

# THE DISTRIBUTED BIOLOGICAL OBSERVATORY: A CHANGE DETECTION ARRAY TO TRACK ECOSYSTEM RESPONSES TO PHYSICAL DRIVERS IN THE PACIFIC ARCTIC

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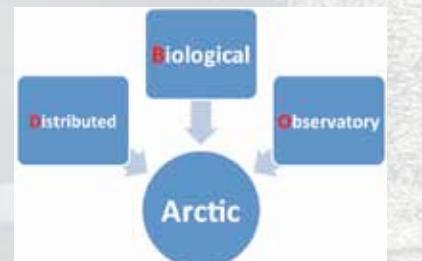
Ocean Sciences Meeting 2014

Session #102- The Chukchi Sea Region: Physical Forcing and Ecosystem Response in the Pacific Arctic

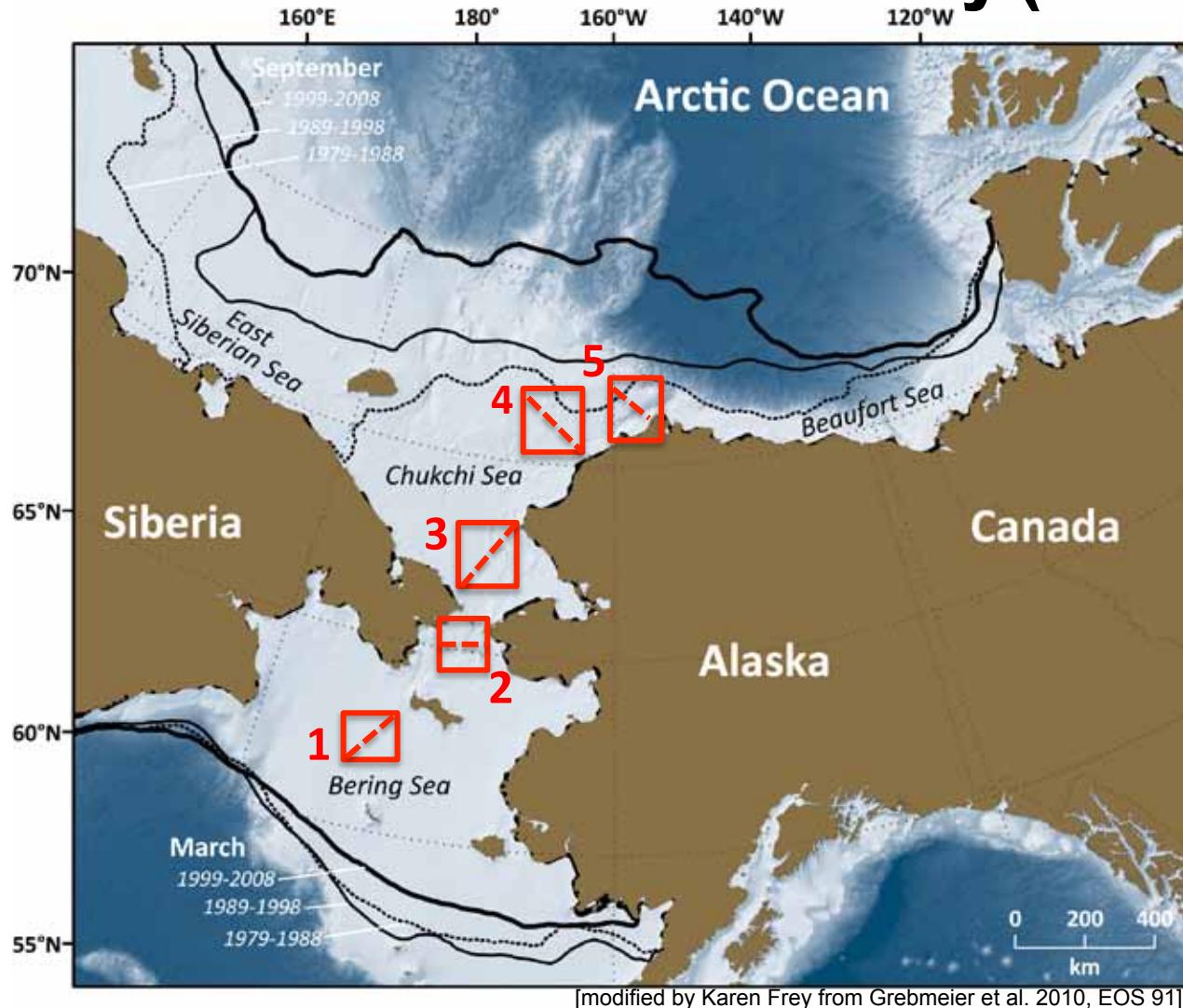


February 26, 2014

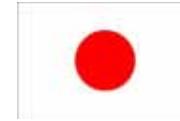
<http://www.arctic.noaa.gov/dbo/>



# 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 will 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



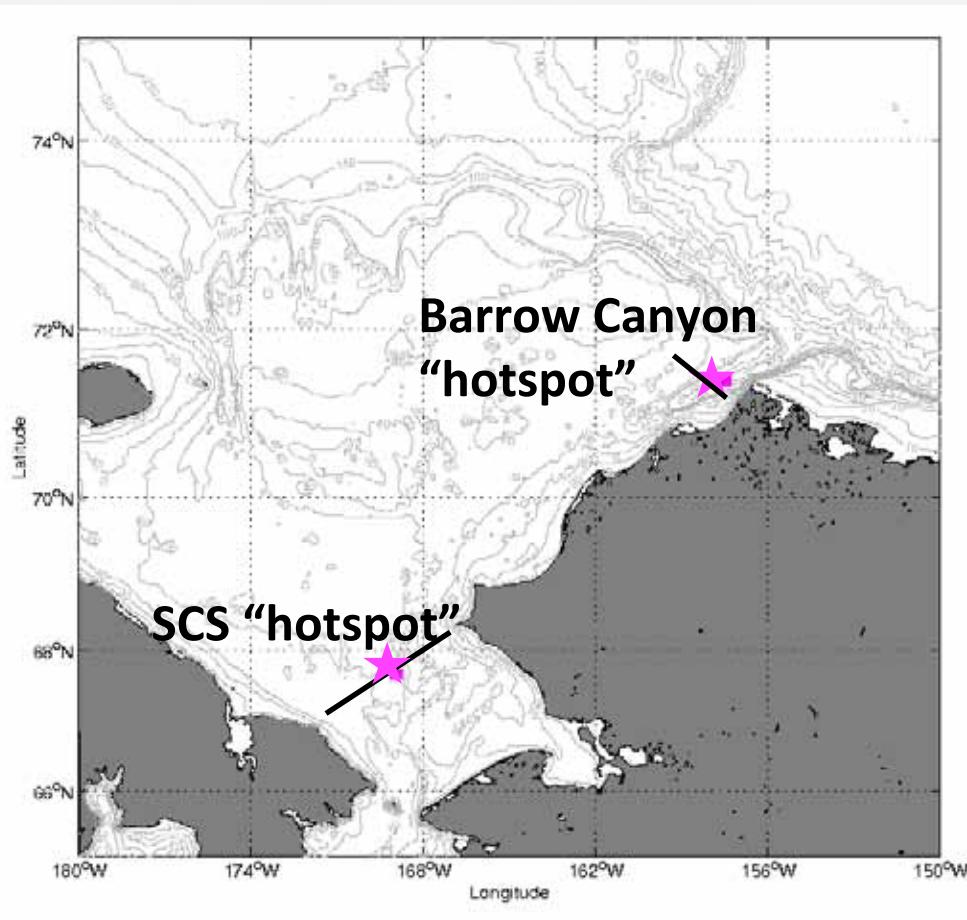
# Outline of Presentation

- Seasonal and interannual changes in sea ice extent, duration and seawater temperature
- Chlorophyll standing stock
- Biological response using the benthos as time series indicator
- Upper trophic connections to prey base
- Tracking ecosystem response to changing system

