From 2001 to 2007:
What We Have Learned and What We Have Done

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Contents

- Key issues from 2001 report
- International policy issues from 2001
- Science needs identified in 2001
- Advances in scientific knowledge since 2001
- New mission drivers perceived in 2007

Key Issues From 2001

Activities Impacted By Sea Ice Reduction

- Maritime activities
- Aviation
- Offshore oil and gas
- Fisheries

Areas Needing Improvement

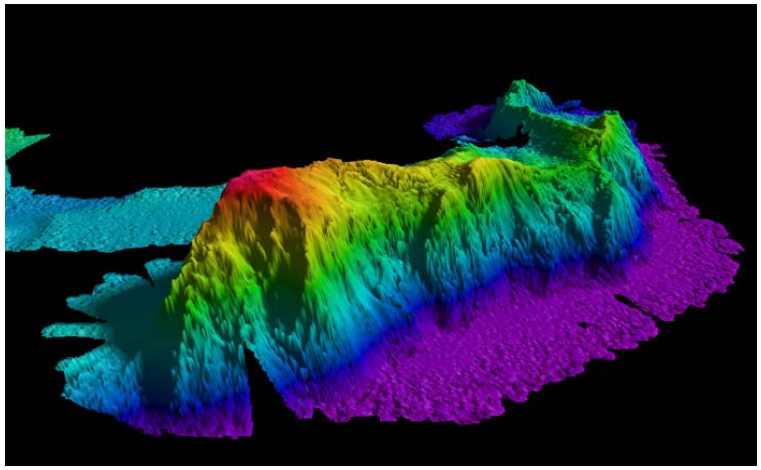
- Search and rescue
- Training in cold-climate procedures
- Communications - land-based, satellite-based
- Coastal land weather stations
- Satellite and in situ observations over/in the Arctic
- Military readiness

2001 International Policy Issues

- USN and USCG will need alliances
- U.S. will need to deal with passage disputes and “Internal waters” vs. “international strait” issue with Canada

- Science agencies will need international partnerships

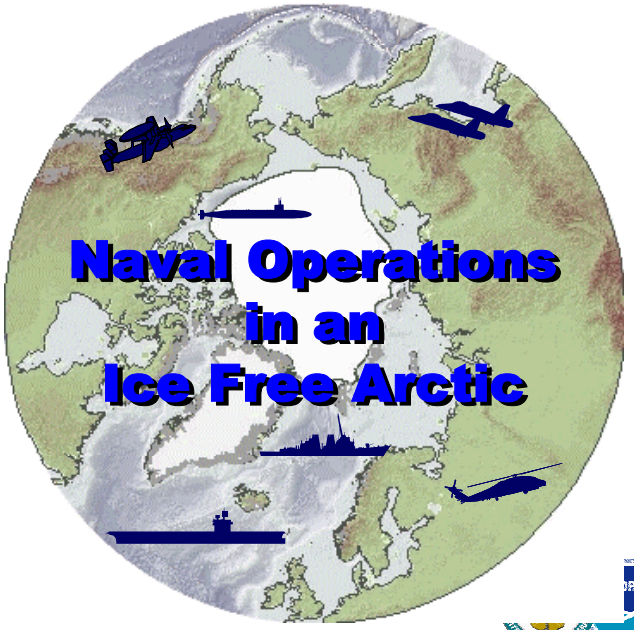
2001 Identified Science Needs



- More satellite observations
- Real-time Pan-Arctic environmental monitoring and modeling
- High resolution bathymetry
- More land and ocean-ice weather platforms and stations
- Improved environmental sensors
- Reliable Arctic climate change predictions

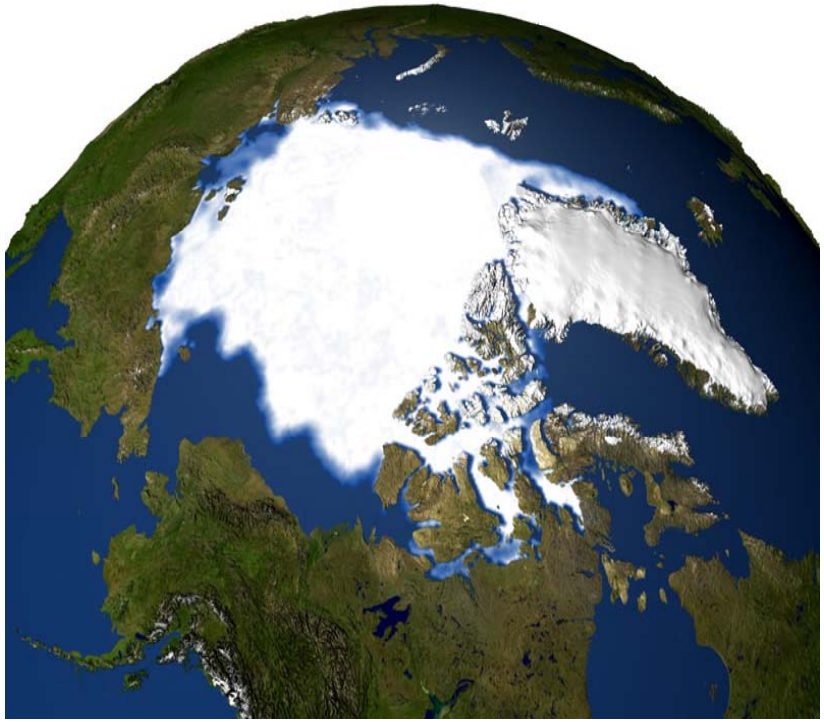
Scientific Advances Since 2001

- Observations of the changing state of sea ice
- New knowledge on fate of sea ice and its age structure
- New insight on role of the Arctic Oscillation (AO) on Arctic
- Change Ice mass balance information
- Warming of Arctic Ocean
- Comparison of model projections and observed sea ice decline
- Representation of sea ice in global climate models

