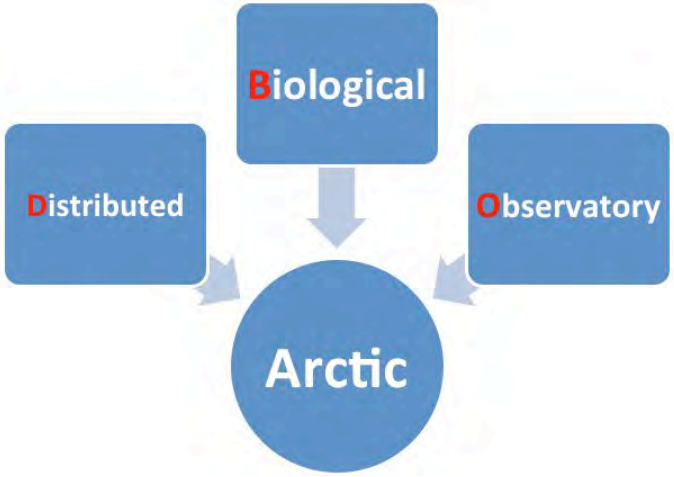
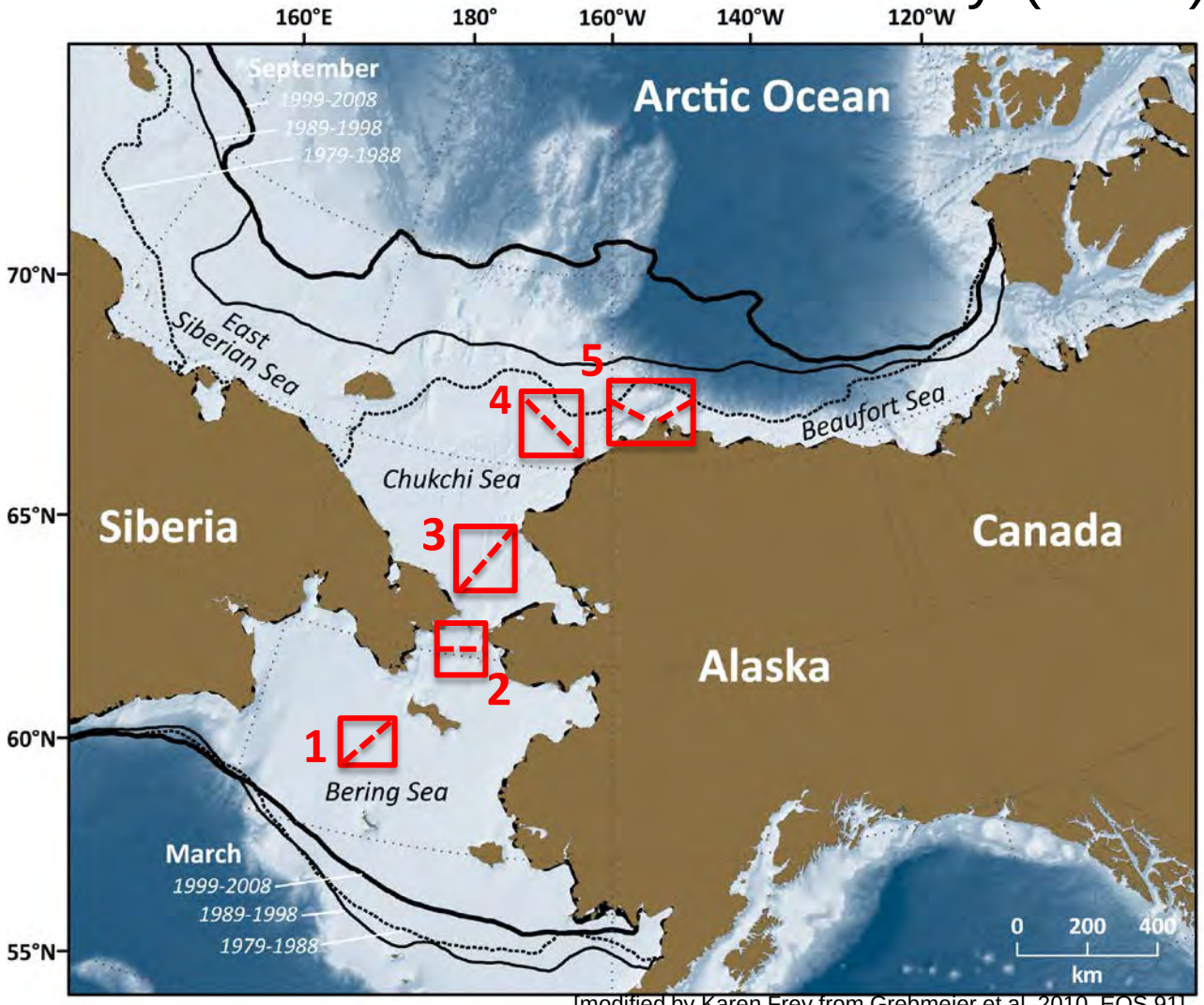


Linking Biology to Physics in an Arctic Ocean Observing System: The Distributed Biological Observatory (DBO)

Jackie Grebmeier, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, MD, USA
http://www.arctic.noaa.gov/dbo/

April 22, 2012
Pacific Arctic Group
Palais des congress, Room 512ae
Montreal, Canada

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



[modified 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 will serve as a change detection array for the identification and consistent monitoring of biophysical responses
- Sites occuppied by national and international entities with shared data plan

Rationale of the DBO

- Biological response and shifts in ecosystems are ecologically significant, requiring multidisciplinary field collections in time and space

- Many developing observation systems in the Arctic are focused on physical sensors, but biological sampling at different scales are required to detect biological changes in response to environmental forcing

- Coordinated ship-based observations on a regular basis, coincident with satellite and moorings could provide an early detection system for biological systems in the Arctic

Distributed Biological Observatory: Linking Physics to Biology

Core standardized ship-based sampling:

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

"Change detection array" – same measurements every year, process information in near real time <6 mos; detect regime shifts in rapid changes

Second tier ship-based sampling:

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

DBO occupations by national and international science programs

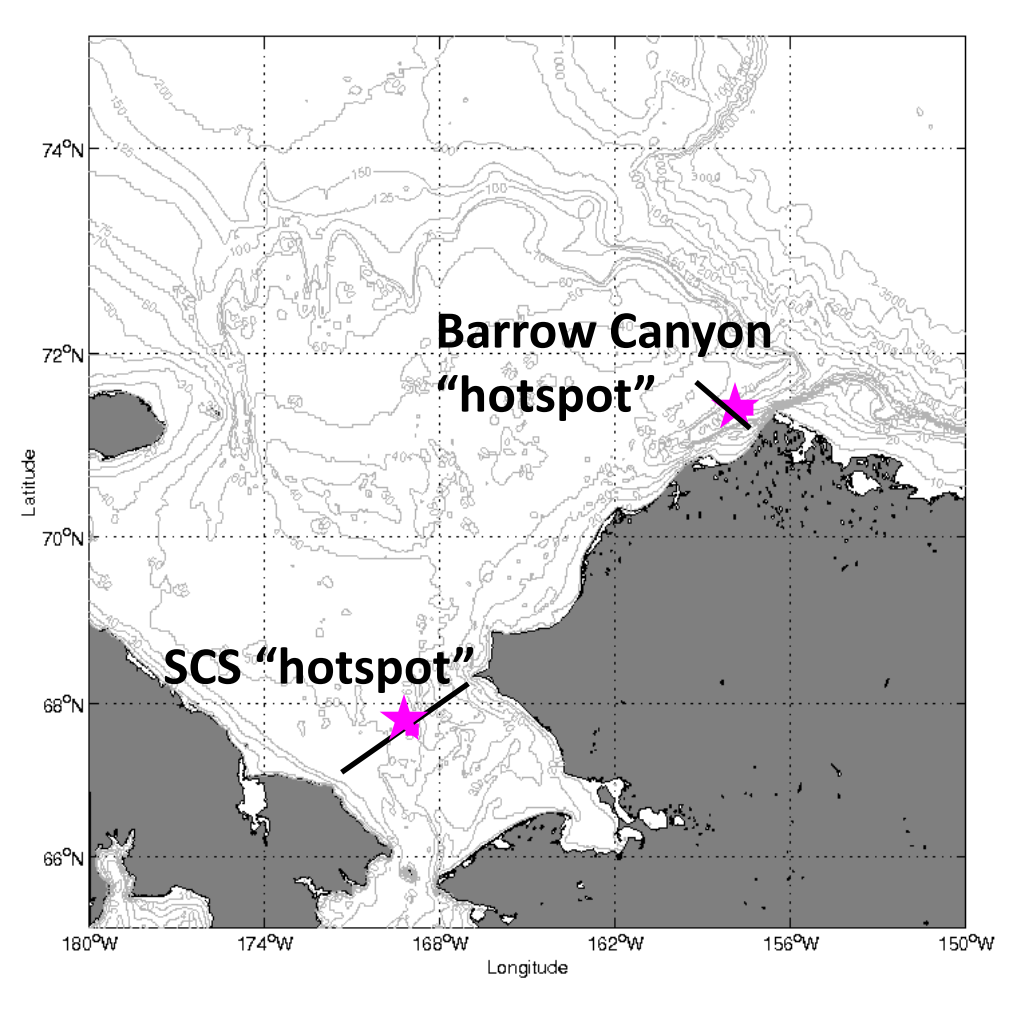
The Goal of the Workshop-Nov 2011 at Institute of Ocean Sciences/DFO, Sidney, BC, Canada (plus Town Hall Oceans Meeting-Feb 2012, USA)

The workshop was organized by the Pacific Arctic Group and the AOSB/Marine Working Group of IASC. During the workshop we :

- reviewed the data collected during the 2010 and 2011 DBO pilot project and analyses
- discussed the potential expansion of the program to a pan-Arctic biological observation network
- Evaluated data management issues
- planned for DBO occupations in 2012 onwards

[http://www.arctic.noaa.gov/dbo/]

DBO 2010 and 2011 "Pilot" Season: International cruises to Pacific Arctic (**both years)



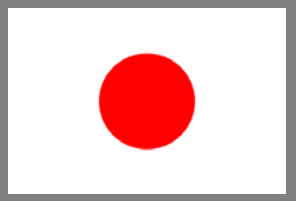
Vessel	Country	PI
Moana Wave	USA	Grebmeier
Healy (**)	USA	Arrigo
Xue Long	China	He
Mirai	Japan	Itoh
Laurier (**)	Canada	Vagle
Khromov (**)	Russia and USA	Woodgate
Alaskan Enterprise	USA	Napp
Annika Marie (**)	USA	Ashjian
Healy (**)	USA	Pickart
Healy (**)	USA	Ashjian

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

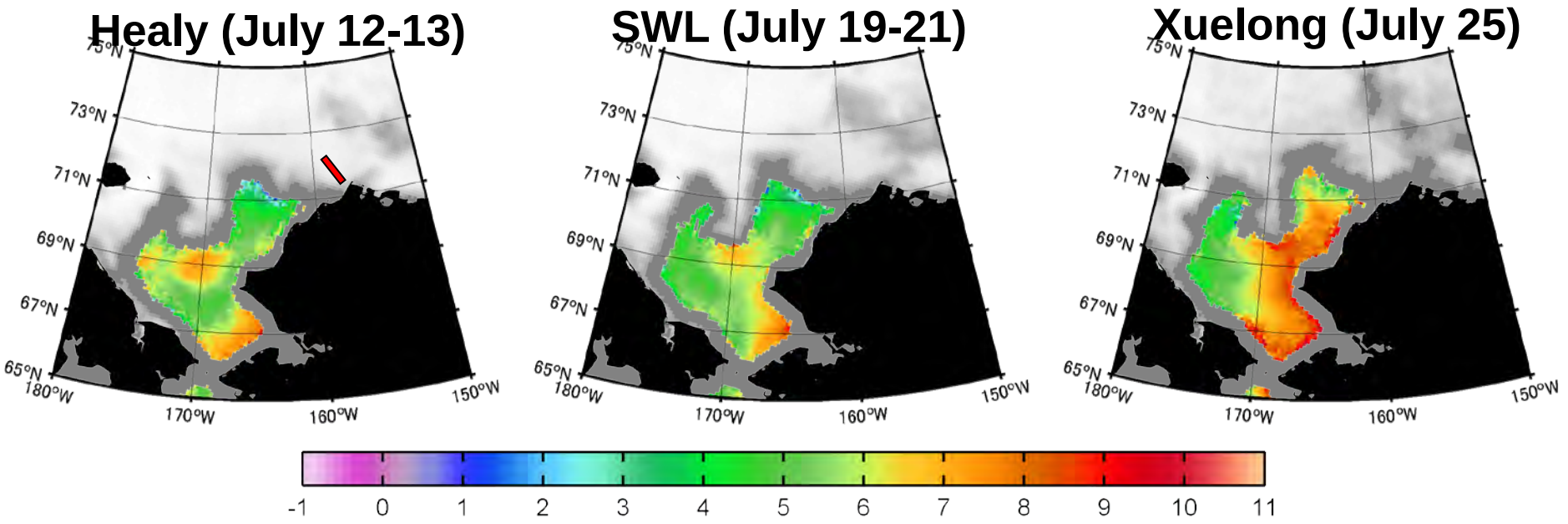
Barrow Canyon fluxes: Results of DBO pilot study in 2010

