

# Linking Biology to Physics in an Arctic Ocean Observing System

Development of a Distributed Biological  
Observatory (DBO) in the Pacific Arctic and  
potential for pan-Arctic system studies

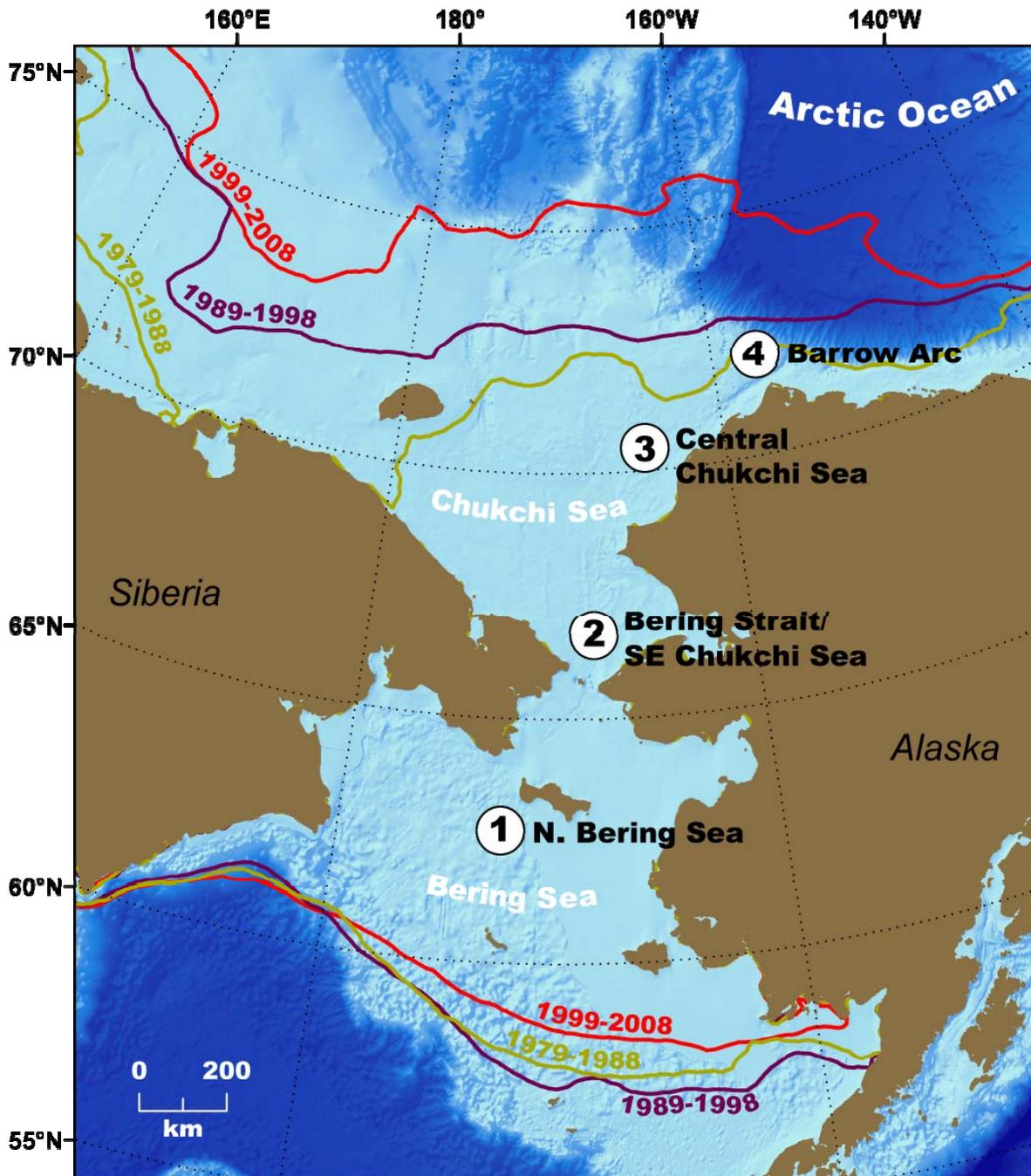


Jackie Grebmeier  
Pacific Arctic Group and the IASC AOSB: Marine Working Group,  
Seoul, Korea  
27 March 2011

# The Goal of the Workshop

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

- review the data collected during the 2010 DBO pilot project and analyses
- discuss the potential expansion of the program to a pan-Arctic biological observation network
- data management issues
- plans for DBO occupation in 2011



[see Grebmeier et al. 2010 for further information]

## Linking Physics-Biology: the Distributed Biological Observatory (DBOs)

- The DBO will focus on four regional “hotspot” locations along a latitudinal gradient
- DBO regions exhibit high productivity, biodiversity, and overall rates of change
- The DBO will serve as a *change detection array* for the identification and consistent monitoring of biophysical responses

# “Vision” for Distributed Biological Observatory

Core standardized ship-based sampling:

- CTD, ADCP measurements
- 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)

Additional leveraged programs both domestic and international for more data types collected, such as carbon components

## **Introduction: The DBO 2010 Pilot Program and Beyond**

- 2008 Discussions within PAG for observations and synthesis activities
- May 2009: NOAA Biology workshop, Seattle, WA; also NSF/NOAA Bering Strait workshop, both in May
- Feb. 2010: Open session on the Distributed Biological Observatory (DBO) planning effort, Feb. 2010, Ocean Science Meeting, ~40 participants
- April 2010: DBO discussion at ASSW, Nuuk, Greenland:,AOSB:MWG
- May 2010: Feature article in EOS on NOAA Biology workshop and DBO
- June-October DBO pilot project
- Dec. 2010: Update on DBO 2010 pilot project and PAR synthesis at PAG meeting in Tokyo, Japan
- Jan. 2011: DBO poster at the Alaska Marine Science Symposium Anchorage, AK
- Jan. 2011: DBO workshop at the AMSS, ~50 participants
- Jan. 2011: Presentation to AOSB/MWG in Potsdam, Germany
- Continued interest by multiple US agencies in DBO planning effort, listed in NOAA strategic plans, discussions with US SEARCH, USGS, BOEM, USGS
- Mar. 2011: DBO workshop at ASSW, Seoul, Korea, status and 2011 plans
- Mar. 2011: PAG meeting discuss 2011 DBO plans, future direction

