NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Highlights from the IPY and Future Arctic Research Directions

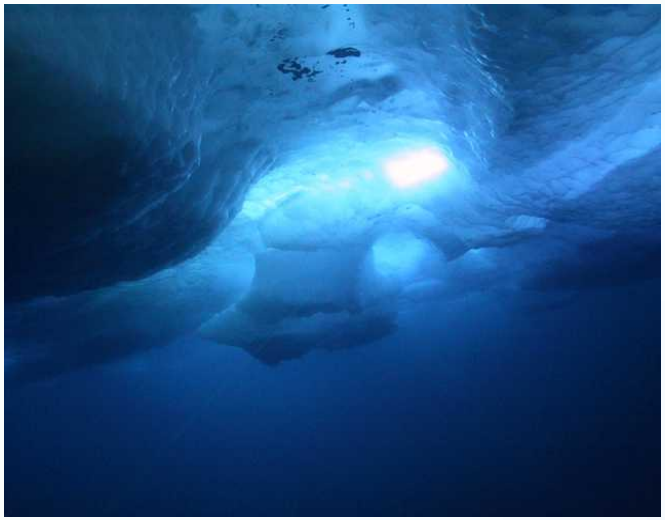
Kathleen Crane, Arctic Research Program, CPO NOAA

NOAA's IPY Programs

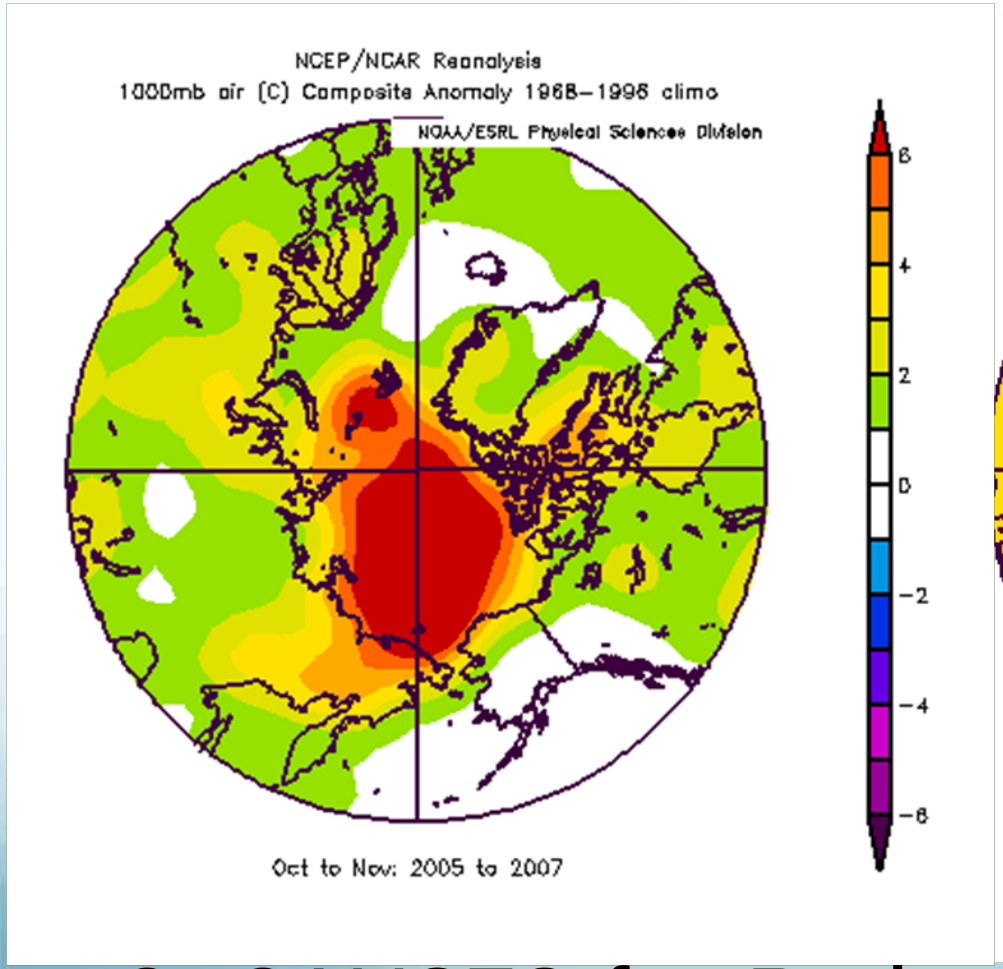
1. Ocean Exploration in Polar Regions
2. Causes and Impacts of Recent Changes in the Arctic Ocean
3. Polar Atmospheric Observatories and Field Campaigns
4. Polar Stratospheric Ozone Depletion Observations
5. Antarctic Marine Living Resource Survey
6. Short-term Arctic Predictability
7. Advances in Satellite Products and Their Use in Numerical Weather Prediction
8. Arctic Climate Modeling
9. Arctic System Reanalysis
10. NOAA's Data, Information for IPY
11. NOAA's Change Detection Strategy
12. Decision support for increasing adaptive capacity to climate change and variability in Alaska and the Arctic.

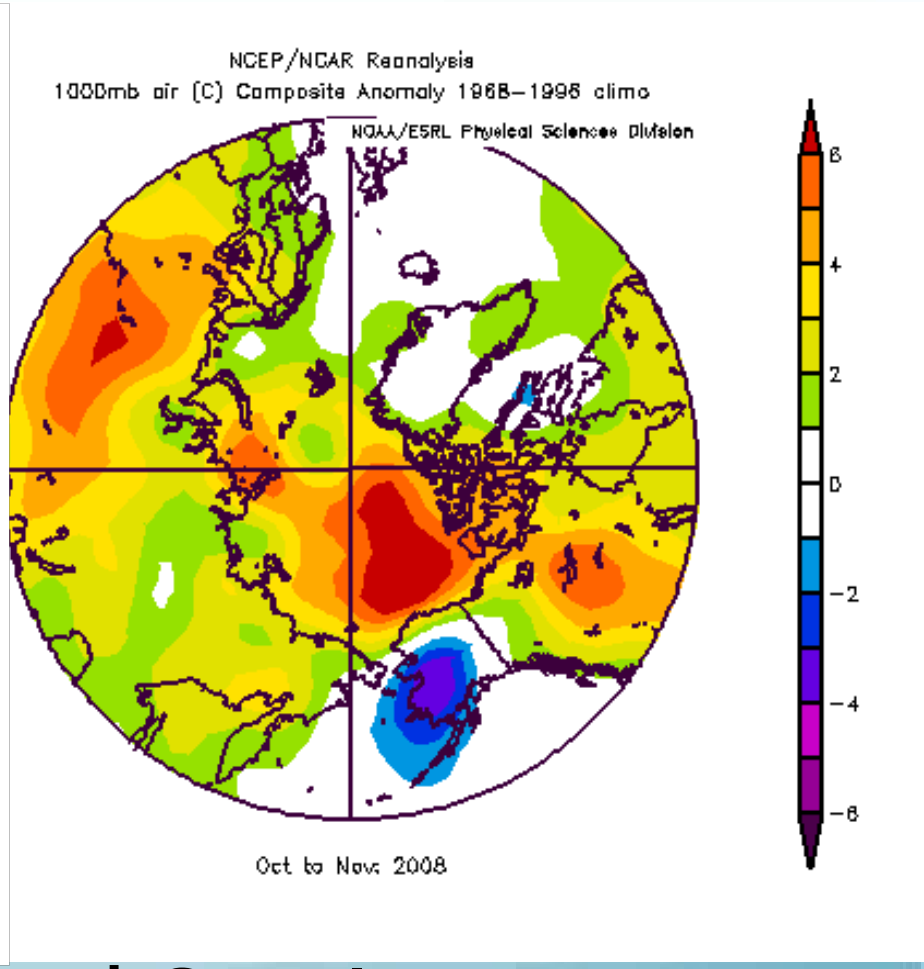
1. Ocean Exploration in the Arctic

- **NOAA Expedition Hears Endangered North Atlantic Right Whales off Greenland**
- 2009
- A team of scientists funded by NOAA's Office of Ocean Exploration and Research recorded the distinctive calls of endangered North Atlantic right whales in an area where it was believed that the historic resident population was hunted to extinction in the early 20th century. Besides providing a better understanding of the whales, the discovery has implications for future shipping in the region.
- Census of Arctic Marine Life