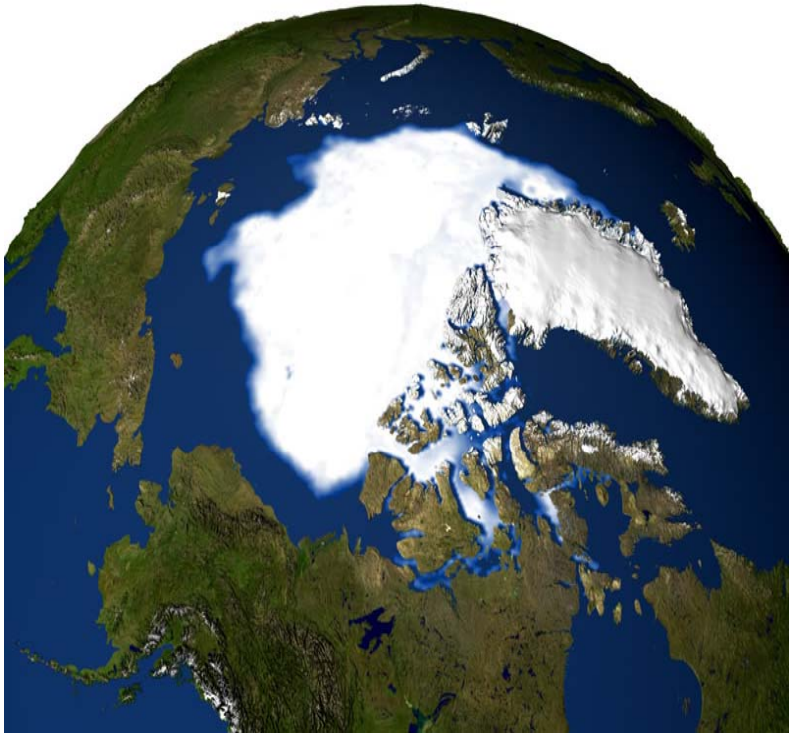


Sea ice changes in the Arctic September 1979 - 2005

1979

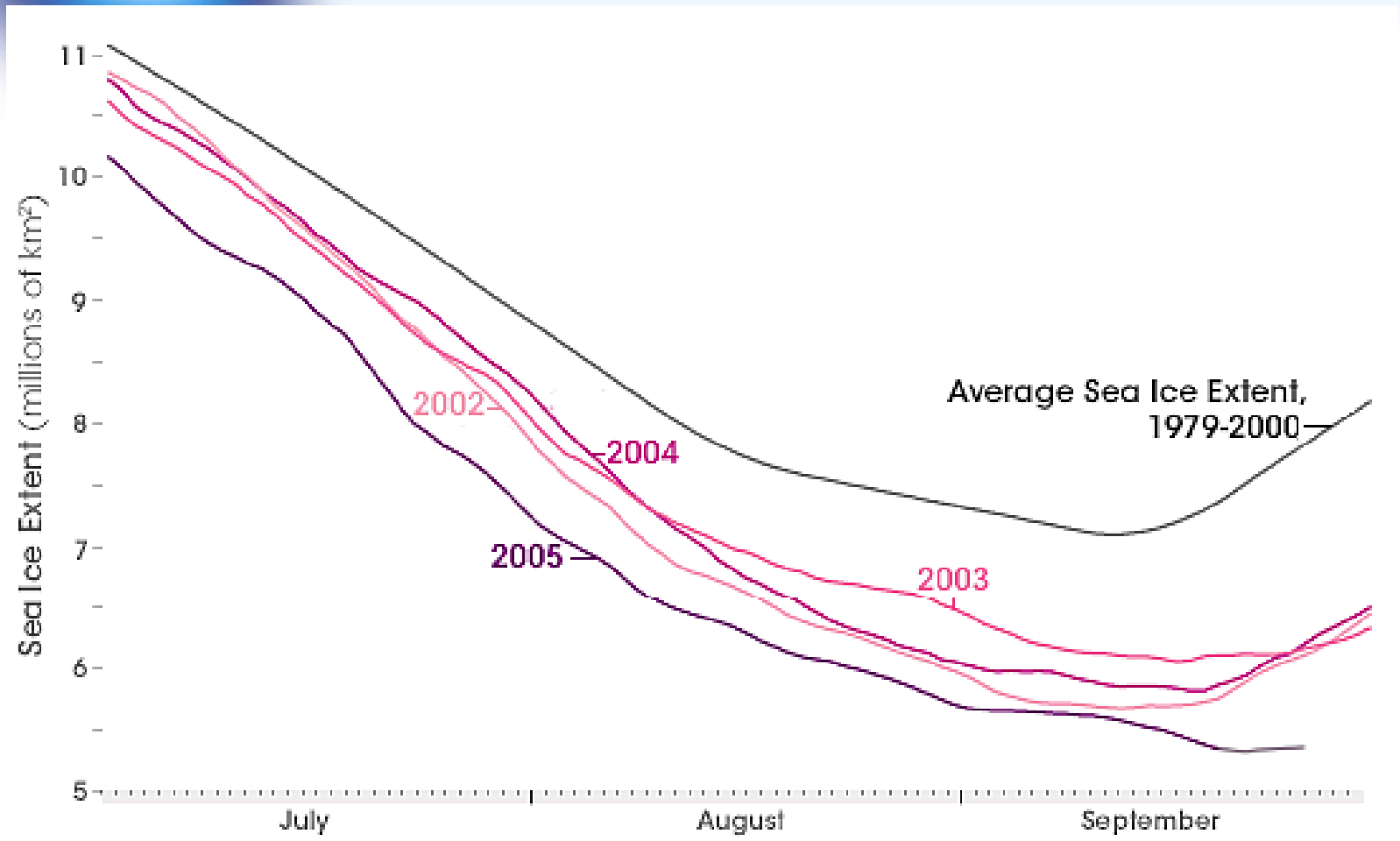