# ASSW 2010= IASC/AOSB Endorsement [April 2010]

## Arctic Ocean Sciences Board: Marine Working Group

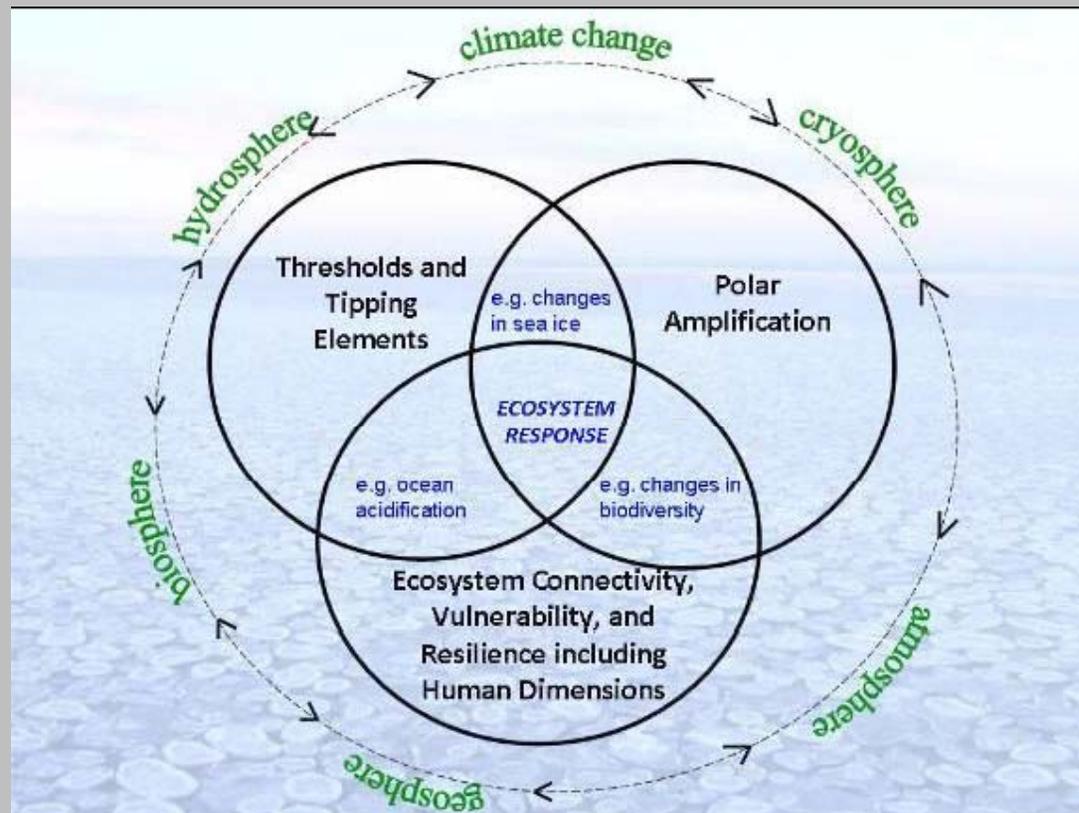
- ▶ **ACTION:** The Board supports the DBO pilot program in the Pacific Arctic Sector, and will...
- ▶ Co-sponsor a workshop w/ PAG to identify ways to expand the program to a pan-Arctic DBO
- ▶ AOSB Steering Group will consult with ICES to determine their interest in the DBO concept.



# Frontiers in Understanding Climate Change and Polar Ecosystems: Report of a Workshop, U.S. Polar Research Board, National Academies

(release March 24, 2011, available in published form May 2011)