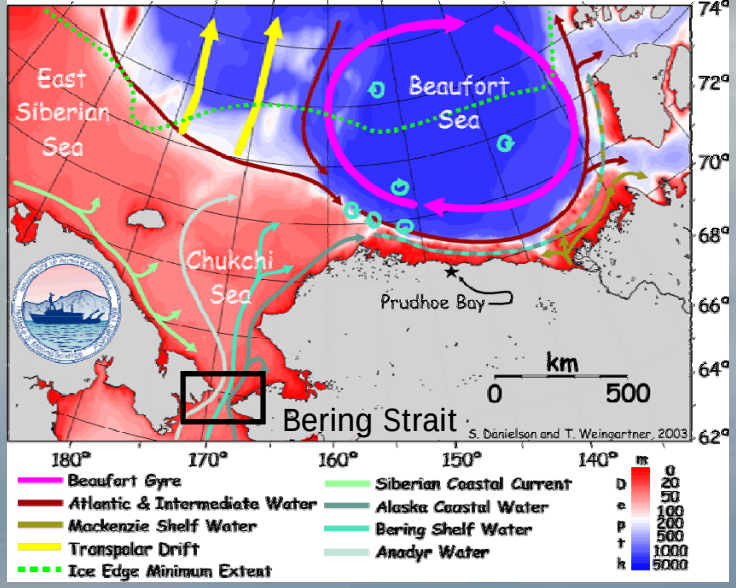
Recent (2005-2008) Arctic Fall Temperature Anomalies Greater Than +5° C

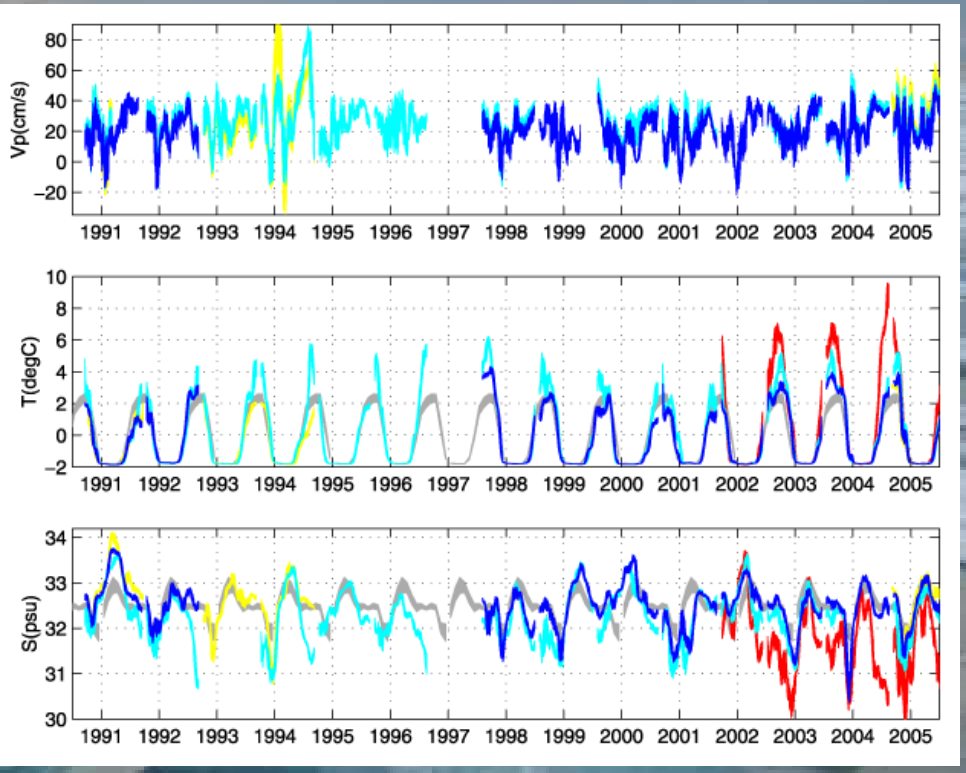




2. CAUSES for Reduced Sea Ice

2. CAUSES: Recent Freshening and Warming of Pacific Inflow



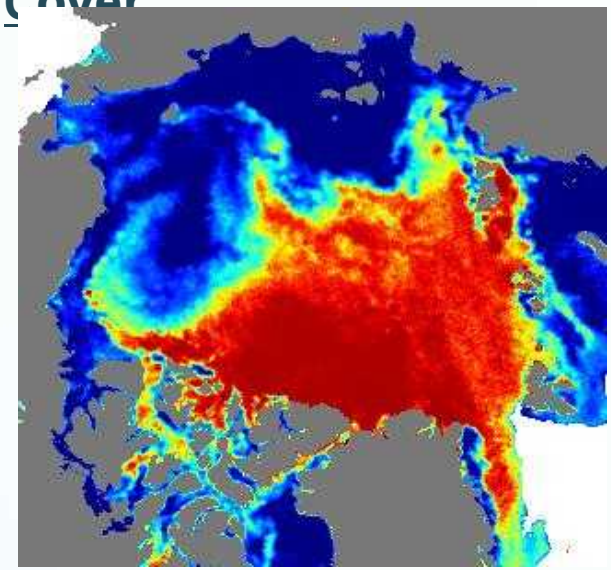


[Woodgate et al. 2006, Geophysical Research Letters]

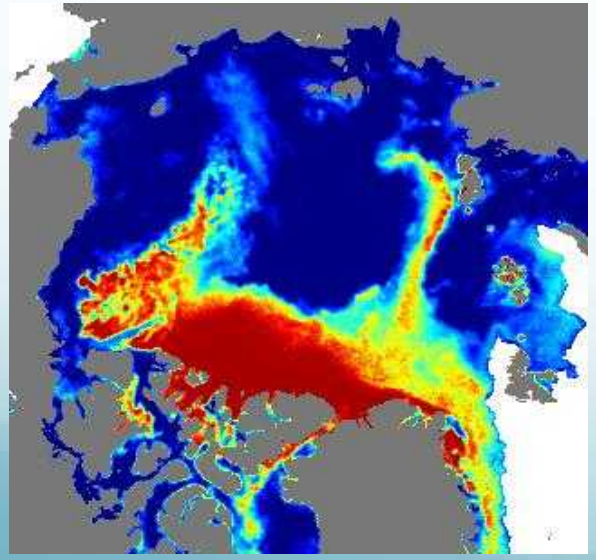
- moorings in Bering Strait show decrease salinity, increase freshwater flux, and temperature
- revised Bering Strait FW influx upwards from 1989
- Bering Strait is the largest Arctic “river” (~40% of freshwater)
- 10% of earth’s freshwater flows into the smallest ocean with the highest proportion of shelf
- currently 7 joint US-Russian moorings part of RUSALCA
- shelf-basin transport via

