

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

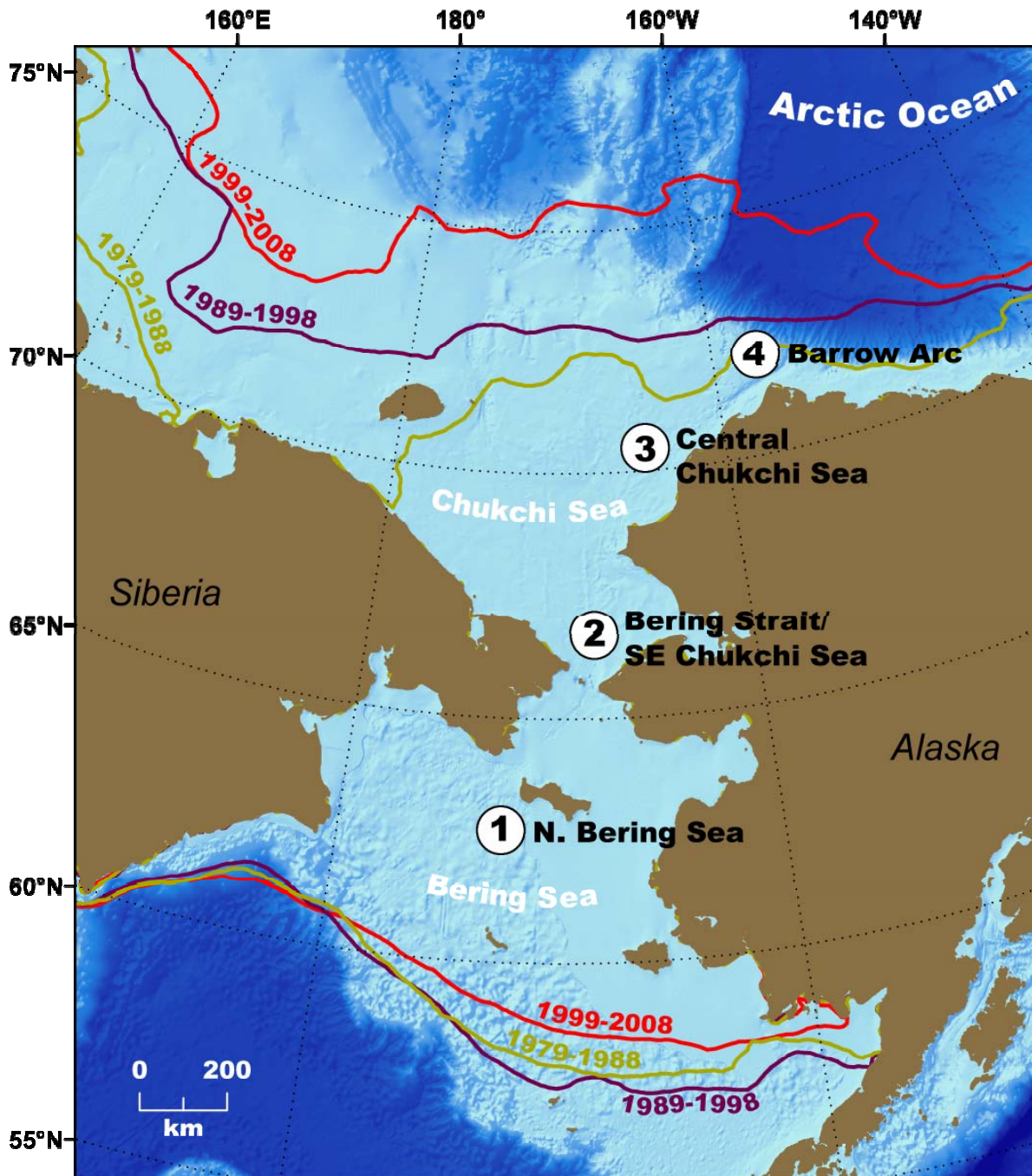


Jackie Grebmeier
Pacific Arctic Group and the IASC AOSB: Marine Working Group,
Seoul, Korea
27 March 2011