# Rationale of the DBO

- Tracking biological responses to physical drivers in the Arctic requires coordinated, multidisciplinary field sampling
- 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

# DBO Pilot Study: 2010-2013



**9 to 11 cruises/year  
Focus on DBO 3 & 5**

<http://www.arctic.noaa.gov/dbo/>  
<http://pag.arcticportal.org>

Vessel	Country	PI
<i>Moana Wave, Healy</i>	USA	Grebmeier
<i>Healy</i>	USA	Arrigo, Cooper, Grebmeier
<i>Xuelong</i>	China	He
<i>Mirai, Oshuru-Maru</i>	Japan	Hirawake, Itoh, Kikuchi
<i>Laurier</i>	Canada	Vagle
<i>Araon</i>	Korea	Chung
<i>Khromov, Norseman II</i>	Russia and USA	Woodgate
<i>Alaskan Enterprise</i>	USA	Napp
<i>Annika Marie</i>	USA	Ashjian
<i>Healy</i>	USA	Pickart
<i>Westward Wind</i>	USA	Day

# Distributed Biological Observatory Standardized Sampling Protocols



## Core ship-based sampling:

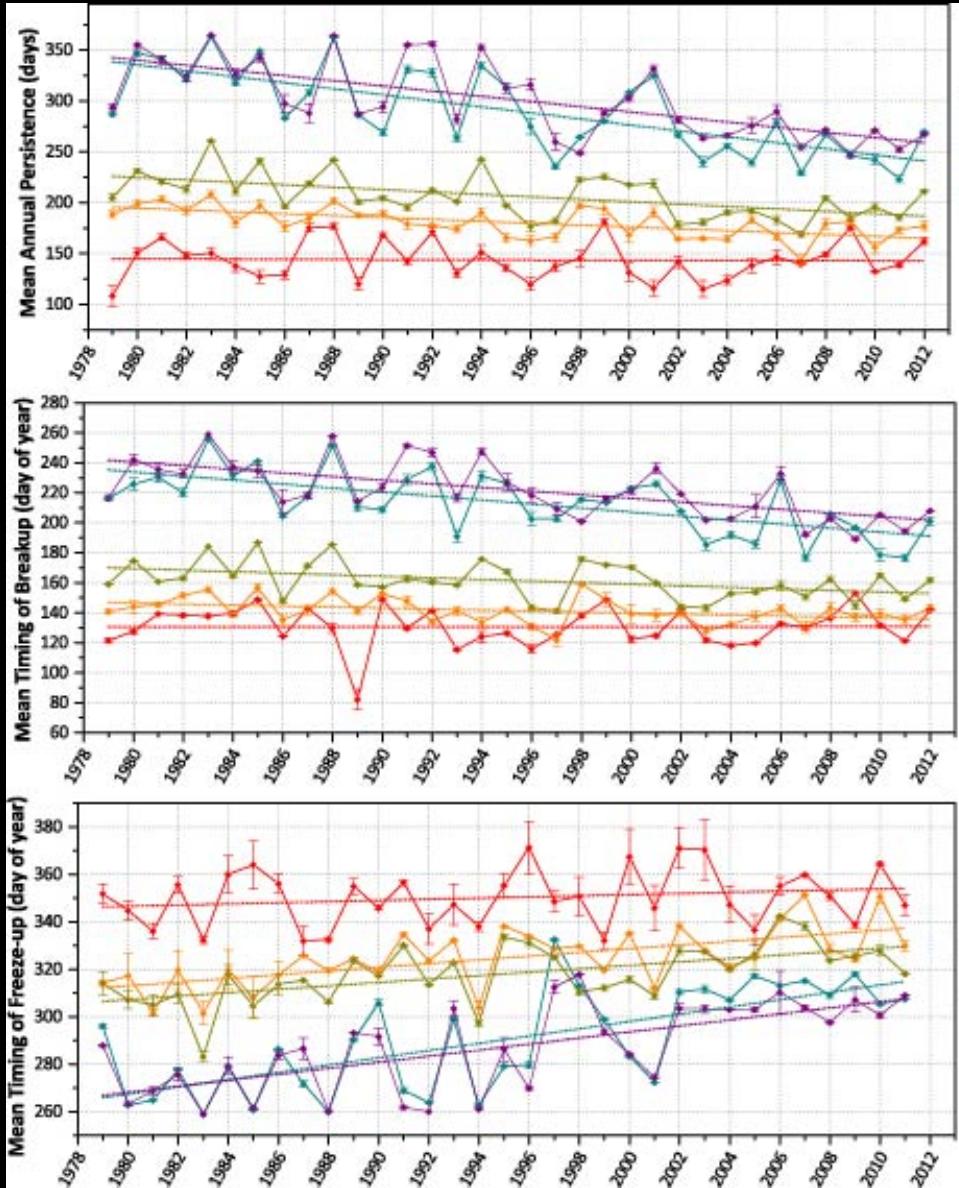
- CTD and ADCP
- Chlorophyll
- Nutrients
- Ice algae/Phytoplankton (size, biomass and composition)
- Zooplankton (size, biomass and composition)
- Benthos (size, biomass and composition)
- Seabird surveys (standard transects, no additional shiptime)
- Marine mammal surveys (no additional ship time)

