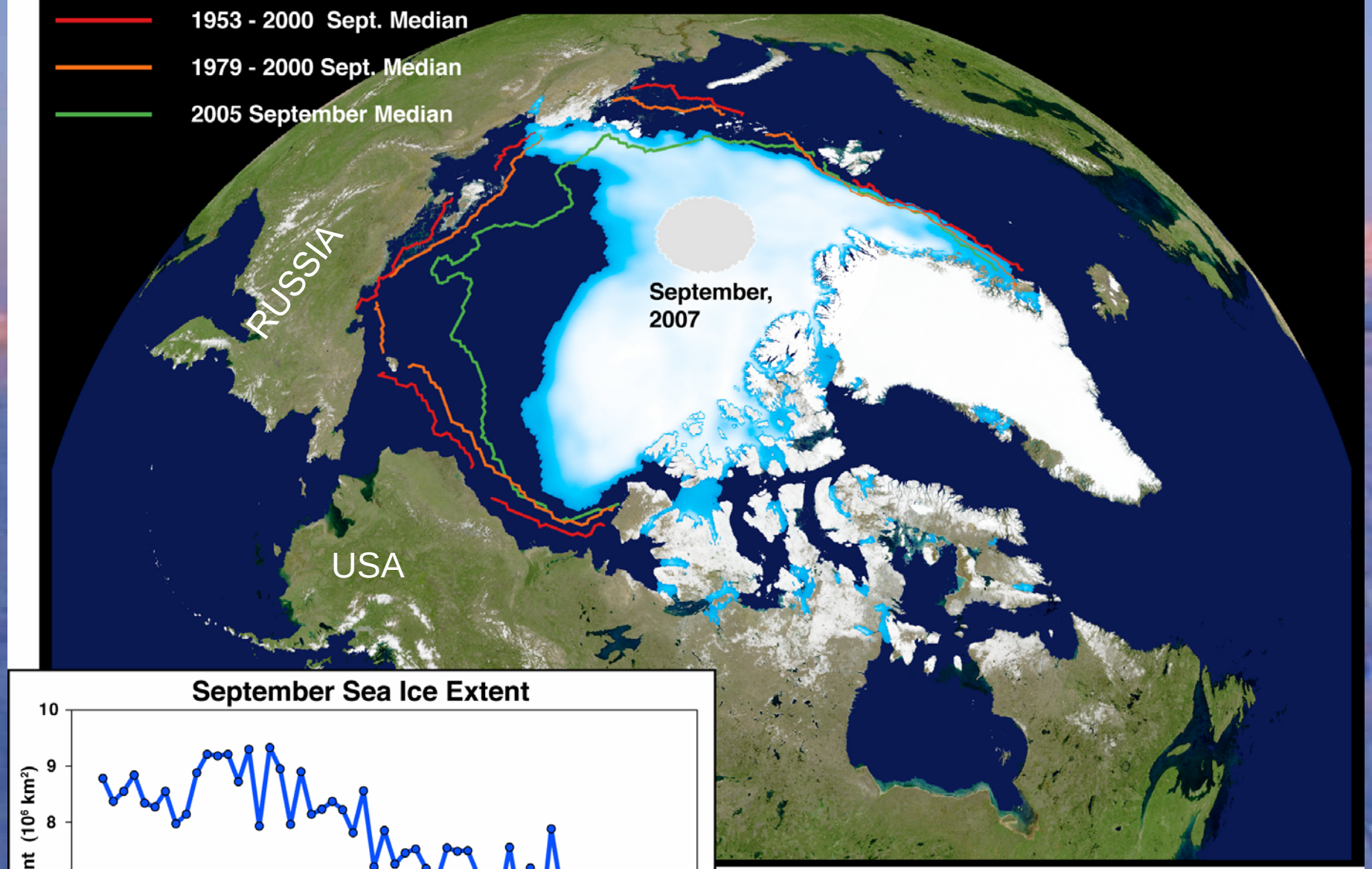
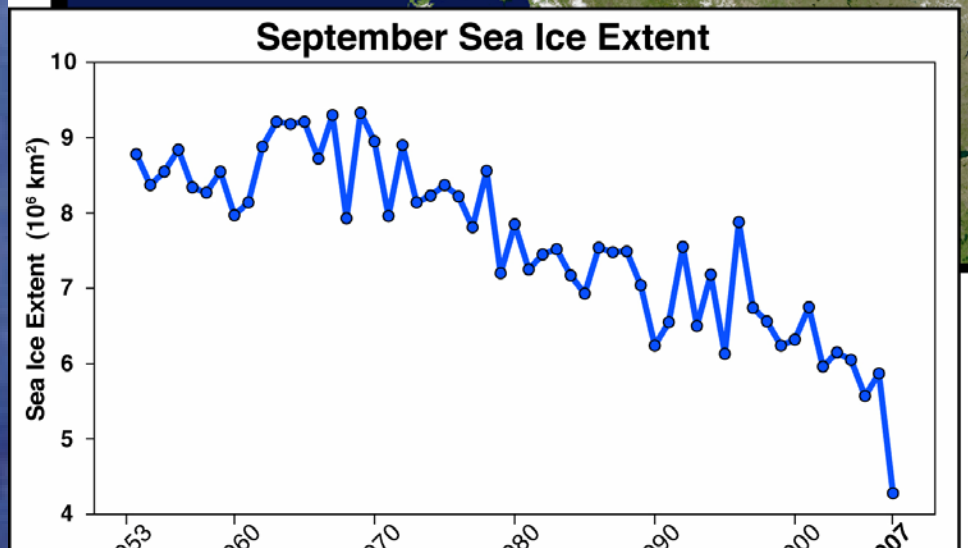

# *US -International Observing in the Pacific Arctic: RUSALCA 2010-future*

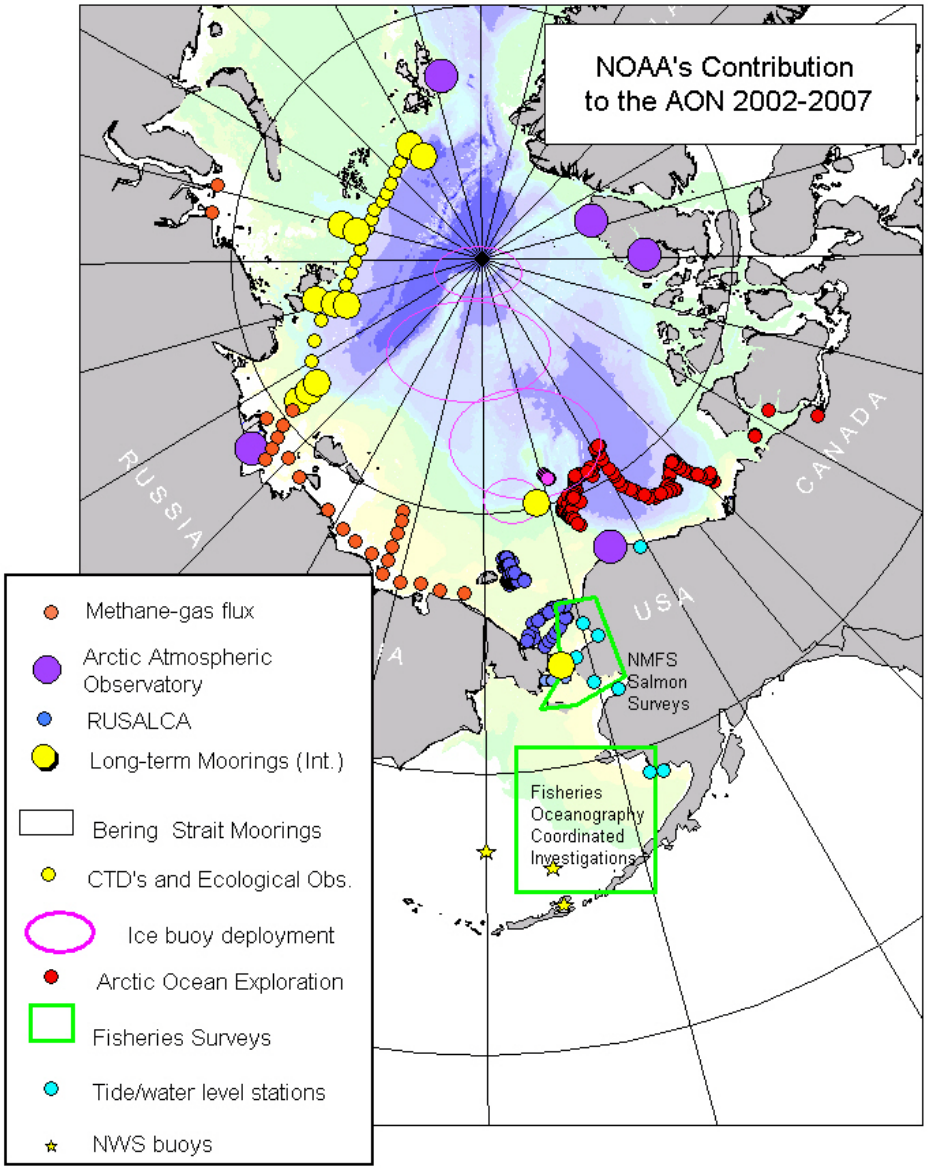
**Kathleen Crane and John Calder**
**Arctic Research Program, CPO, NOAA, USA**
**Aleksey Ostrovskiy, Group Alliance, Russia**




# RECUCTION OF SEA ICE COVER

# Ocean and Sea Ice Observing 2002-2007




Collaboration with Russia, Japan, China, Korea And Canada

# RUSALCA 2004-2010

**Umbrella coordination by Russia and USA**

**(Also includes participation with Korea, Germany, Denmark and Bermuda)**

## RUSALCA Goals:

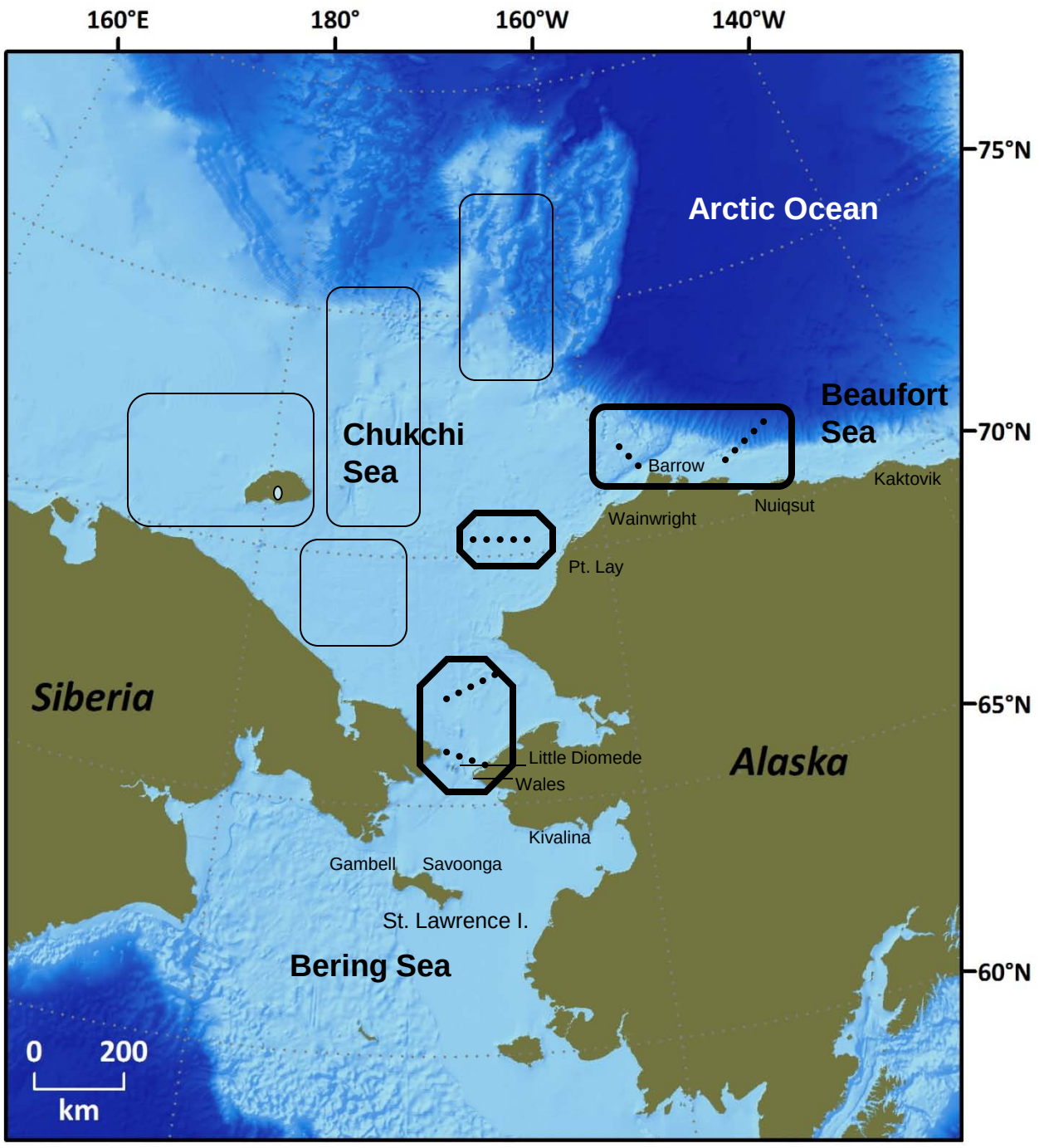
- **Observations where Arctic sea ice is reducing rapidly**
- **Bering St. fresh water, nutrient fluxes**
- **Regional physics and ecosystem response to change.**
- **Improve international Arctic science collaboration (also with other PAG countries)**
- **Explore the unknown Arctic**