2005



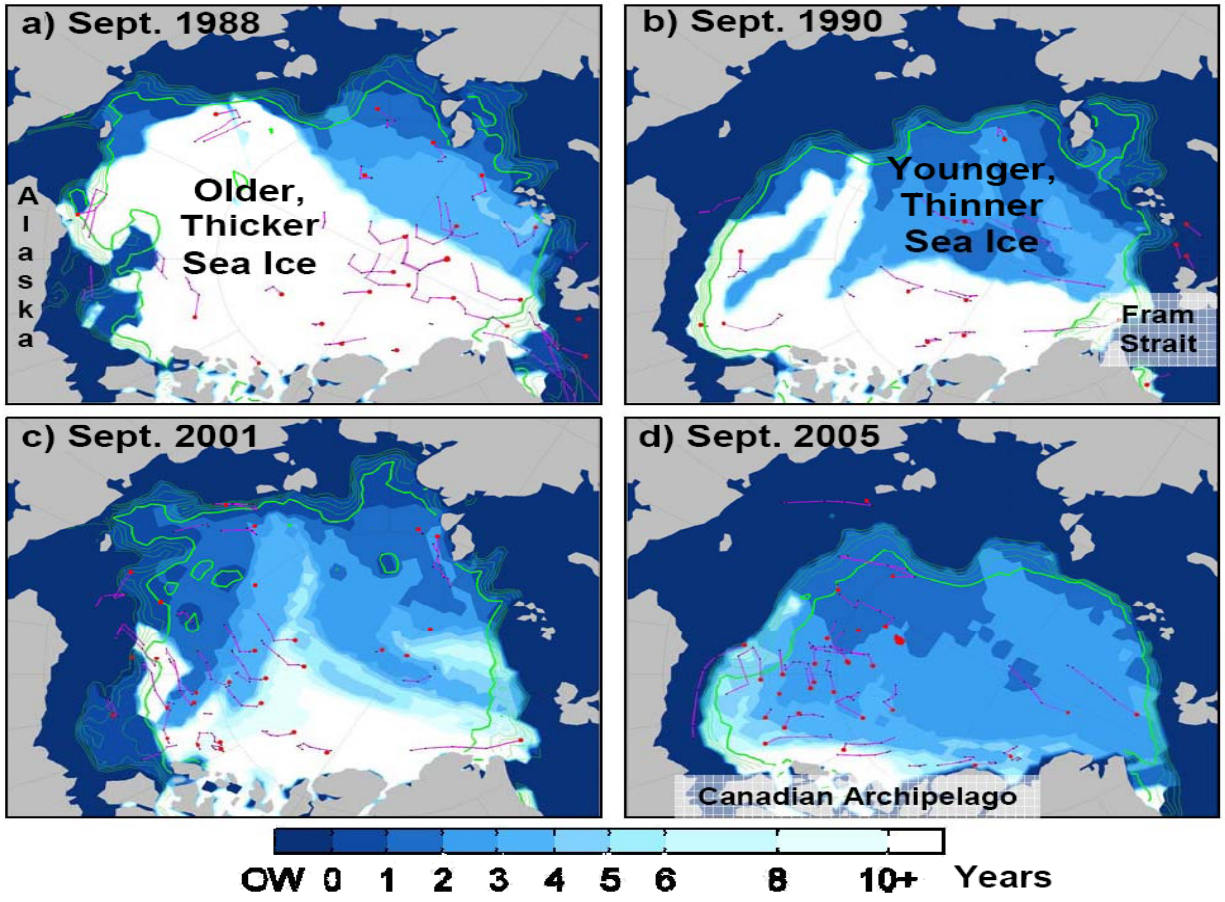
From Pal Prestrud - CICERO

Changes in Summer Sea Ice 2002-2005 (NASA 2005)