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

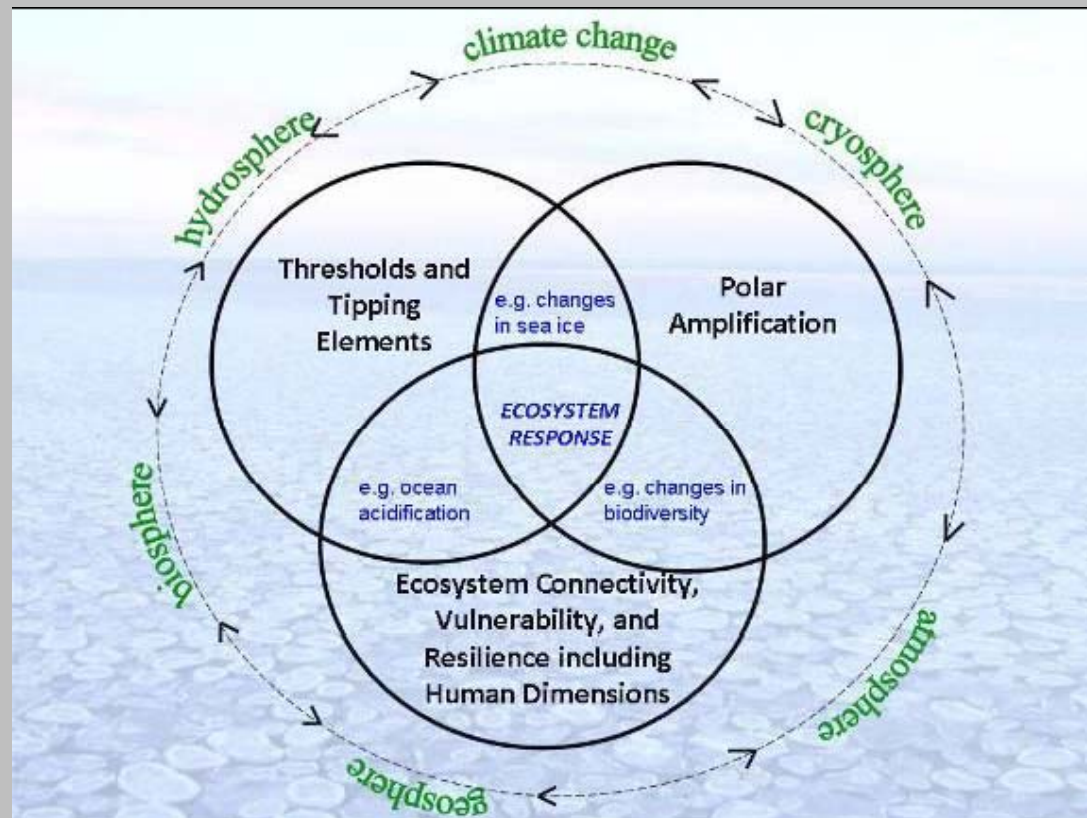
- ▶ **ACTION:** The Board supports the DBO pilot program in the Pacific Arctic Sector, and will...
- ▶ Co-sponsor a workshop w/ PAG to identify ways to expand the program to a pan-Arctic DBO
- ▶ AOSB Steering Group will consult with ICES to determine their interest in the DBO concept.



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)

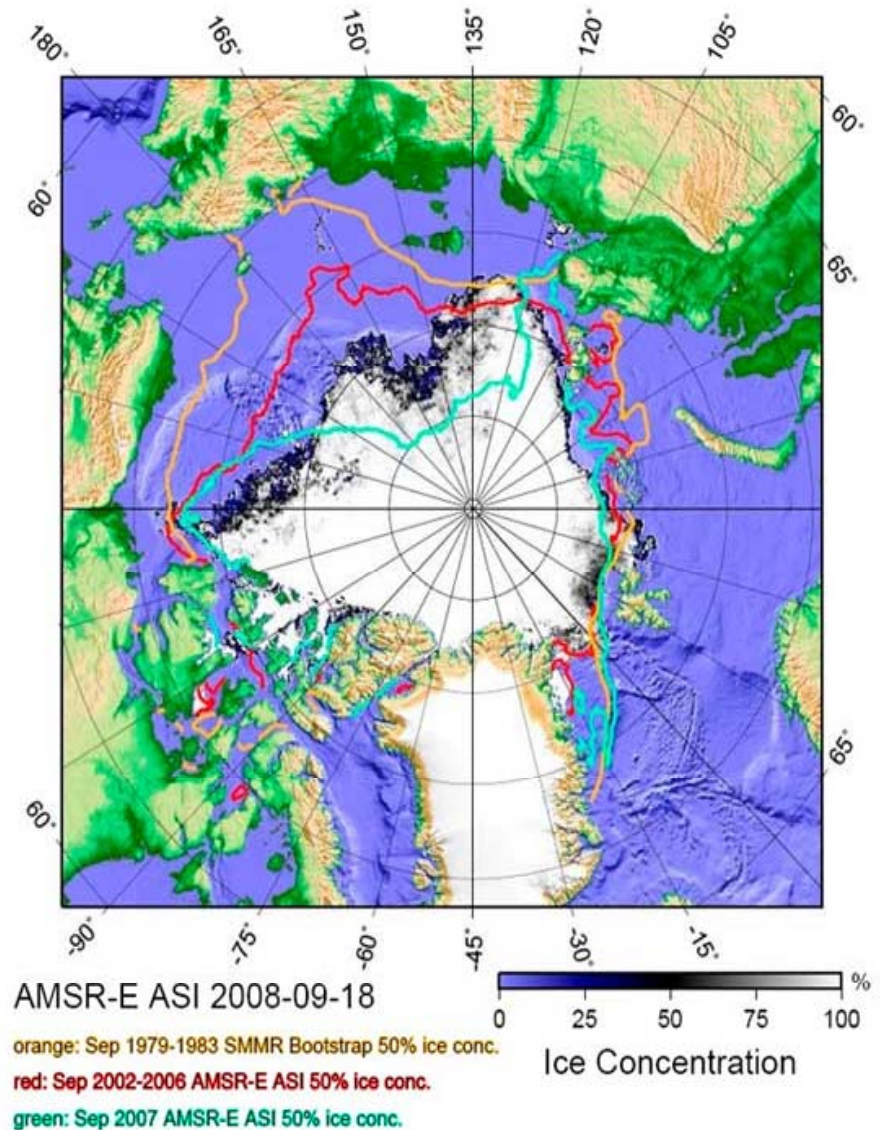
Committee: Jacqueline M. Grebmeier and John C. Priscu (co-chair), Rosanne d'Arrigo, Hugh W. Ducklow, Craig Fleener, Karen E. Frey, and Cheryl Rosa