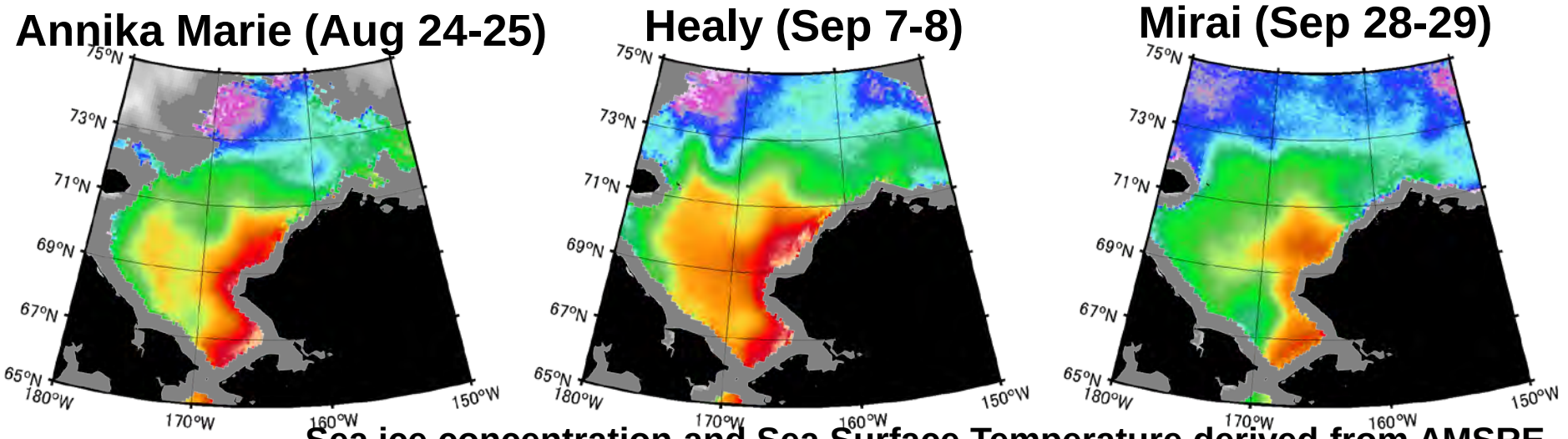
Motoyo Itoh (JAMSTEC), Kevin Arrigo (Stanford),
Svein Vagle (IOS), Jianfeng Zhang (PRIC),
Carin Ashjian (WHOI) and Robert Pickart (WHOI)



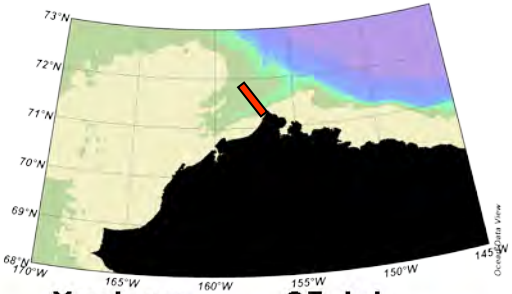
Sea ice extent and surface temperature in summer 2010



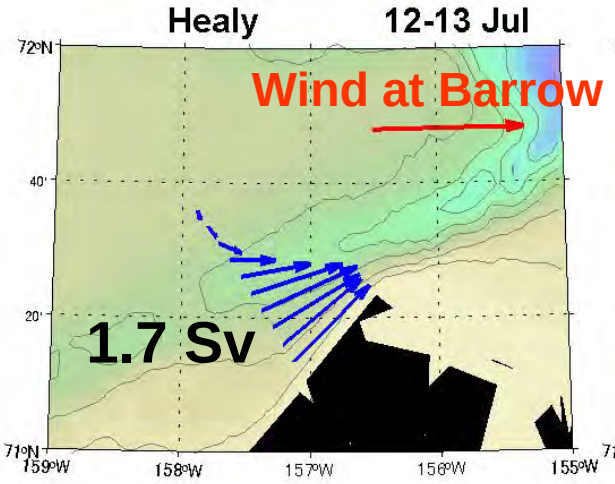


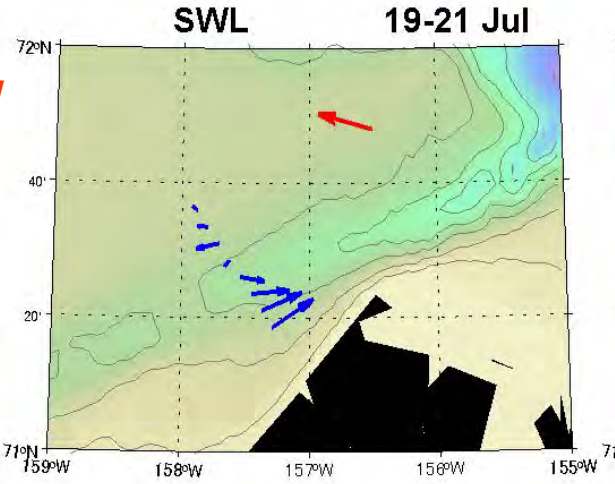
Sea ice concentration and Sea Surface Temperature derived from AMSRE