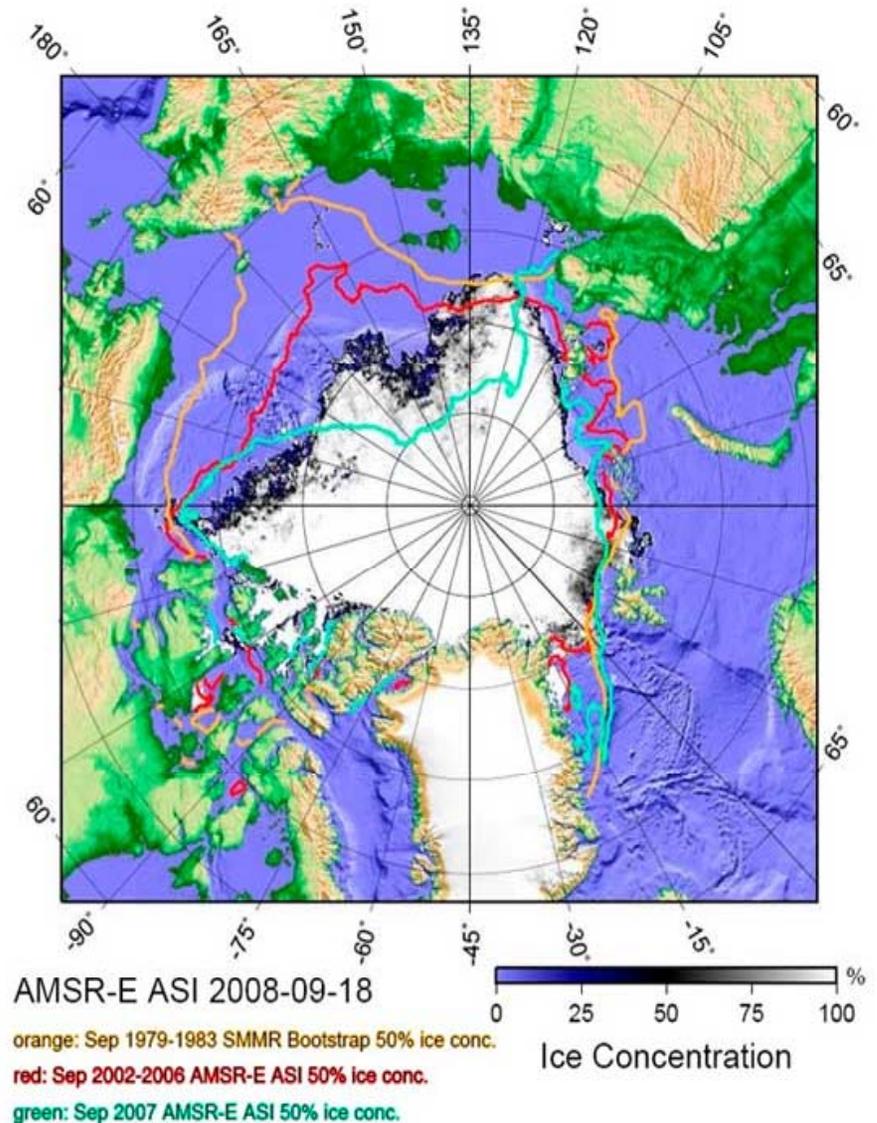
Committee: Jacqueline M. Grebmeier and John C. Priscu (co-chair), Rosanne d'Arrigo, Hugh W. Ducklow, Craig Fleener, Karen E. Frey, and Cheryl Rosa

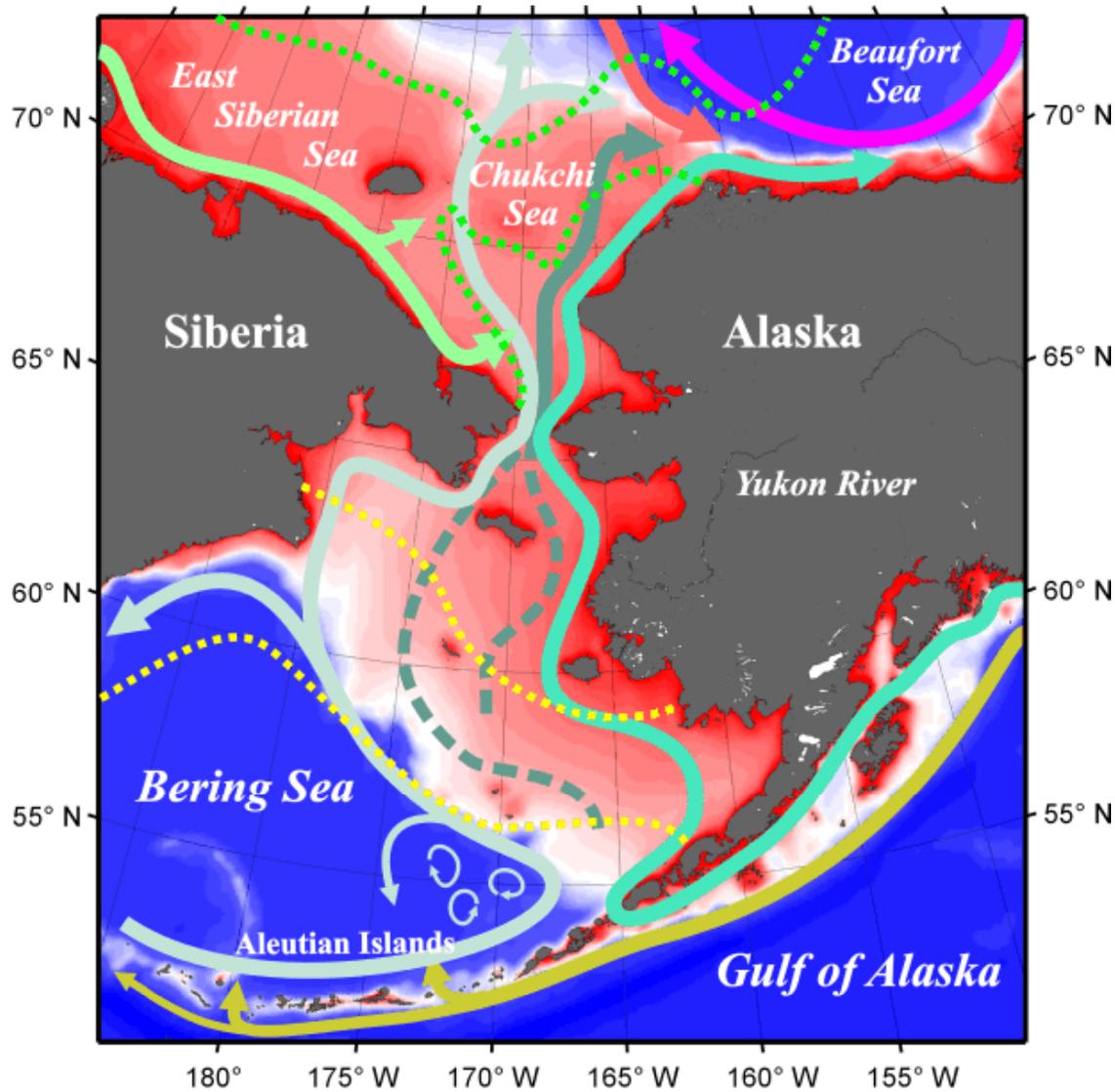


It highlights the need for biologically-oriented, time-series, long-term observations in the polar marine environment to track ecosystem response to climate forcing