2. Recent Changes in the Arctic Ocean Sea Ice Cover

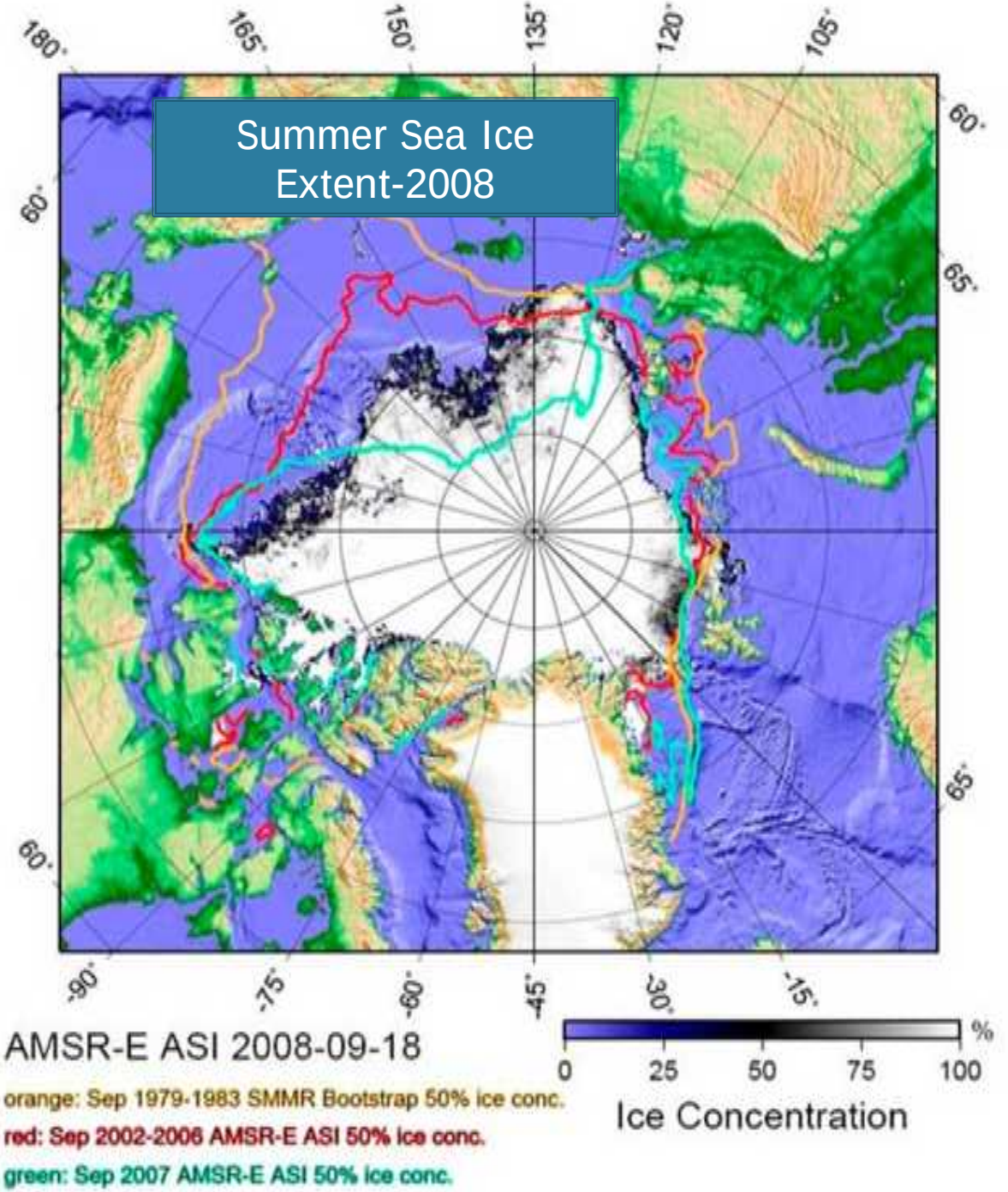
2004



2008

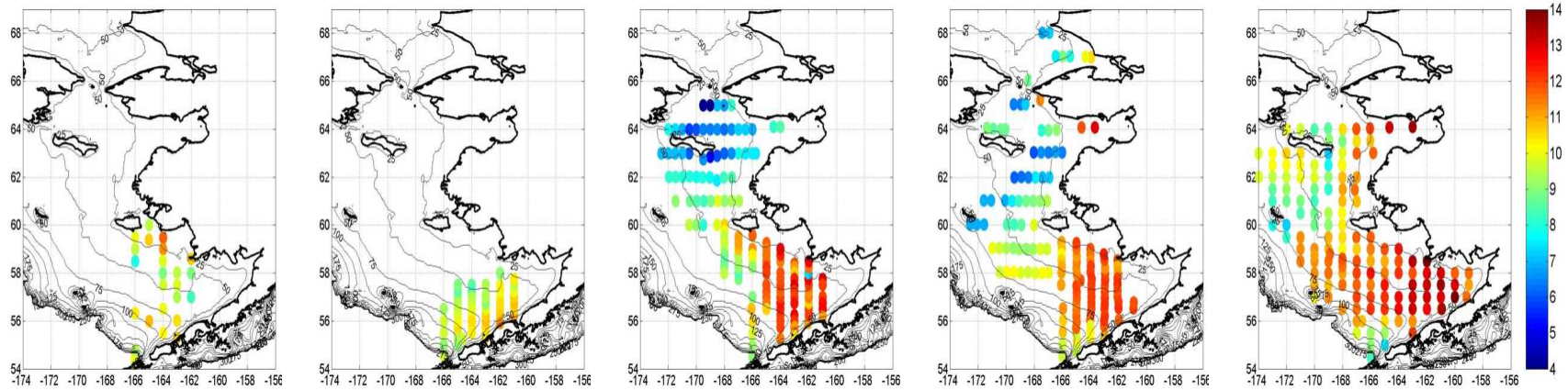


Loss of Multi-year (thick) Sea Ice: Jan.



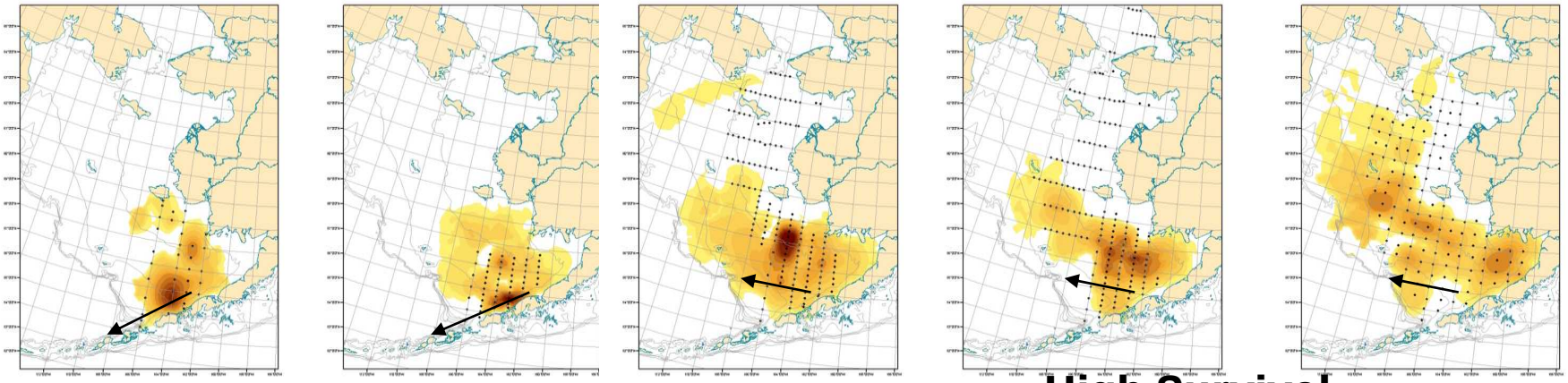
2. Impacts: warming and northward fish migration