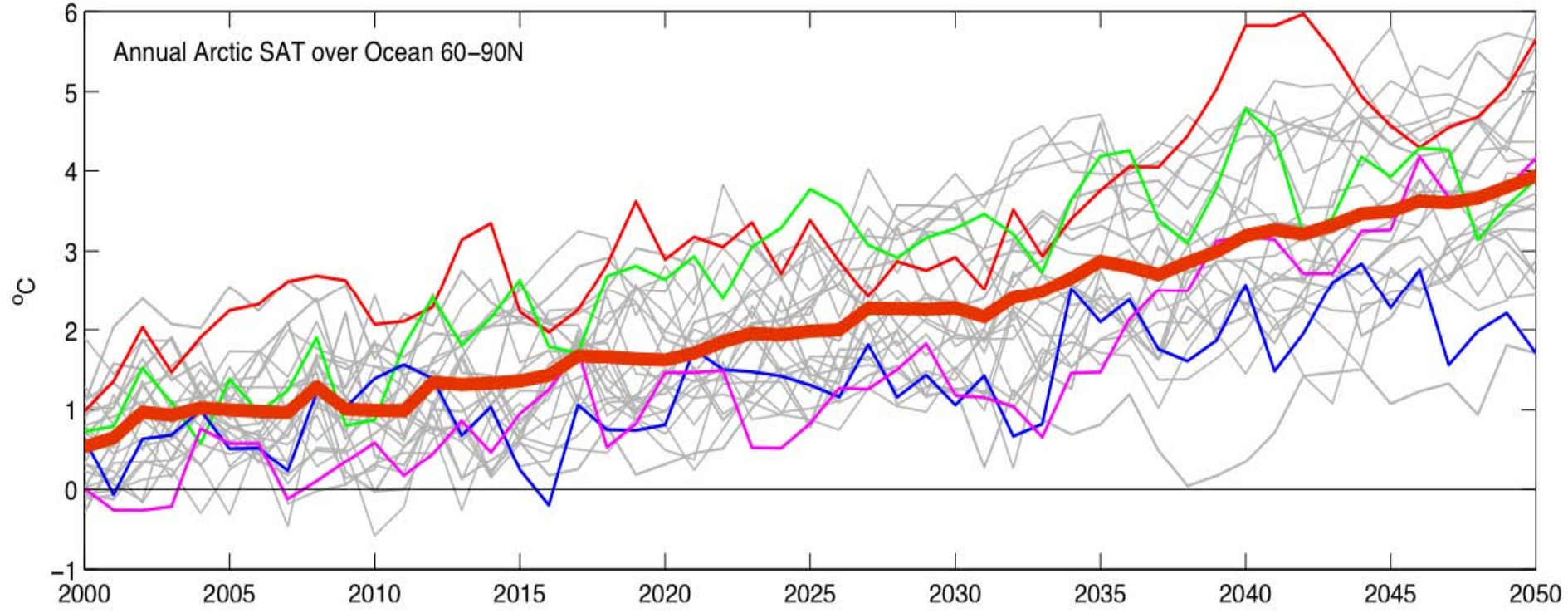
From Pal Prestrud - CICERO

Changes in Age of Sea Ice 1988-2005 (NOAA 2006)