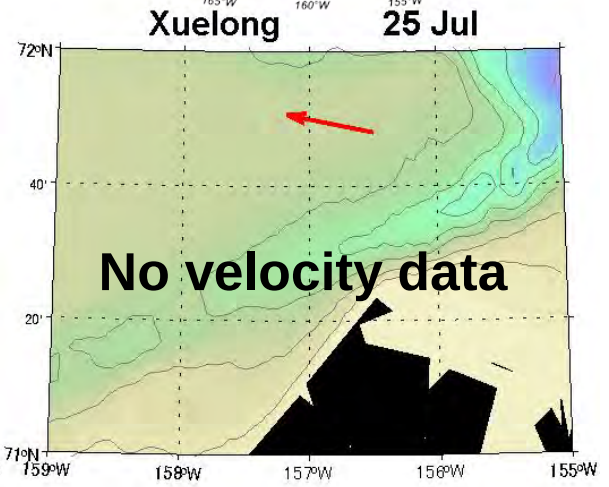
Barrow Canyon through flow

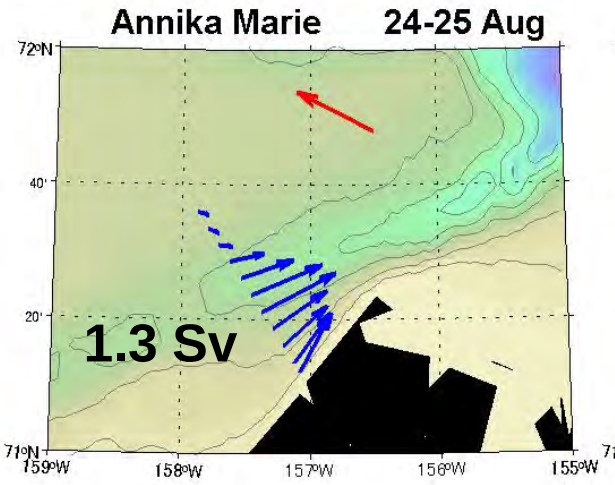


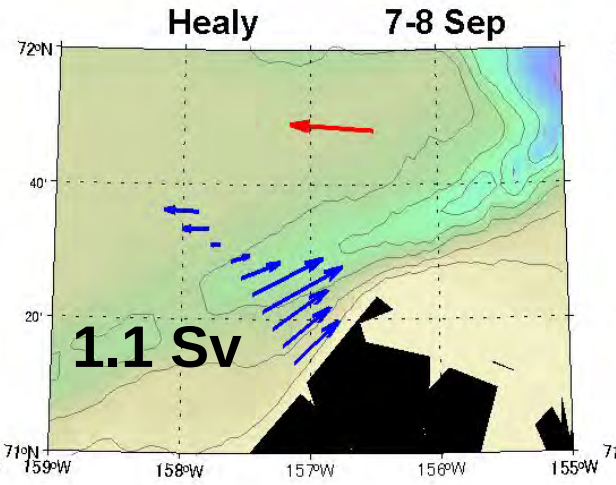
Depth averaged velocity

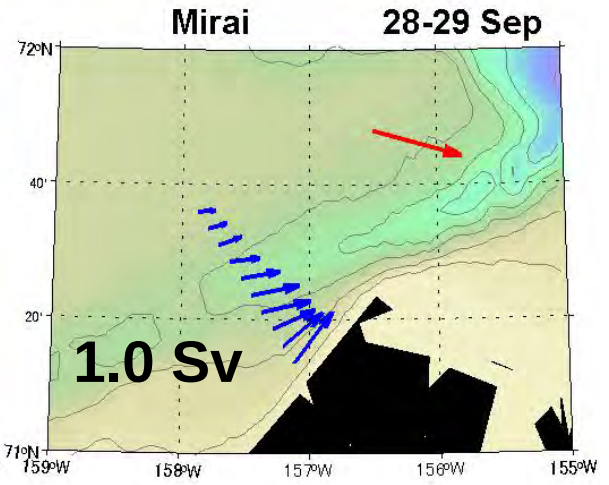






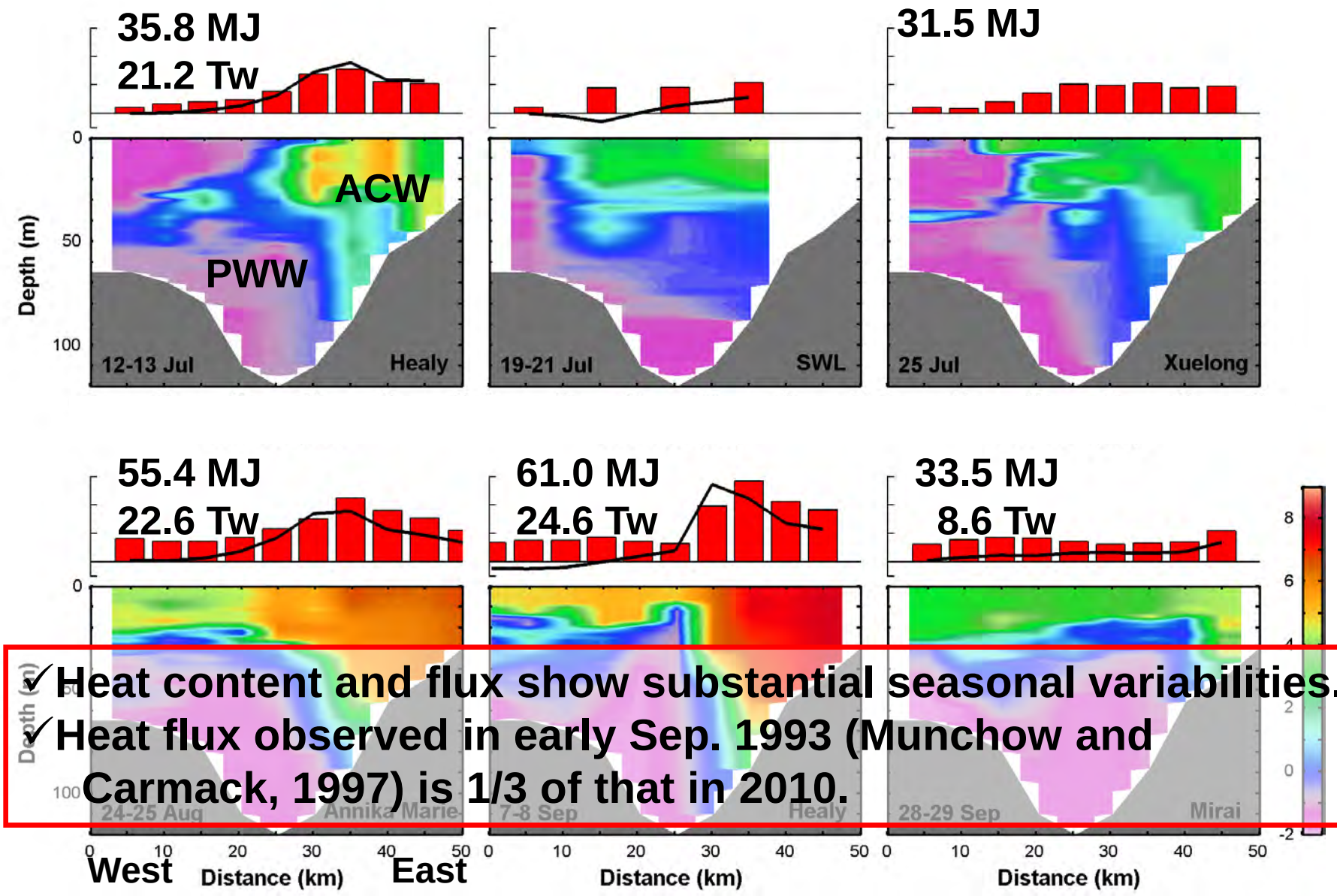






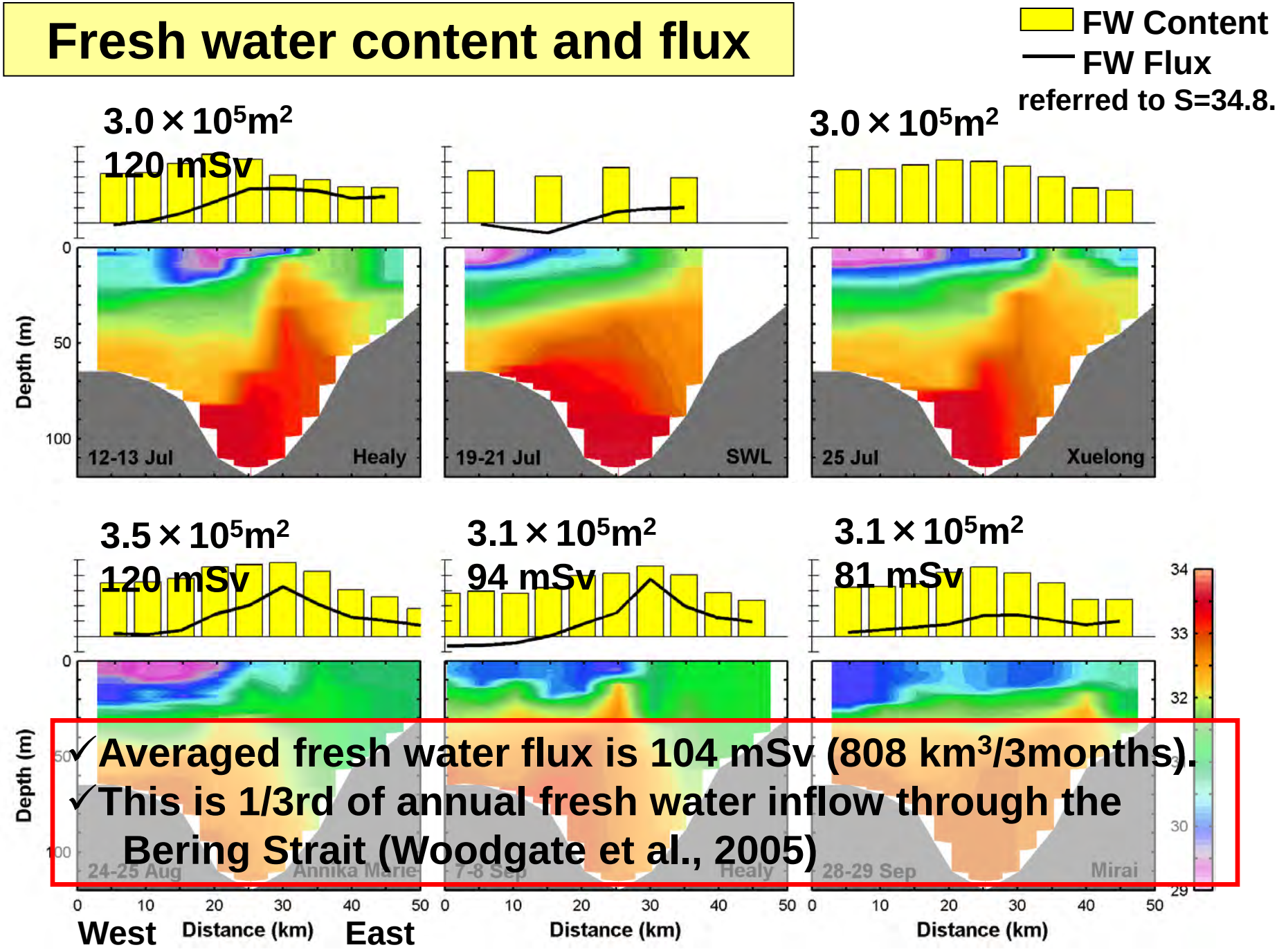
Heat content and flux

Heat Content
Heat Flux
referred to freezing temp.



- ✓Heat content and flux show substantial seasonal variabilities.
- ✓Heat flux observed in early Sep. 1993 (Munchow and Carmack, 1997) is 1/3 of that in 2010.

Fresh water content and flux

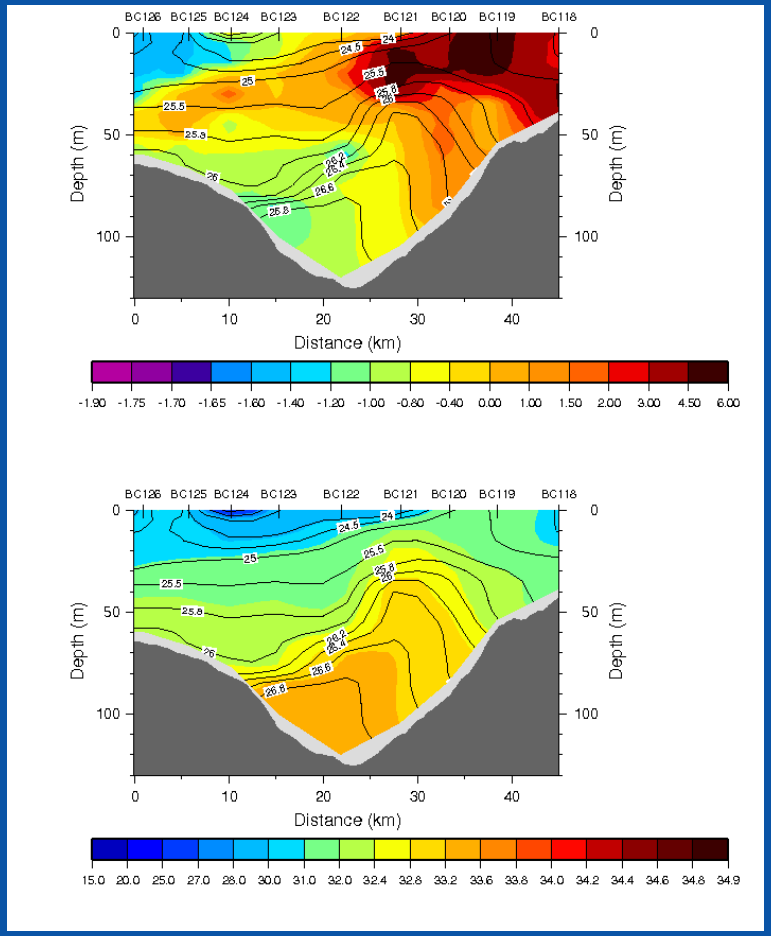


✓Averaged fresh water flux is 104 mSv (808 km^3/3months).

✓This is 1/3rd of annual fresh water inflow through the Bering Strait (Woodgate et al., 2005)

Comparison between July 2010 and July 2011

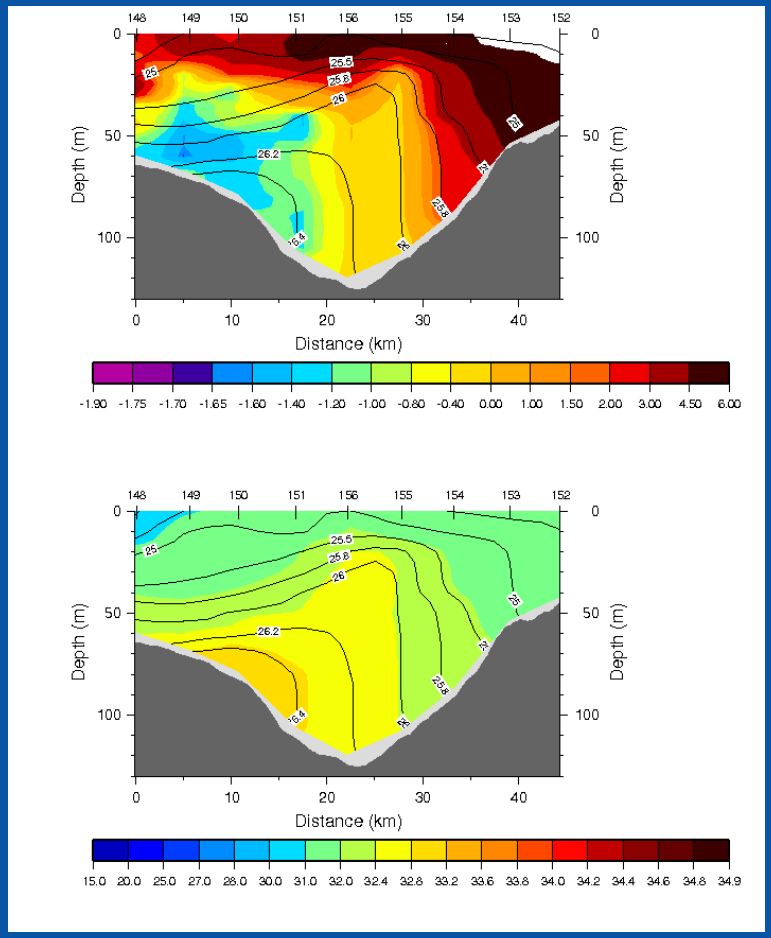
2010



Temp (°C)

Salinity

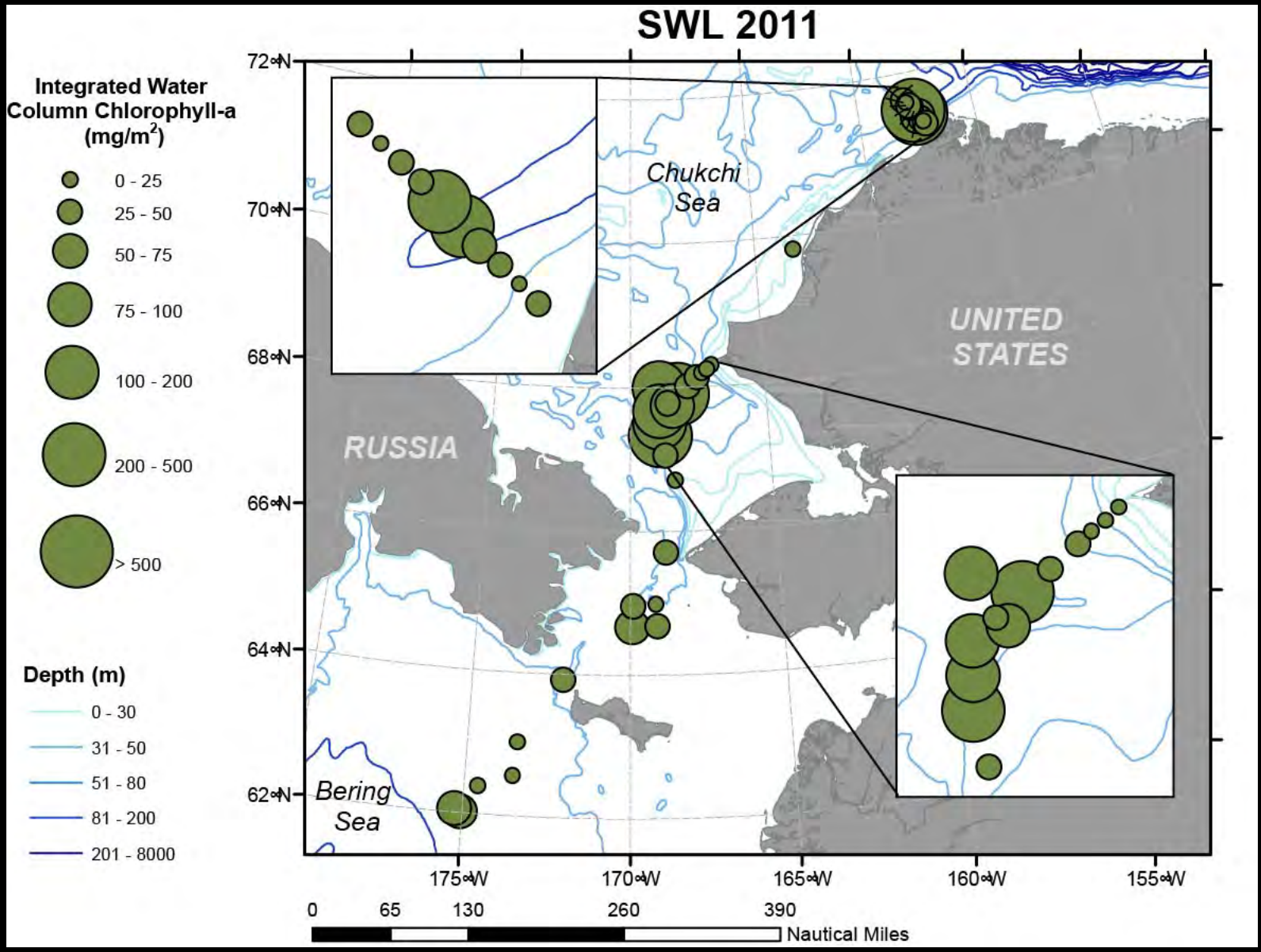
2011



In early summer 2011 the ACC was warmer and the subsurface winter-remnant water was colder. However, the winter water was pronouncedly less dense. *Why* ??