Surface Seawater Temperature (5 m)



2000 2001 2002 2003 2004

Sockeye Salmon Survival

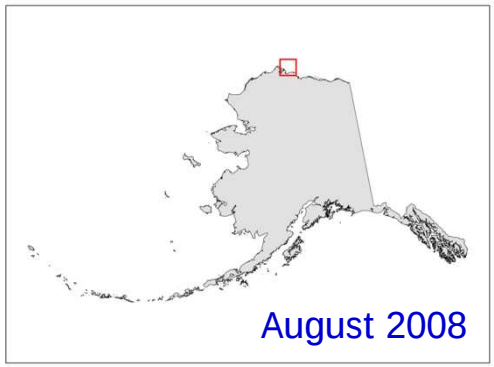


Low Survival

High Survival

[courtesy Ed Farley/NOAA]

2. Impacts: Migration of Marine Life Northward



Beaufort Sea Survey

Six Species Have Extended Range from the Bering or Chukchi Seas to the Beaufort Sea

Marbled eelpout

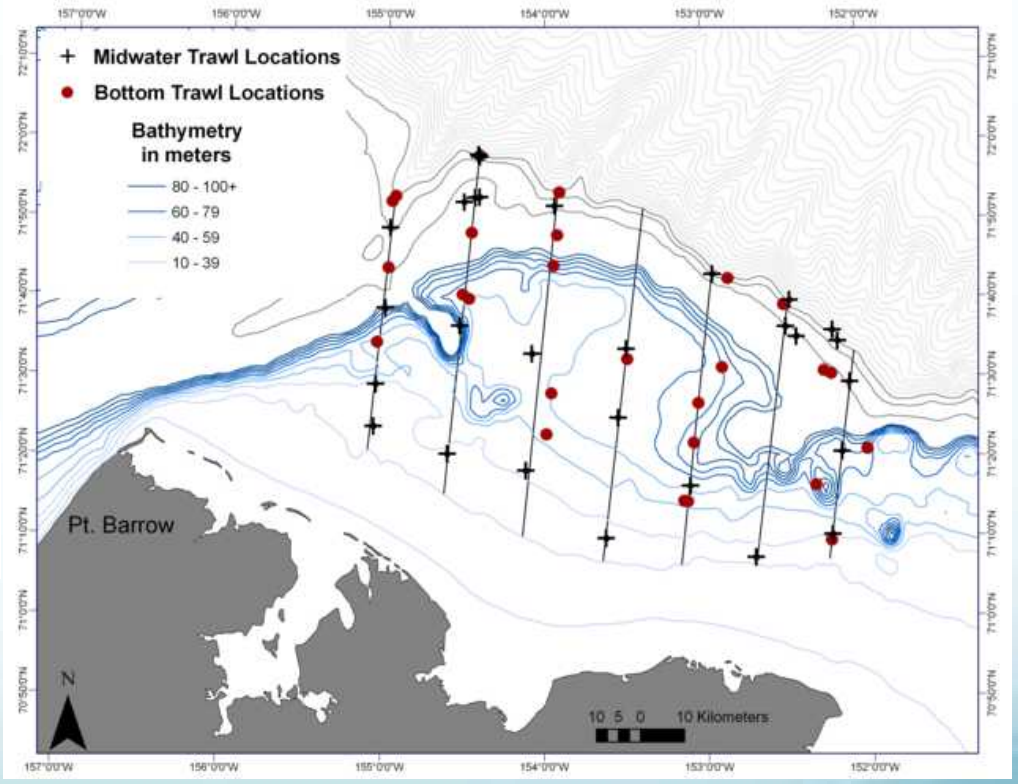
Bering flounder

Pacific cod

Walleye pollock

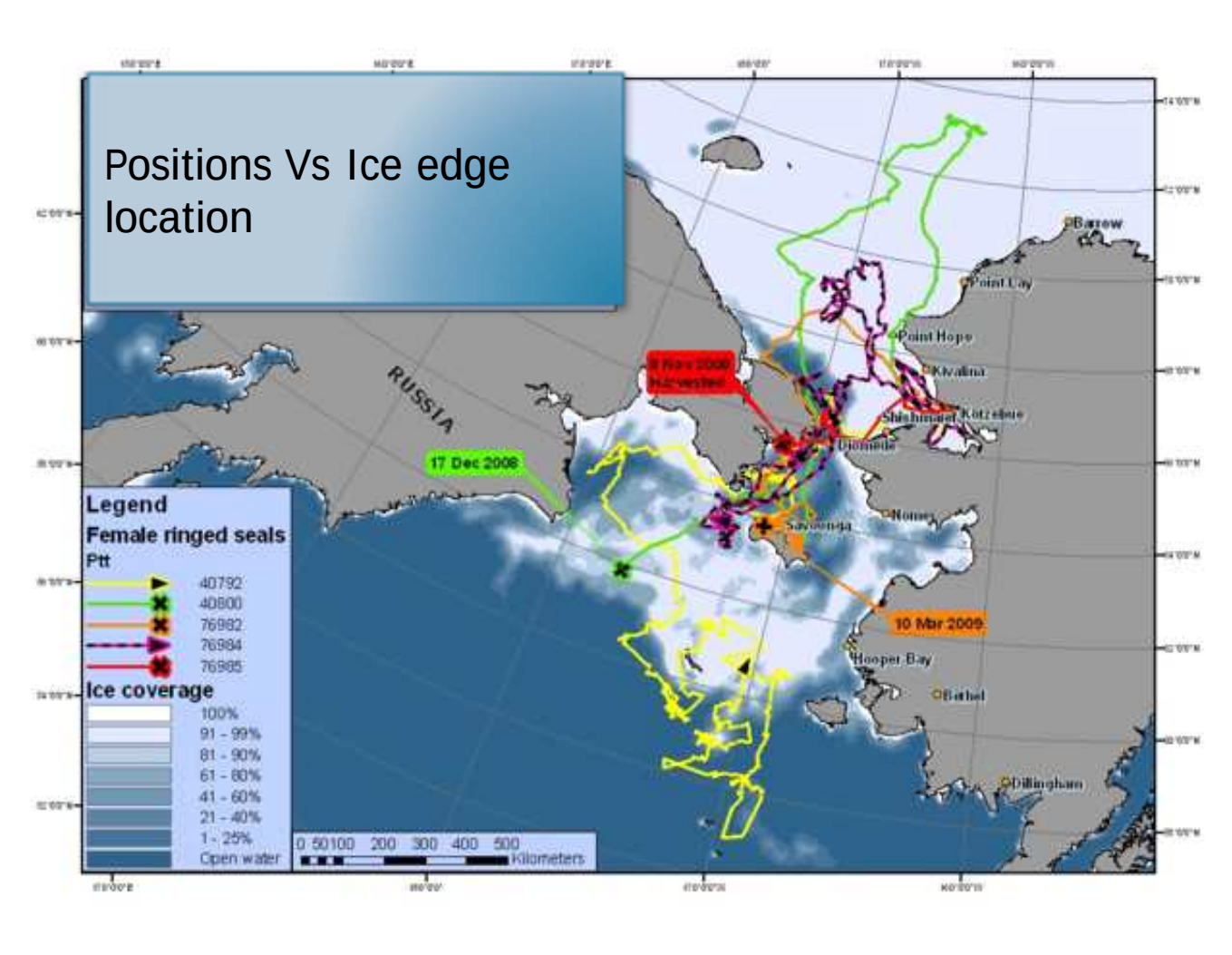
Bigeye sculpin

Salmon snailfish



Logerwell, L. 2008. Cruise Report for the 2008 Beaufort Sea Survey.
http://www.afsc.noaa.gov/REFM/Stocks/fit/PDFS/Beaufort_sea_cruise_report.pdf