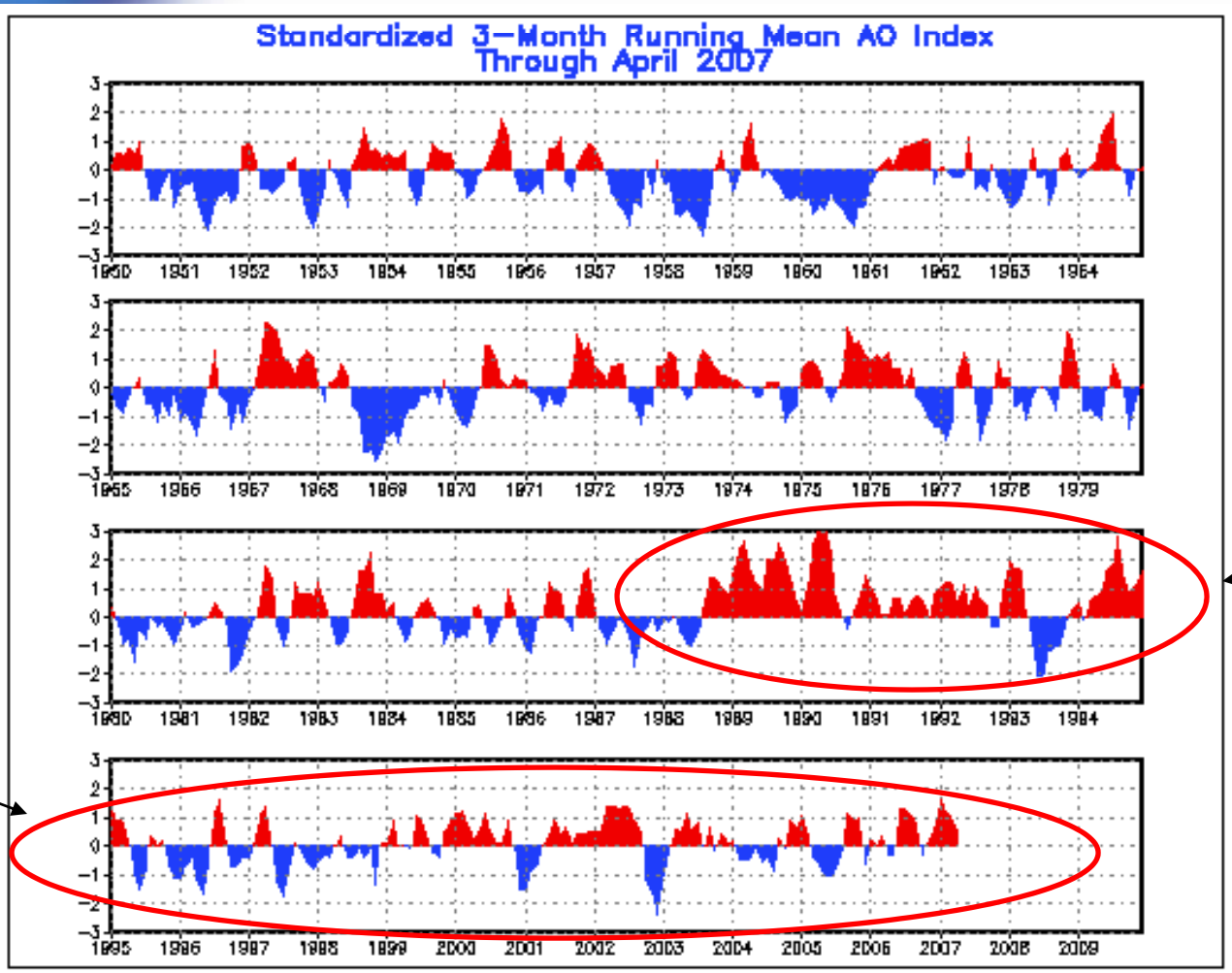


From Pal Prestrud - CICERO

Surface Air Temperature



Arctic Oscillation as Driver of Arctic Change

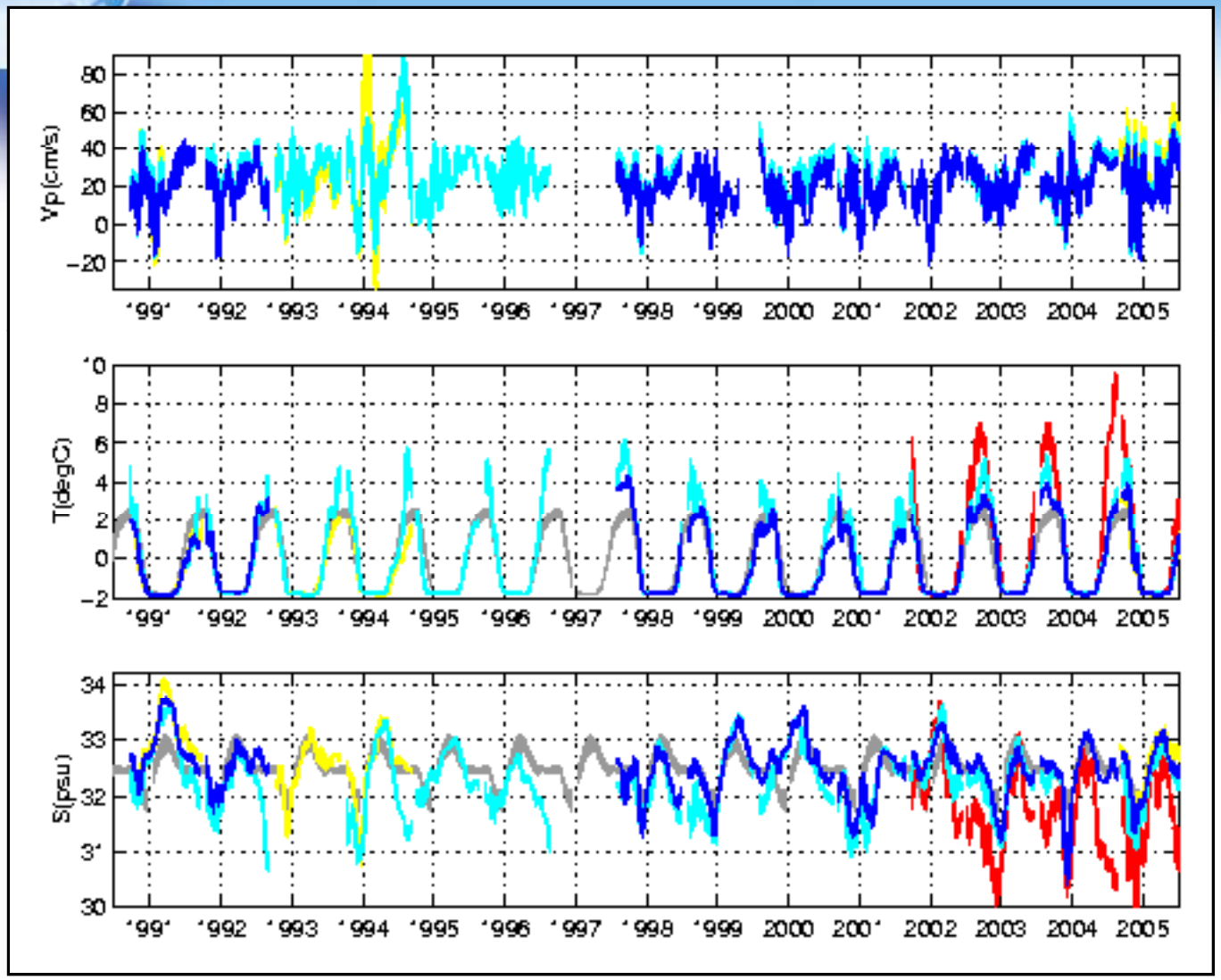


More recent neutral AO; yet changes are continuing