## Second tier ship-based sampling:

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

**DBO sampling by national & international science programs**

# Sea Ice Persistence, Timing of Break-up, and Freeze-Up from DBO1 (south) to DBO5 (north)



**Annual Sea Ice Persistence**

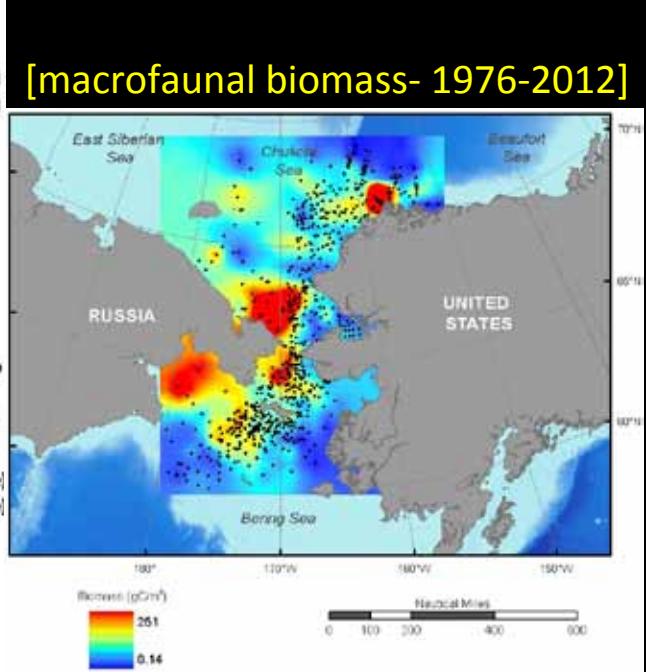
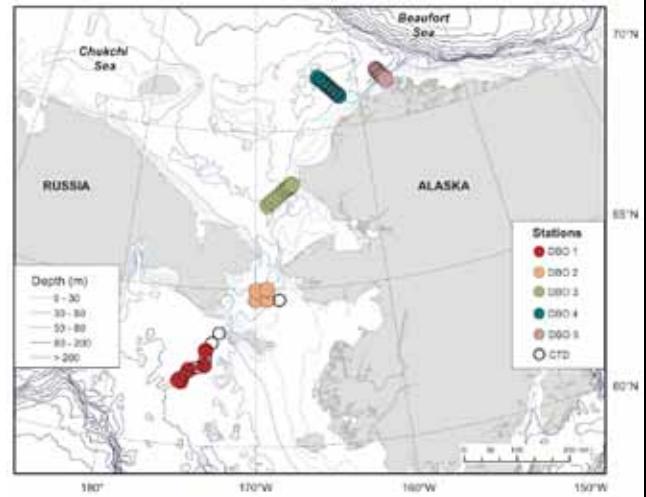
- DBO 1
- DBO 2 (-9.21 days/decade)
- DBO 3 (-11.84 days/decade)
- DBO 4 (-29.50 days/decade)
- DBO 5 (-25.30 days/decade)

**Timing of Sea Ice Breakup**

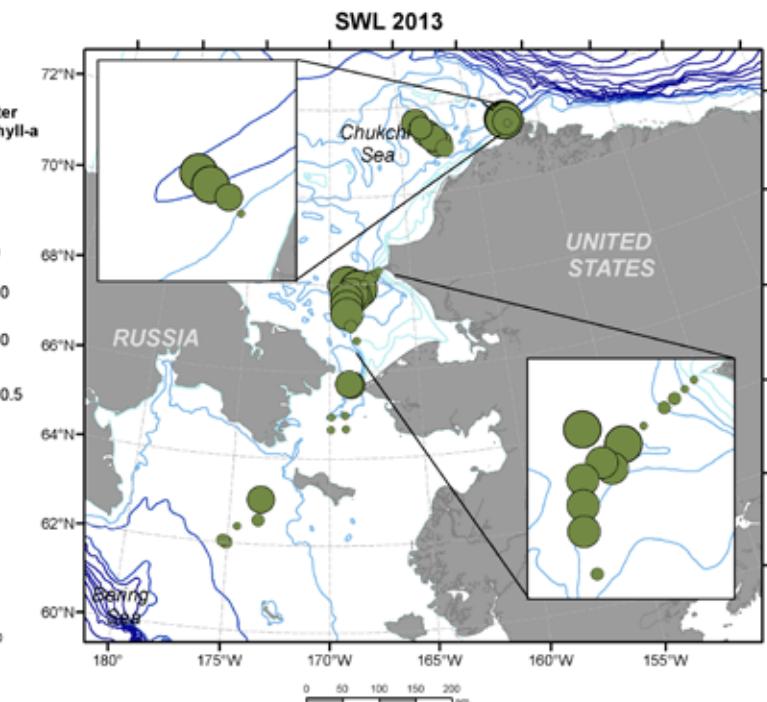
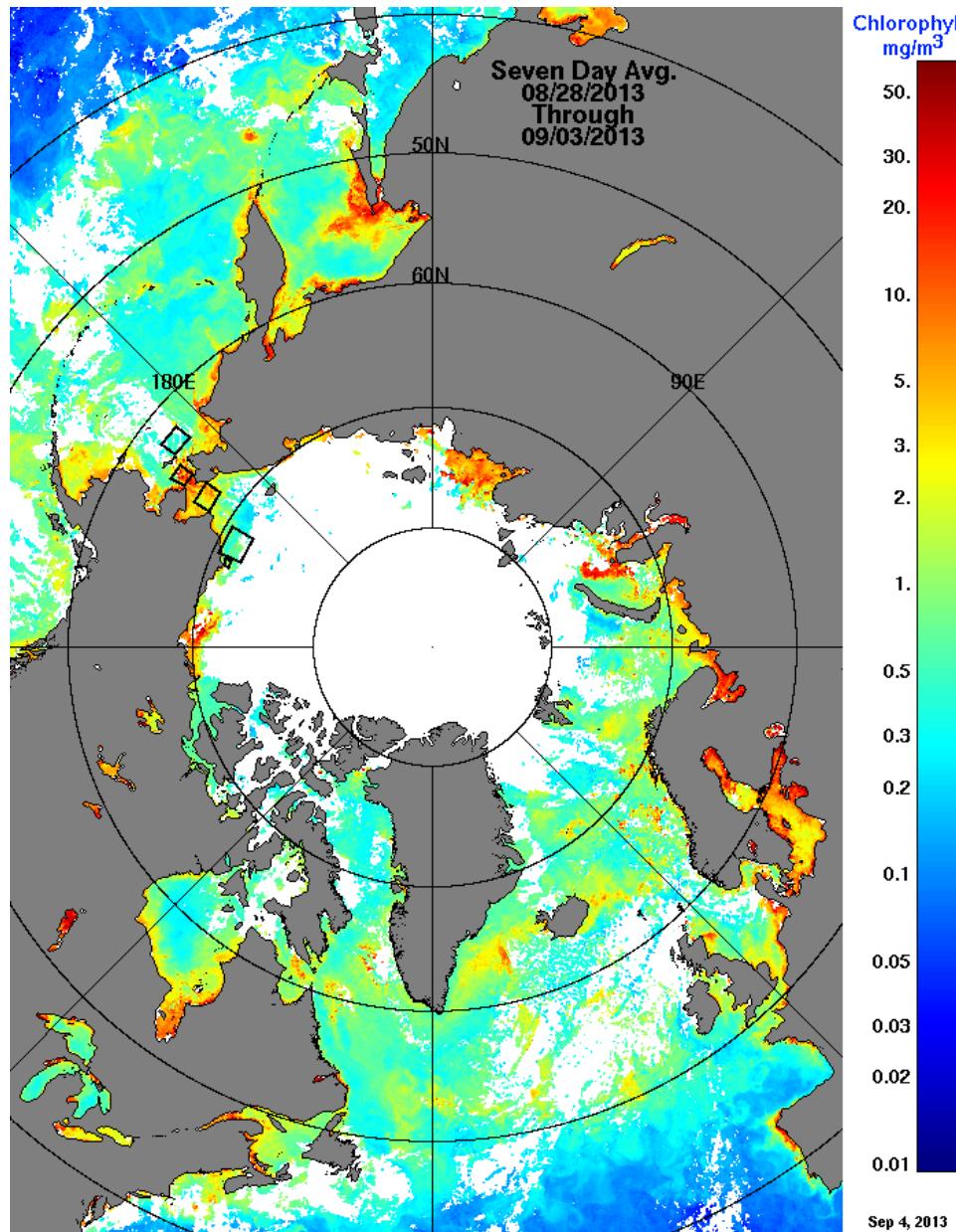
- DBO 1
- DBO 2 (-3.29 days/decade)
- DBO 3 (-5.22 days/decade)
- DBO 4 (-13.37 days/decade)
- DBO 5 (-12.12 days/decade)