**Russian American Long-term Census of the Arctic GATEKEEPERS OF THE REGION**

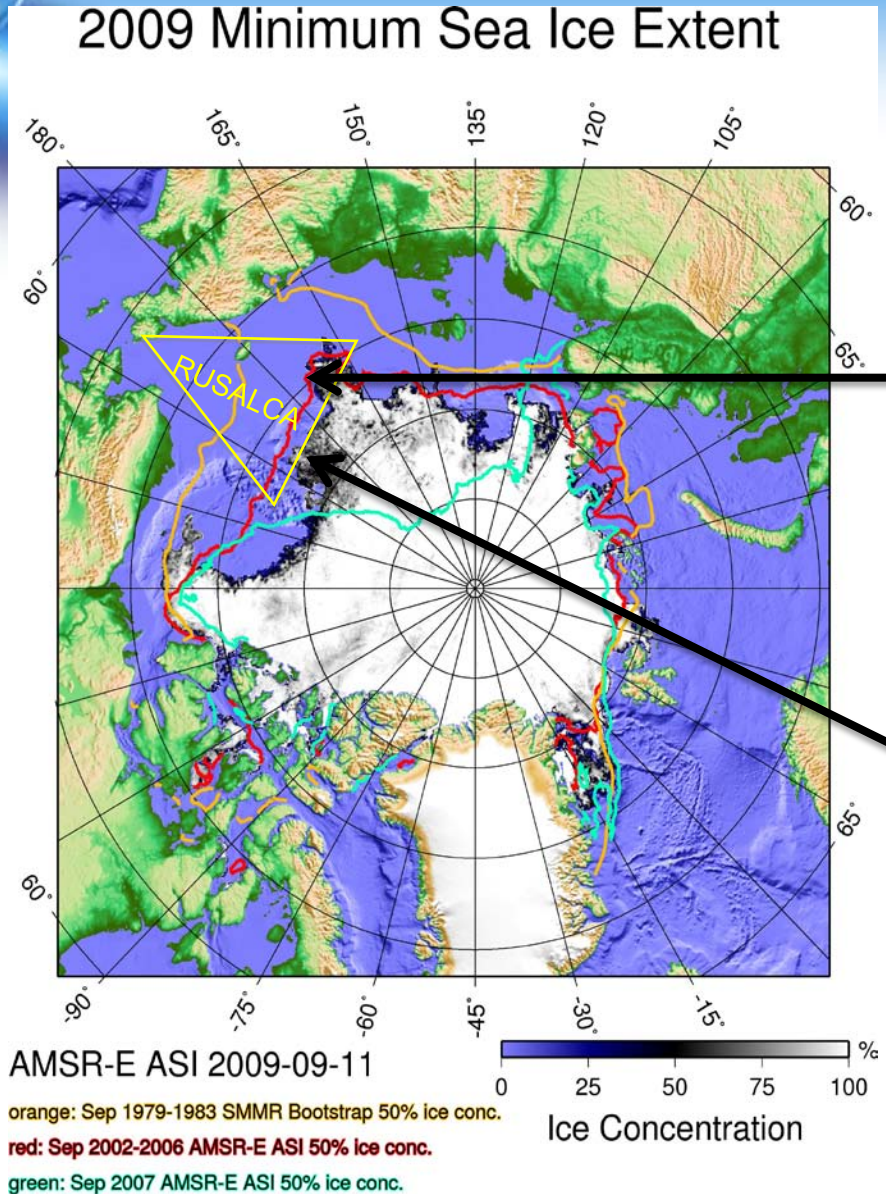
# Research Directions

- 12 research proposals funded 2004 - 2013 RUSALCA.
- Bering Strait Mooring Observatory, AARI, UW, UAF
  - Physical and chemical oceanography, AARI,UAF, UW, WHOI
  - Observations of Seafloor fluxes, Carbon, CH4,etc. VNIIOkeangeoloiga, Institute of Microbiology, Bermuda Bio. Obs, UMD
  - Observations of Atmospheric fluxes and contaminants
  - Seafloor mapping and paleoceanography: POI, VNIIOkeangeologia
  - Benthic ecosystems observations, UAF, ZIN, UMD
  - Water column observations of biota, RAS Shirshov, UAF, WHOI
  - Nutrients and Productivity, KOPRI, UAF
  - Fish ecosystems: UAF, Pt. Stephens, NOAA, ZIN
  - Ice biology: UAF,Chinare?

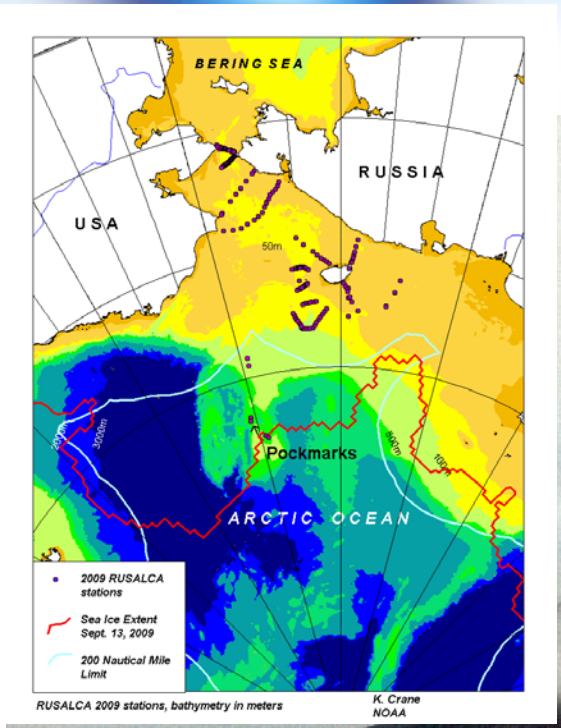
(RUSALCA focal observing Regions)



# Recent Changes in the Arctic Ocean Sea Ice Cover, 2009: RUSALCA Region of Study



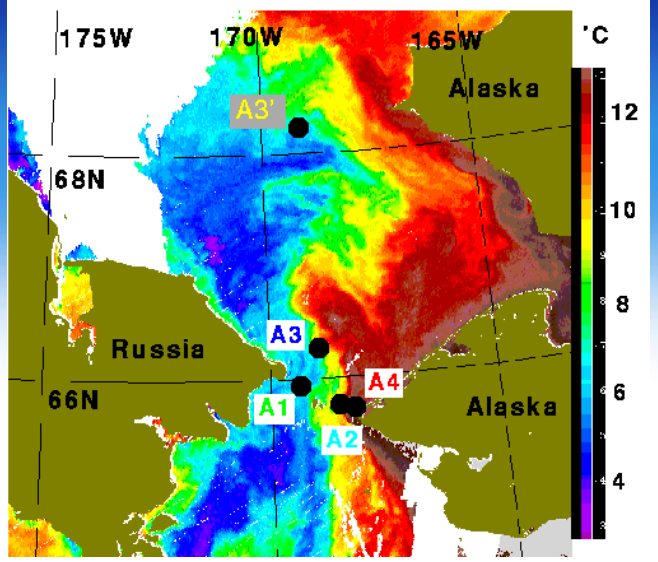

# RUSALCA 2009

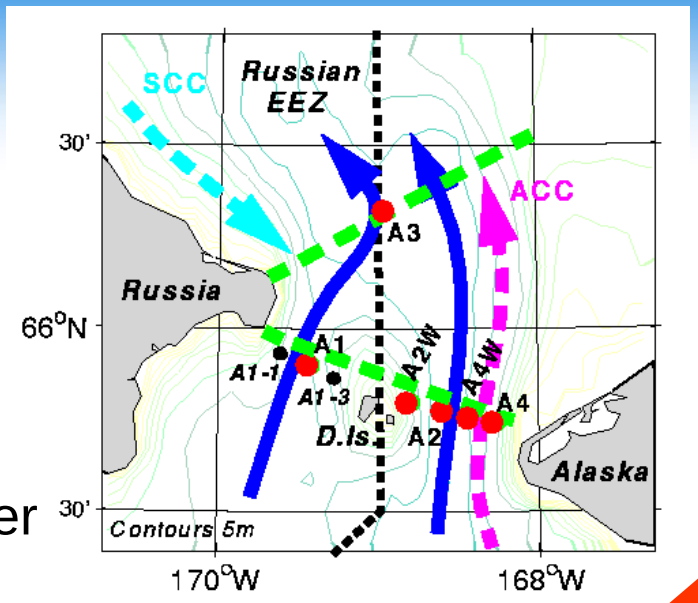


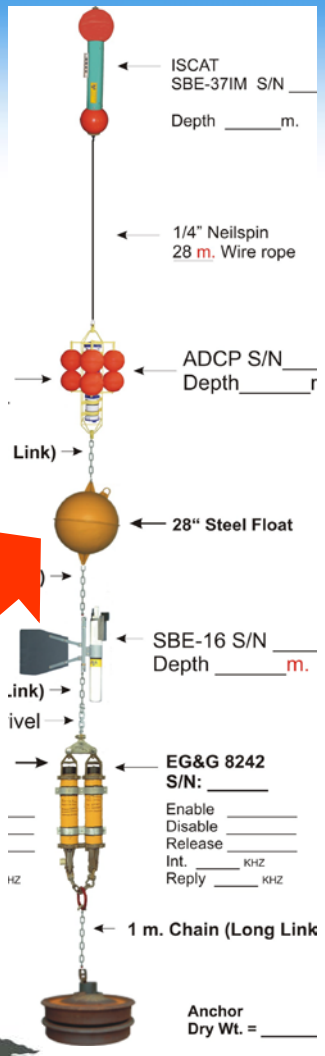


- Took the furthest north trawl in the Pacific Arctic
- More than 300 km north of the ice line in 2004
- Moved to the East Siberian Sea.

# Bering Strait Moorings




Since 2007

*(International Polar Year)*

8 moorings with upper and lower sensors

Bering Strait flow could melt 0.6- 2 million square km of 1m thick ice

Your instrument here!!!!

Now also with

- Whale Recorders – Kate Stafford and Carter Esch
- pH and pCO2 sensors – coming 2011, Kelly Falkner

Annual CTD sections

RUSALCA

# Ice Edge reflects flow Pathways

Flow carries
- ice?
- heat from the Strait
- local heat

TRIGGER for
sea-ice retreat

Also:

1) can't hide mass

*.. strong Bering Strait flow*

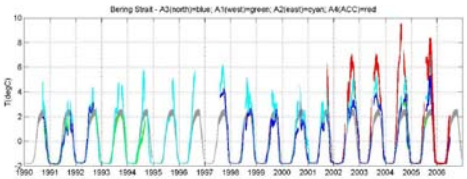
*= strong outflow to Arctic proper*

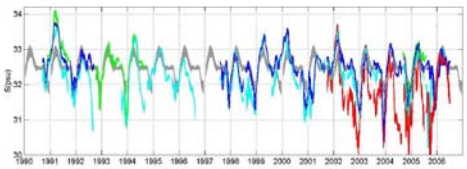
2) Time to Transit Chukchi

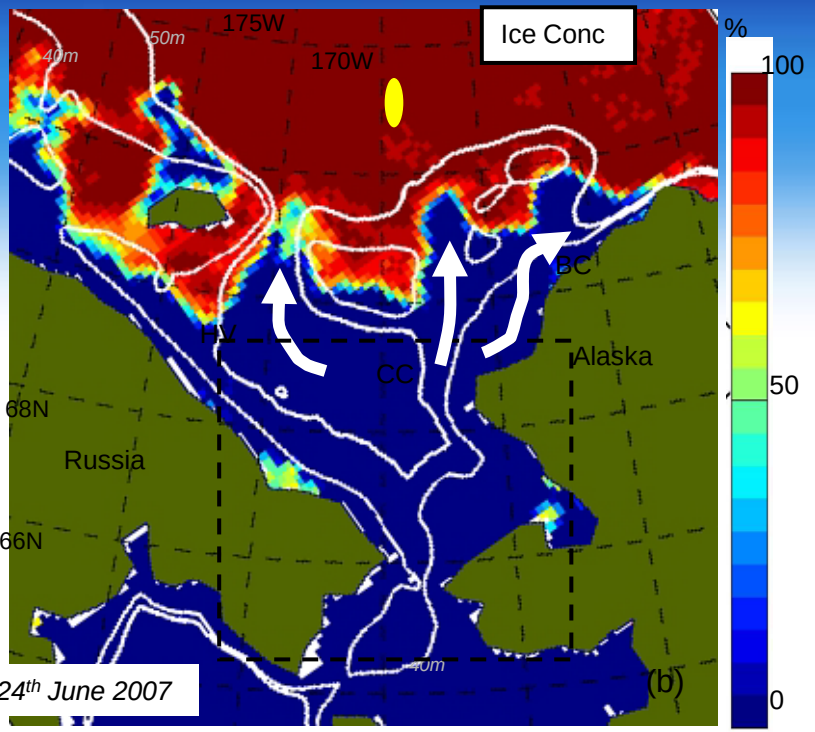
*... many months, and changes*

*... (0.6 Sv ~ 9 months; 1 Sv ~ 5.5 months)*

•3) Supply to Arctic








*Woodgate et al, 2010*

Implicated in the seasonal melt-back of ice

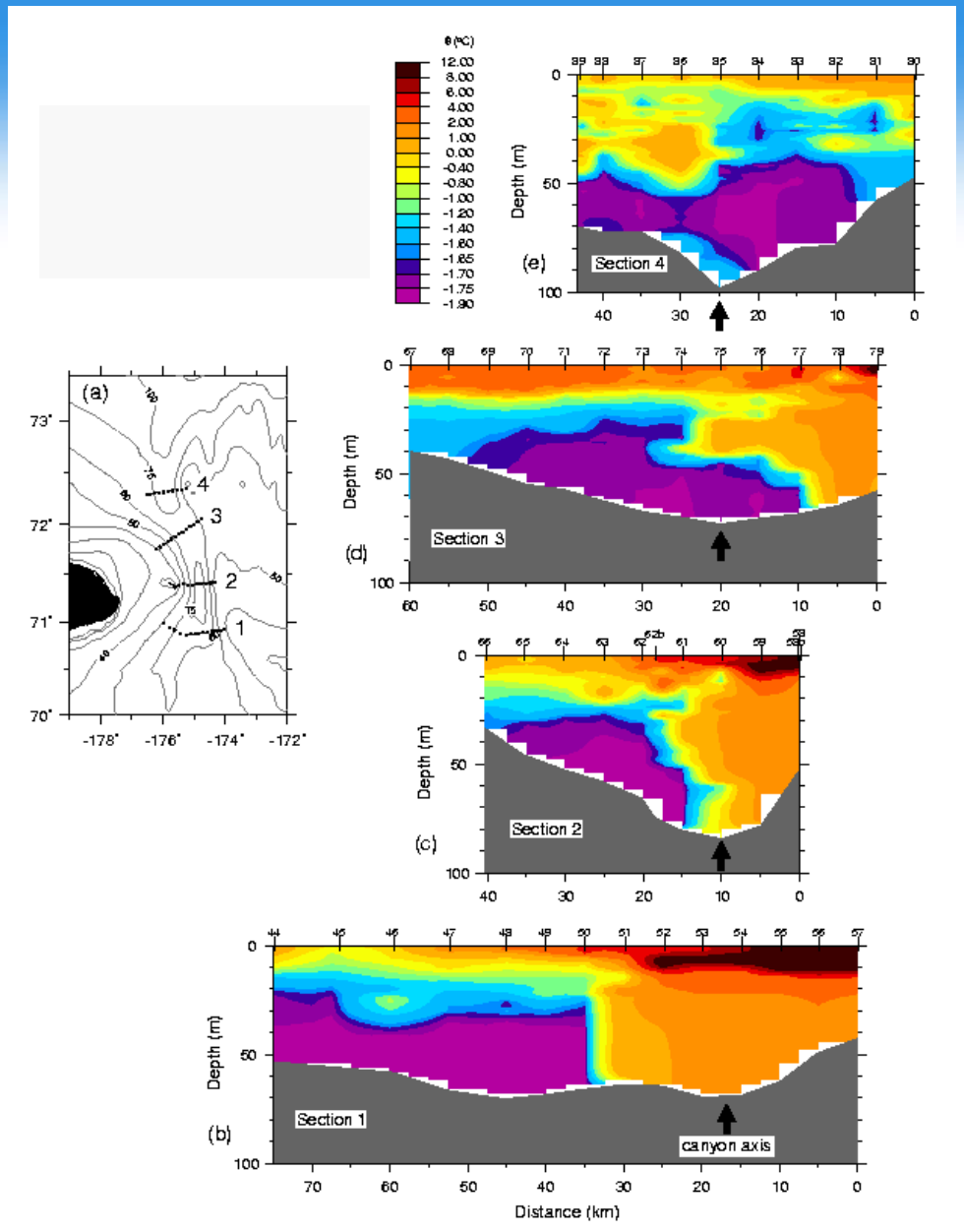
*In summer, source of near-surface heat to the Arctic*