Strong positive AO; thought to be the main driver of Arctic change

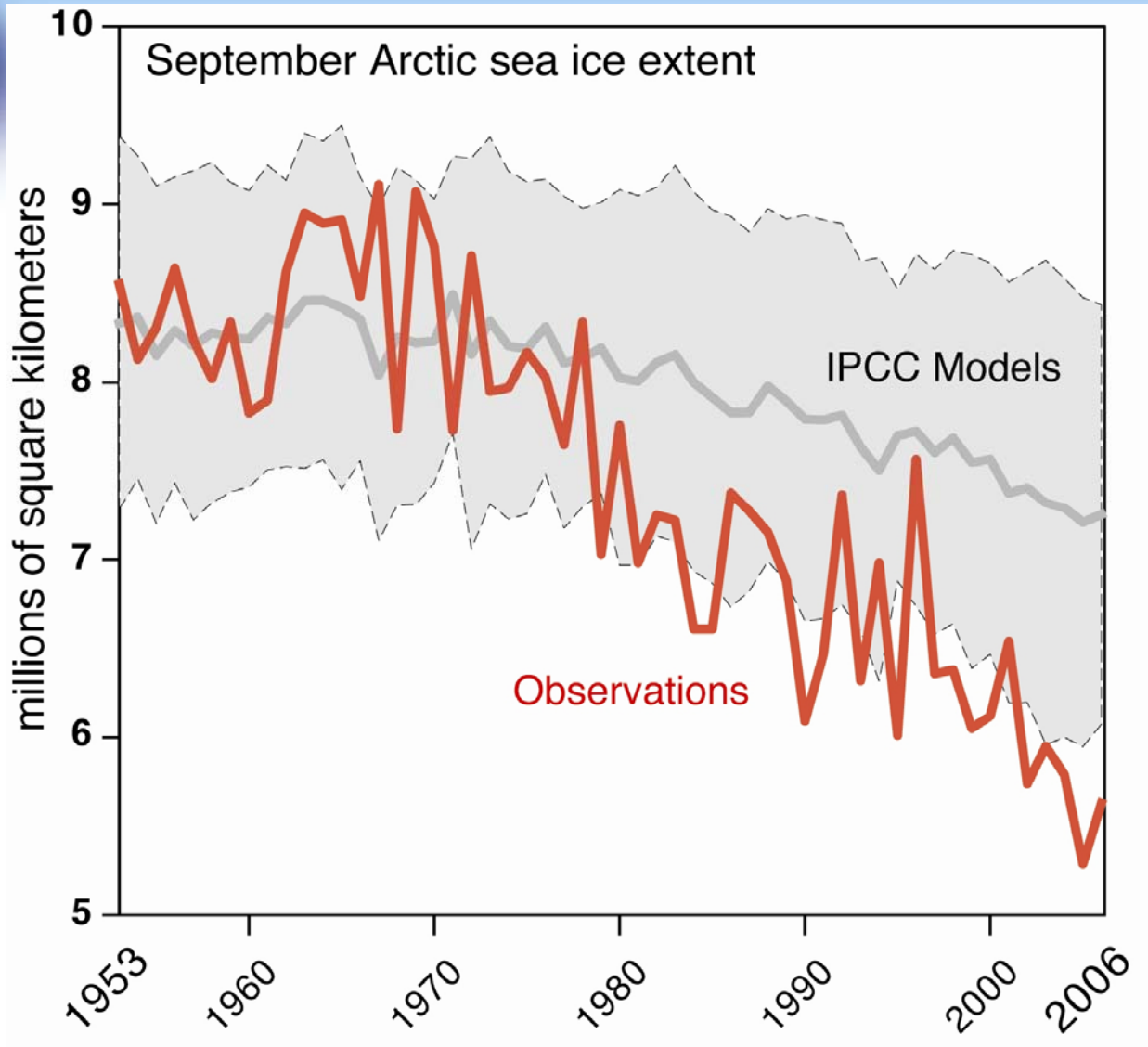
From NOAA-CDC

Flow Through Bering Strait



From Rebecca Woodgate - UW/APL

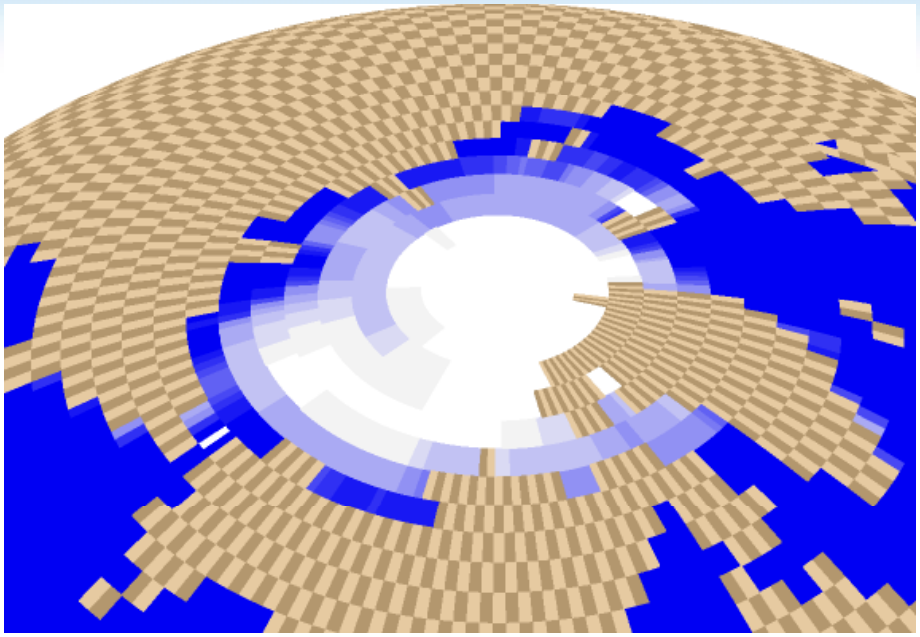
Sea Ice Decreasing Faster than Predictions