**Timing of Sea Ice Freeze-up**

- DBO 1
- DBO 2 (+7.84 days/decade)
- DBO 3 (+7.22 days/decade)
- DBO 4 (+15.32 days/decade)
- DBO 5 (+12.72 days/decade)

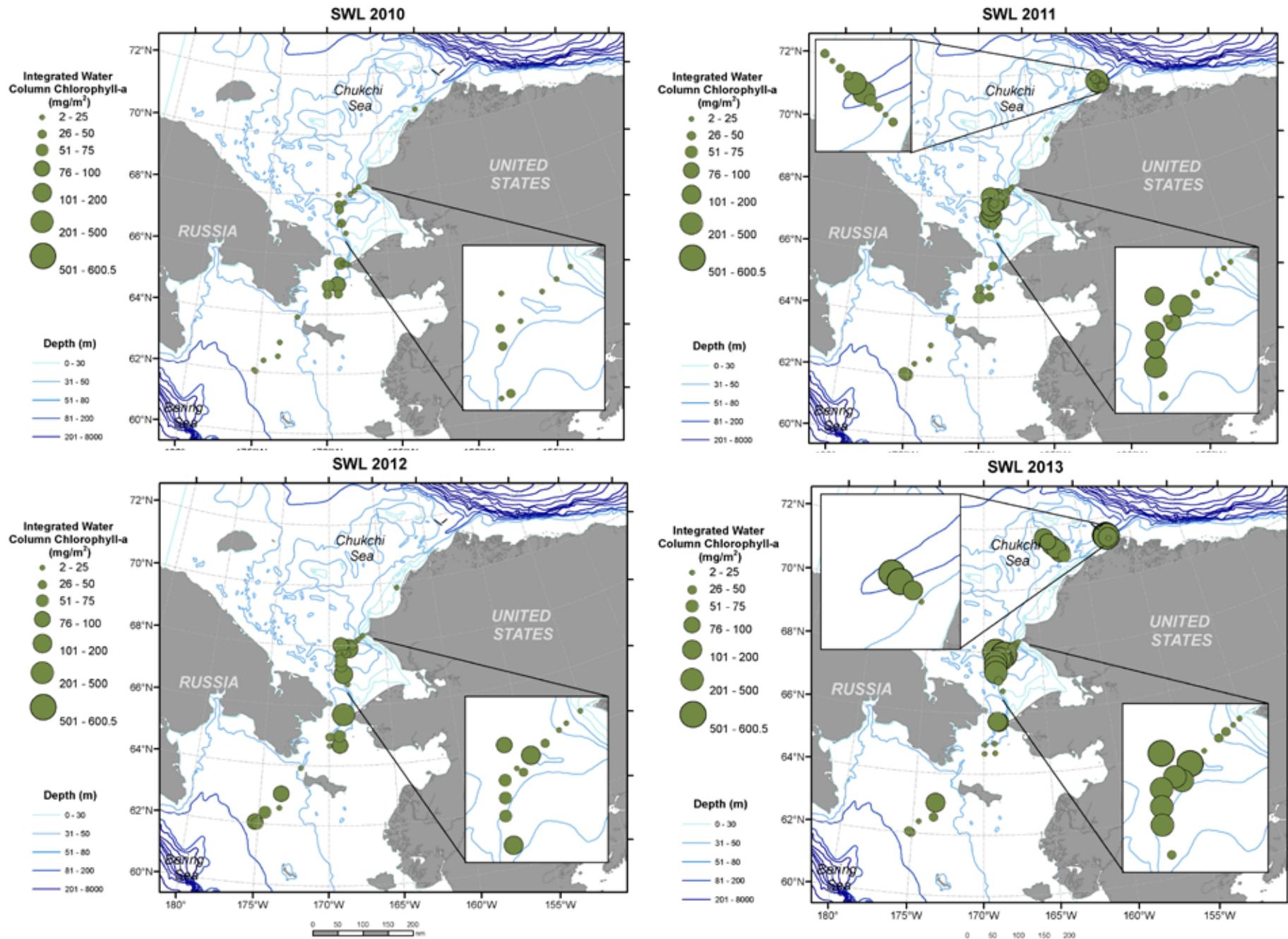


# NASA DBO-surface chlorophyll and field collected integrated values

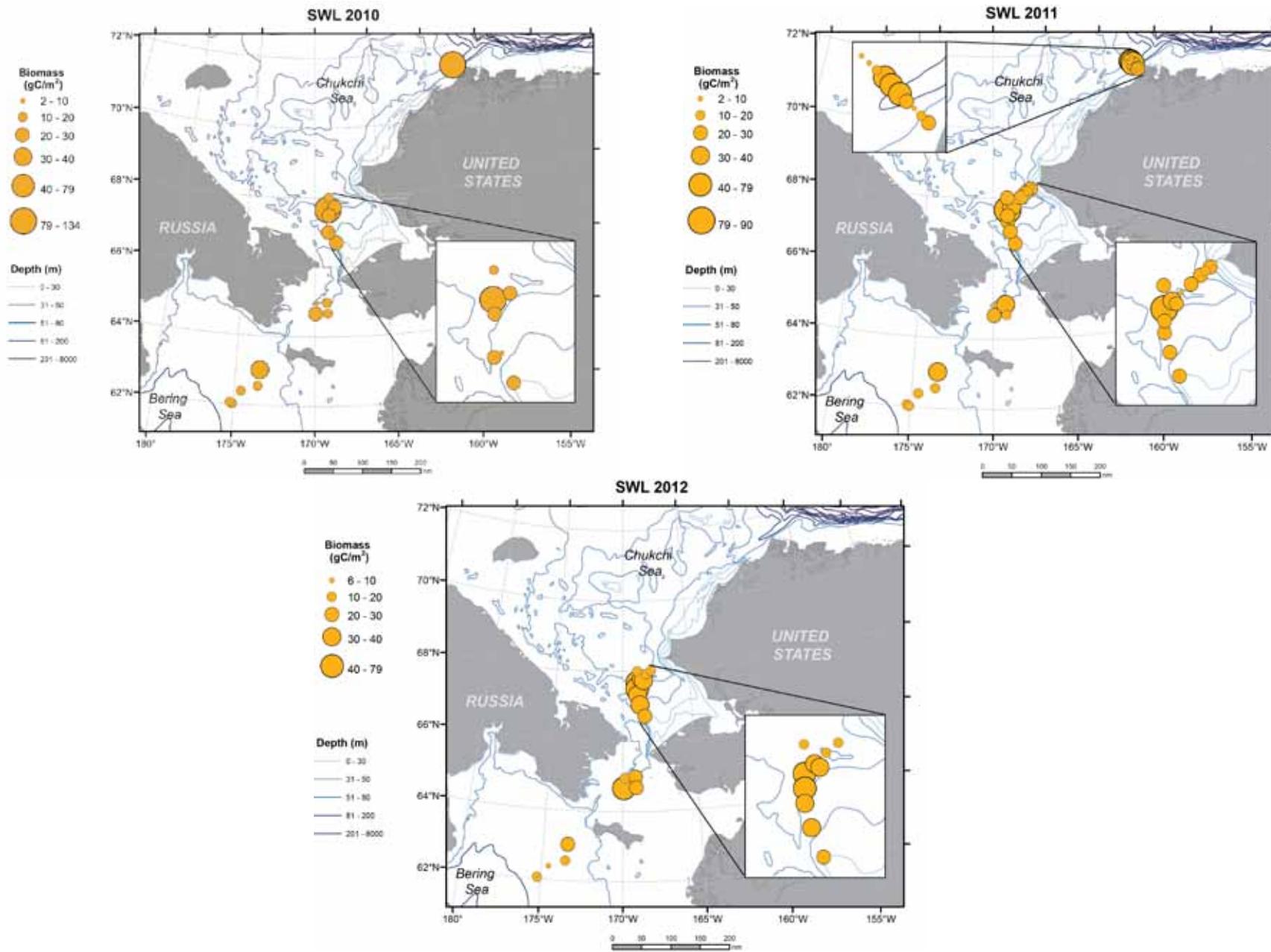