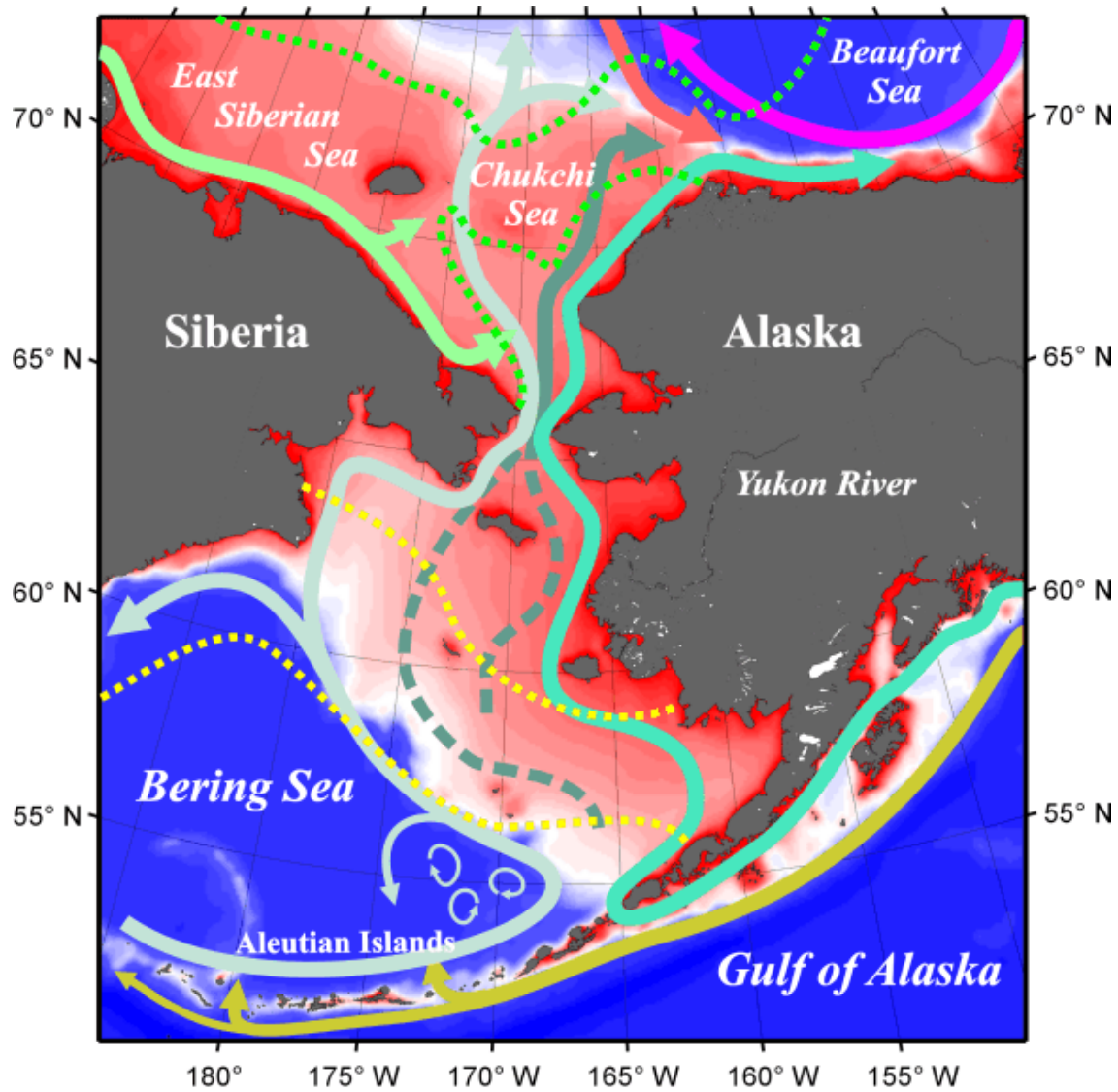


It highlights the need for biologically-oriented, time-series, long-term observations in the polar marine environment to track ecosystem response to climate forcing