*(Paquette & Bourke, 1981; Ahlnäs & Garrison, 1984)*

Bering Strait ~ 2-6 $10^{20}$ J/Y

Bering Strait flow could melt 0.6-2 million square km of 1m thick ice

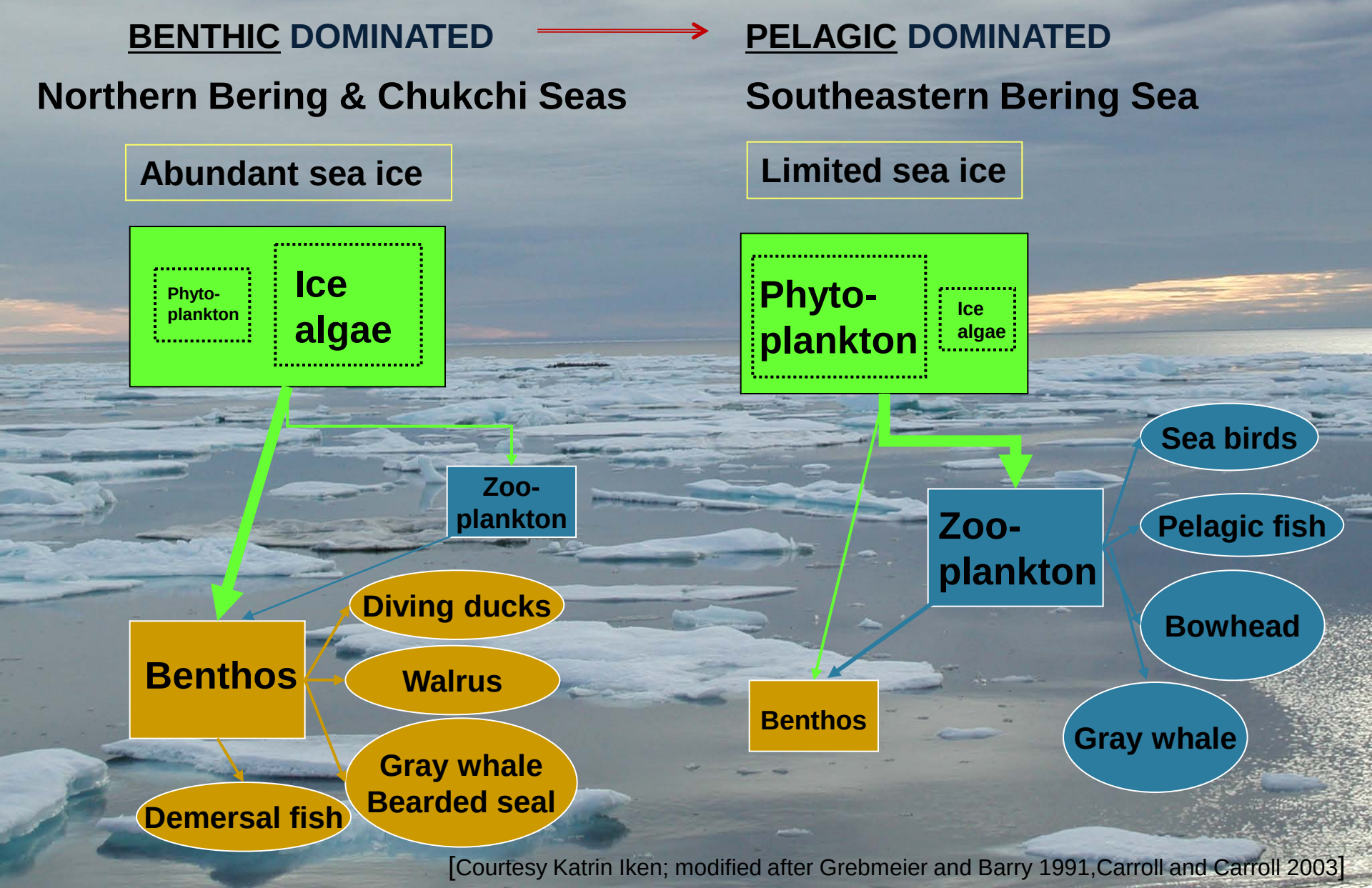
## Potential temperature (ºC, color)




# Evolution of flow through Herald Canyon August 2004

R. Pickart, WHOI

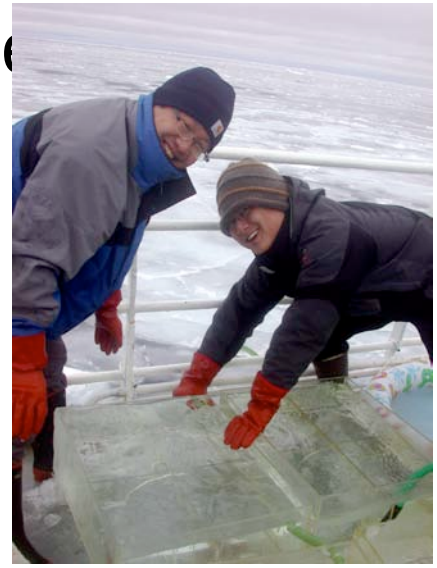
# Linking Ice Cover to Ecosystem Structure the 'Conceptual Model'




[Courtesy Katrin Iken; modified after Grebmeier and Barry 1991,Carroll and Carroll 2003]

# Changes in Nutrients and Productivity

- Quantify the range of nutrients, phytoplankton biomass and productivity in water masses
- Establish physical and chemical factors that are conducive to large rates of primary production
- Compare contemporary rates under warm conditions with those from the pr decade
- 8 productivity bottle experiments
- 49 stations



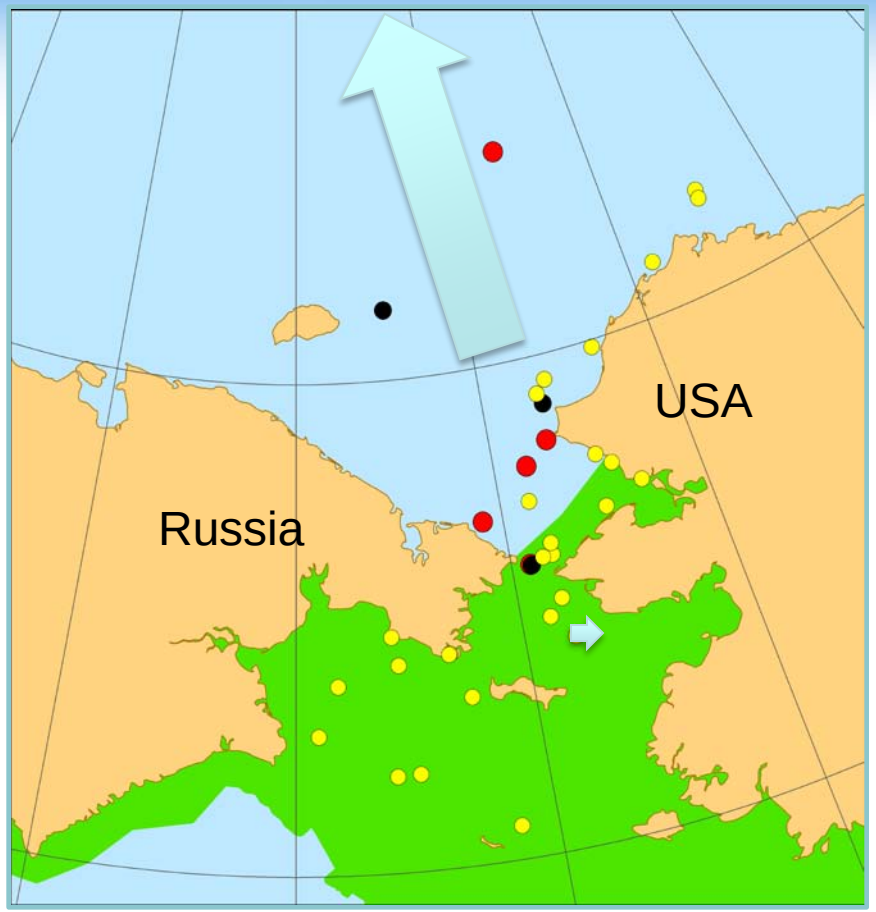
P.I.'s Terry Whitledge, Sang Lee, Hyoung Min Joo and Mike Kong

*Photo courtesy of RAS-NOAA, RUSALCA 2009*

# RUSALCA

**Role of Warming Pacific – Bering Strait Water on The Northward migration of the Walleye Pollock 2004-2009**

**Walleye Pollock**
***Gaddus chalcogramma***



# *Lycodes adolfi*
## Adolf's Eelpout

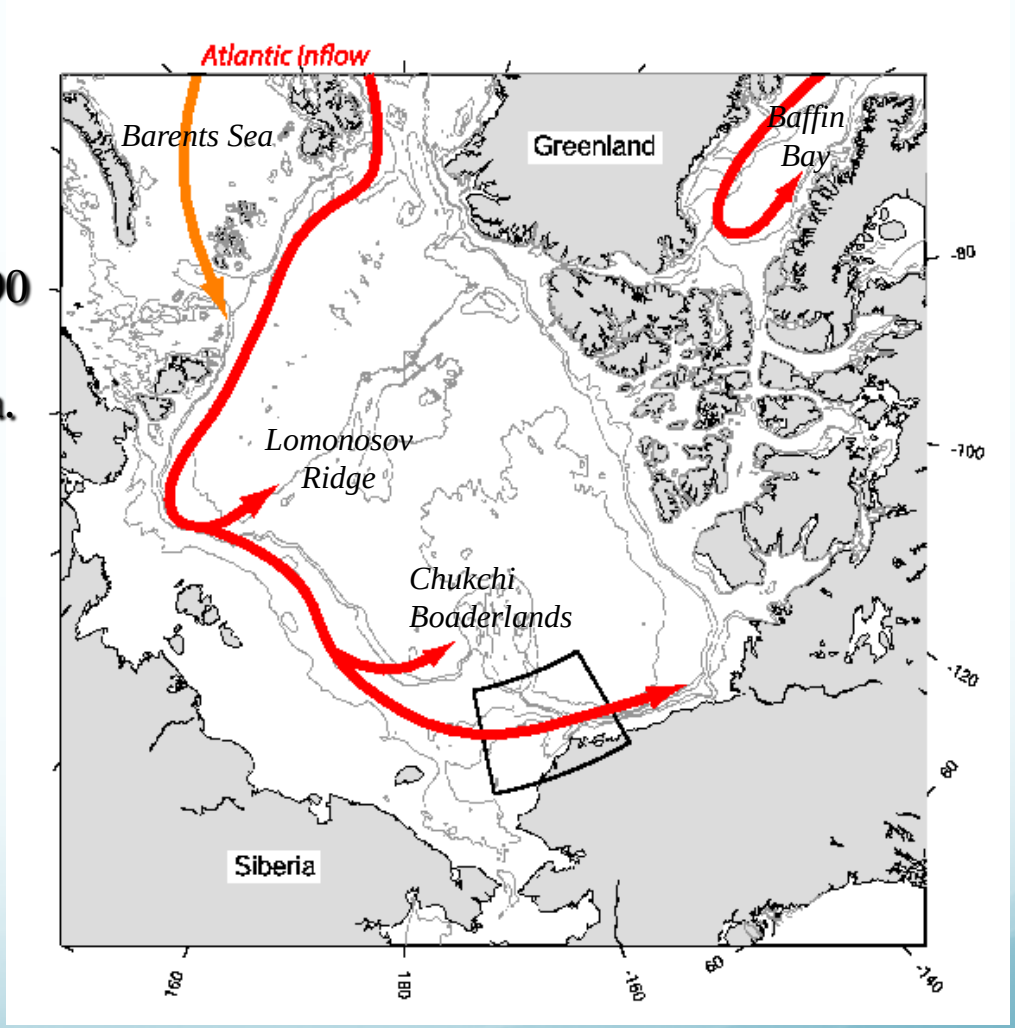
### Nielsen & Fosså 1993

Found north of Spitsbergen on east side of Yermak Plateau in 2007–2009 (Byrkjedal In press), indicating distribution probably extends eastward along the upper slope of Nansen Basin (and thence to the Pacific-Arctic, where we caught it)

RUSALCA 2009
Chukchi Cap →

# Role of Atlantic Water Transport and Warming on the Migration of Atlantic Arctic Fish into the Pacific Arctic

- Warming of AW inflow since 1980.
- Two pronounced pulses: one around 1990 and the other around 2000, tracked by hydrographic sections and mooring data.