[R. Pickart]

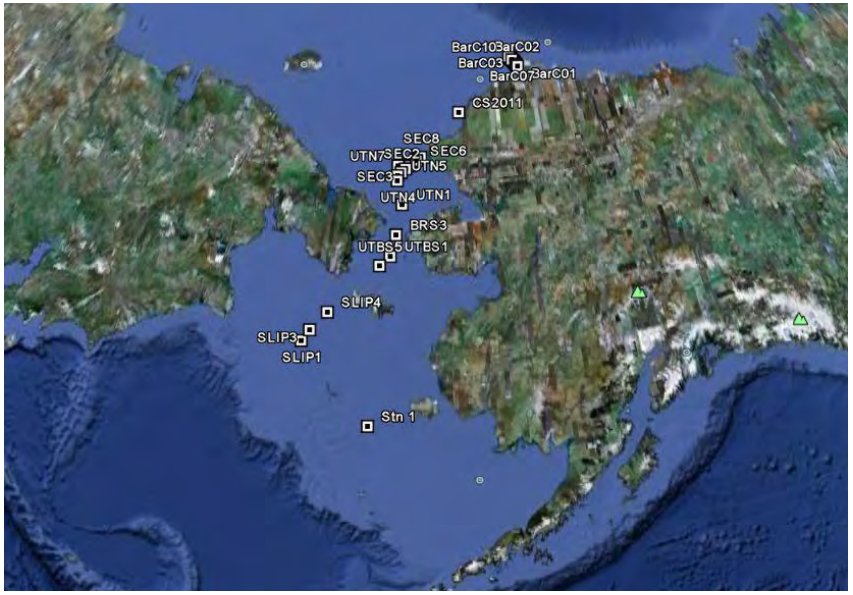
SWL 2011 Integrated Chl (mg/m2)

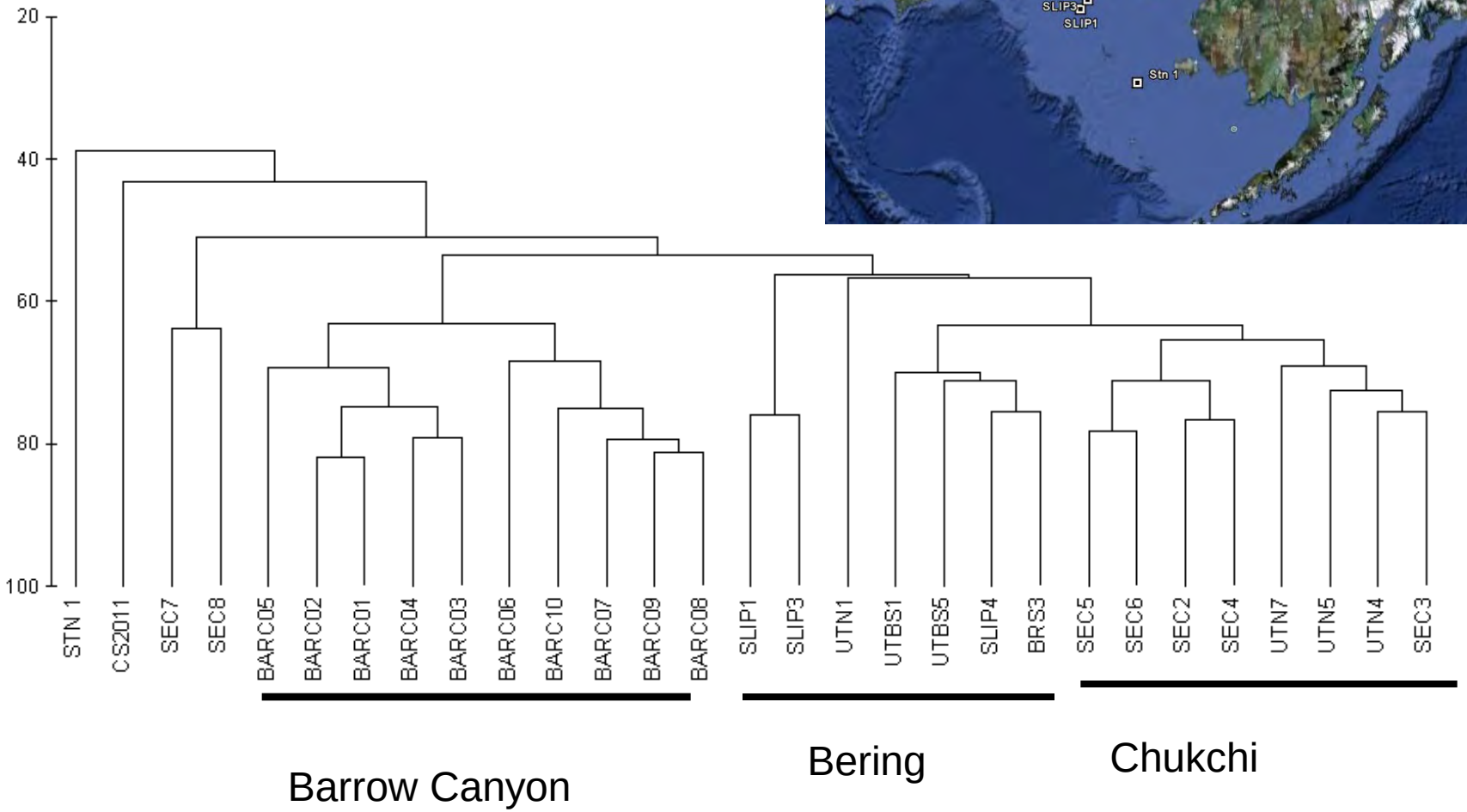


[Canada's Three Oceans (C30) Program-Grebmeier/Cooper]

2011Integrated C3O and DBO Zooplankton Analysis-John Nelson

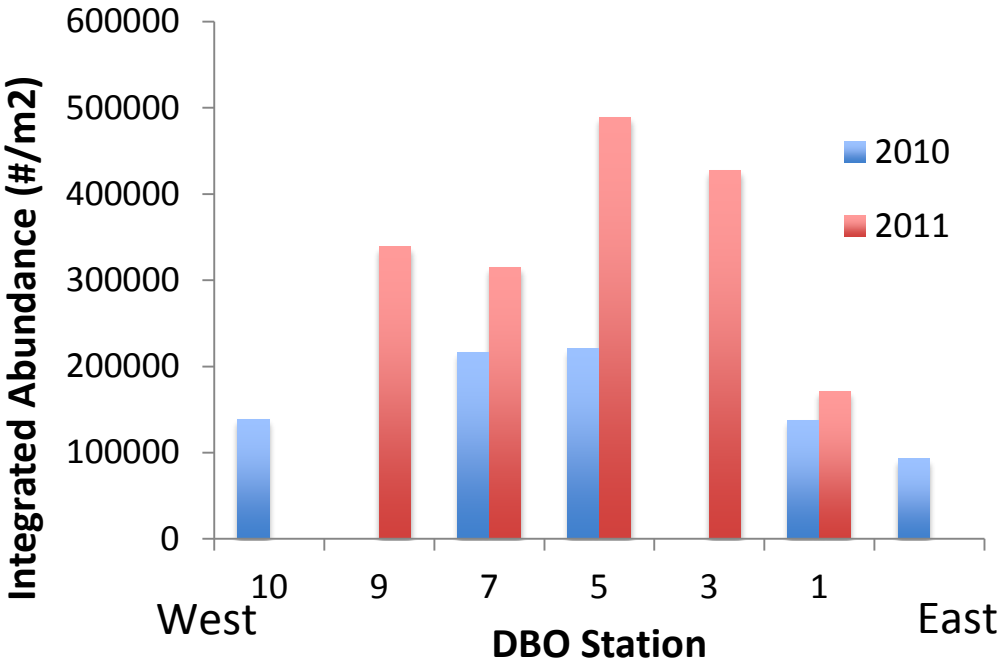
Community structure observed across the DBO region -