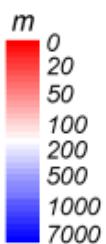
Arctic Sea Ice = 'New State'

- ▶ 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

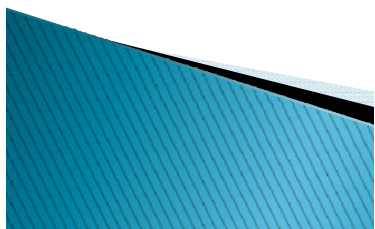




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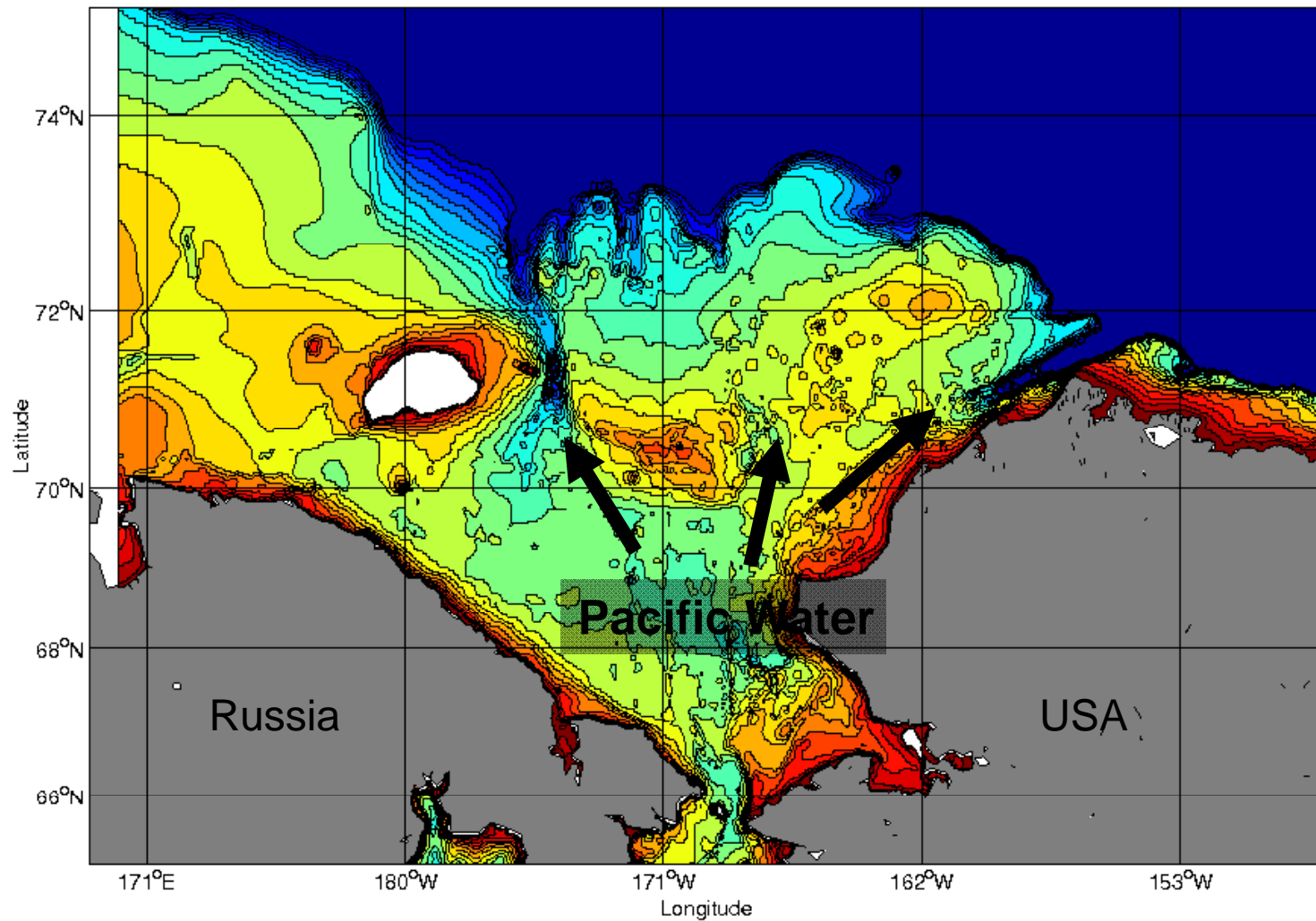