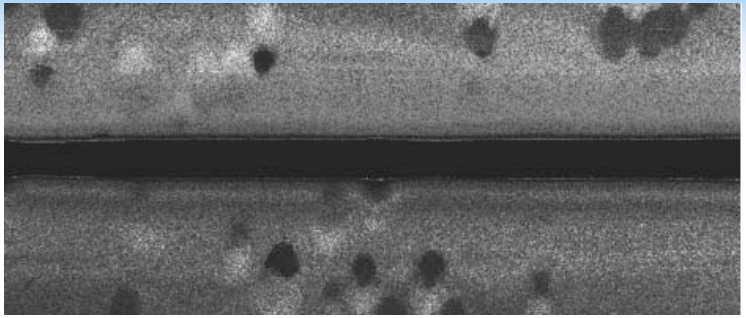



Pickart, 2010

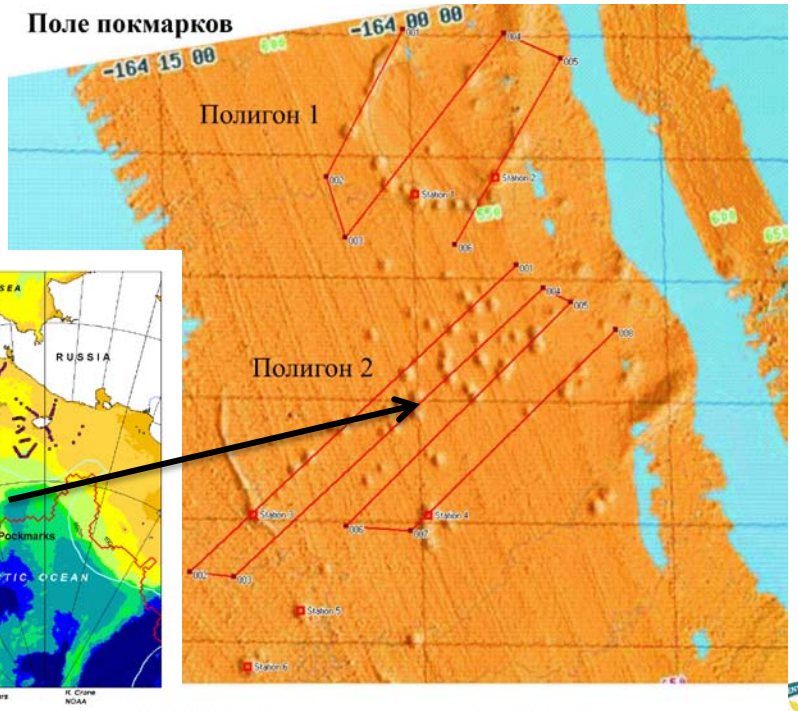
# PACIFIC-ARCTIC SEAFLOOR FLUX OBSERVATIONS :

Tatiana Matveeva and Liza Logvina P.Is

- Objective is to determine the magnitude and distribution of the flux of methane from submarine permafrost and other regions into the Arctic Ocean
- Instrumentation is supplied from VNIIOkeangeologia, Russia,: A SONIC deep-water side-looking sonar 30Khz and sub-bottom profiler were used for the investigations.
- Investigations took place along the Herald Canyon and above a pockmark field located on the Chukchi Plateau. To date, no evidence of present day methane fluxes have been located

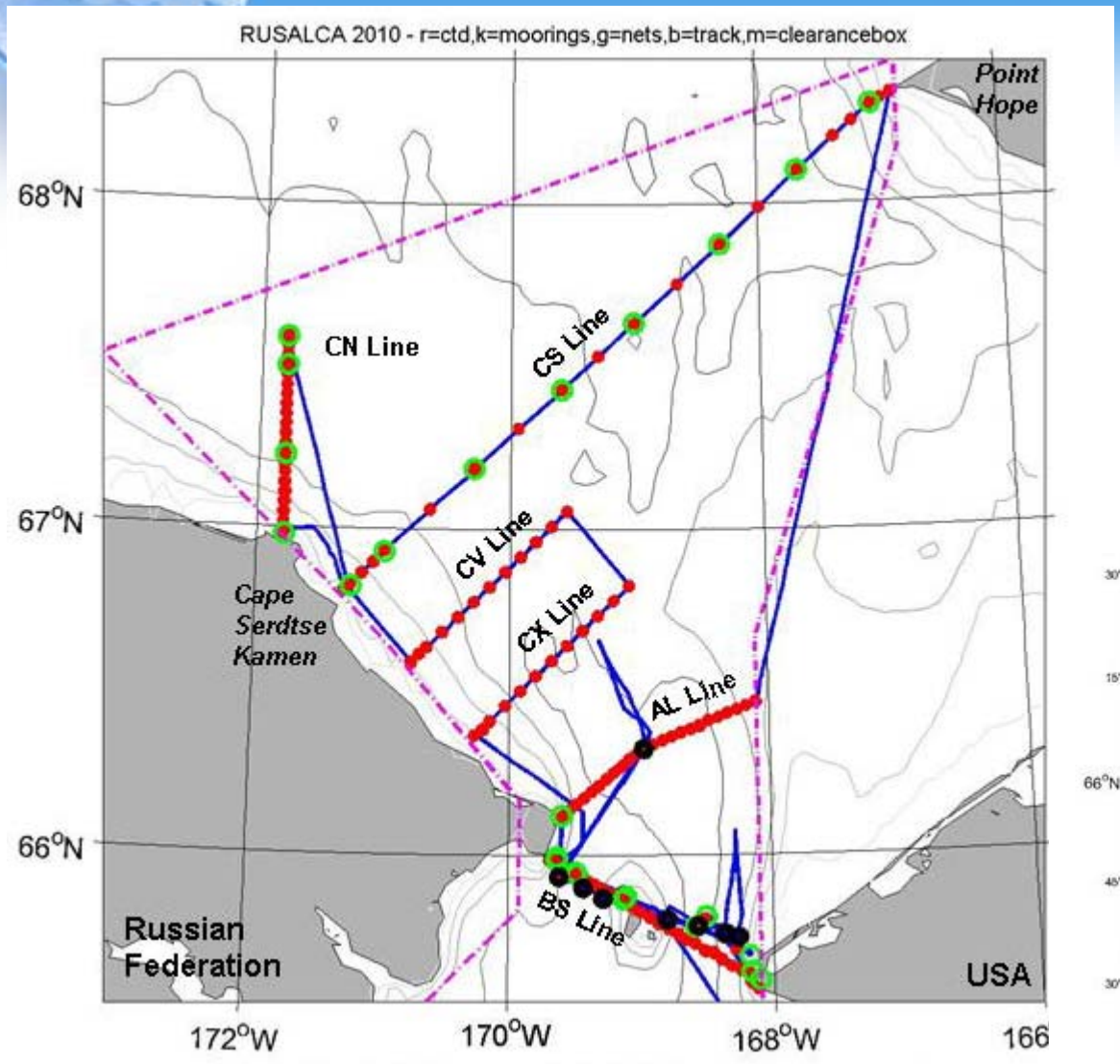


*Multibeam sonar map from Healy, 2003, 76.5°N*

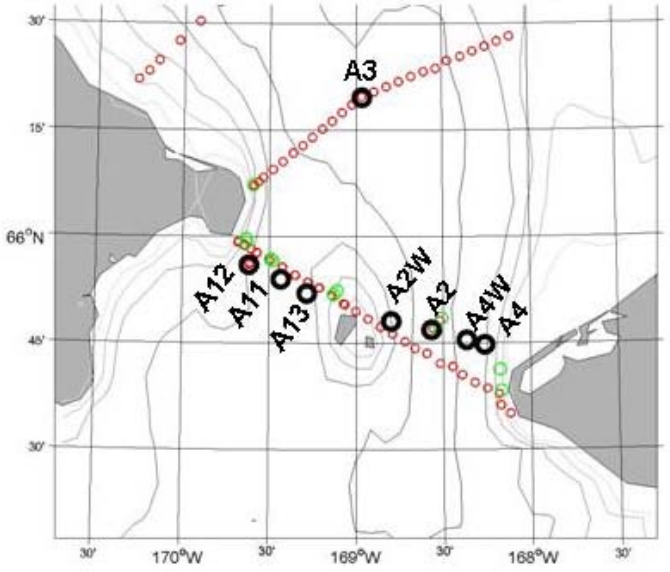


# RUSALCA 2010

31st July – 11th Aug 2010
Nome to Nome

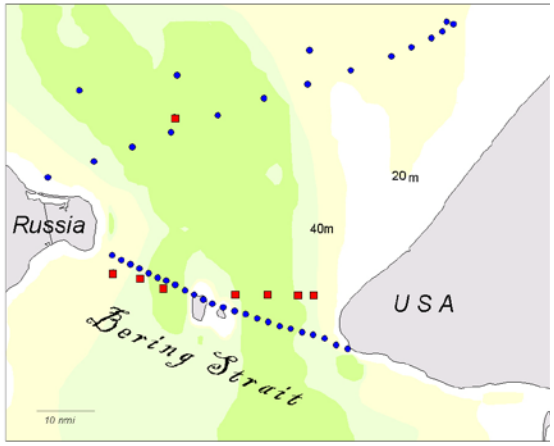



*Mauve = clearance box*
*Blue = ship track*
*Black dots = moorings*
*Red dots = CTDS*
*Green dots = nets*
*+ 4 Primary productivity stations*