2011 DBO Barrow Canyon line crosses a biogeographical boundary.

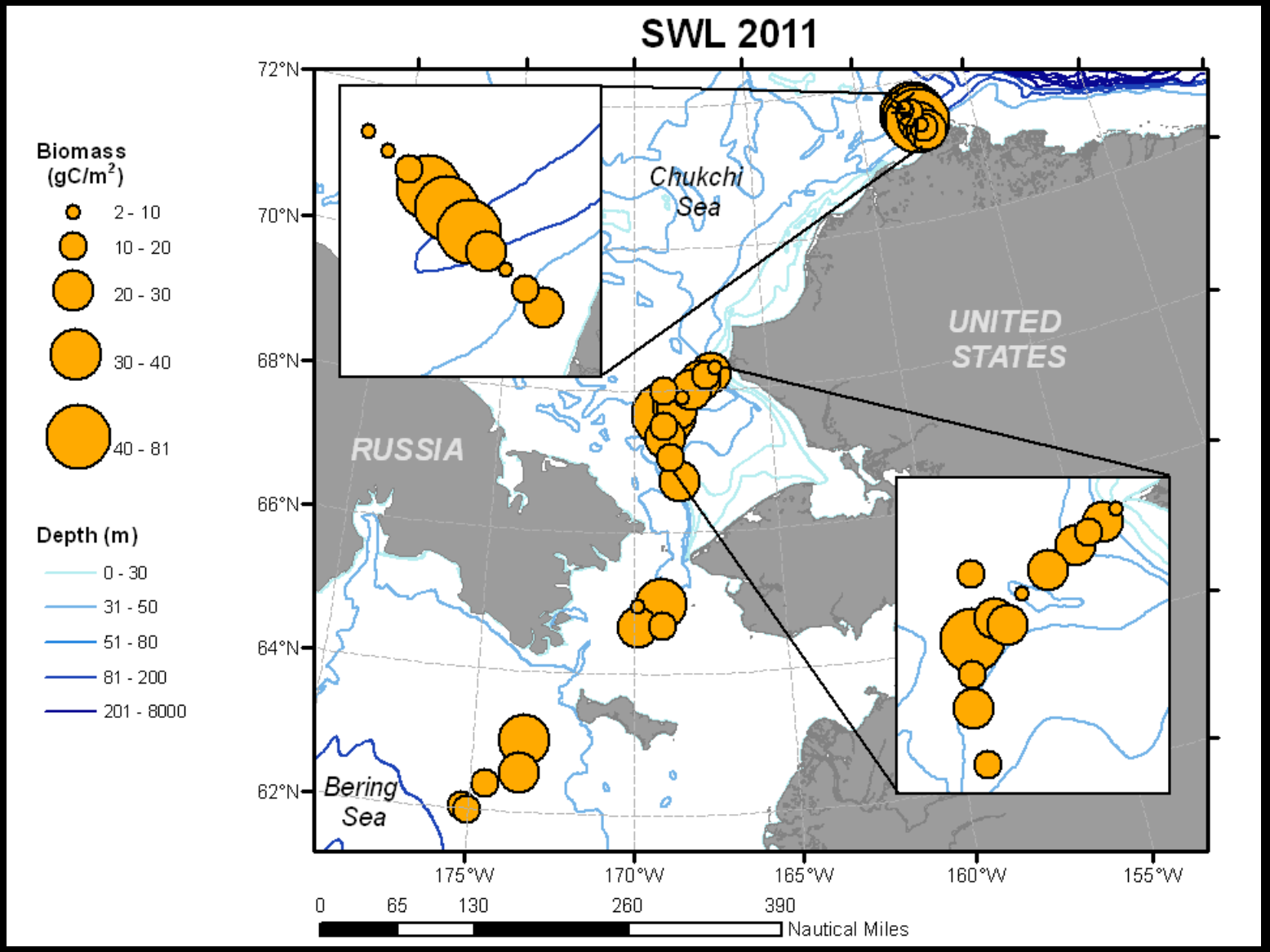
Total Zooplankton Abundance



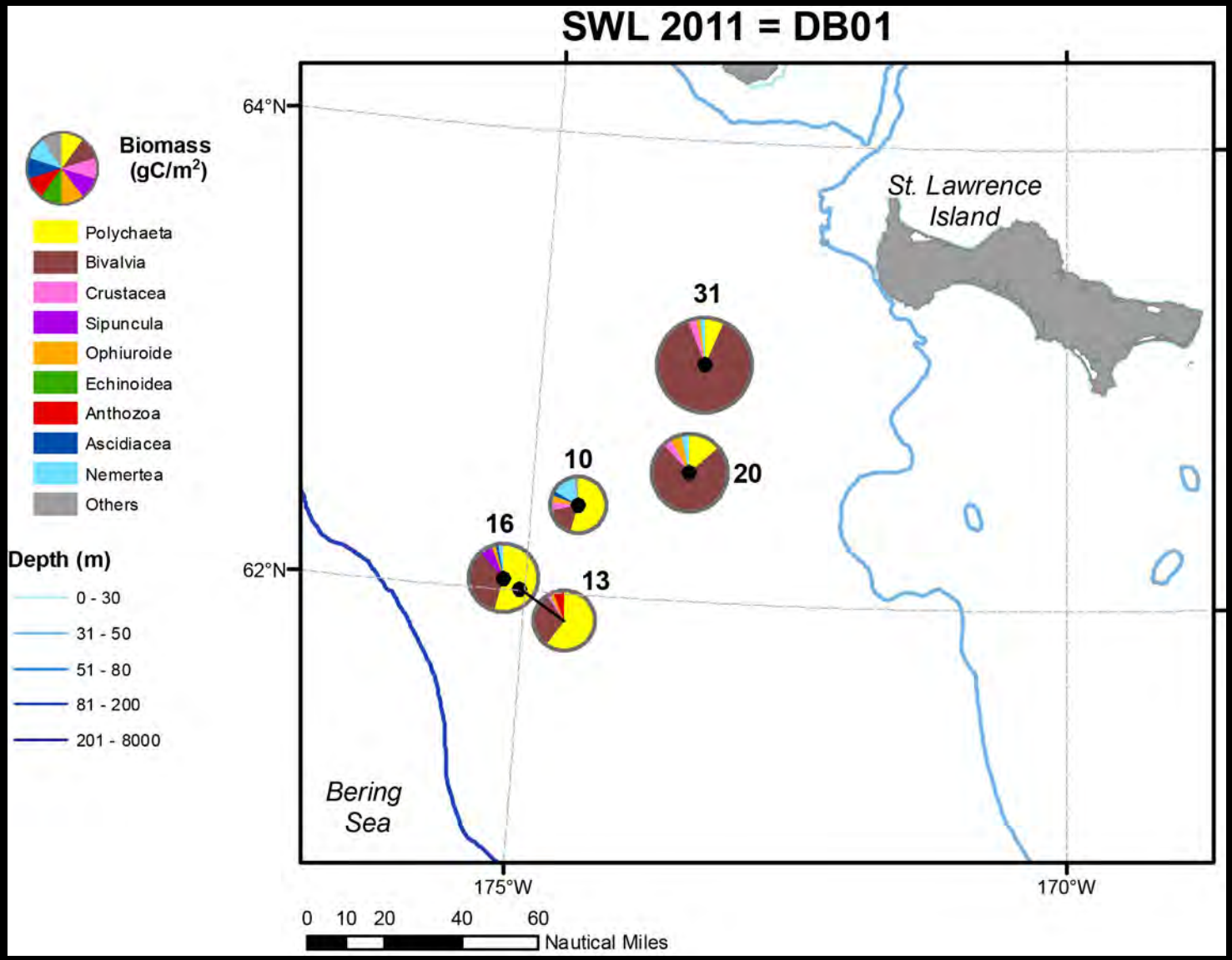
Abundance greater in 2011 than in 2010 at all locations

[Carin Ashjian]

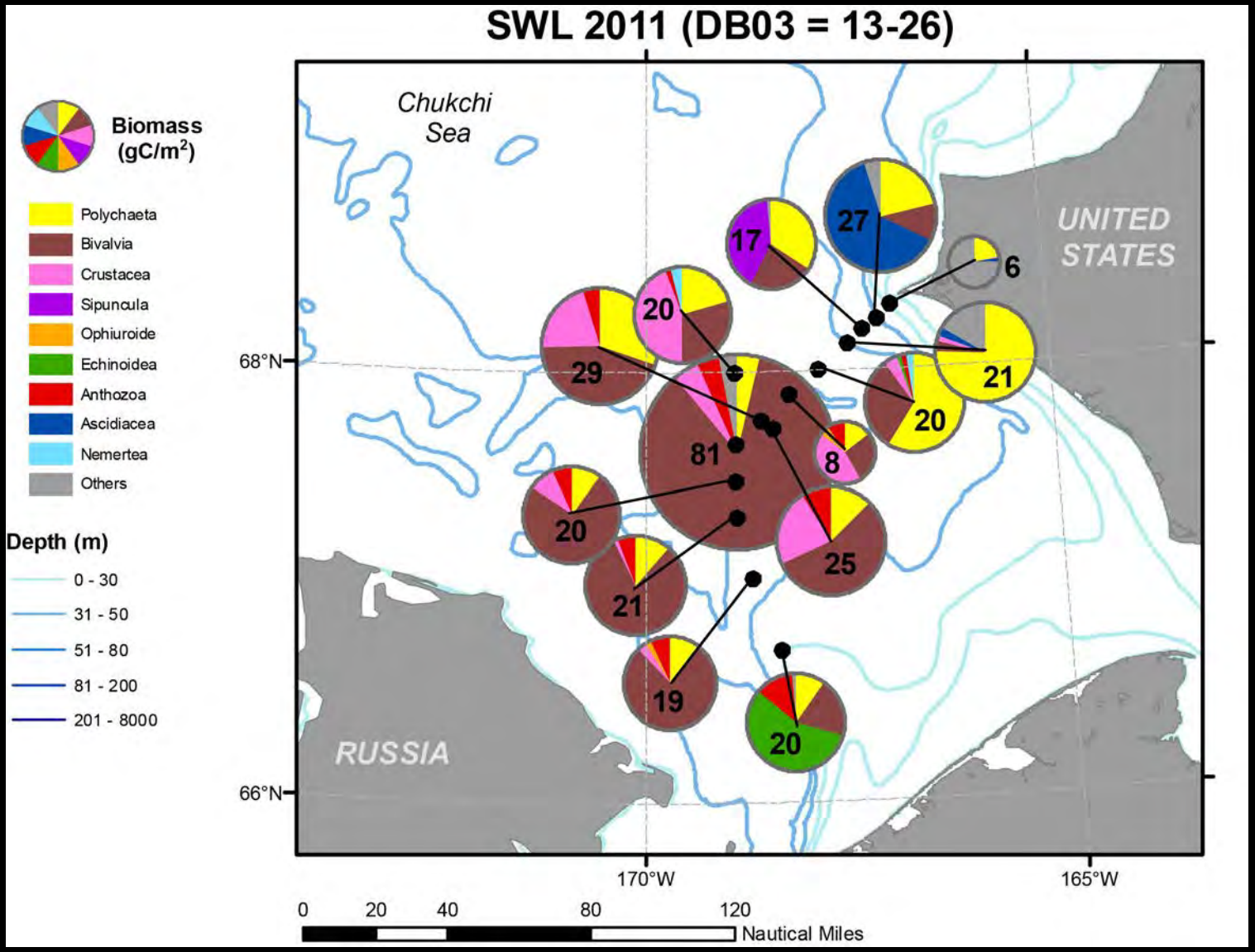
SWL 2011 Benthic Biomass (gC/m2)



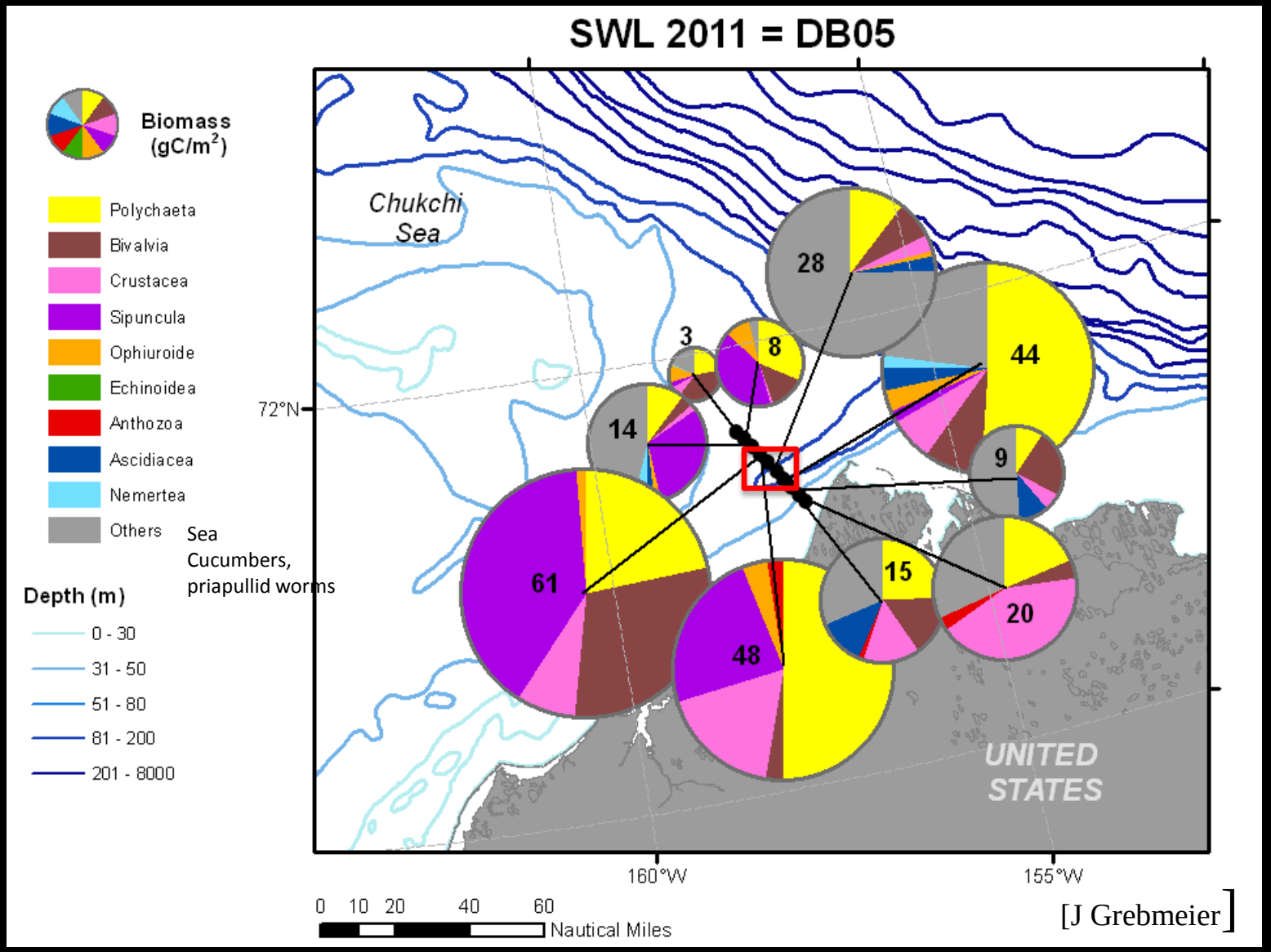
DBO 1-So SLI benthic macroinfaunal biomass-July 2011