- █ Beaufort Gyre
- █ Atlantic Water
- █ Siberian Coastal Current
- █ Alaska Coastal Water
- █ Bering Shelf Water
- █ Aleutian North Slope - Bering Slope - Anadyr Waters
- █ Alaskan Stream
- ⋯ September Ice Edge Maximum and Minimum Extents
- ⋯ March Ice Edge Maximum and Minimum Extents



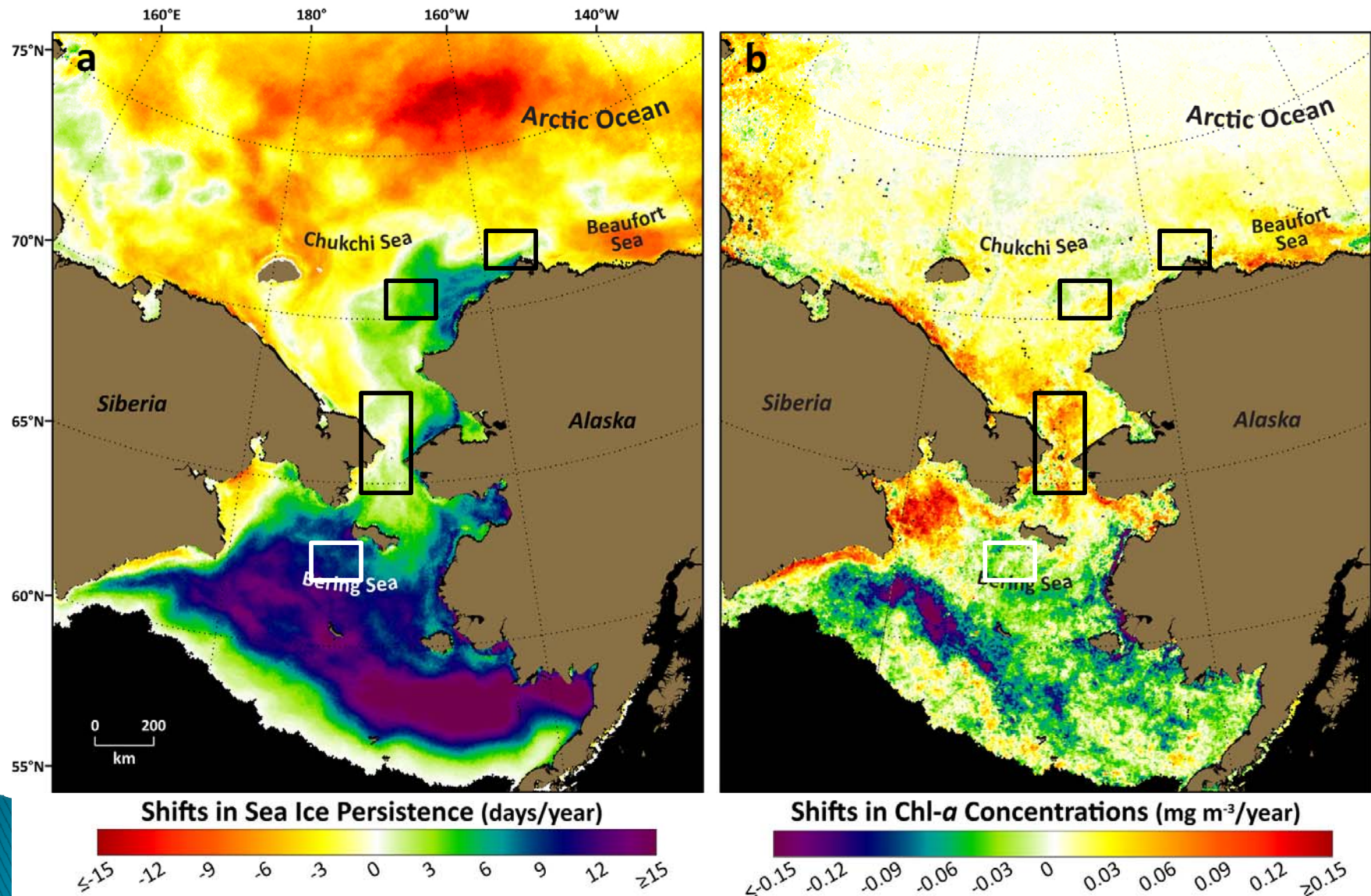
[courtesy Tom Weingartner and Seth Danielson]