# Arctic Sea Ice = 'New State'

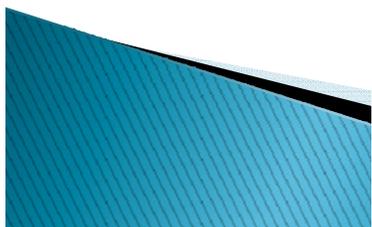
- ▶ 2007 sea ice retreat called 'catastrophic' (Shimada 2007)
- ▶ Nearly ice-free September now predicted for 2037 (Wang & Overland 2009)
- ▶ Biggest change is **loss of multi-year ice** + **delay** in fall freeze-up





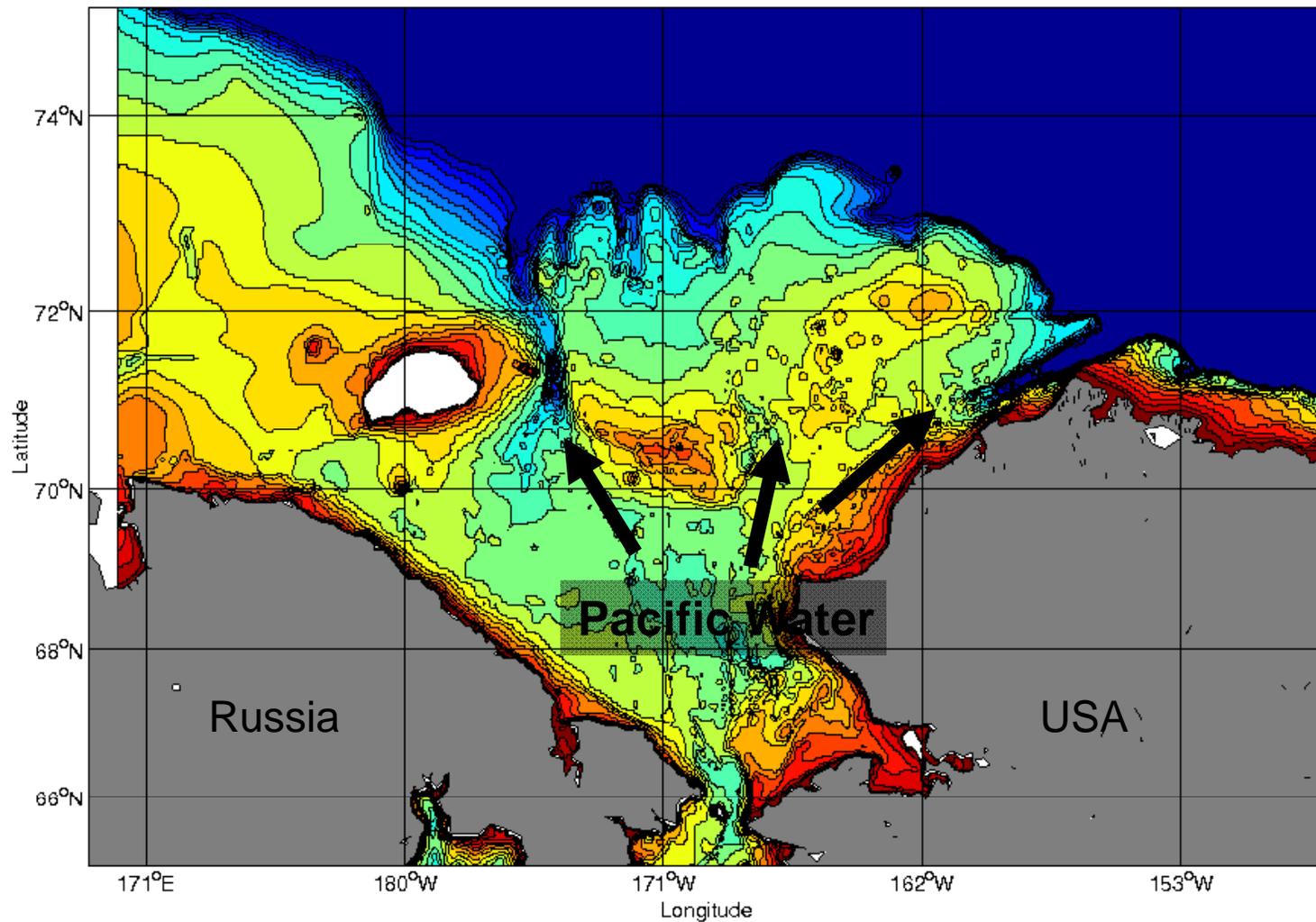
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- Beaufort Gyre
- Atlantic Water
- Siberian Coastal Current
- Alaska Coastal Water
- Bering Shelf Water
- Aleutian North Slope - Bering Slope - Anadyr Waters
- Alaskan Stream
- September Ice Edge Maximum and Minimum Extents
- March Ice Edge Maximum and Minimum Extents