DBO 3-So Chukchi Sea Benthic macroinfaunal biomass-July 2011

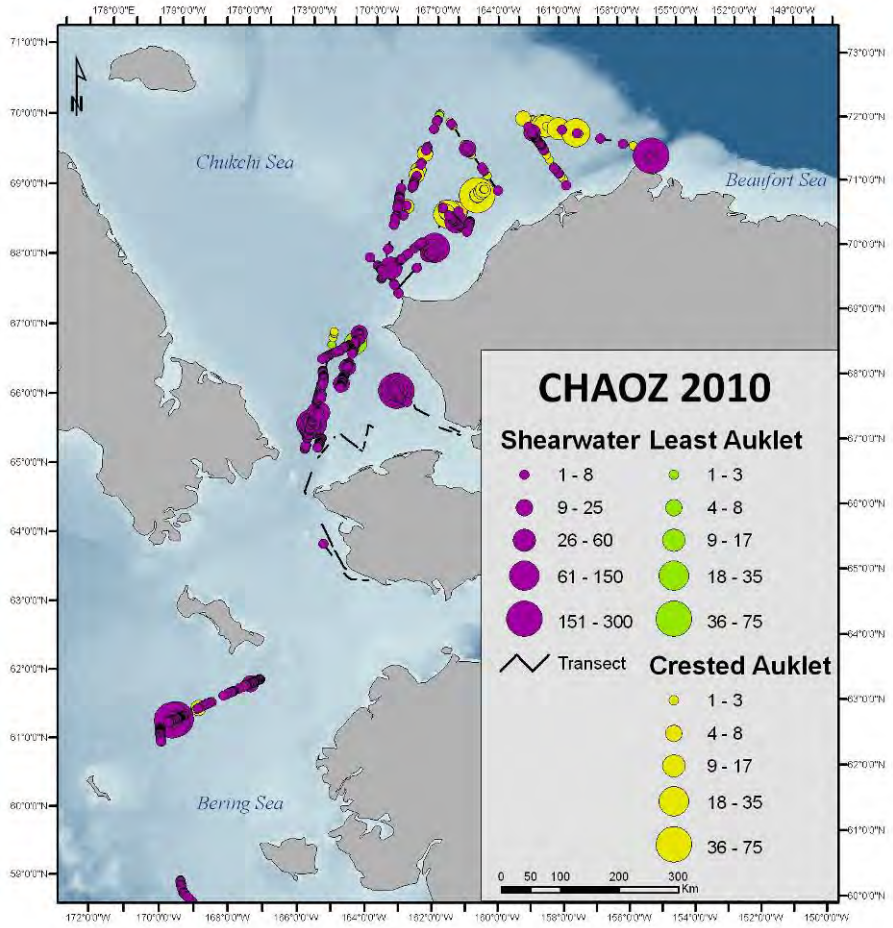


DBO 5-Barrow Canyon benthic macroinfaunal biomass-July 2011

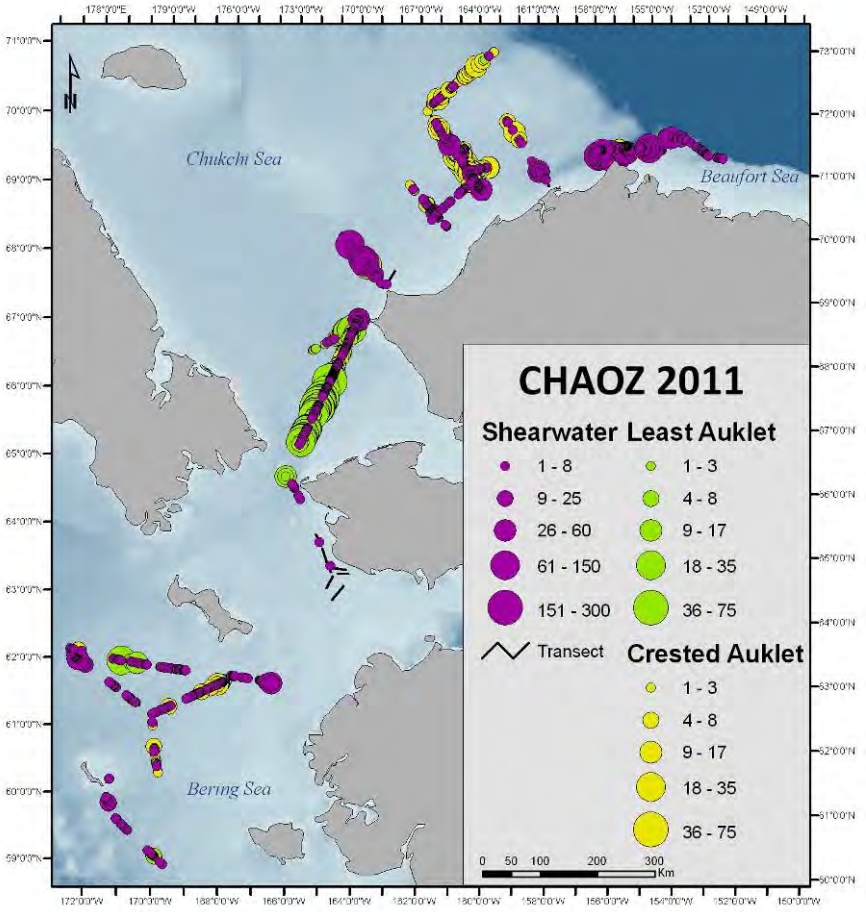


Seabird Sightings from CHAOZ Cruises (USFWS Survey Protocol)

2010 – DBO Region 3 – 'hotspot'



2011: DBO Region 1& 3 – 'hotspot'



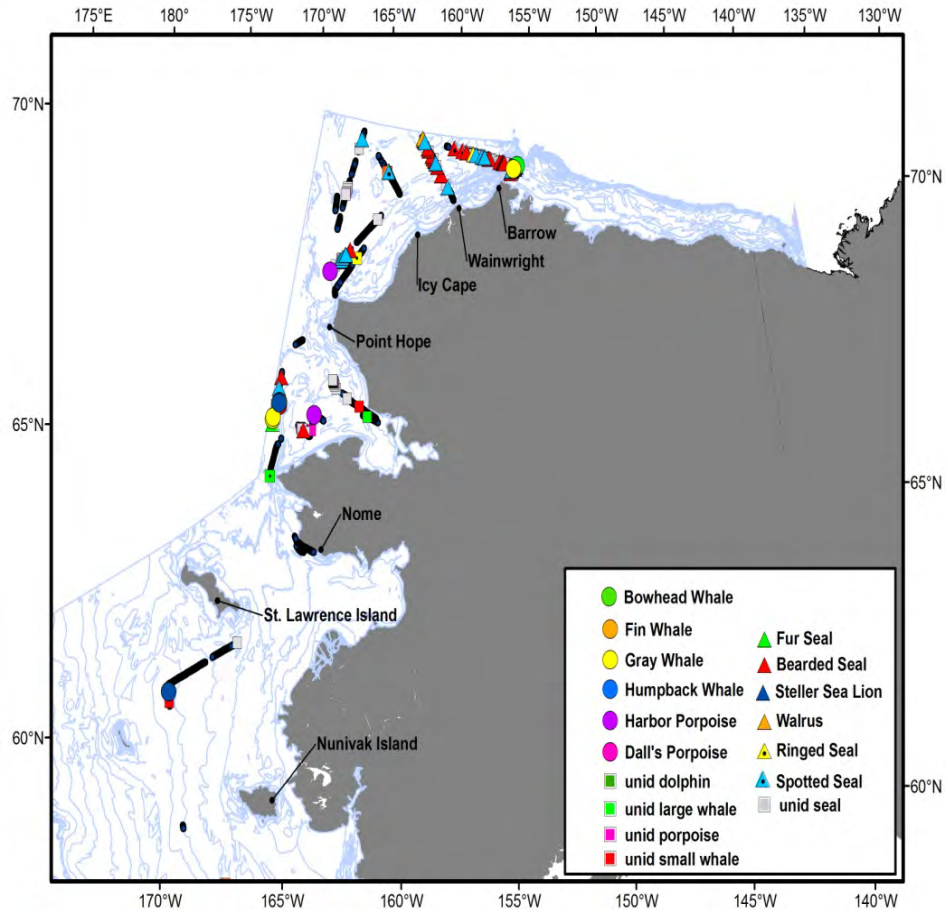
CHAOZ = **CH**ukchi **A**coustic **O**ceanographic and **Z**ooplankton study

[Sue Moore]

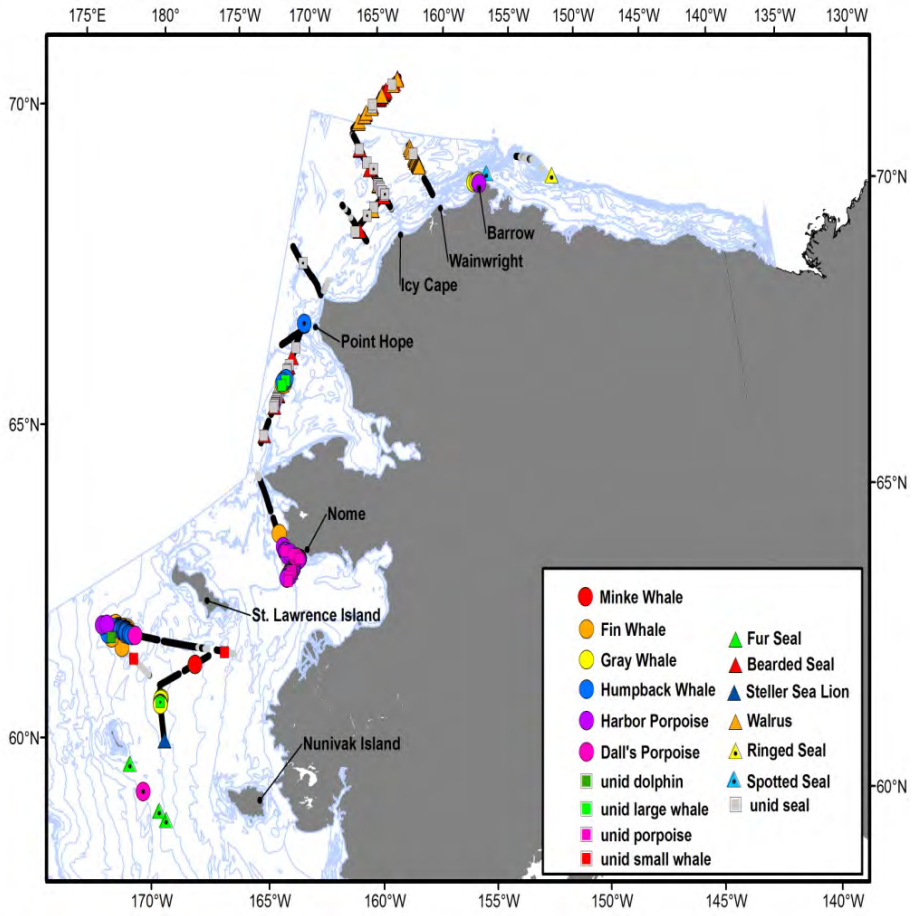
Marine Mammal Sightings (CHAOZ)

Standard Survey Protocol

2010 – DBO Region 3 – 'hotspot'



2011: DBO Region 1 – 'hotspot'



[Sue Moore]

DBO Data Management Considerations

>Develop an International DBO data policy and exchange protocol (including priority measurements) to facilitate:

- •Dataset exchange and access
- •Preparation of datasets for data integration, intercomparison and modeling studies

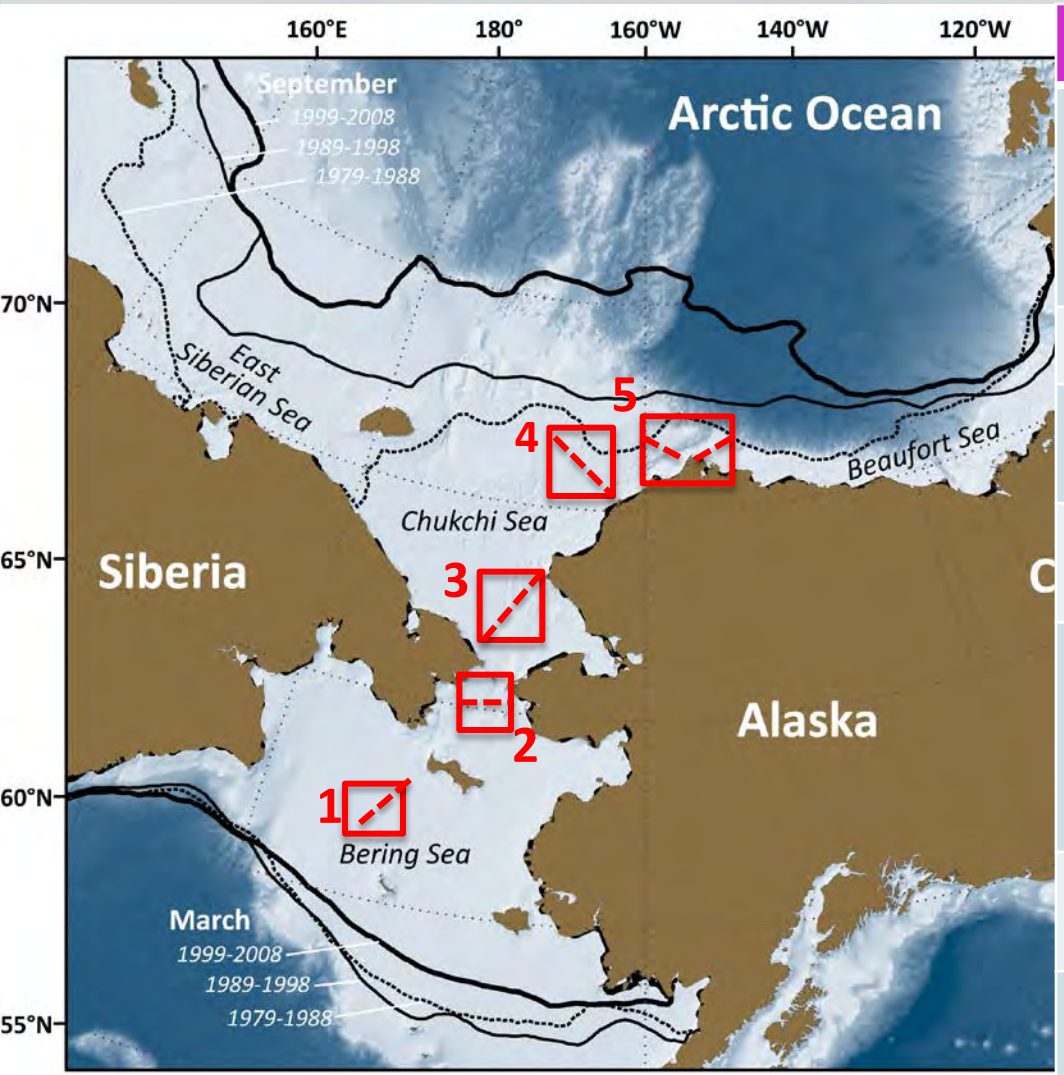
>Encourage broad access to data and metadata beyond national restrictions through scientific collaboration/cooperation

>Coordinate with other National and International Projects

>Consider data format and documentation guidelines to enhance international data exchange and analysis

>Document and standardize (if possible) data collection protocols (time, sensors, processing, parameters, units)

DBO 2012 Season: cruises to Pacific Arctic



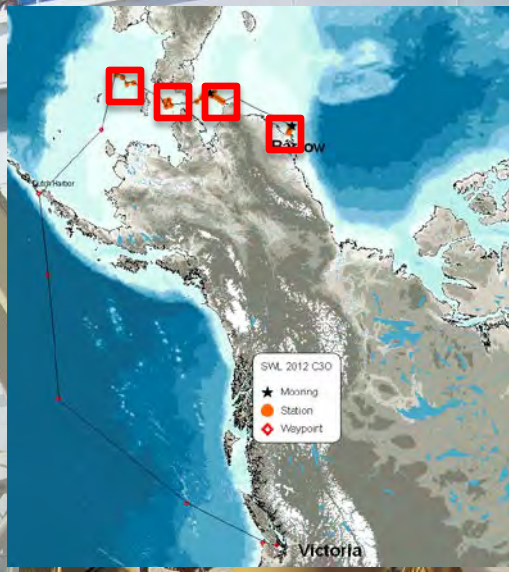
Vessel	Country	PI
Laurier (July)	Canada	Vagle
Khromov-Leg 1 (July)	Russia and USA	Woodgate
Healy (Aug)	USA	Grebmeier
Xue Long (Aug-Sept)	China	He
Khromov-Leg 2 (Aug-Sept)	Russia and USA	Woodgate
Fairweather (July-Aug)	USA	TBD/NOAA
CESP (Aug)	USA	TBD
TBD (Aug)	USA	Napp
Annika Marie (Sept)	USA	Ashjian
Mirai (Sept-Oct)	Japan	Kikuchi
Healy (Oct)	USA	Pickart