2. Impacts: Fate of ice dependent marine mammals



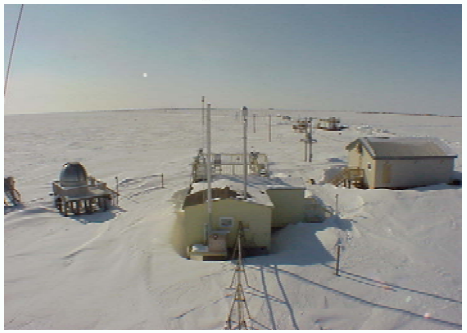
Movements of 5 female ringed seals from Oct. 2008-May 2009

3. INTERNATIONAL ARCTIC SYSTEMS FOR OBSERVING THE ATMOSPHERE (IASOA)

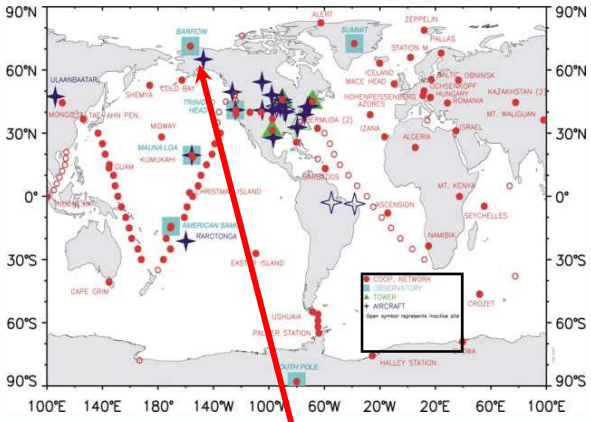
- Objective is to determine the mechanisms that drive Arctic-Polar climate change
- Observatories in north Alaska, northeast Canada, and north-central Russia
- Long-term measurements of clouds, radiation, aerosols, surface energy fluxes and chemistry

3 NOAA BARROW OBSERVATORY RESEARCH

NOAA Barrow Atmospheric Baseline Observatory

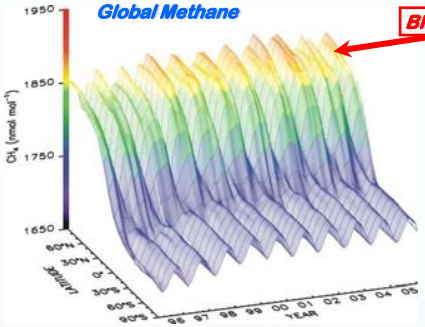


NOAA Global Cooperative Air Sampling Network



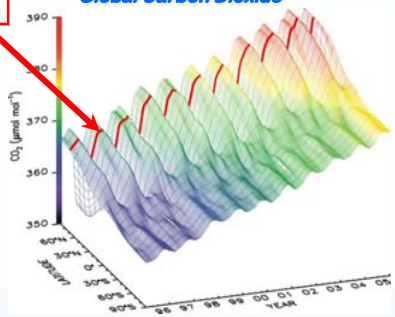
Buntings Respond to Longer Summer (Raise 2 Families in 2002, a First)

Global Methane

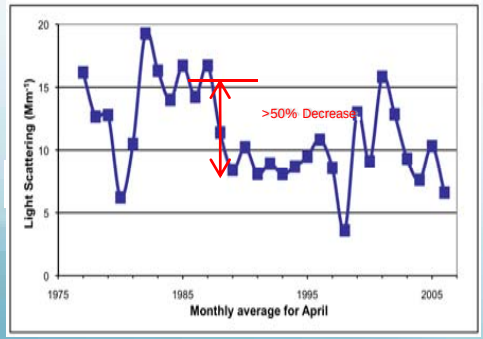


BRW Data

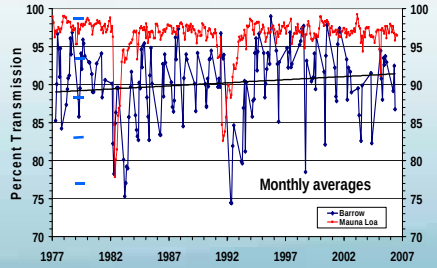
Global Carbon Dioxide



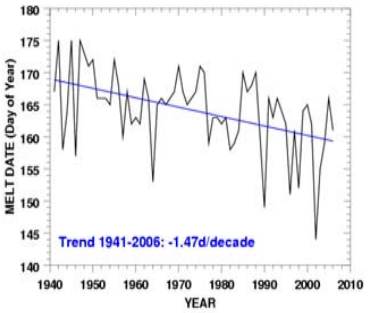
Barrow Arctic Haze Air Pollution (Decrease Since the Fall of the USSR)



Barrow Solar Radiation (Cloudiness Increasing , Sunlight Decreasing)