From Mark Serreze - U. Colo./CIRES

NOAA-GFDL Sea Ice Model: 2001 Formulation

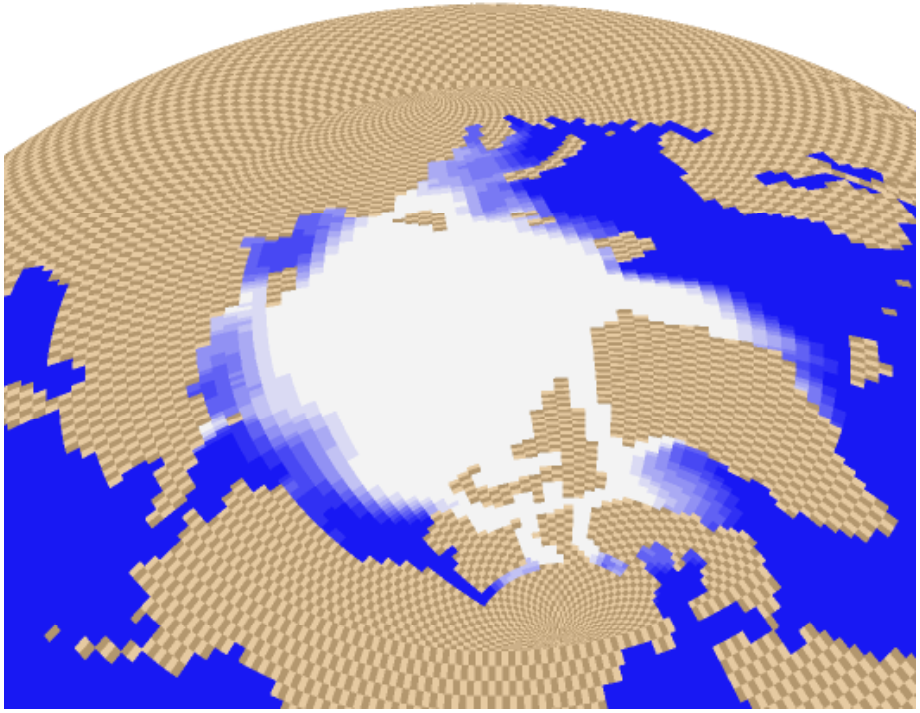
Previous generation GFDL R30 Model (circa 2000)



- No dynamics
- Single layer thermodynamics, no input of heat capacity
- No explicit inclusion of snow
- No ice leads

NOAA-GFDL Sea Ice Model: Current Formulation

- Includes full sea ice dynamics with elastic-viscous-plastic rheology
- 5 ice thickness categories + open water (leads)
- 3 layer thermodynamics