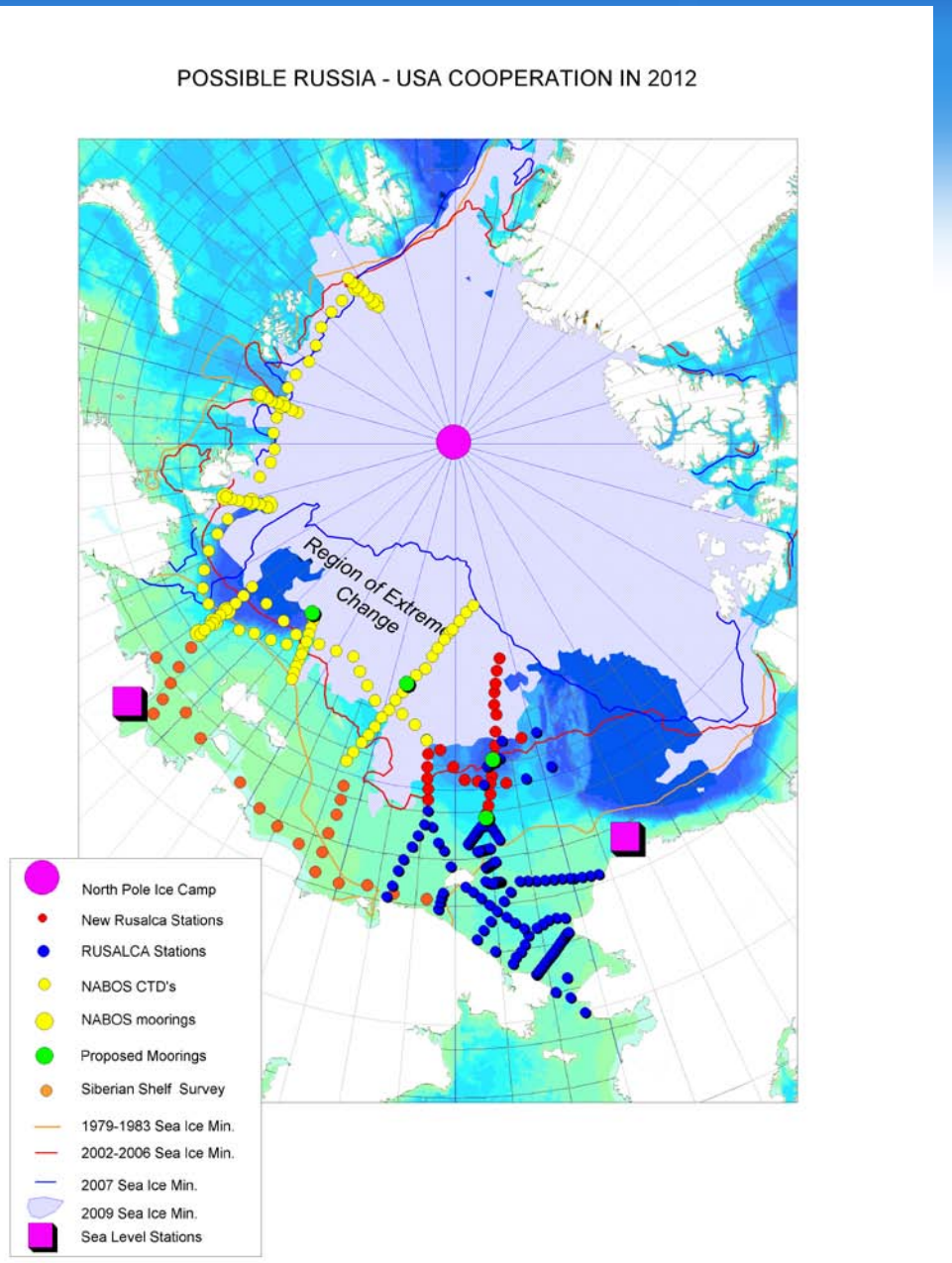


# FUTURE PRIORITY : Causes and Consequences of Sea Ice Loss

**Pacific and Atlantic Water Confluence And effects On Ecosystems**

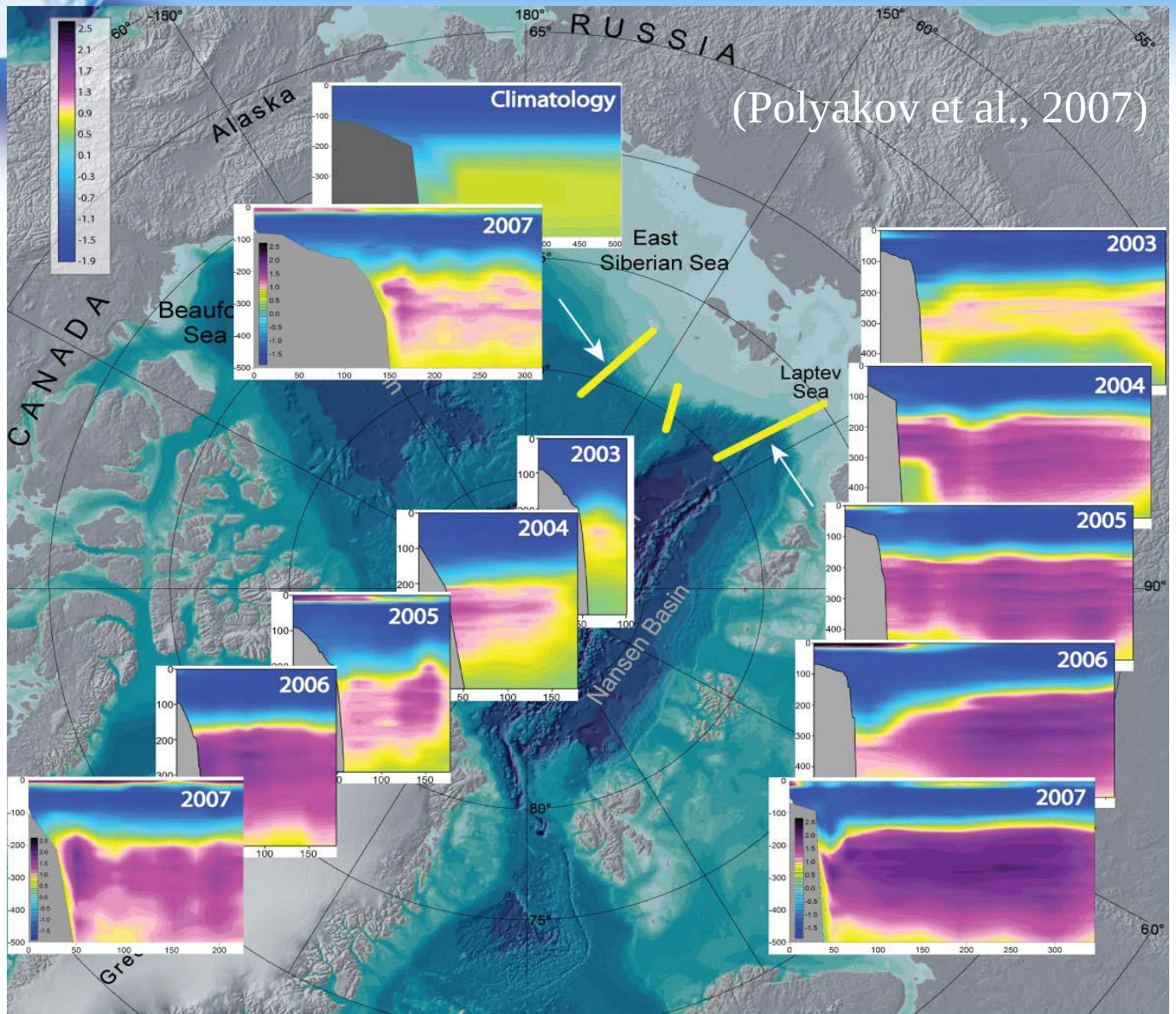



Proposed 2012 Observations



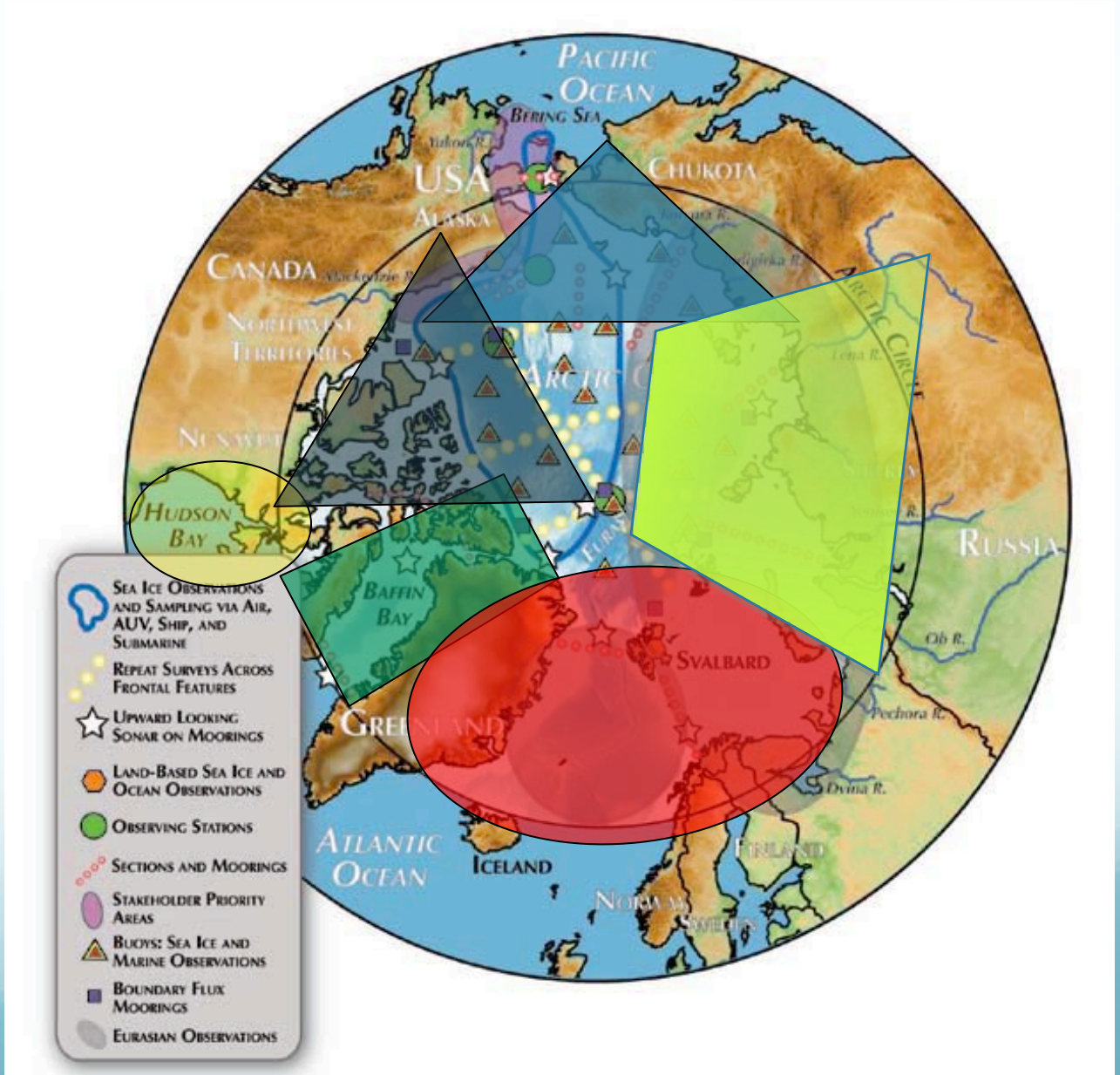
*THANK YOU*

# Atlantic Water is moving towards Alaska. There is a need to monitor this region.



# Arctic Marine Biodiversity Monitoring

NOAA is co-leading an Arctic Council (CAFF) effort to monitor Arctic Marine Biodiversity Change. These data will contributed to the **Sustained Arctic Observing Network (SAON)**




| Vessel | Country | PI |
|---|---|---|
| *Moana Wave* | USA | Grebmeier |
| NMML/TBD | USA | Berchok, Stabeno Weingartner |
| *Aaron* | Korea | Lee |
| *Xue Long* | China | Zhao |
| *Mirai* | Japan | Itoh |
| *Laurier* | Canada | Fudge |
| *ST Laurent* | Canada | Carmack |
| *Healy* | USA | Arrigo |
| *Healy* | USA | Pickart |
| *Annika Marie* | USA | Ashjian |
| *Khromov* | USA–Russia | RUSALCA |

## Example: *Laurier* Cruise

**Grebmeier/Fudge: 6-21 July 2010**

## DBO 2010 'Pilot'Season:

**Cruises to DBO regions, 2010**

http://pag.arcticportal.org

SAON
SUSTAINING ARCTIC OBSERVING NETWORKS

CIRCUMPOLAR BIODIVERSITY MONITORING PROGRAM

The DBO, the Arctic Marine Biodiversity Monitoring Program and the Russian-American coordinated physical-biological oceanographic monitoring will depend on international cooperation to provide sustained and coordinated sampling.

It is envisioned that data will be made available either through the CBMP or directly to the Sustaining Arctic Observing Network (SAON)

IASC

ARCTIC COUNCIL

WMO

INTERNATIONAL POLAR YEAR 2007-2008

*www.arcticobserving.org*

# "Vision" for Distributed Biological Observatory

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)

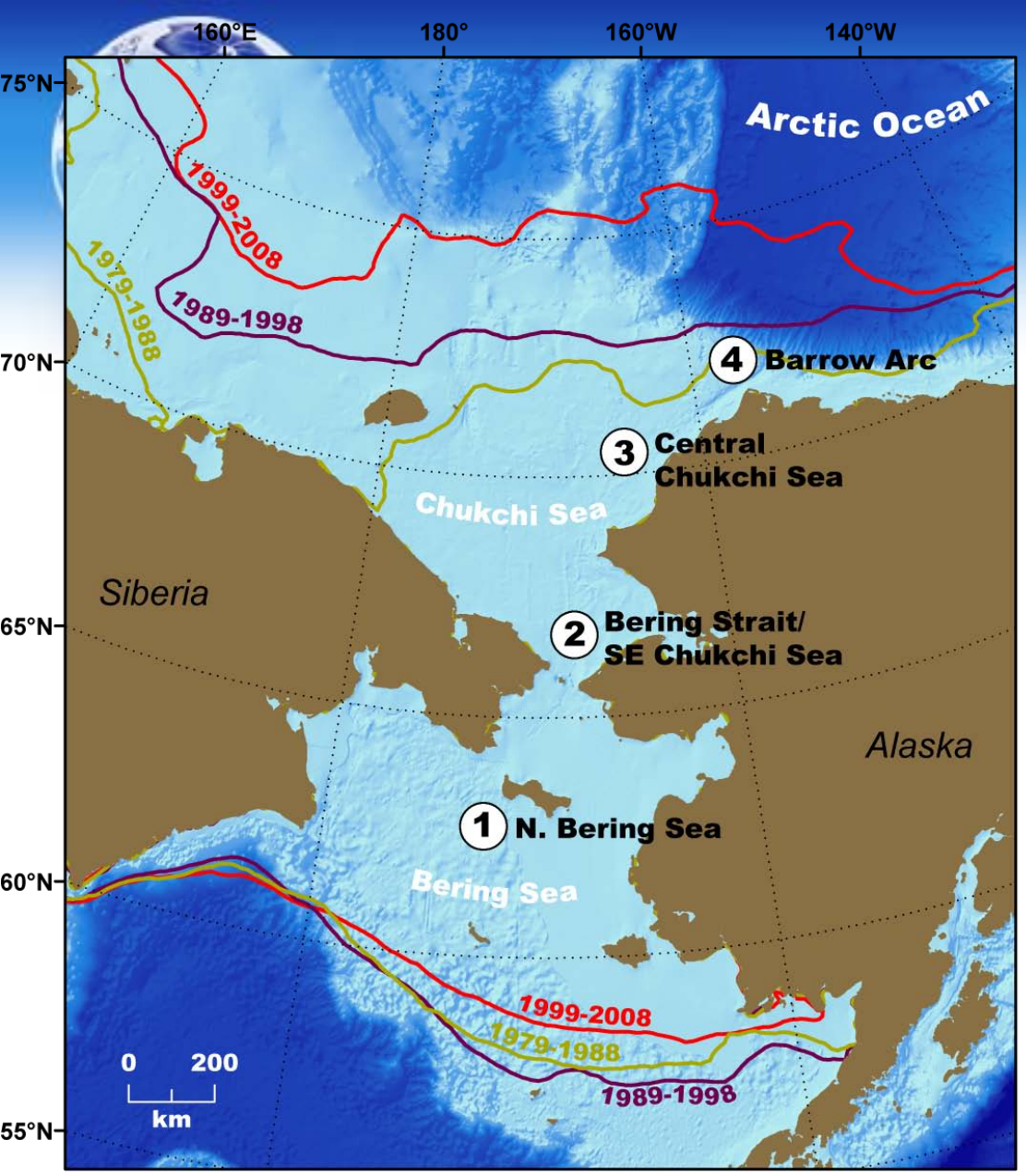
"Change detection array" – same measurements every year, process information in near real time <6 mos; detect regime shifts in rapid changes

Second tier ship-based sampling:

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

Additional leveraged programs both domestic and international

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

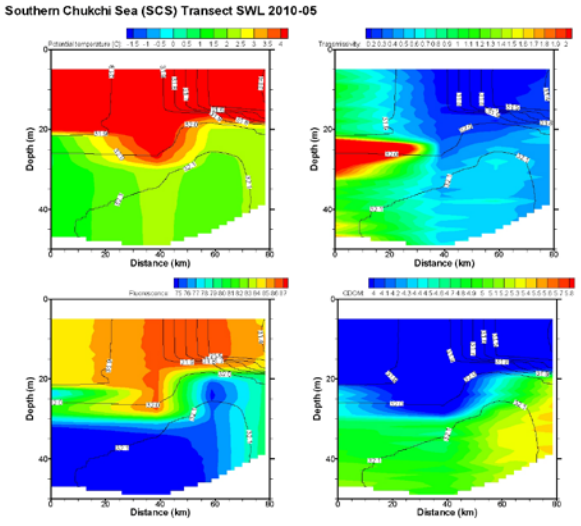


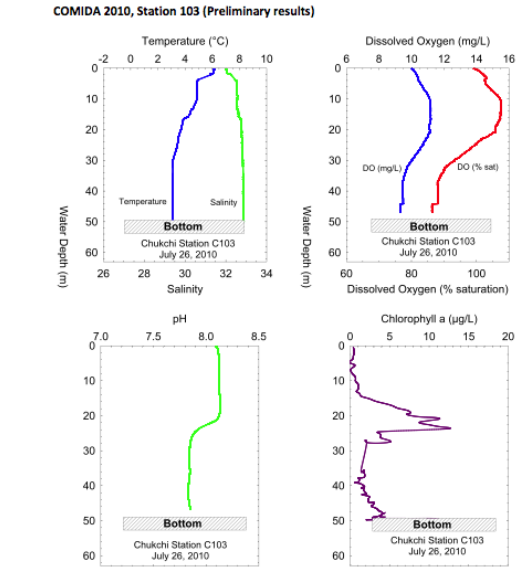

[map courtesy Karen Frey; further details see Grebmeier et al. 2010, EOS 91(18):161-162]