Pathways: Pacific water into the Arctic



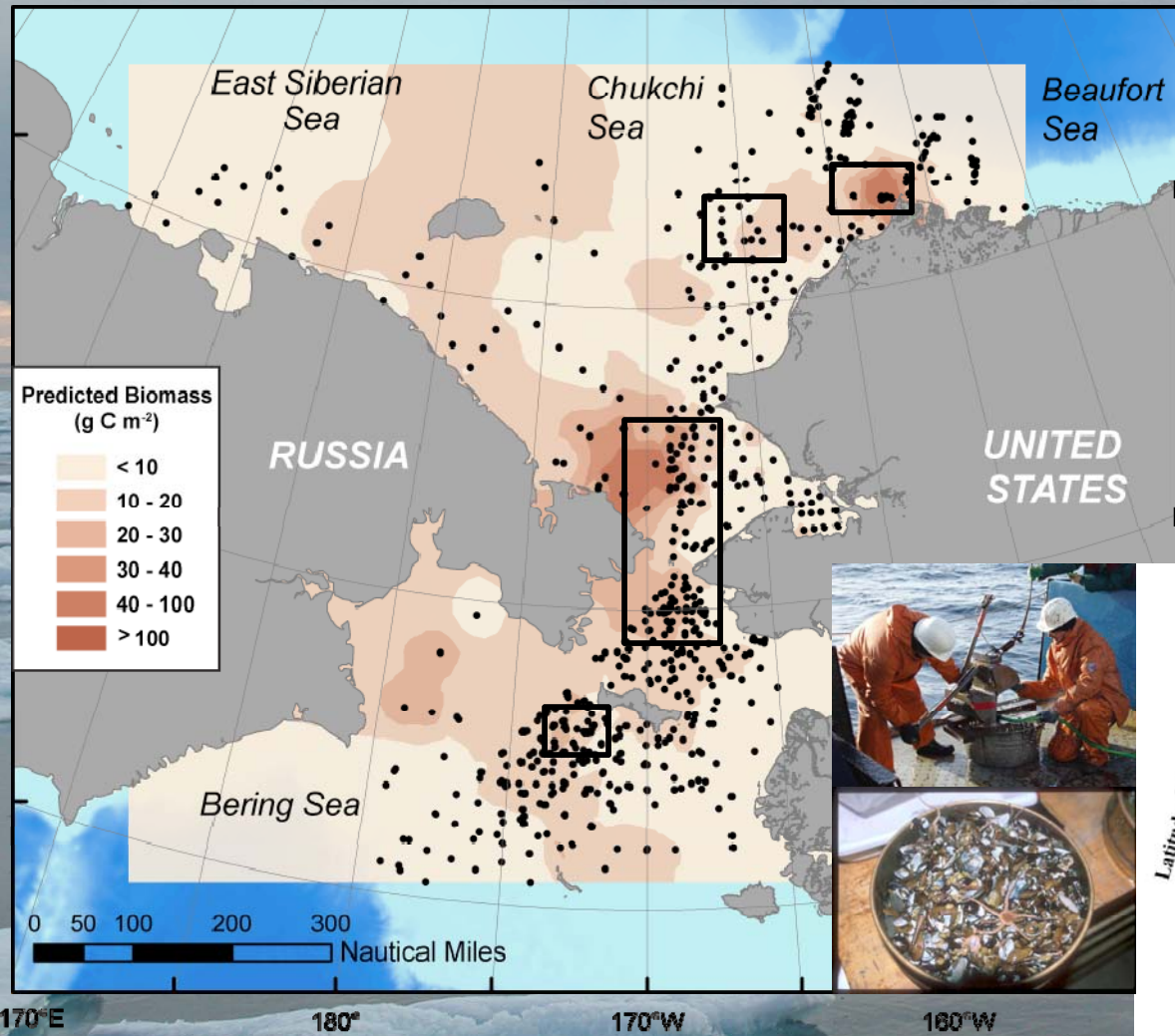
[courtesy R. Pickart]

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

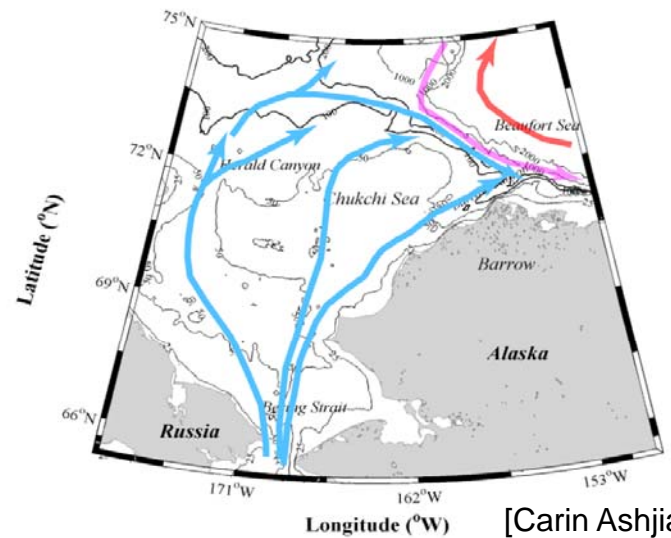


Based on SSM/I Sea Ice Concentrations and the GlobColour (SeaWiFS, MODIS, MERIS) satellite time series, courtesy Karen Frey