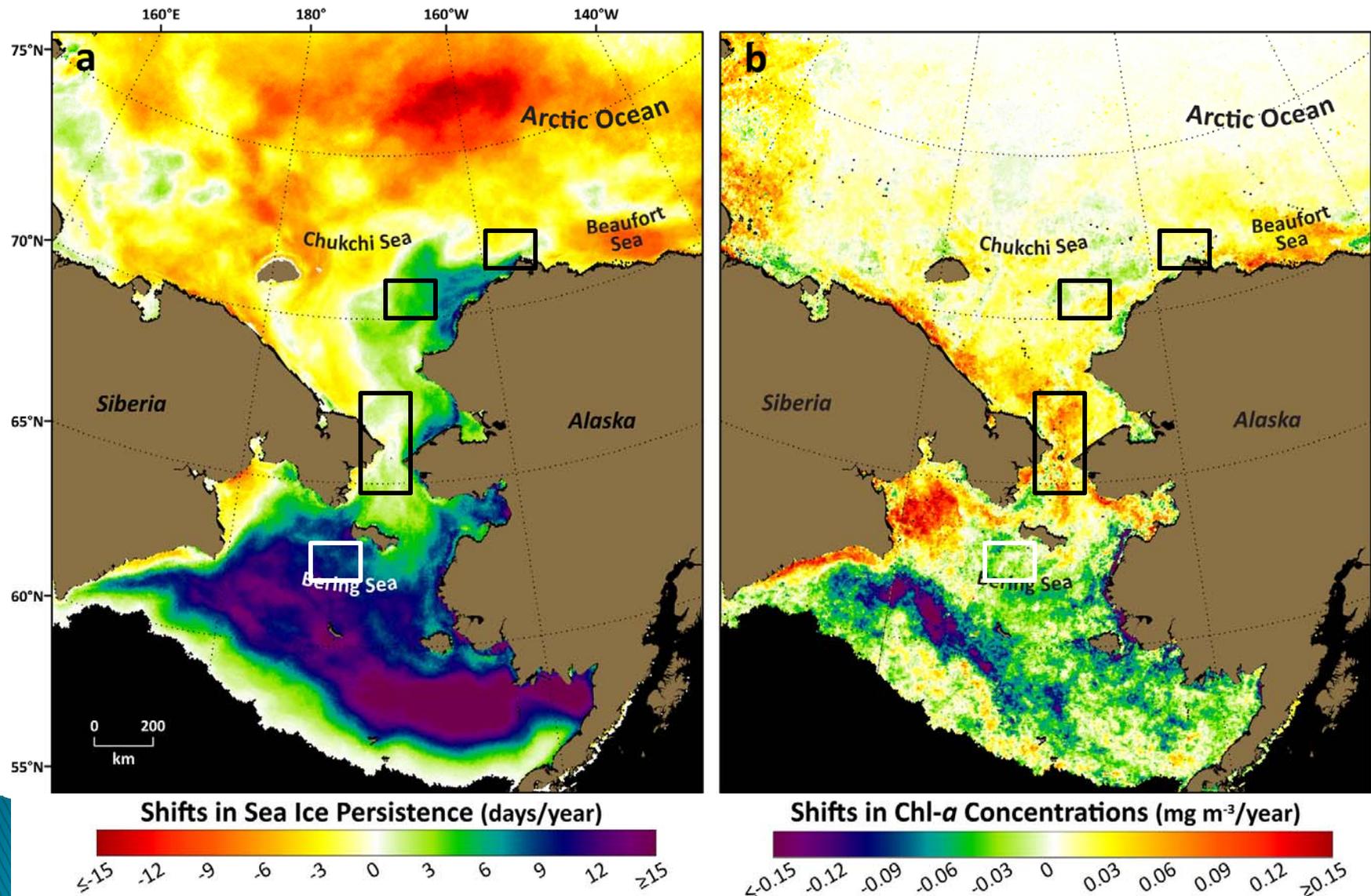
[courtesy Tom Weingartner and Seth Danielson]

# Pathways: Pacific water into the Arctic



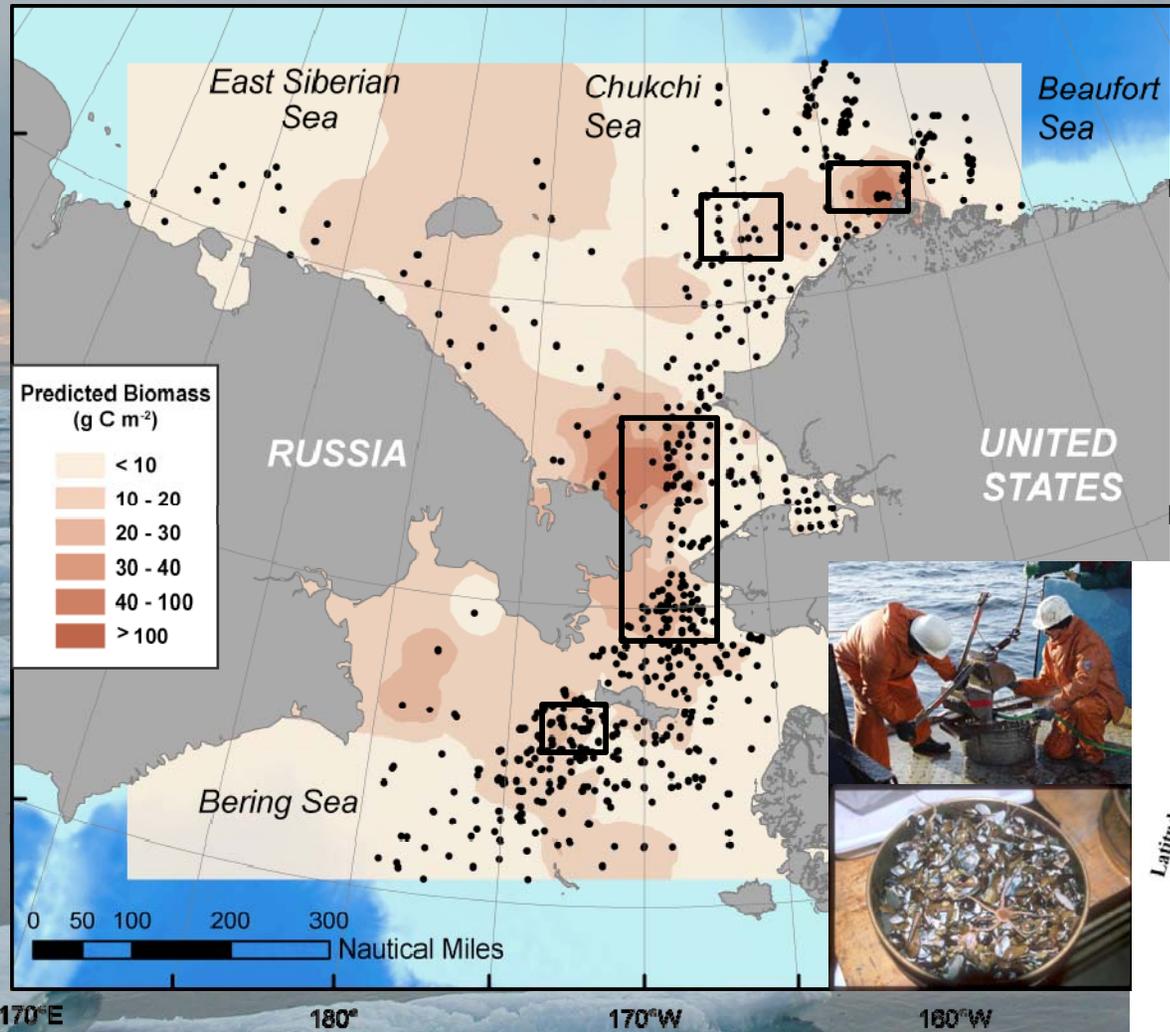
[courtesy R. Pickart]