- Highest chl a via satellites and field data in Bering Strait and offshore SE Chukchi Sea DBO3 SE Chukchi Se hotspot

# DBO Integrated Chlorophyll a (mg/m<sup>2</sup>) during July

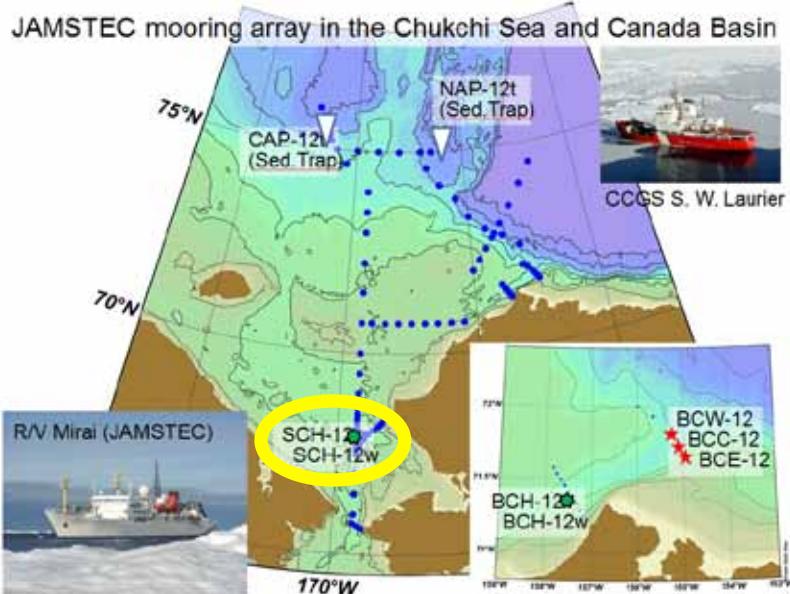


# Distribution of macrofaunal biomass (gC/m<sup>2</sup>) 2010-2012

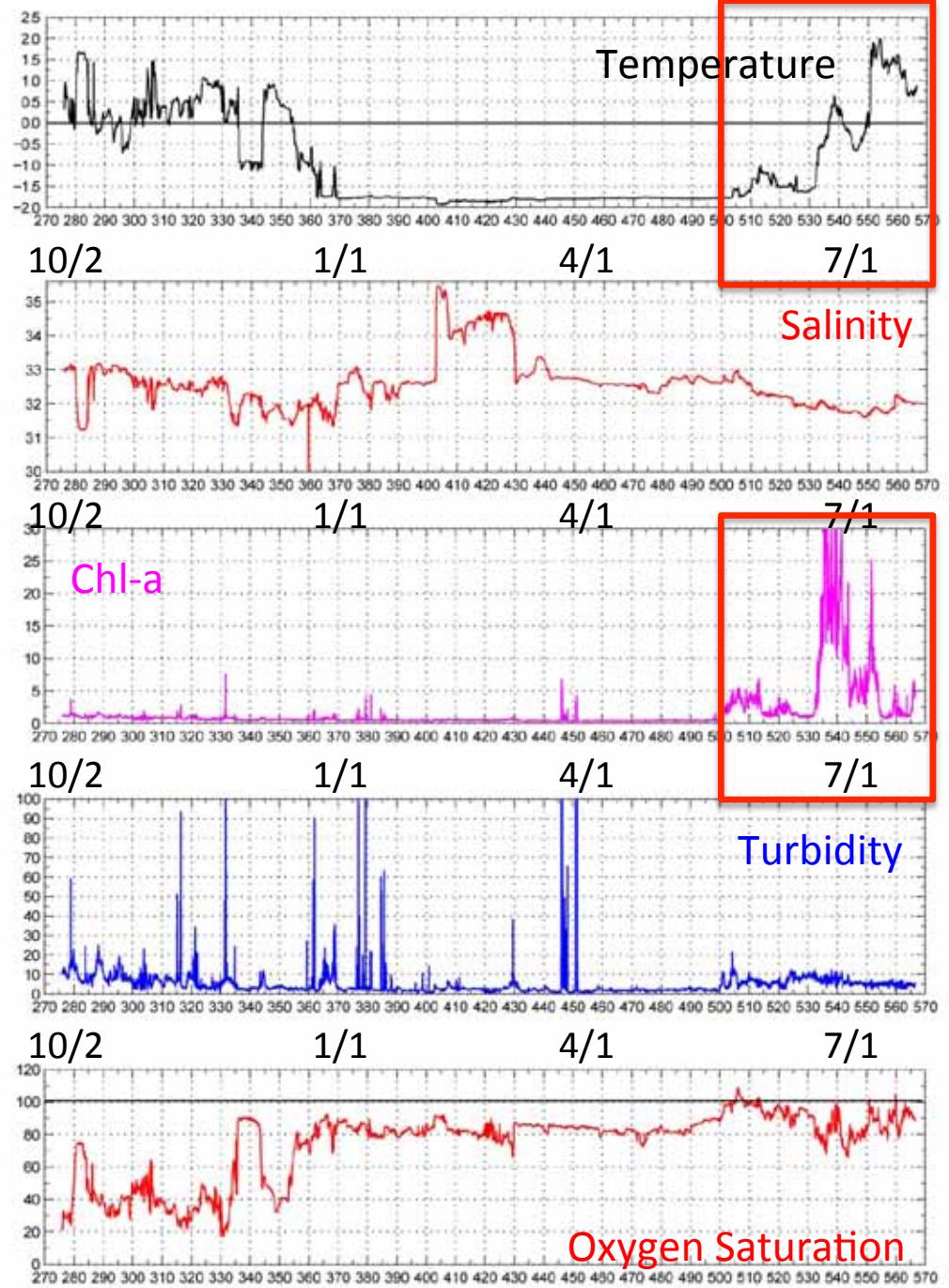
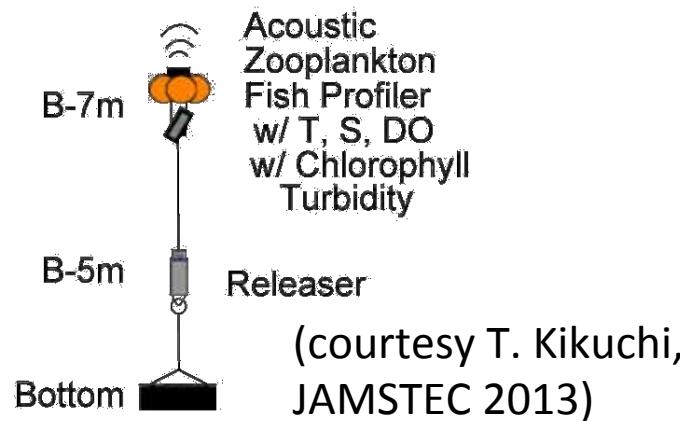