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]

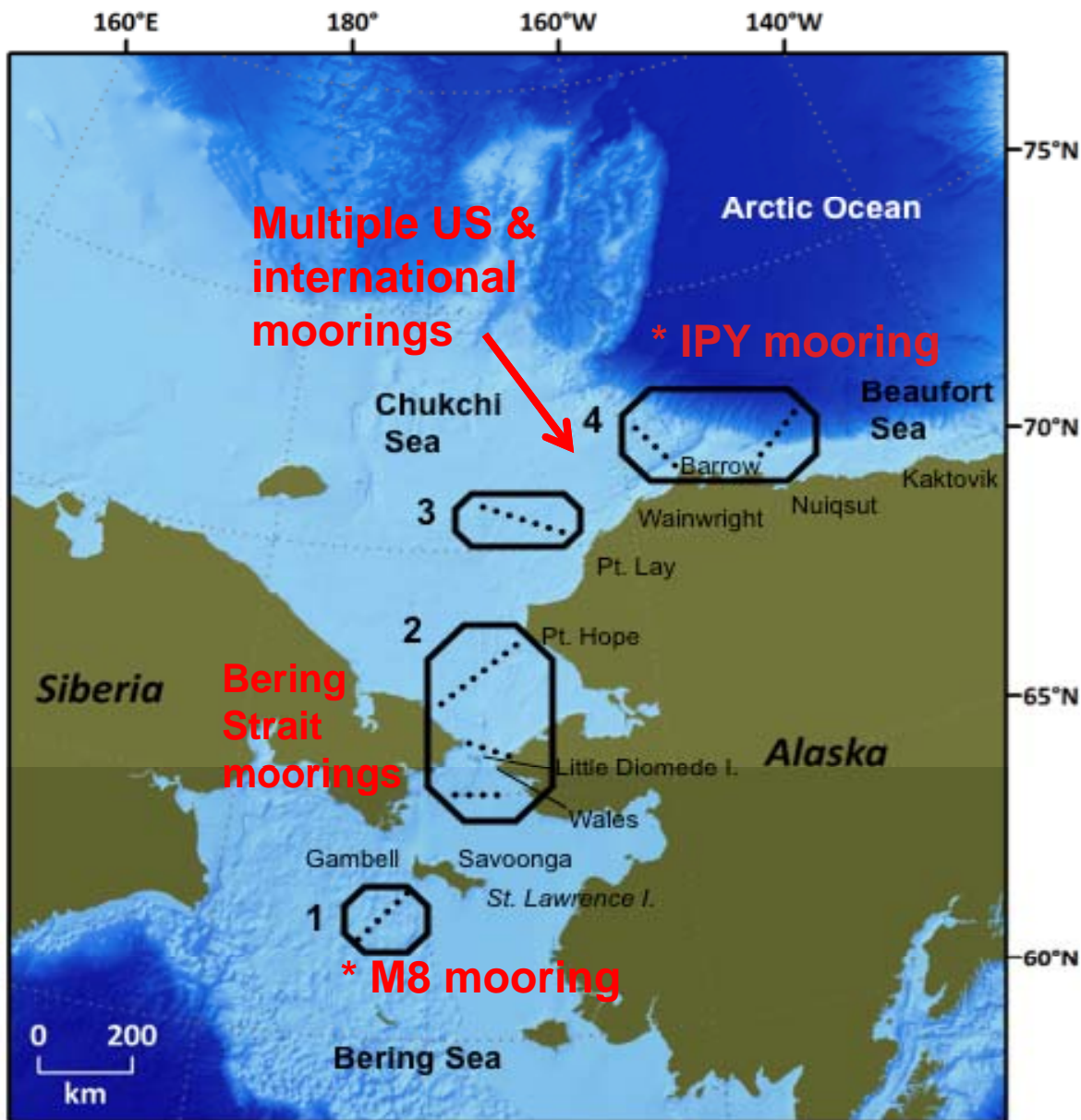
Observed Changes in the PAR

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”