- **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**

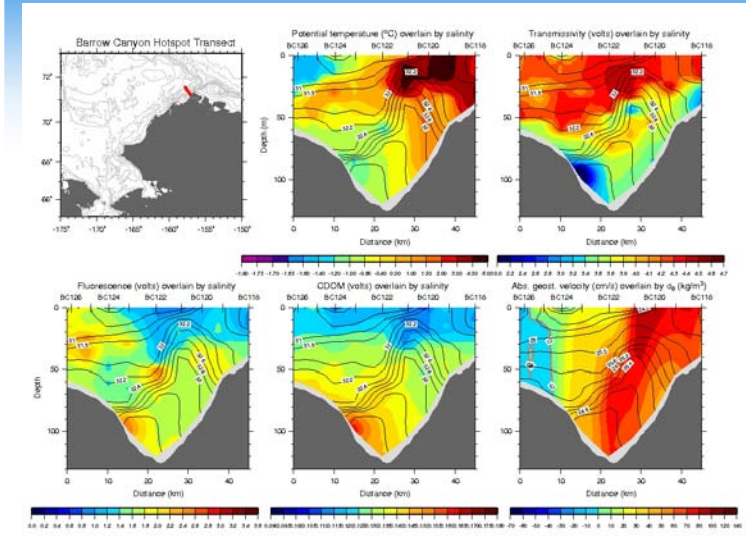
# Examples of DBO Hydrographic Data 2010