# Shifts in sea ice persistence and Chl-a concentration from 2003-2009

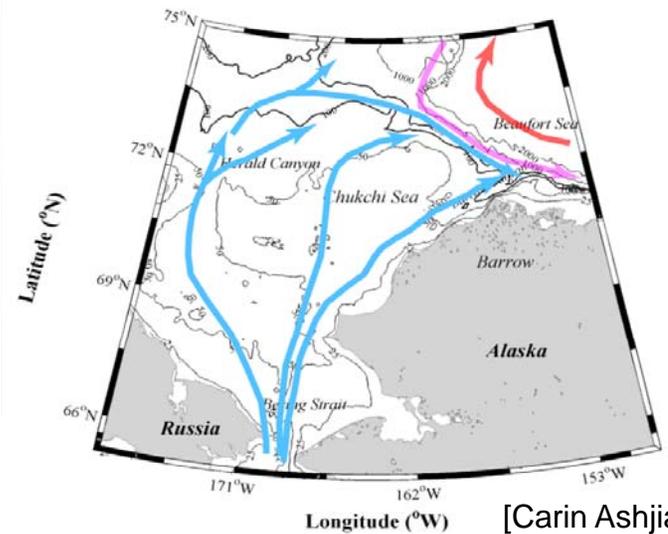


Based on SSM/I Sea Ice Concentrations and the GlobColour (SeaWiFS, MODIS, MERIS) satellite time series, courtesy Karen Frey

# Rich benthic communities on the western side of the Bering/Chukchi Sea system 1970-2010



- “foot prints” of high benthic biomass reflect pelagic-benthic coupling and export of carbon to sediments
- infaunal dominated by amphipods, bivalves, polychaetes, and sipunculids



[updated from Grebmeier et al. 2006]

Weir

[Carin Ashjian]