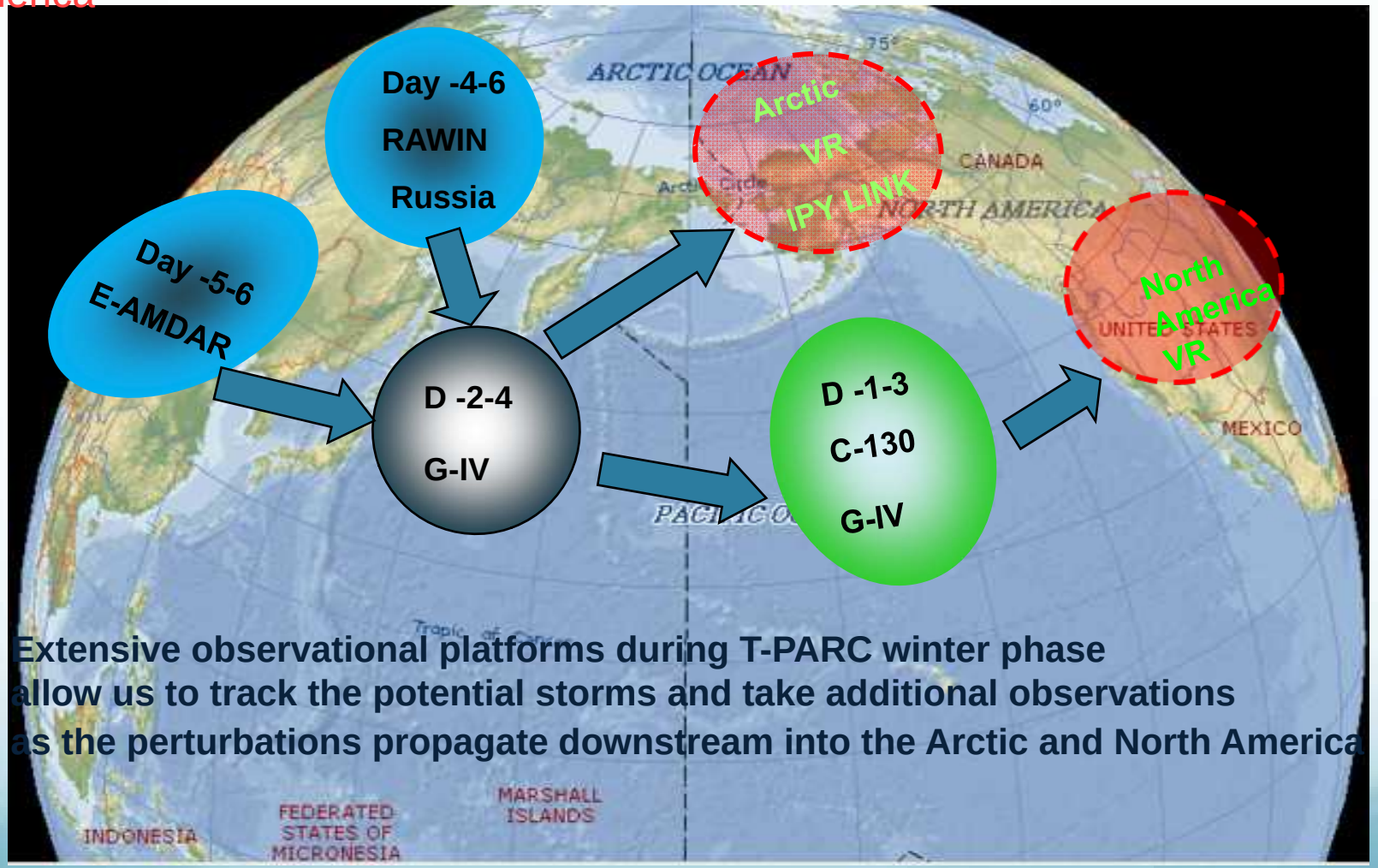
Barrow Snow Melt Dates (Spring is Advancing)



6. Short-term Arctic Predictability-NCEP

The THORPEX Pacific-Arctic mission- IPY

Enhanced Observing Platforms in Russia, North Pacific, Alaska, USA and North America



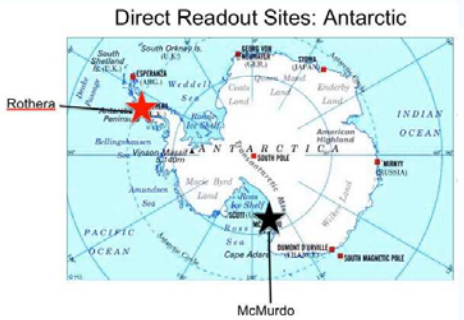
Extensive observational platforms during T-PARC winter phase allow us to track the potential storms and take additional observations as the perturbations propagate downstream into the Arctic and North America

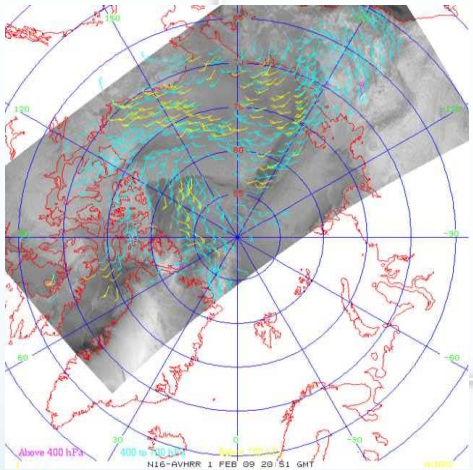
Yucheng Song and Zoltan Toth

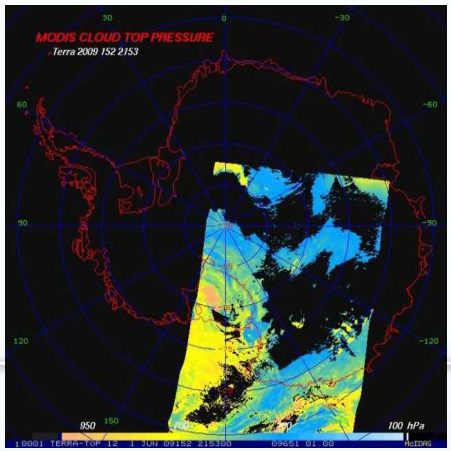
7. Advances in Satellite Products for IPY

For IPY, a variety of new satellite products were developed, both real-time and historical.

New direct readout sites: Fairbanks, Alaska, Barrow, Alaska, and Rothera, Antarctica sites now generate real-time satellite products, complementing previously developed sites at Tromsø, Norway, Sodankylä, Finland, and McMurdo, Antarctica.







New real-time atmosphere and cryosphere products: Polar winds from NOAA's AVHRR instrument provide coverage in areas without MODIS direct readout capabilities. New ice products (extent, concentration, motion, thickness) from MODIS have been added.

Historical satellite products have been developed for studies of recent climate change:

–The AVHRR Polar Pathfinder extended (APP-x), 1982-2004, covers both poles and provides cloud properties, surface temperature and albedo, and radiative fluxes.

–Polar winds from the AVHRR over the period 1982-2007 are available for the Arctic and Antarctic.

Use in weather and climate models: The polar wind products are being used by eleven numerical weather prediction centers in seven countries. Some of the historical satellite products will be used in future climate reanalyses.

Contact: Jeff Key, NESDIS

8. Climate Change Detection

http://www.arctic.noaa.gov/reportcard

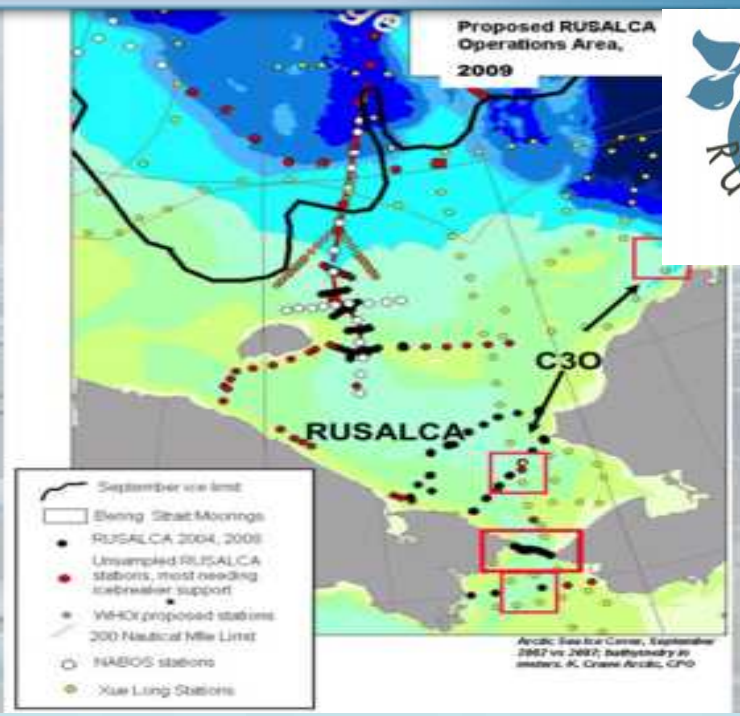
Future Legacy Activities

1. **PACIFIC ARCTIC GROUP**
2. **CO_2 Changes in the Region of Extreme Sea Ice Change**
3. **Arctic Observing Network**
4. **Arctic Marine Biodiversity Monitoring- Arctic Council**
5. **Enhanced Sea Ice Forecasting**
6. **Fate of Heat and Fresh Water from the Atlantic, Pacific and Greenland**
7. **Unmanned Aircraft Program-Linking the Arctic Climate Observatories**