# SCH mooring

Time series of T, S, Chl-a,  
Turbidity, and Oxygen Saturation  
(Oct. 2, 2012 to Jul.20, 2013)



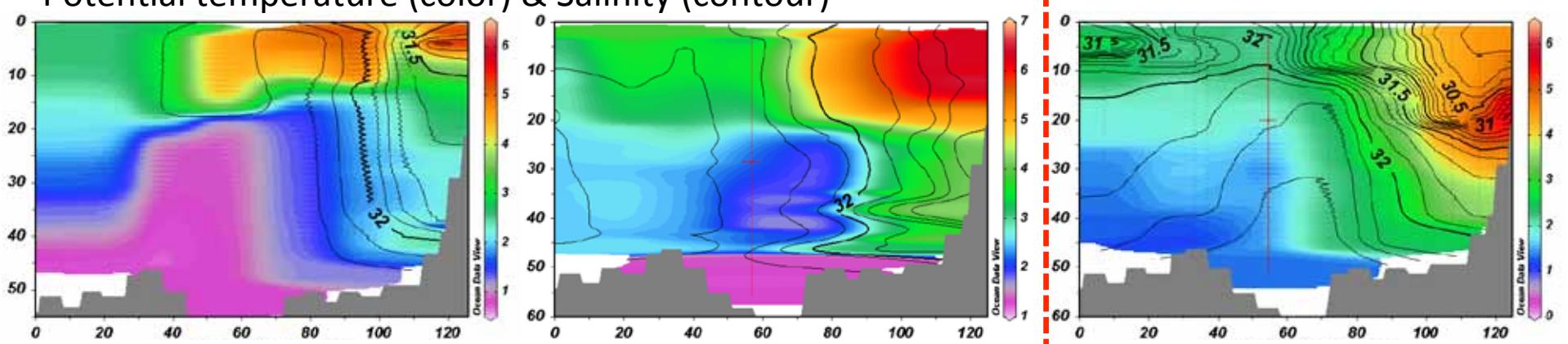
SCH-12



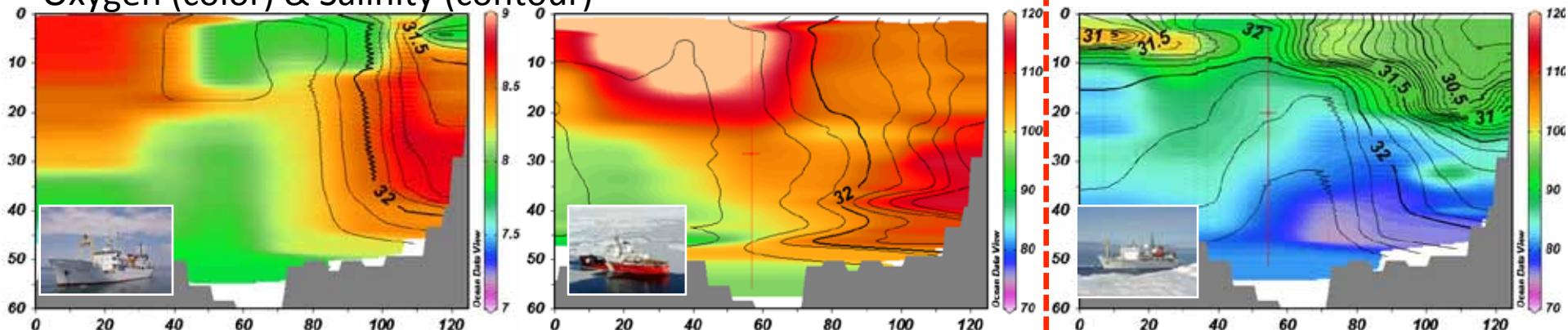
# PAG related observational activities in 2013

## **Comparison of CTD data on the DBO-3 line among Oshoro-maru (Jul.16), SWL (Jul.19-20), & Mirai (Oct.2-3)**

Potential temperature (color) & Salinity (contour)



Oxygen (color) & Salinity (contour)