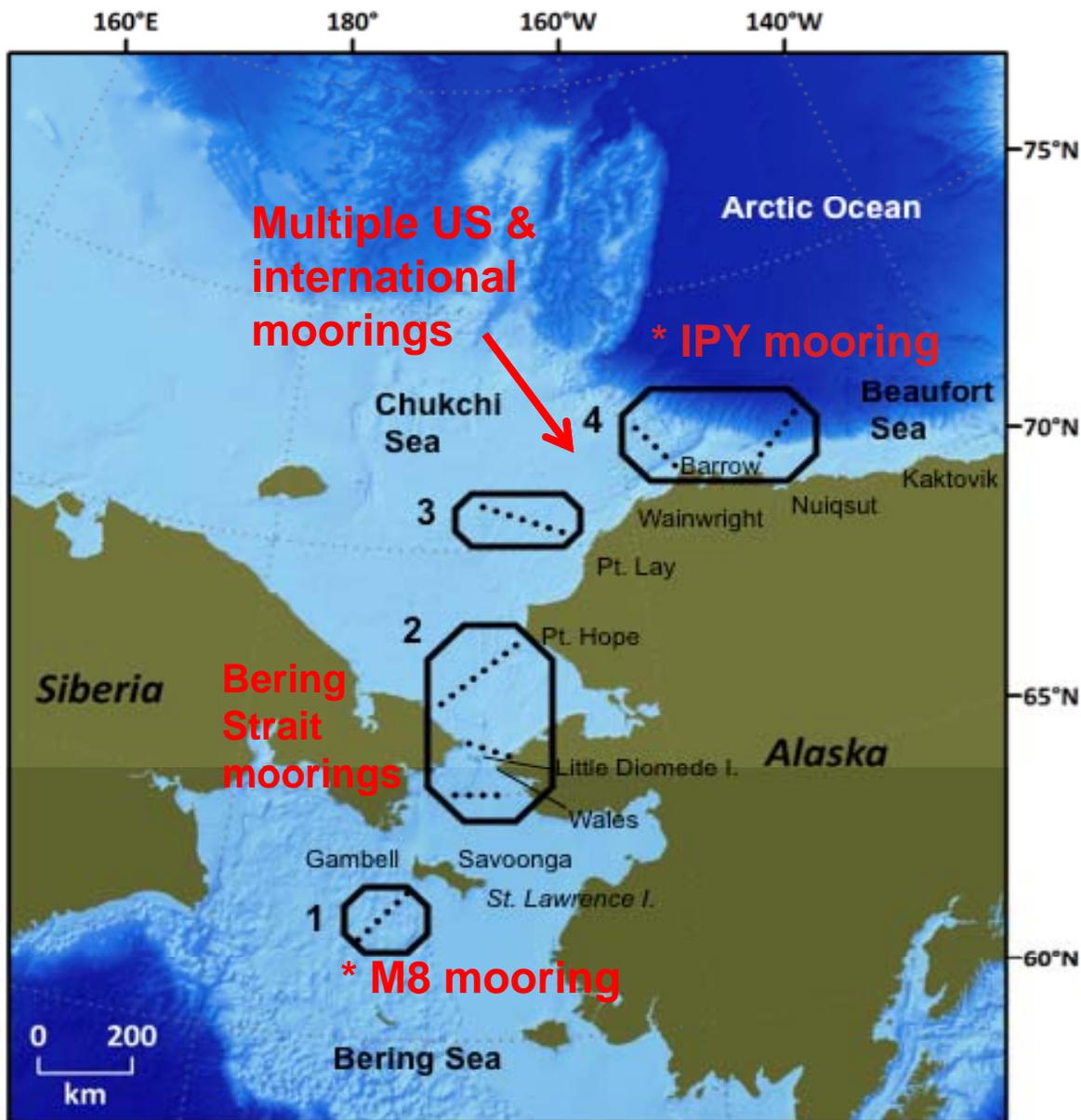
# Observed Changes in the PAR

## a few examples

- ▶ Pacific zooplankton in Beaufort Sea
- ▶ Commercially fished 'Bering species' & snow crab in the western Beaufort Sea
- ▶ Seabird declines with drop in clam biomass [eiders] & access to ice-associated cod [guillemots]
- ▶ Gray whale feeding-focus shift from N. Bering to Chukchi
- ▶ Walrus hauling out on land in unprecedented numbers
- ▶ Polar bears reported drowned at sea, scavenging & denning on land



# DBO- Repeated Oceanographic Sampling with **Links** to Community-based “research partnerships”

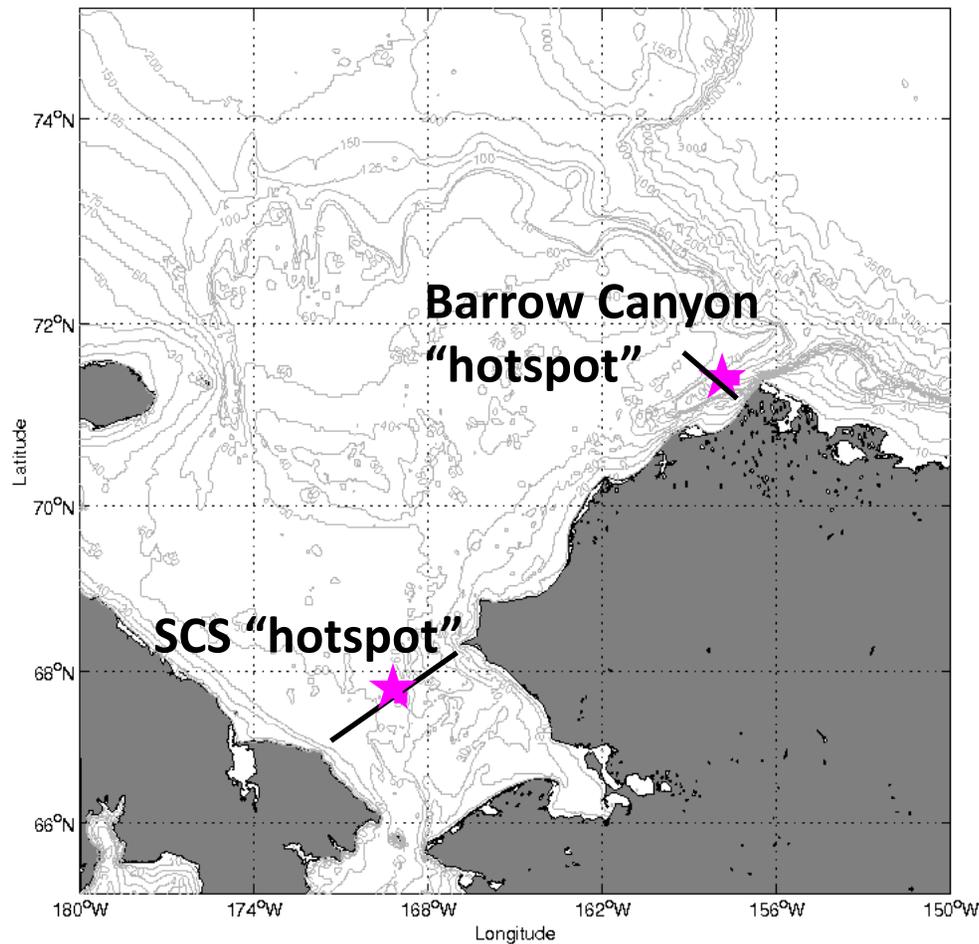


- Stations from prior & existing research programs: SBI, RUSALCA, SNACS, BOWFEST

Framework for integration of IPY \* and many other research programs

Links to prior & existing Community-based Research: SLI/Diomedes Pt. Lay, Barrow

# DBO 2010 “Pilot” Season: International cruises to Pacific Arctic



Vessel	Country	PI
<i>Moana Wave</i>	USA	Grebmeier
<i>Alaskan Enterprise</i>	USA	Napp
<i>Xue Long</i>	China	He
<i>Mirai</i>	Japan	Itoh
<i>Laurier</i>	Canada	Vagle
<i>Healy</i>	USA	Arrigo
<i>Healy</i>	USA	Pickart
<i>Annika Marie</i>	USA	Ashjian
<i>Khromov</i>	Russia & USA	Woodgate