Causes and Impacts of Recent Changes in the Pacific-Arctic Ocean : Ecosystem Changes

PACIFIC ARCTIC GROUP

RUSALCA- study of physical, chemical and biological change in the Pacific-Arctic: Causes and Effects



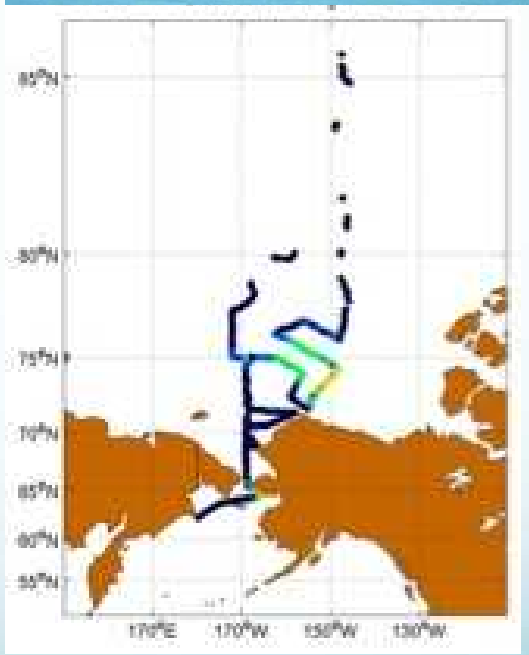
Russia, USA, Canada, China, Korea and Japan

Contact: K. Crane

Ecosystem-CO_2 Variability in the Region of Extreme Sea Ice Change

- In 2008 NOAA funded the PCO_2 sampling in the Arctic Ocean using the Chinese Vessel Xue Long. The results showed: a **very large CO_2 sink** in the entire region, including in the ice

- What will be the impact of an ice-free Arctic on this large sink region for CO_2?



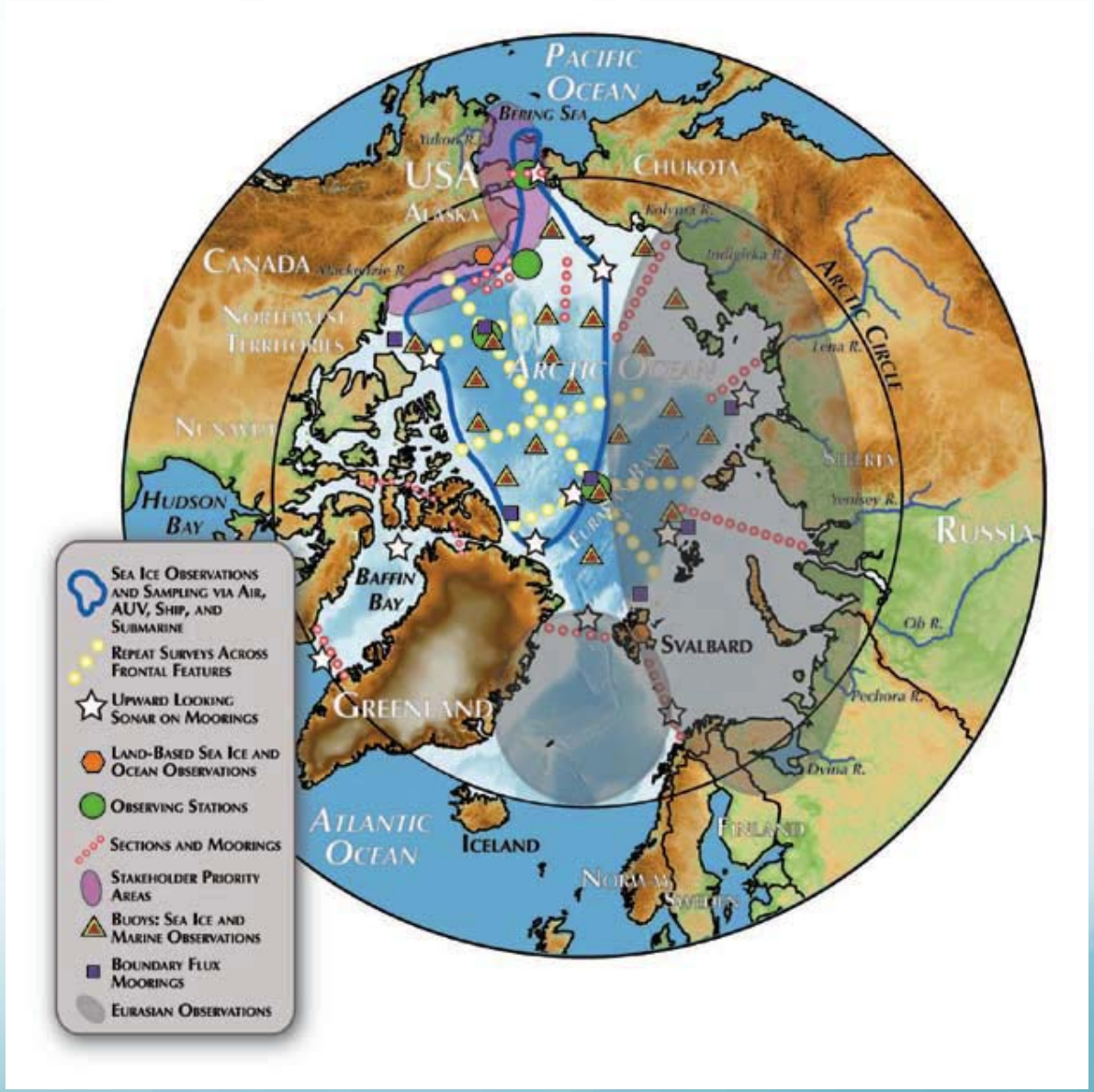
CO_2 sink < 380 ppm (green and blue(very large sink) Arctic Cruise, July-September 2008

Courtesy of Rik Wanninkof, NOAA

The Arctic Observing Network (USA PLANS)

The U.S. SEARCH Implementation Plan has begun to define the components of AON and places them in priority locations regardless of national boundaries.