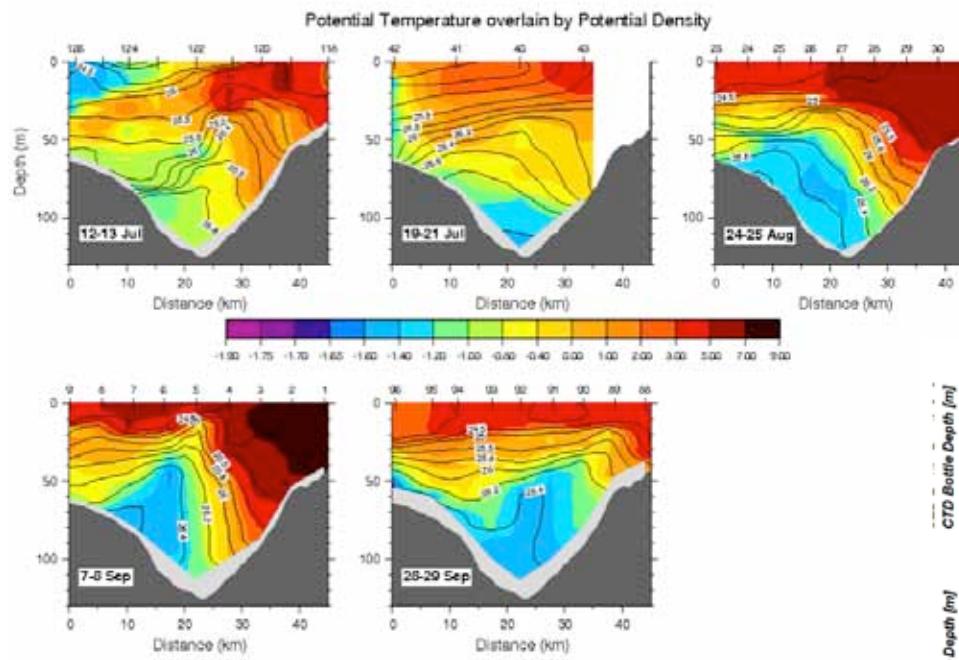
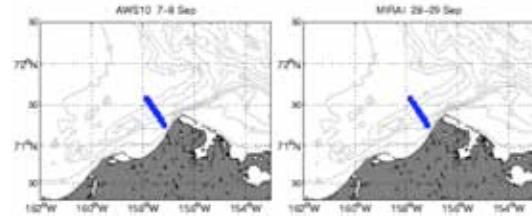
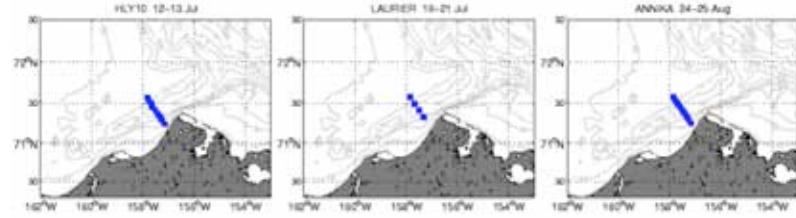
TS Oshoro-Maru (Jul.16)

CCGS S. W. Laurier (Jul.19-20)

RV Mirai (Oct.2-3)

(courtesy Takashi Kikuchi)

# DBO 5: Barrow Canyon Section



[R. Pickart]

[see Grebmeier et al. 2012, Arctic Report Card 2012, available at [http://www.arctic.noaa.gov/reportcard/barrow\\_canyon.html](http://www.arctic.noaa.gov/reportcard/barrow_canyon.html)]

-5 reoccupation of sections by international partners from June-October 2010

-observed seasonal warming of Alaska Coastal Water (ACW)

-high nitrate and silicate in the western Bering Sea water compared to eastern ACW

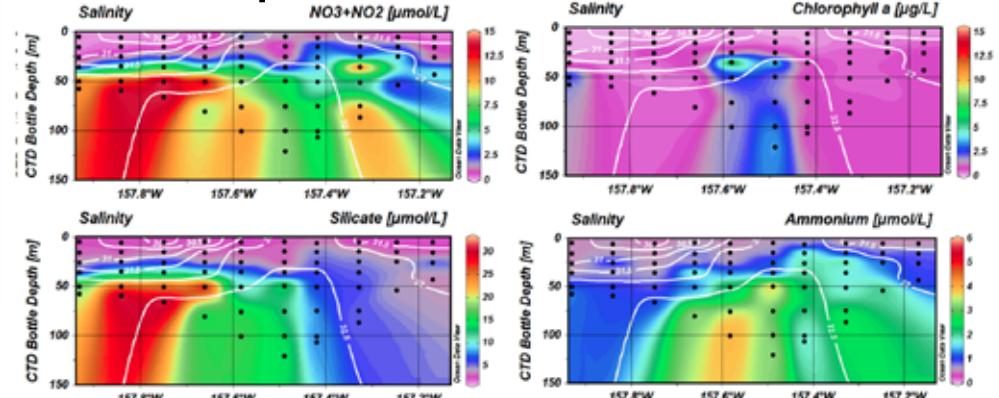
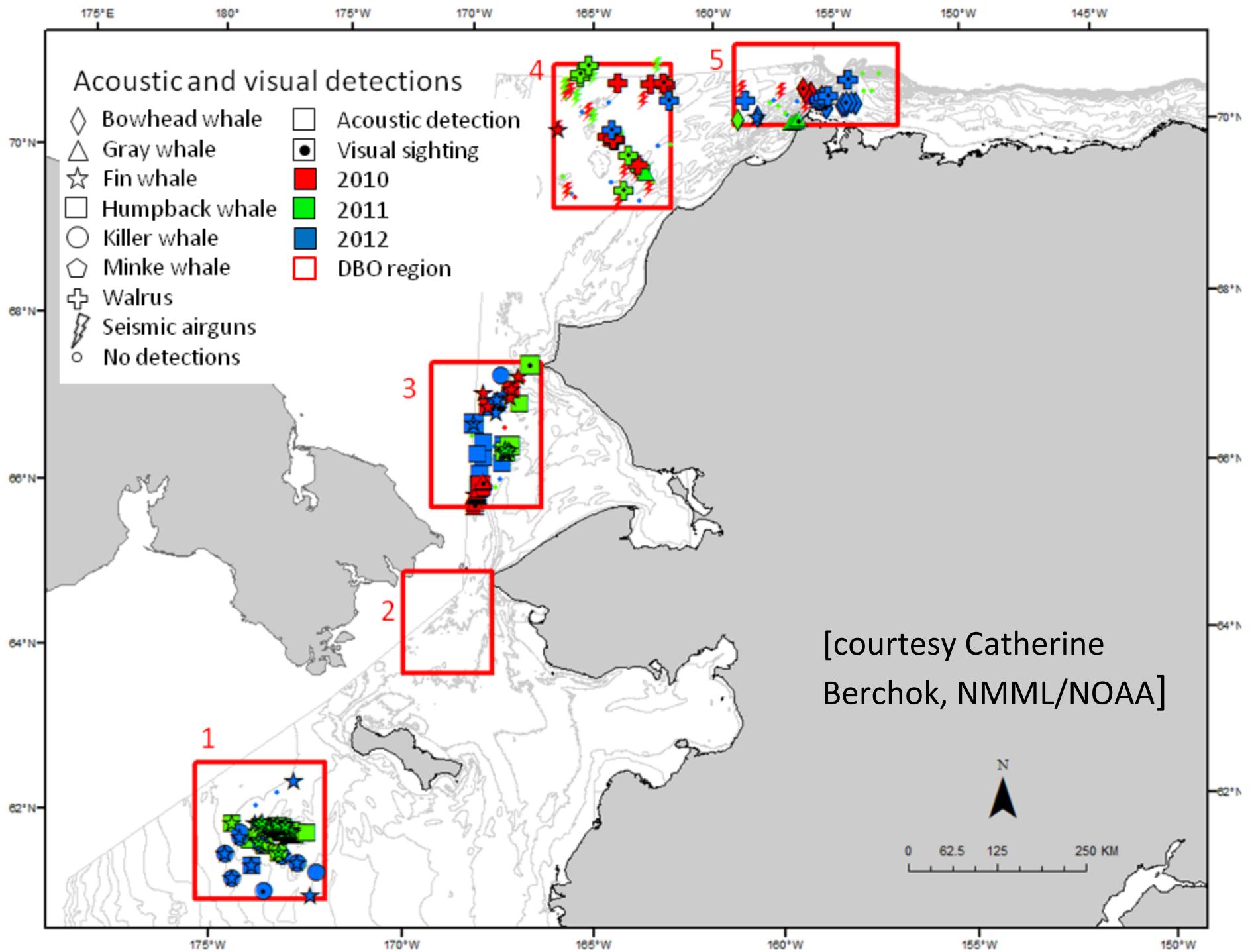