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

Canada's Three Oceans – 2012 Science Plans

C3O & DBO
CCGS *SWL*: Victoria to Barrow (Jul 08 – 21)

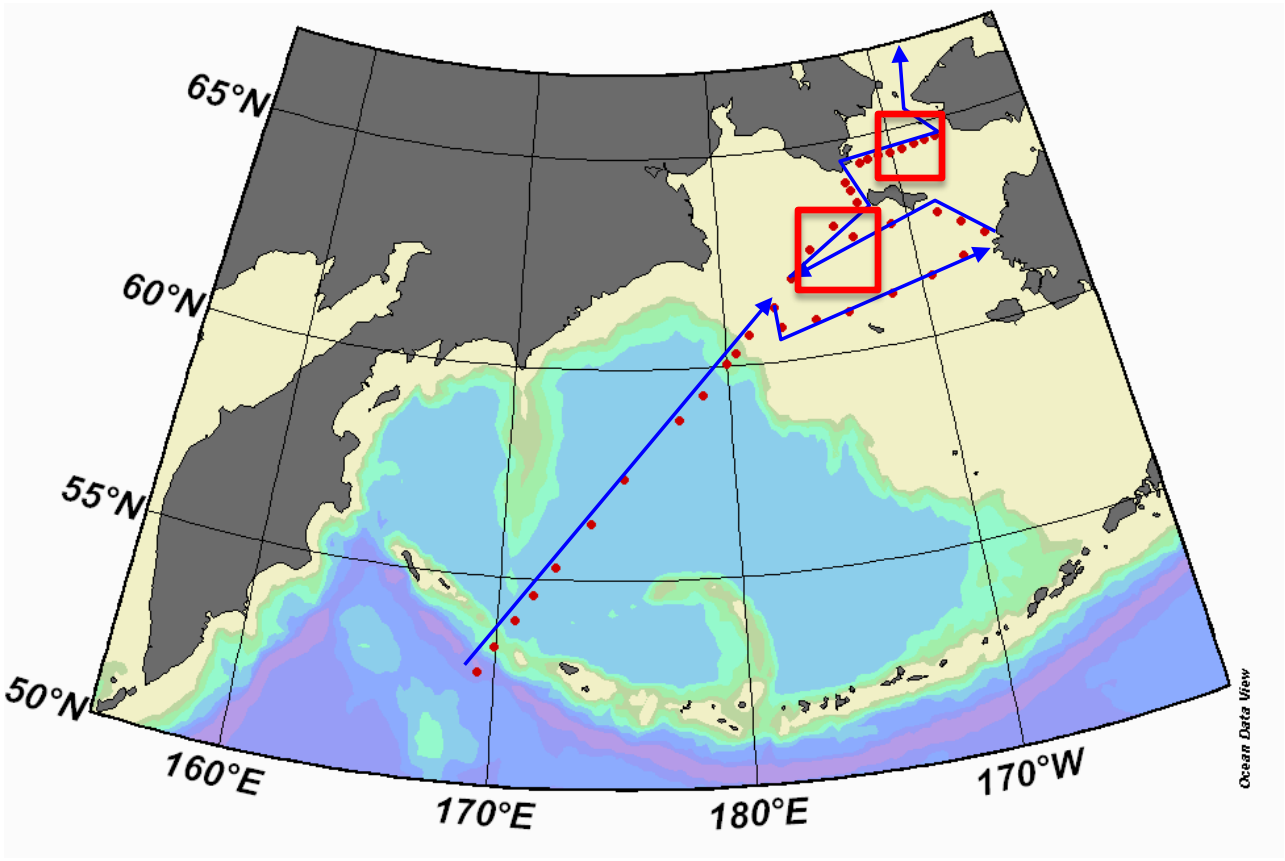
- 5 days dedicated ship time
- xCTDs deployed from stern
- Seawater loop monitoring
- Bird observations
- Collect sediment samples using VanVeen grabs and Happs corer at 40-50 stations (Bering and Chukchi Seas). Also, collect CTD and geochemical samples with the rosette and plankton samples with vertically towed bongos.
- Drag for sediment equipment lost during 2010 C3O July cruise at UTBS5 station.
- Deploy two physical-bio-geochemical moorings for JAMSTEC
- Deploy 13 Argo floats between Victoria and the Aleutians,
- Deploy 1 UpTempO and 4 SVP (surface velocity program) drifting buoys along the track in the Chukchi.



Canada

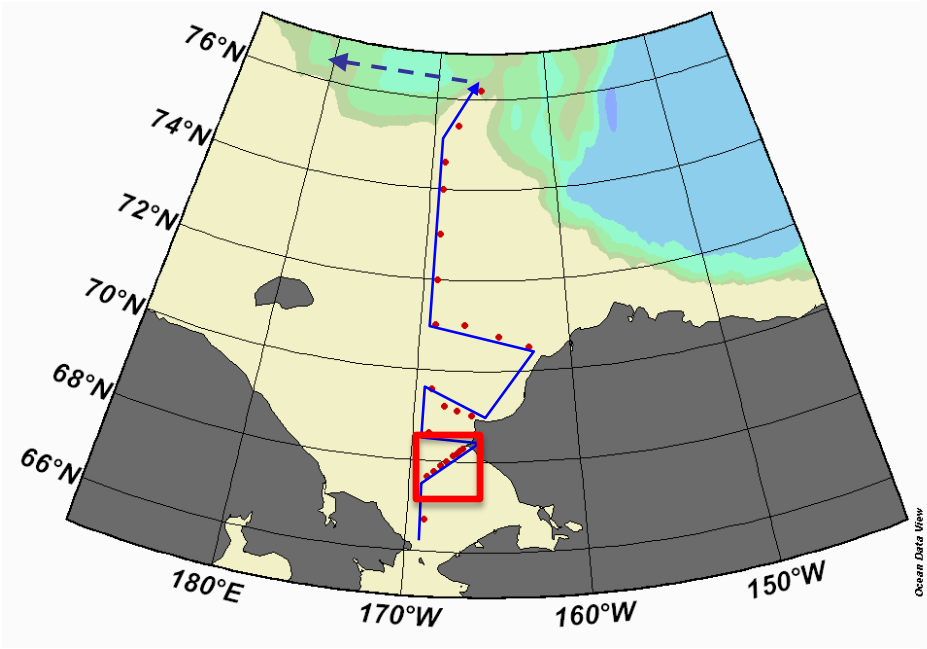
[R. Fudge]

Jianfeng He: Chinese Xuelong 2012 cruise plans
1st or 2nd plan

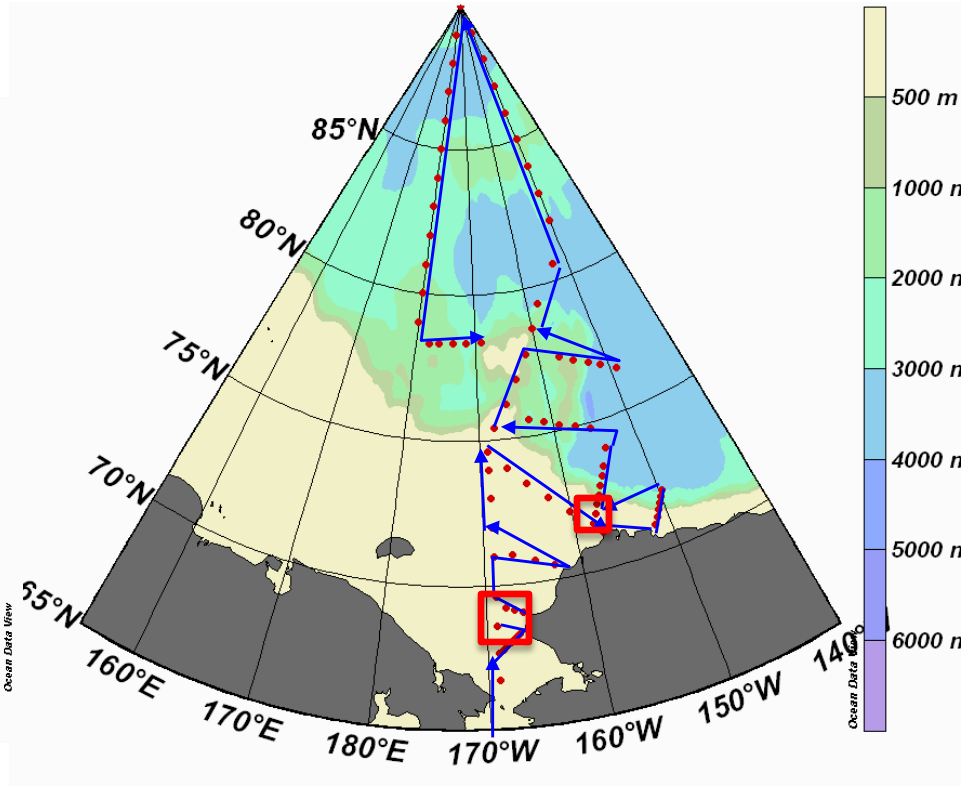


Jianfeng He: Chinese Xuelong 2012 cruise plans

CHINARE 1st plan



CHINARE 2nd plan

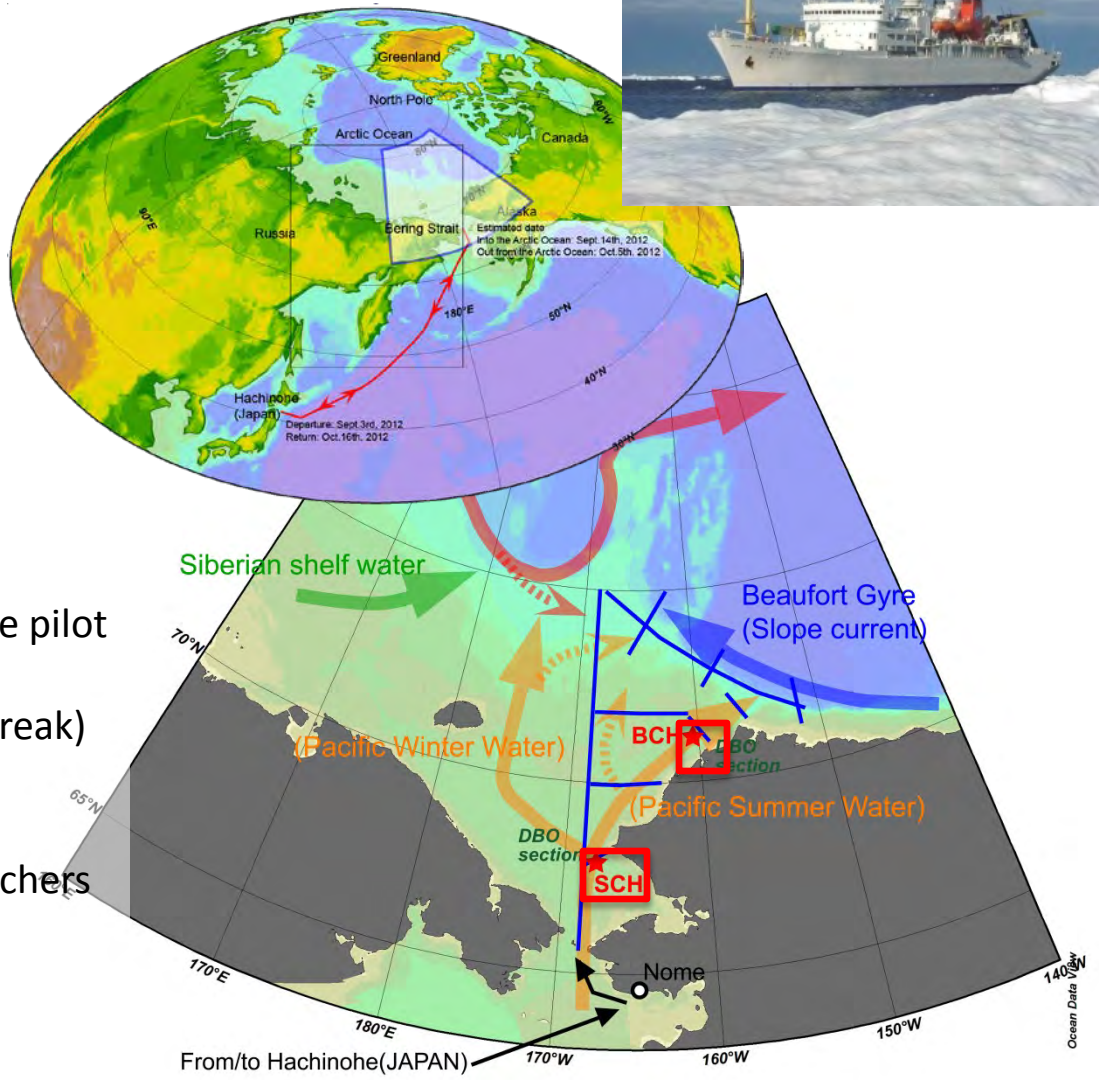


Ecosystem studies of the Arctic Ocean declining Sea ice (ECOARCS)