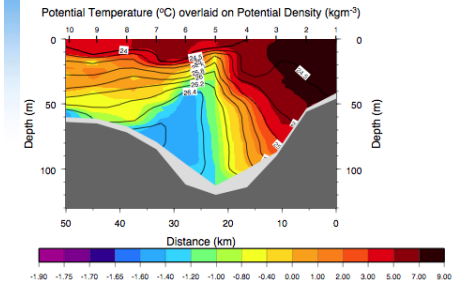
## SE Chukchi Sea

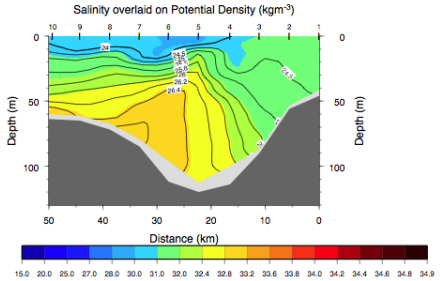


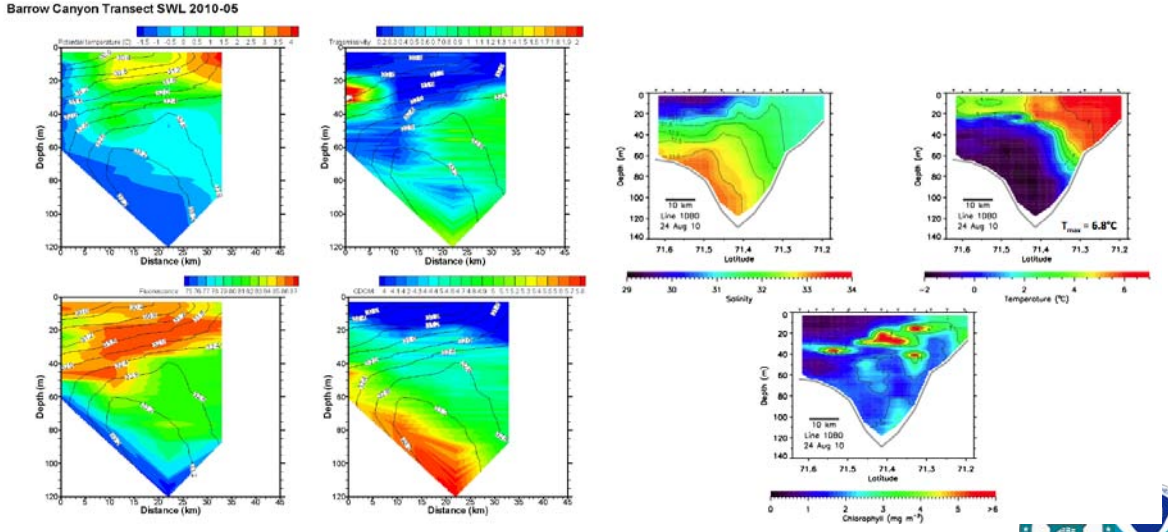




## Barrow Canyon

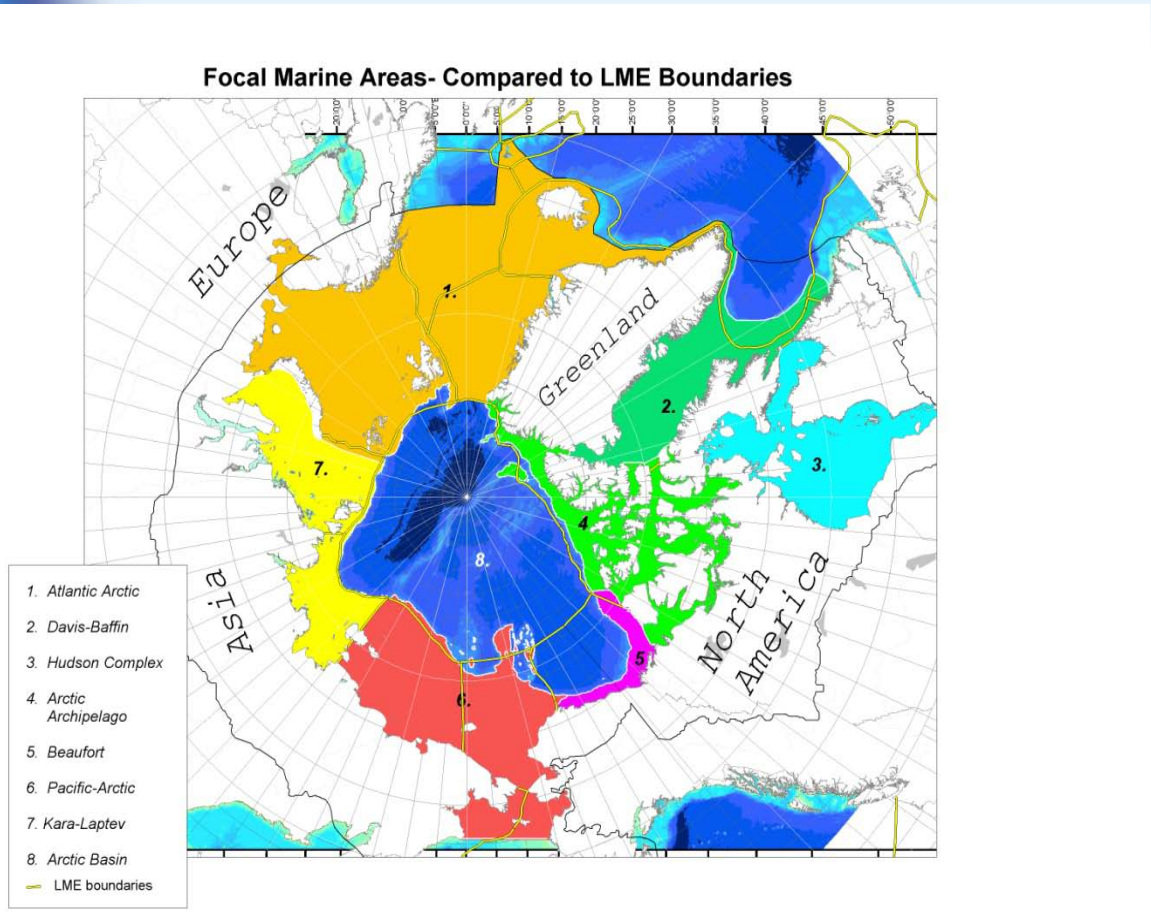


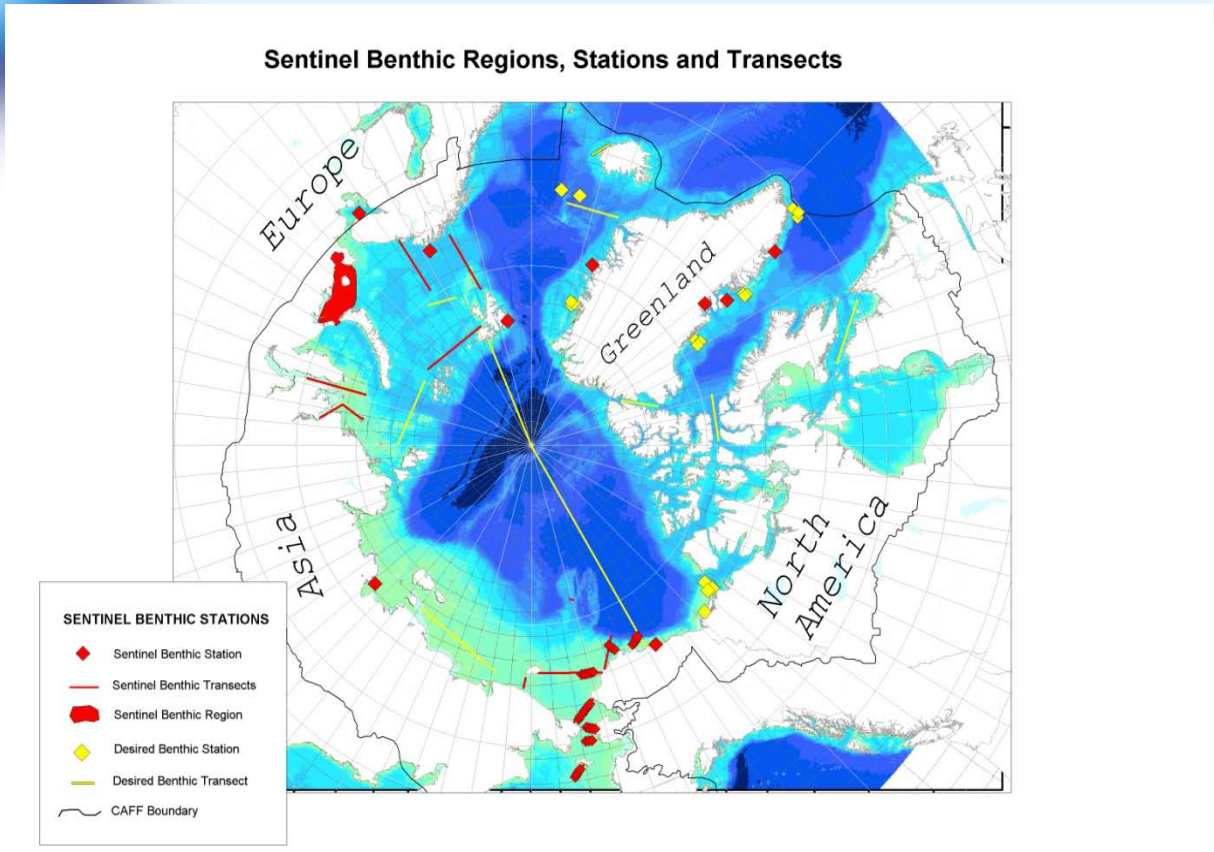



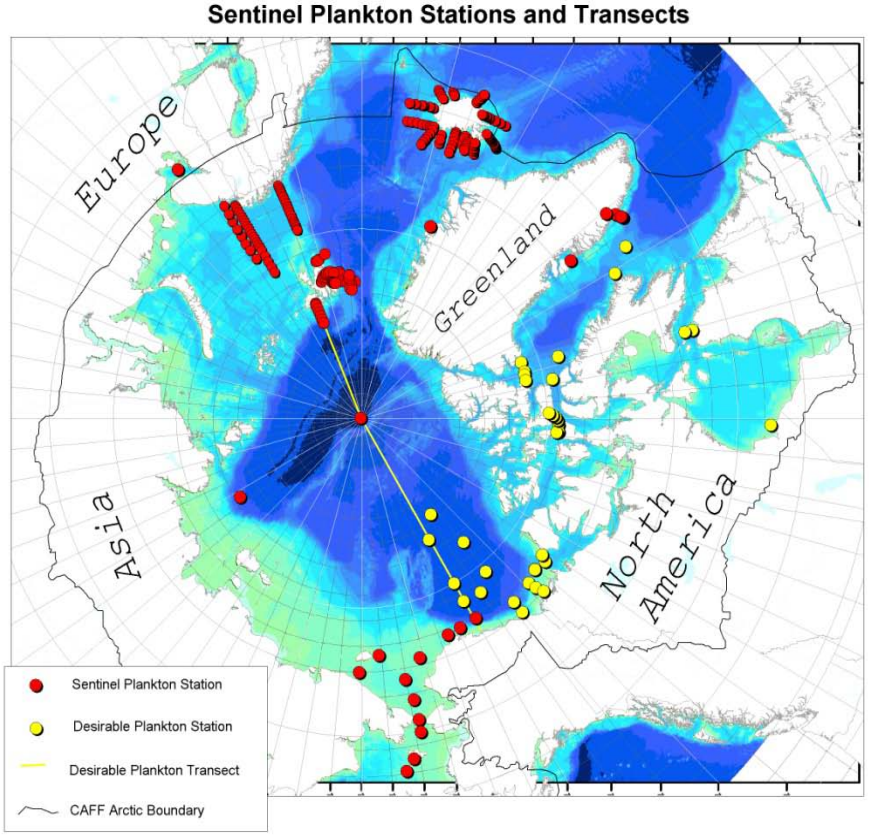
# AMA's and LME's



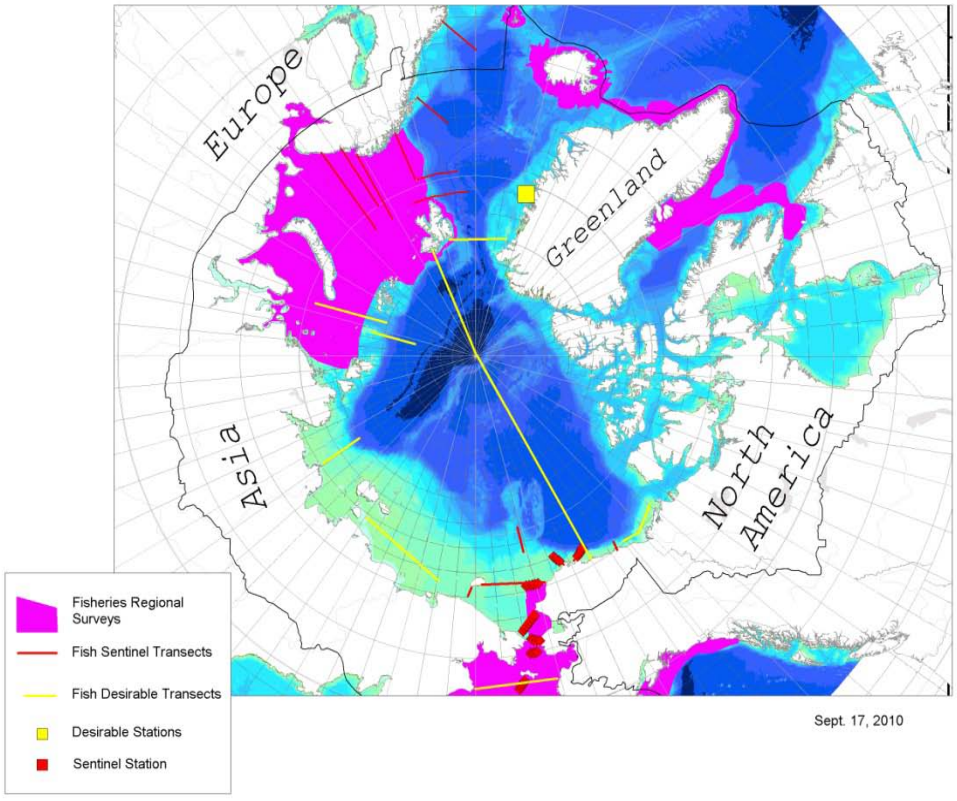
# Benthic Sentinel Stations



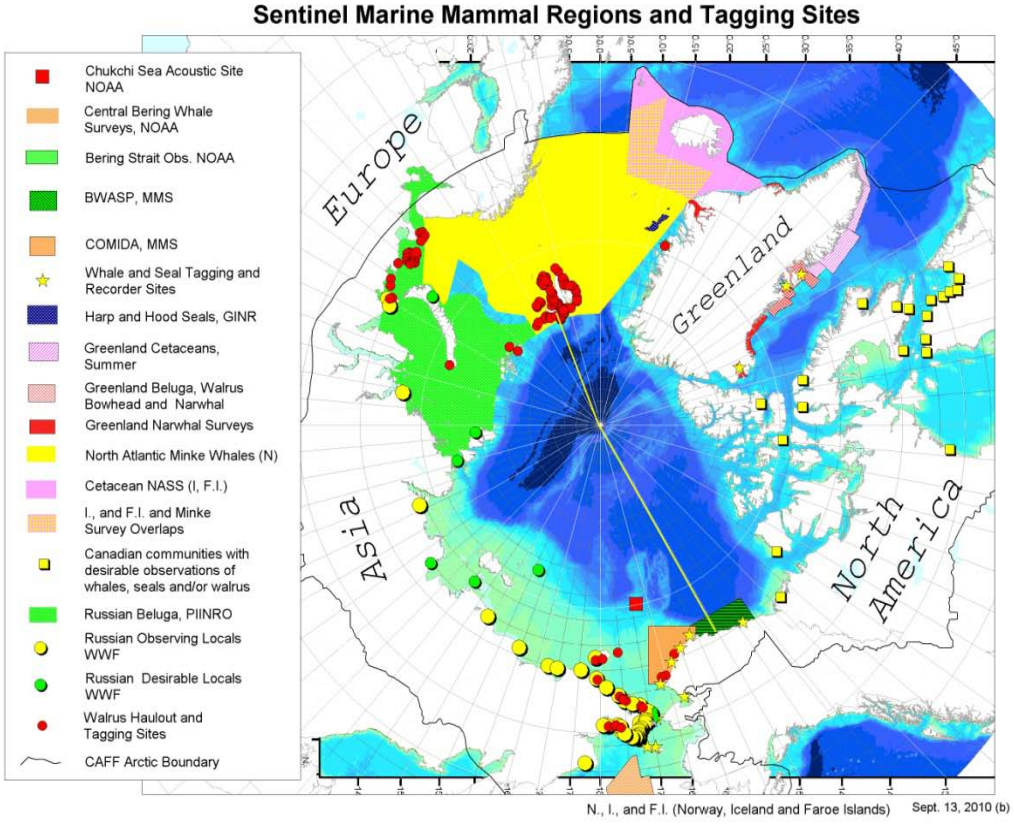
# Plankton Sentinel Stations



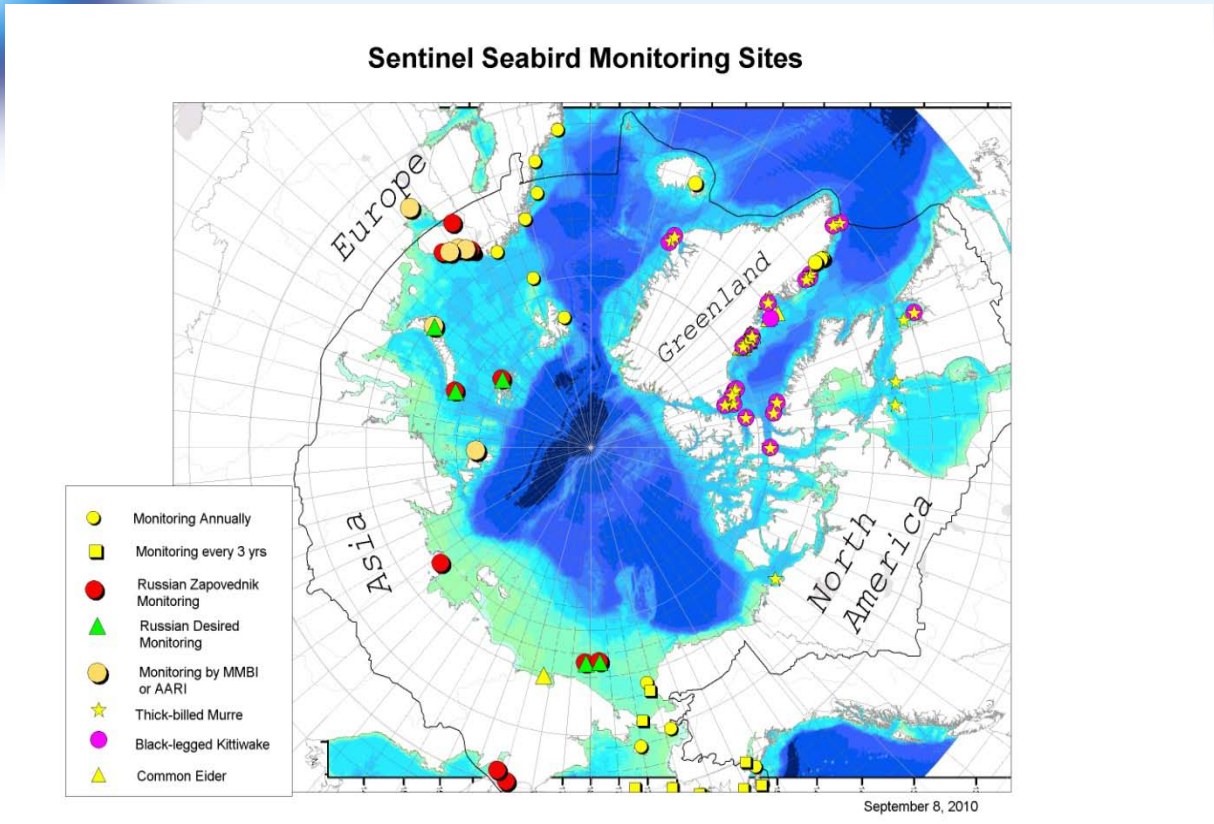
# Fish Sentinel Stations



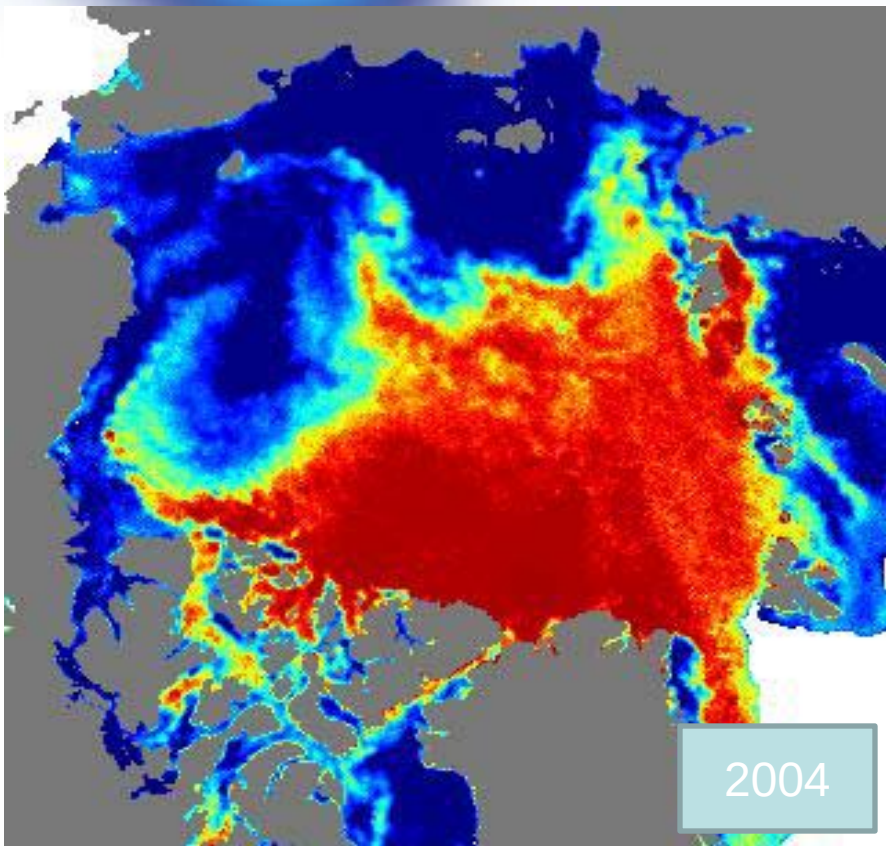
# Marine Mammal Sentinels

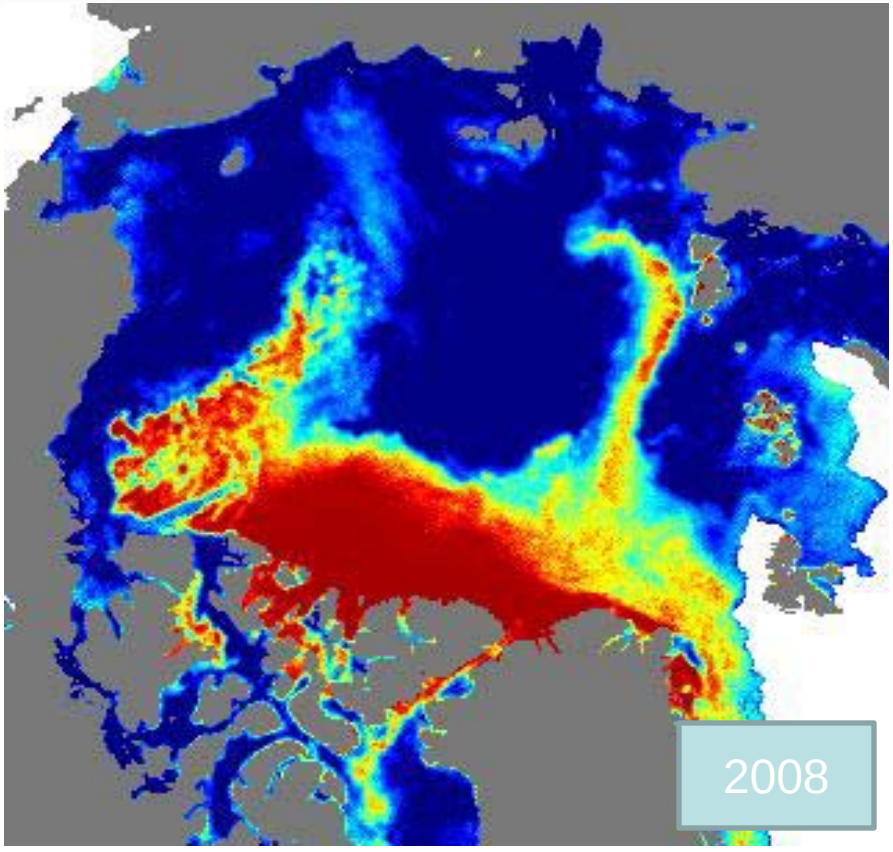


# Seabird Sentinel Stations



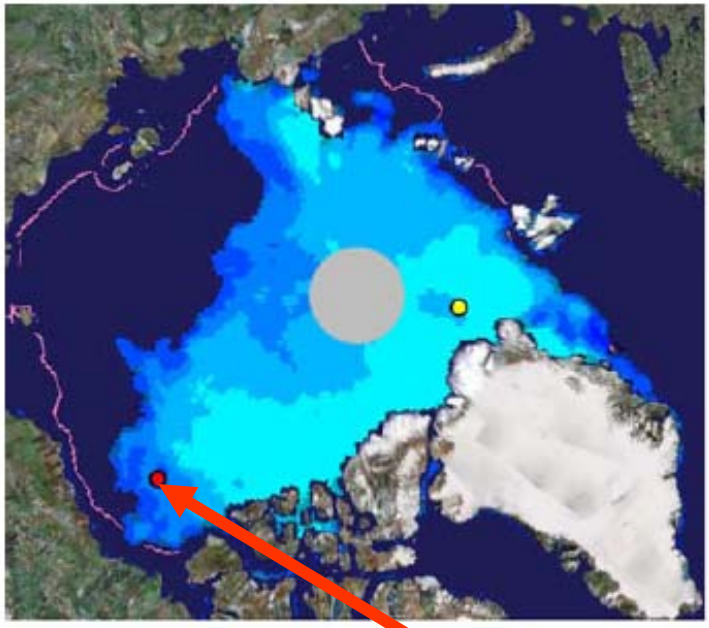
# 42 % Loss of Multi-year (thick) Sea Ice between 2004 and 2008