# 2010 DBO International Pilot Project

DBO 2010 Data Parameter Matrix (SE Chukchi Sea-SECS) and Barrow Canyon (BC)									
Cruise (DBO PI Lead)	Period	CTD*	Chlorophyll-extractions	Nutrients	Algae-Ice/Phytoplankton: size, biomass, composition	Zooplankton: size, biomass, composition	Benthos: size, biomass, composition	Seabird surveys	Marine Mammal surveys
Healy 1001 (Pickart)	June-July (both)	x	x	x					
Sir Wilfrid Laurier (Vagle)	July (both)	x	x	x		x	x	x	
Araron (Chung)	July								
Moana Wave (Grebmeier)	July-Aug (both**)	x	x	x	x**	x**	x**	x	x
Xuelong (He)	July-Aug	x	x	x	x	x	x***		
Annika Marie (Ashjian)	August (BC)	x	x	x	Lugols samples for microplankton	x		x	x
Alaskan Enterprise (Napp/CHAOZ)	Aug-Sept (BC)	x				x			x
Khromov (Woodgate)	Aug (SECS)=CS line	x	x	x		x			x
Healy 1003 (Pickart)	Sept (BC)	x		x					
Mirai (Itoh)	Oct (BC)	x	x	x		x (hotspot)			

\*=T, S, plus some cruises transmissivity, fluorescence (chlorophyll), CDOM, dissolved oxygen, pH

\*\*=all water column, plankton and benthic data at "hotspot" sites only; seabird and marine mammal survey throughout

**10:00-10:30 Introduction: What and why a DBO? The DBO 2010 Pilot Program and Beyond** (*Jackie Grebmeier*)

**10:30-12:30 Data analysis and integration: DBO 2010 Pilot Program**

Presentations and discussion of initial joint analysis

- “DBO Sea ice time series analysis” (*Karen Frey*)
- “Seasonal variation of water masses in the Chukchi Sea results of DBO pilot study in 2010” (*Motoyoh Itoh and Robert Pickart*)
- “Evolution of water masses and nitrate in Barrow Canyon during the summer 2010: Preliminary results from the DBO Pilot Study” (*Robert Pickart via Jackie Grebmeier*)
- “Plankton and benthic collections coincident with seabird and marine mammal surveys during DBO 2010” (*Jackie Grebmeier et al.*)
  - Identify other analyses with use of existing data or with additional multi-year data and/or hotspot areas

**12:30-13:45 Lunch Break**

**13:45-15:30 Program Expansion and external outreach and interfaces**



## 13:45-15:30 Program Expansion and external outreach and interfaces

- Discuss the benefit and approaches to expanding the concept to cover other areas of the Arctic
- Examples of DBO-types studies in other areas of the Arctic:
  - “Multidisciplinary long-term studies at the Arctic deep-sea observatory HAUSGARTEN” (*Michael Klages*)
  - “Some visions on DBO type studies from a Swedish perspective” (*Leif Anderson*)
  - “Biological observations in Norway and some thoughts on the DBO strategy” (*Marit Reigstad*)
  - Others?
- Discussion on how do we develop a pan-Arctic network of DBO transects and sites?
  - Relation of the DBO planning to the CBMPs Marine Expert Monitoring Groups (MEMG) “Circumpolar Marine Biodiversity Monitoring Plan” (*Kathy Crane*)
  - Ways forward to develop the DBO into an observations network within the SAON framework (*John Calder*)

## 15:30-15:45 Coffee Break

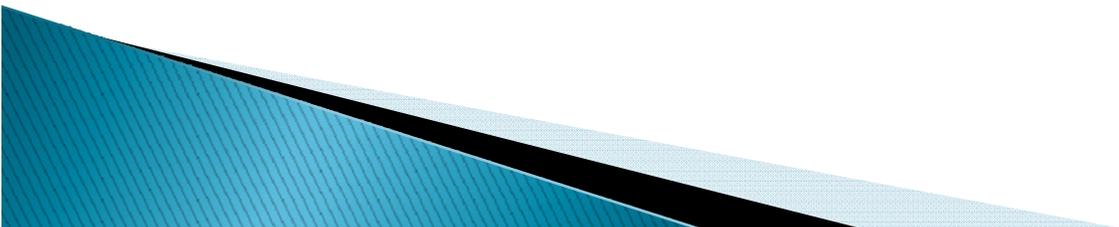
## 15:45-17:30 Review data sharing, identify gaps, and future direction

- Review draft DBO data templates (*Grebmeier*)
- Discuss concept of integrated databases (*Grebmeier*)
- PAG DBO Ship plans for 2011 (*National members*)



# Questions and comments?

Financial support from the US National Oceanic and Atmospheric Administration, the National Science Foundation, Minerals Management Service, and international science partners in the Pacific Arctic Group (PAG)



## Slide 19

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**JG1** Jackie Grebmeier, 1/11/2011

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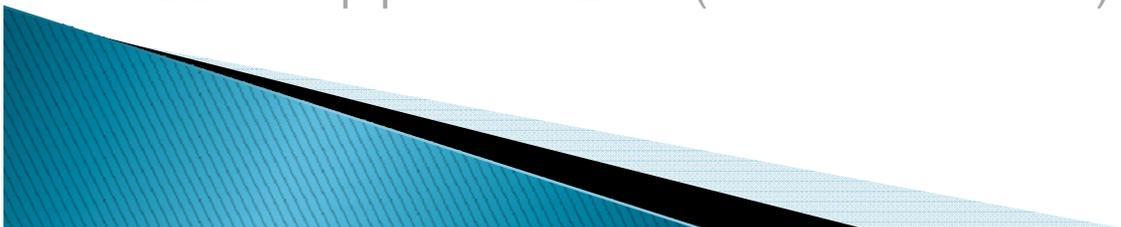
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