data Policy
- Map of DBO Regions 1-5
- Map of DBO Regions 6-8
- Map of DBO Bounding Boxes
- DBO Bounding Boxes
- Coordinates
- DBO Station Listing 1-8
- Instructions for the DBO parameters form
- DBO Generic Metafile Template

PUBLICATIONS

DBO Publications

RELATED LINKS

- ACADIS Gateway
- RUSALCA
- IASOA
- NOAA DBO Web Site
- WHOI DBO Cruise Database
- NASA Satellite Visualization Data

DBO REGION IDENTIFICATION

- 1 N Bering Sea- South St. Lawrence Is.
- 2 N Bering Sea-Chirikov Basin
- 3 SE Chukchi Sea
- 4 NE Chukchi Sea
- 5 Barrow Canyon
- 6 Beaufort Sea-152W
- 7 Beaufort Sea-143W
- 8 Beaufort Sea-Bathurst Polynya

- International collaboration with a goal for sharing and access

- Data collection on up to 8 sampling transects

- Metadata profile standard to facilitate exchange and synthesis activities

- International distributed archive centers rely on the metadata for exchange and access

- Earth Observing Laboratory DBO Project page with 4 metadata forms: Transects, Upper Trophic Data, Satellites, Moorings

http://www.eol.ucar.edu/field_projects/dbo

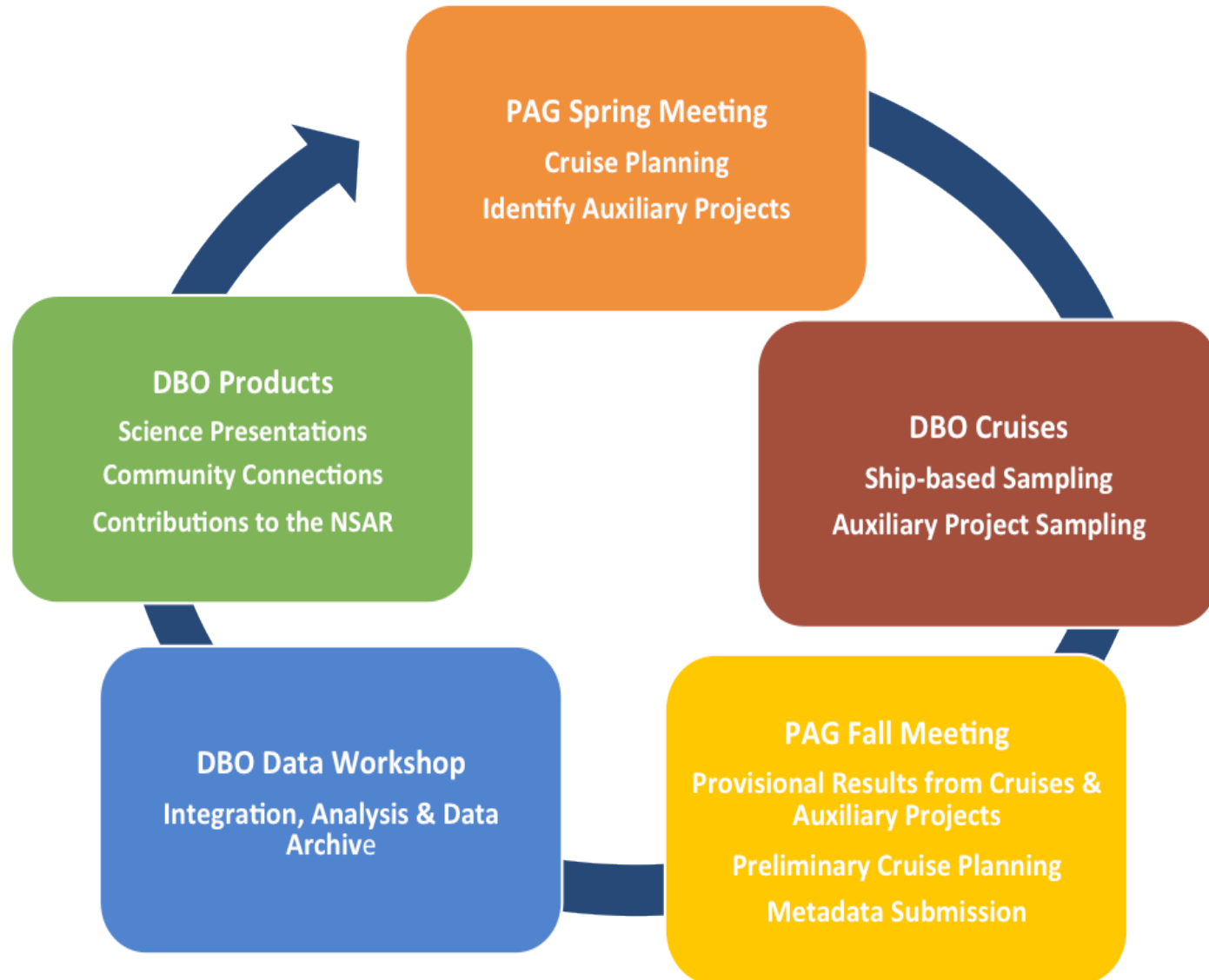
3rd DBO Workshop: Data Synthesis and 10-year Implementation plan

- 46 participants, 5 countries, all career levels of scientists
- **3 Objectives**
 - Present results from the 2010-2015 DBO field program and commit to multidisciplinary papers to showcase results of the DBO international effort
 - Evaluate the DBO data submission effort through the EOL DBO Metadata site and linkage to other national archives
 - Overview of US-IARPC Draft DBO Implementation Plan + International 10-year future efforts



March 9-10, 2016 , Pacific Marine Environmental Laboratory, NOAA, Seattle,

DBO IMPLEMENTATION PLAN ANNUAL CYCLE



Future Plans

- Expand the DBO to a larger pan-Arctic network in the Beaufort Sea
- Extend the NE Chukchi Sea DBO line westward into Russian waters
- Encourage DBO-type lines in the northern Barents Sea via SI-Arctic and through recently IASC support for an Atlantic-focused DBO workshop
- Test the developing Arctic Marine Pulses (AMP) conceptual model with seasonal DBO data to track seasonal biophysical 'pulses' across a latitudinal array
- Engage coastal stakeholders in nearshore coastal zone to the DBO via developing community-based networks

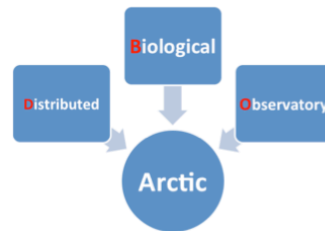
Summary

- DBO collects and evaluates key information to enable ecosystem approaches to management in the Pacific Arctic region and onwards to pan-Arctic ecosystems
- DBO network is endorsed and facilitated by the Pacific Arctic Group that is providing a process for engaging and organizing the international scientific community in monitoring the Arctic
- DBO effort developed to track biological responses in the context of ongoing ecosystem-based, multidisciplinary studies that are supported by a network of international stakeholders

Thank you for your attention.

Questions and comments?

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



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

USA agency support