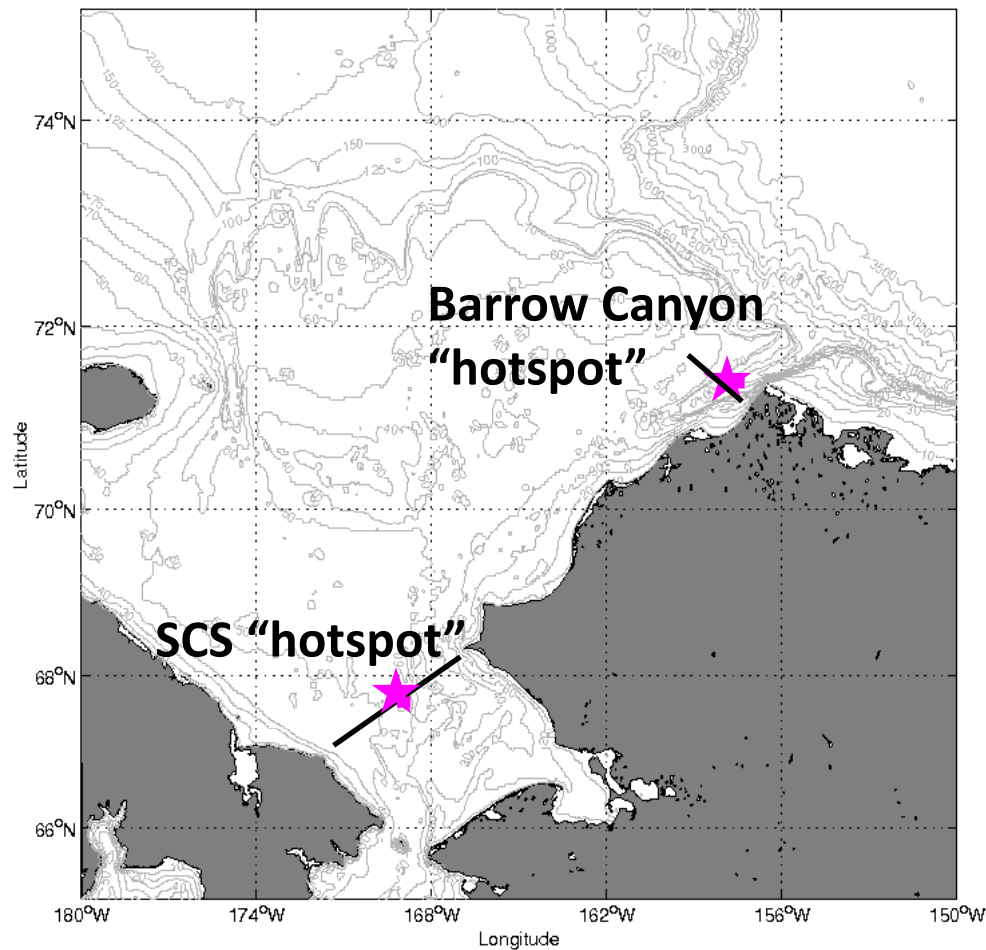


- Stations from prior & existing research programs: SBI, RUSALCA, SNACS, BOWFEST

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



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- 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

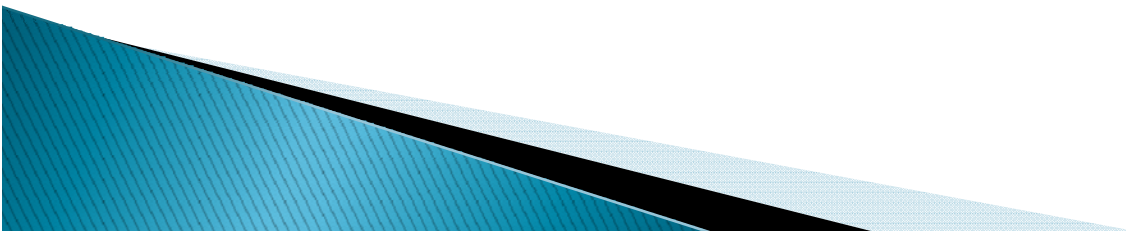
15:45-17:30 Review data sharing, identify gaps, and future direction

- 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

JG1 Jackie Grebmeier, 1/11/2011

JG2 Jackie Grebmeier, 1/11/2011

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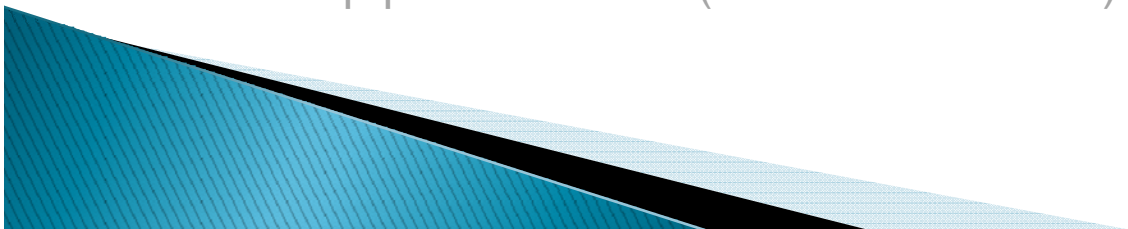
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