R/V Mirai Arctic cruise in Sept.-Oct. 2012

In 2012 there is a tentative R/V Mirai Arctic Ocean cruise plan scheduled for early September to late October. The main target will be the Chukchi shelf and shelf slope areas. Tentative activities will include:

- CTD/LADCP/water sampling & XCTD
- Mooring recovery/deployment
- Plankton net sampling
- Bio-geochemical measurements
- Multiple corer sampling
- General meteorological monitoring
- Surface water sampling/monitoring
- Shipboard ADCP monitoring
- Sea bird and marine mammal survey



Cruise Plan:

Sept. 4th, Hachinohe (JAPAN)

Sept. 14th?, Nome for embarkation of ice pilot

Sept. 14th, Bering Strait
(Chukchi continental shelf and shelf break)

Oct. 5th?, Bering Strait

Oct. 5th?, Nome for disembarkation of
ice pilot and some researchers

Oct. 16th, Hachinohe (JAPAN)

Contact:
Dr. Takashi Kikuchi, takashik@jamstec.go.jp

Leg 1 Region of Operations, 2012

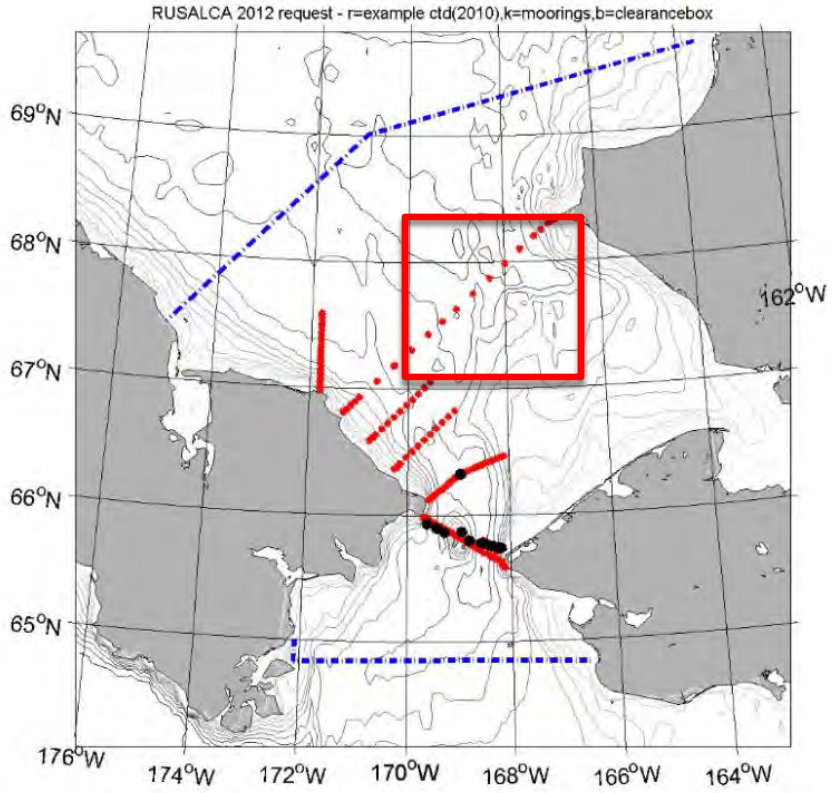
July 10-July 21

Chief Scientist:
Rebecca Woodgate

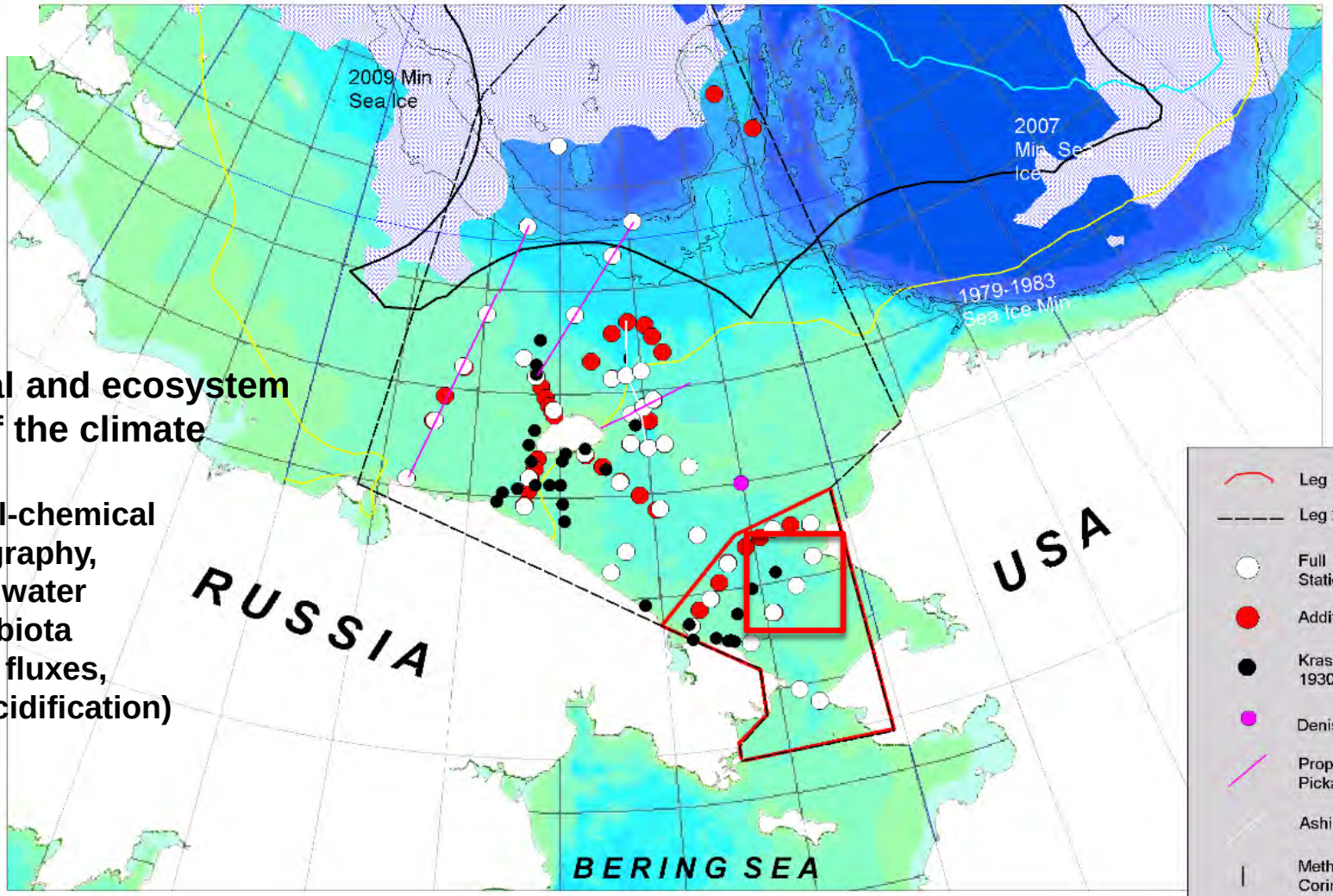
US coordinator:
K. Crane
Kathy.crane@noaa.gov

Russian Federation Coordinator:
A. Ostrovskiy
aao7777@gmail.com

Bering Strait Mooring Array: heat, fresh water, nutrient fluxes, marine mammals, plankton, ocean acidification



2012 Proposed RUSALCA Leg 2 Stations



Physical and ecosystem Parts of the climate System (Physical-chemical Oceanography, Benthic, water Column biota Methane fluxes, Ocean acidification)

(August 24- September 17) Chief Scientist: T. Whitledge

Timeline 2012 Activities-USA (+PAG DBO effort)

July

- C30 and **DBO**, Canada and USA
- RUSALCA-Leg 1, Bering Strait moorings **(DBO)**

August:

- COMIDA Hanna Shoal (BOEM) (HLY1201) **(DBO)**
- NOAA (CHAOZ, Fish surveys, marine mammal surveys **(DBO)**
- RUSALCA-Leg 2 **(DBO)**
- CSEP (Chukchi Sea Environmental Program (Conoco-Phillips/Shell/StatOil) **(DBO)**

September

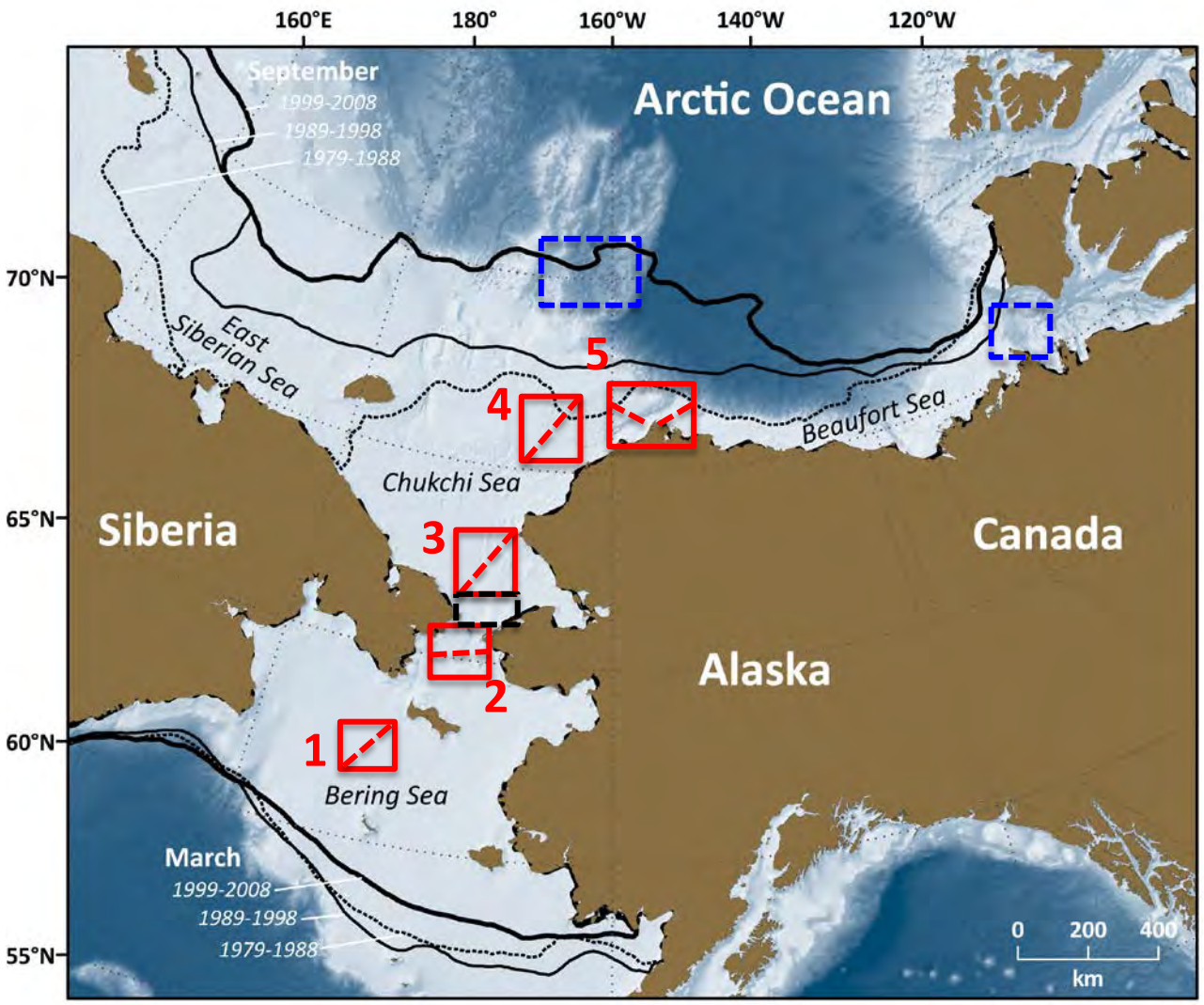
- AON-BOWFEST**(DBO)**
- RUSALCA-Leg 2 **(DBO)**
- UNCLOS (Mayer, Healy 1202) 26 Aug/26 Sept Barrow-Dutch Harbor-Mayer/UNH (HLY1202)

October

- AON-Pickart/WHOI (HLY1203) **(DBO)**

- Plus other US cruises **(some DBO collaboration)**

DBO current and potential sites



- **DBO sites (numbered red boxes) are regional "hotspot" transect lines and stations**
- **Potential future sites (blue dashed boxes) are regions of changing physical processes, biochemical and atmospheric "hotspot" sites, some tired to biological indicators of change**
- **Black box: ongoing Bering Strait study**

Thank you for your attention.
Questions and comments?

Financial support from international science partners in the Pacific Arctic Group (PAG) and the IASC AOSB/Marine Working Group, along with US National Oceanic and Atmospheric Administration, National Science Foundation, Bureau of Ocean Energy Management, and others