Priorities for ocean and sea ice observing activities as illustrated in the SEARCH Implementation Plan



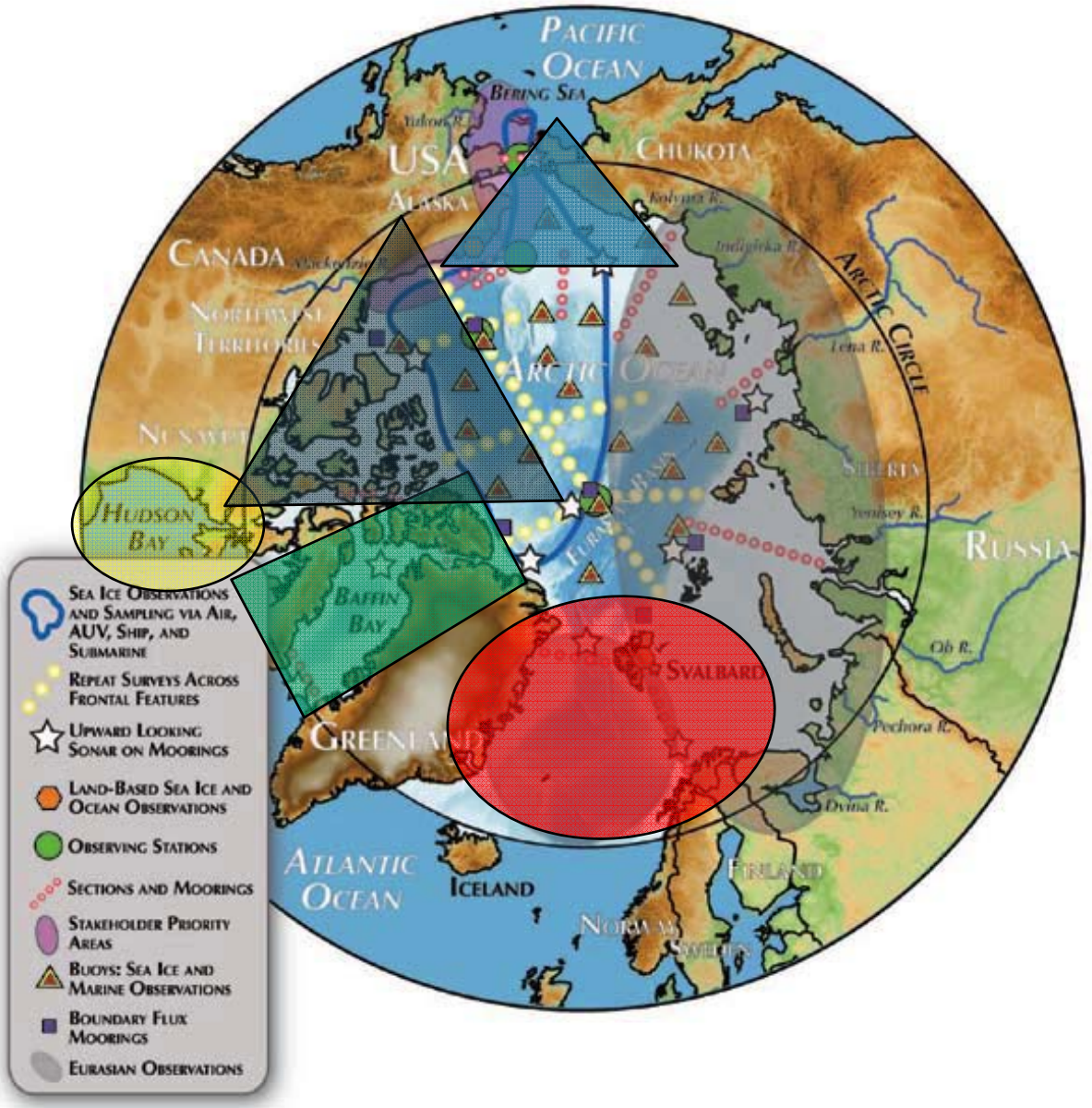
Contact: J. Calder, K. Crane
And M. Johnson, NOAA COM

Arctic Marine Biodiversity Monitoring

Plans are developing to build an International **Sustained Arctic Observing Network-**

Question: How much biodiversity monitoring is being proposed?

NOAA is co-leading an arctic Council effort to monitor Arctic Biodiversity Change



Contact: K. Crane

Enhanced Sea Ice Forecasting

- **DELIVERING SEA ICE FORECASTS & SERVICES TO THE NATION *FY12-16***

- **GOAL** To deliver authoritative, accessible, user-responsive sea ice information & predictions required by NOAA, stakeholders, decision managers & policymakers.

- **URGENCY** Dramatic environmental change in the Arctic region is occurring faster than any other region on Earth. A potentially, seasonal, ice-free Arctic presents significant additional challenges, requirements & opportunities for shipping, energy resources, fisheries, ecosystems, national security & governance --all with increasing needs for sea ice information.

OBSERVING *air, ice & ocean conditions*

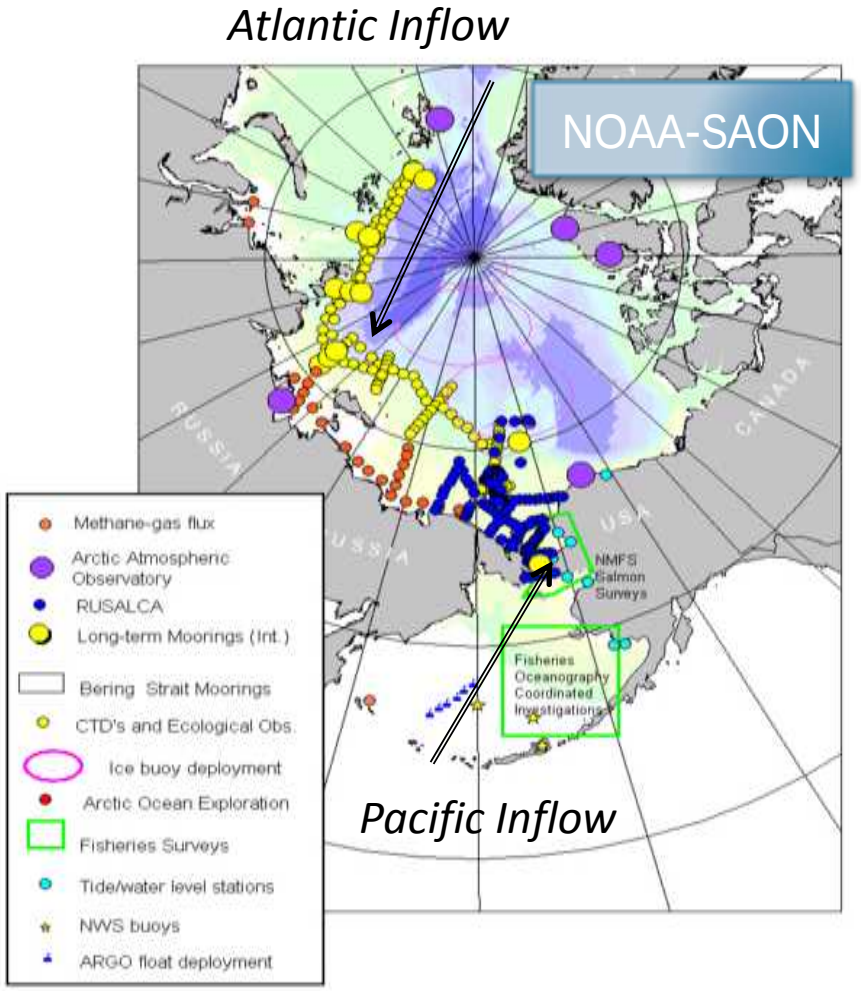
PREDICTING *daily, weekly, seasonal, annual, regional, & decadal sea ice*

PROVIDING *needed information for NOAA, stakeholders, decision managers & policymakers*

Contact: J. Intrieri

Fate of Heat and Fresh Water from the Atlantic, Pacific and Greenland

Fate of Atlantic and Pacific Water in the Arctic
Impacts on Ecosystems



Fate of Greenland Melt Water in
The Ocean

Increased Contributions from NOAA to the IASOA Infrastructure

A UAS can link up the Arctic Observatories

Contacts: T. Uttal, B. Weatherhead