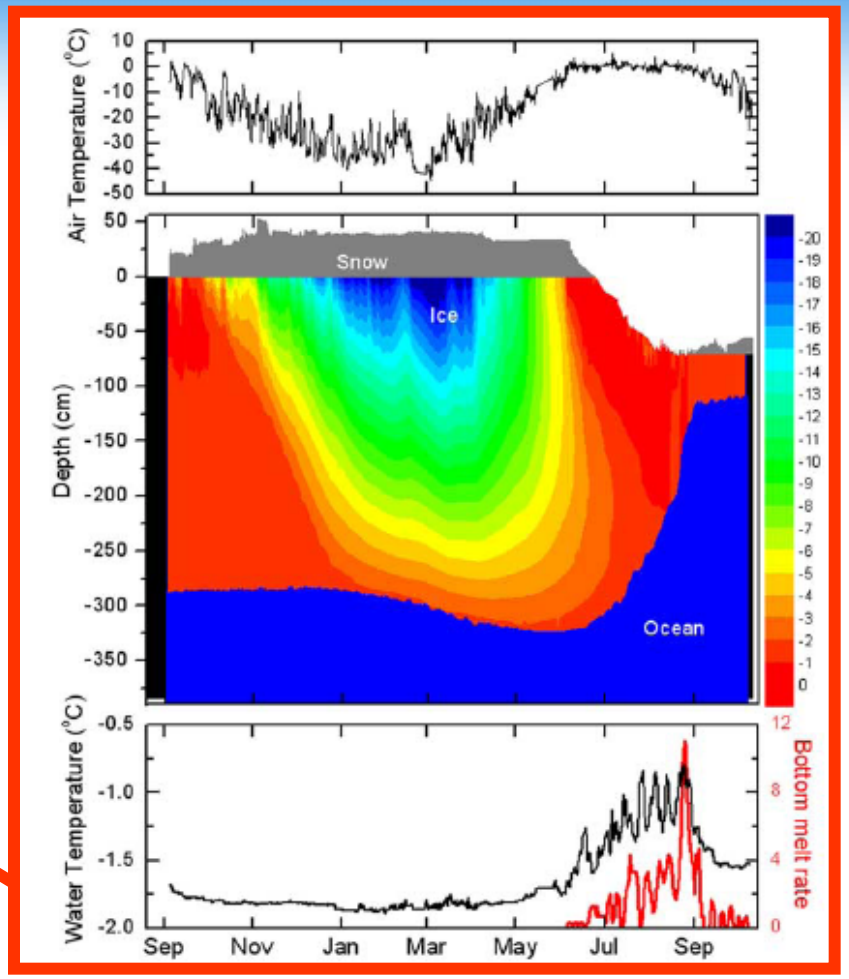



JANUARY Satellite Data (QuickScat) Ron Kwok (JPL; *JGR* 2009)

# Bottom versus Top Melt of Sea Ice



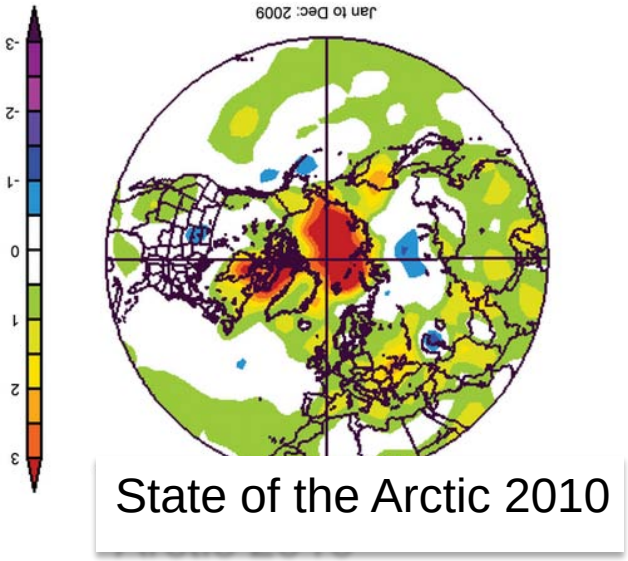



*Perovich et al, GRL, 2008*

**Figure 2.** Time series from August 2006 to October 2007 from the Beaufort Sea ice mass balance buoy. (top) Air temperature. (middle) Internal ice temperature using color contours, with blue being cold and red warm. The gray shaded area represents snow, the black areas represent missing data, and the dark blue represents the ocean. (bottom) Upper ocean temperature near the bottom of the ice (black) and the bottom melt rate (red) in cm per day. Bottom melt rates were smoothed using a three-day running mean.

# INTERNATIONAL ARCTIC SYSTEMS FOR OBSERVING THE ATMOSPHERE (IASOA)

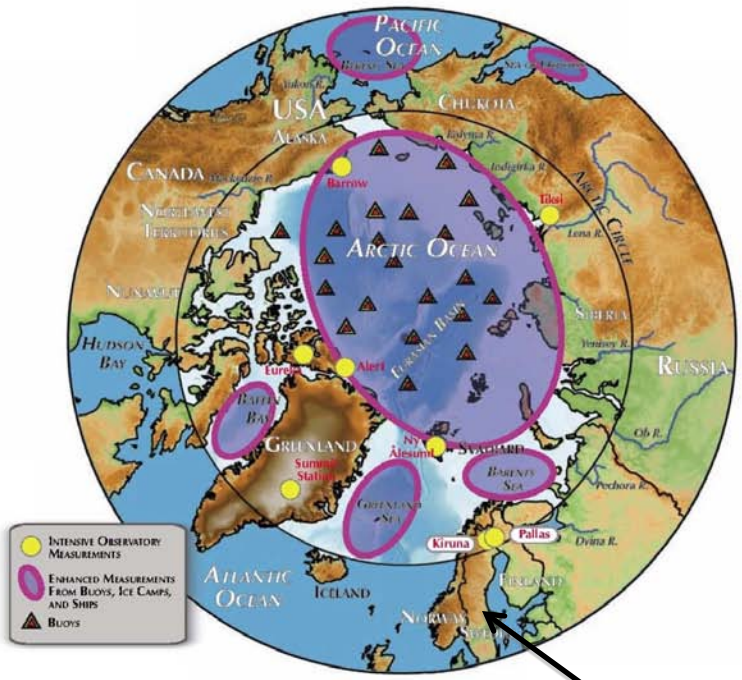
- NOAA-federated network monitors aerosols at Barrow, Alert, and Summit
- NOAA began aerosol measurements atTiksi in 2009
- NOAA coordinates aerosol measurements at Ny-Ålesund and

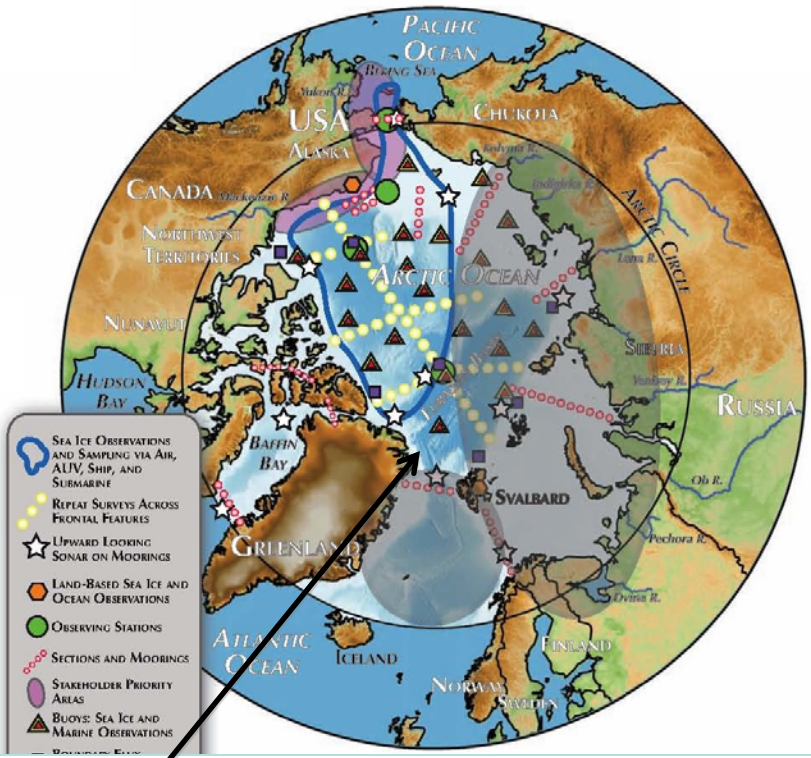



State of the Arctic 2010

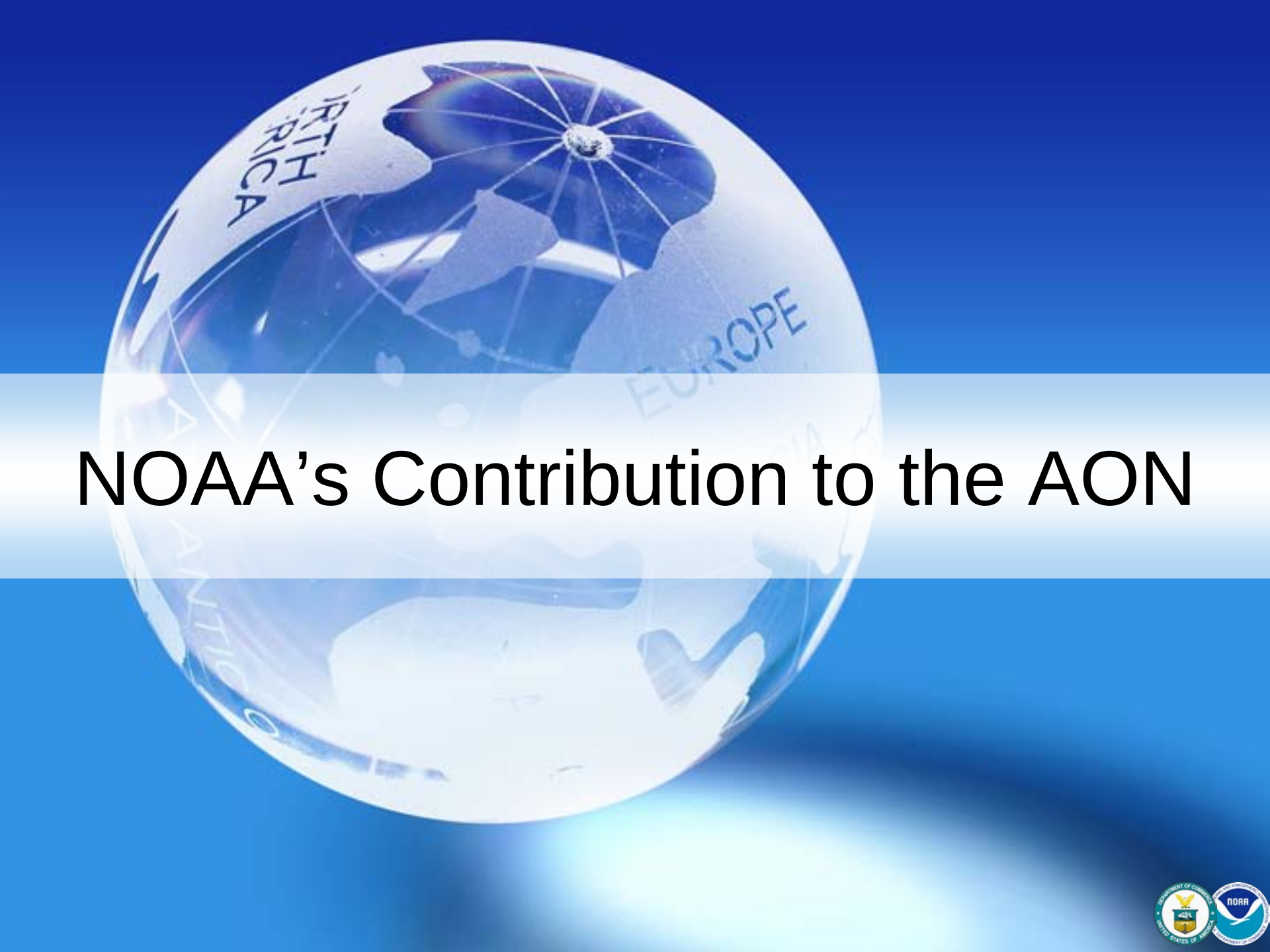
Near-surface (1000 mb) annual air temperature in °C anomalies for 2009 over the northern hemisphere relative to 1968–96 mean according to the NCEP–NCAR reanalysis through the NOAA / Earth Systems Research Laboratory.

# Arctic Observing Network- Pan Arctic Goals



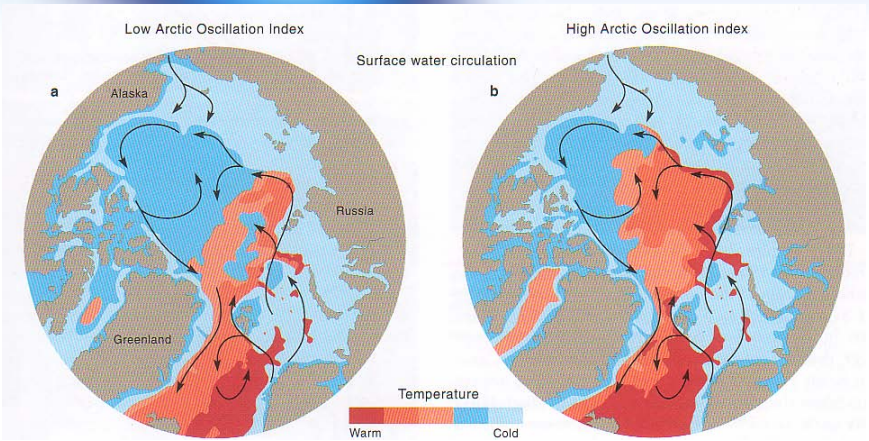




Interagency Plan to build a suite of atmospheric observing tools, and tools
To observe the Arctic Ocean, ice and ecosystems




# NOAA's Contribution to the AON

**Surface air temperature, Atlantic Water and Freshwater trends** for 1979-1998. The warming trends found over land extended over the Arctic Ocean; strongest during spring. Black dots show areas where the trends are significant at the 95% confidence limit. *[Rigor et al. 2000]*




Atlantic Water Influx

Freshwater Changes