Figure 3. Nutrient data (nitrate, silicate and ammonium) and chlorophyll a ( $\mu\text{g/L}$ ) over salinity in Barrow Canyon during the CCGS Sir Wilfrid Laurier cruise July 2011.



# National & International Links

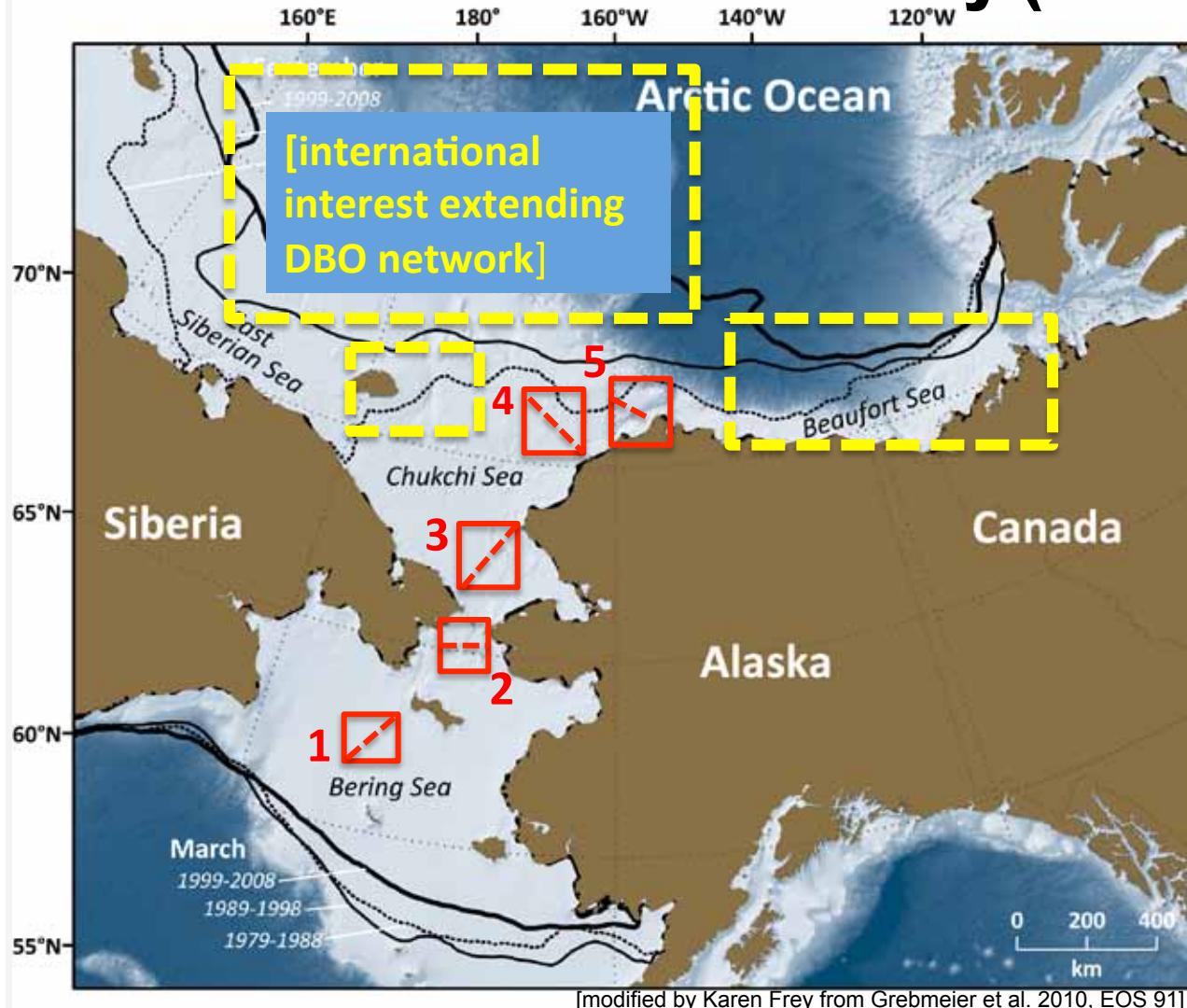
## NATIONAL

- NSF/AON – 5 yr funding (2012)
- NOAA-Industry MOU
- IARPC/DBO Interagency Task Teams – federal agency contributions
- NOAA Arctic Vision & Strategy (2011)
- NOAA's Arctic Action Plan (2013)
- US National Arctic Strategy (2013) and Arctic Implementation Plan (2014)

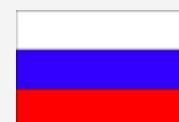
## INTERNATIONAL

- PAG – 6 nations
- RUSALCA – bilateral
- CBMP – Arctic Council
- IASC/Marine working group
- ICARP III – DBO focus by PAG for 3<sup>rd</sup> meeting in 2015

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# Summary

- Observe the seasonal warming and freshening of Pacific seawater as it transits northward from the northern Bering Sea to Barrow Canyon, coincident with levels of pelagic and benthic prey bases for larger marine mammals and seabirds
- Repeat time and space collections of various environmental and biological parameters allowing us to evaluate seasonality of ecosystem status and trends
- Continued persistence of benthic “hotspots” spatially, although observations of changes in benthic dominant macrofauna and biomass over last decade
- Latitudinal “change detection array” organized through the Pacific Arctic Group (PAG) & endorsed by the International Arctic Science Committee (IASC) marine working group; designated as SAON (Sustaining Arctic Observing Networks); within US National Ocean Policy and Implementation Plan
- Ongoing effort to develop coordinated data submission, management, access, and publications

# **Thank you for your attention.**

## **Questions and comments?**

Financial support from the international science partners in the Pacific Arctic Group (PAG), the US National Oceanic and Atmospheric Administration, National Science Foundation, Bureau of Ocean Energy Management, and Chukchi Sea Environmental Studies Program

Further information at <http://www.arctic.noaa.gov/dbo/> and  
<http://pag.arcticportal.org>