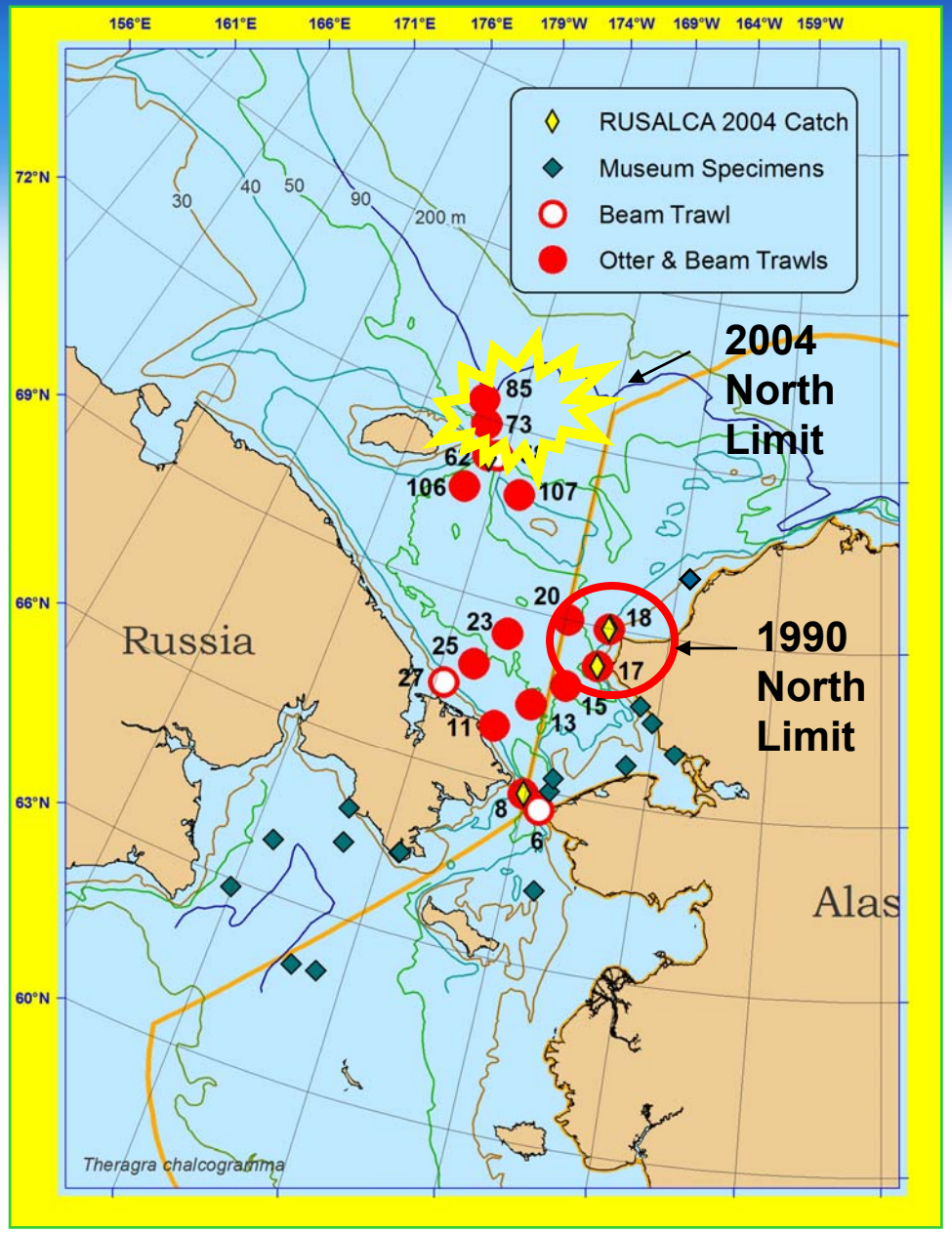


Current "workhorse" GFDL CM2.1 Model (circa 2005)

RUSALCA

Found Further North

Walleye Pollock
Theragra chalcogramma



From K. Mecklenburg

New Mission Drivers 2007

- Increased economic activity
  - Access to Arctic natural resources
  - Use of shorter transit routes through the Arctic
- Increased law enforcement/security
  - LOS/ illegal resource use
  - Drug smuggling
  - Illegal entry
  - Counter-terrorism
  - Resource protection
  - Countering any increased military threat
- Climate
  - Coastal regions-storm impacts
  - Impact on global thermohaline circulation
  - Impact on mid-latitude climate in Asia, Europe and North America
  - Impacts on coastal cities, and global infrastructure

Improving Documentation of Native Perspectives on Sea Ice

- Marine Mammal Commission workshop in 2000
- “Earth is Faster Now” in 2002
- Arctic Climate Impact Assessment in 2004
- IPY in 2007 includes several projects with native participants such as SIKU (Sea Ice Knowledge and Use in the North)
- Native perspective on observational scales is important to incorporate into the Arctic Observing Network

Developing International Science Partnerships

- IPY
- Arctic Regional GOOS
- Arctic Observing

Network (AON) and its developing international counterpart

- Arctic GOOS, GEOSS component

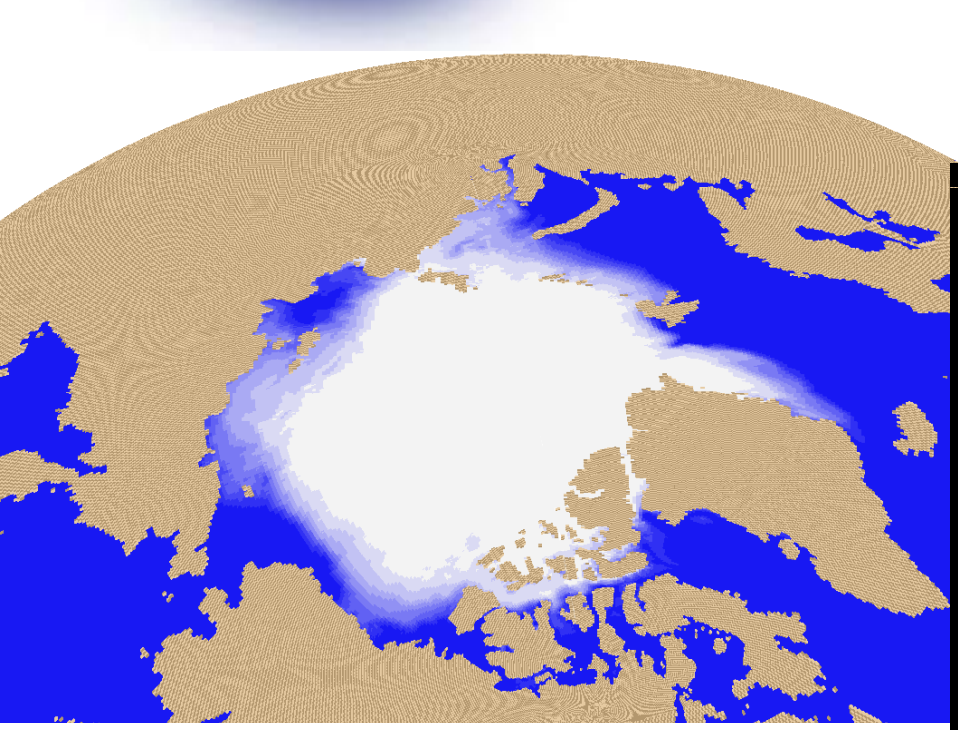
Summary

- Early trends detected in 2001
- Improvements in Observations and Scientific Understanding
- Dramatic changes continue

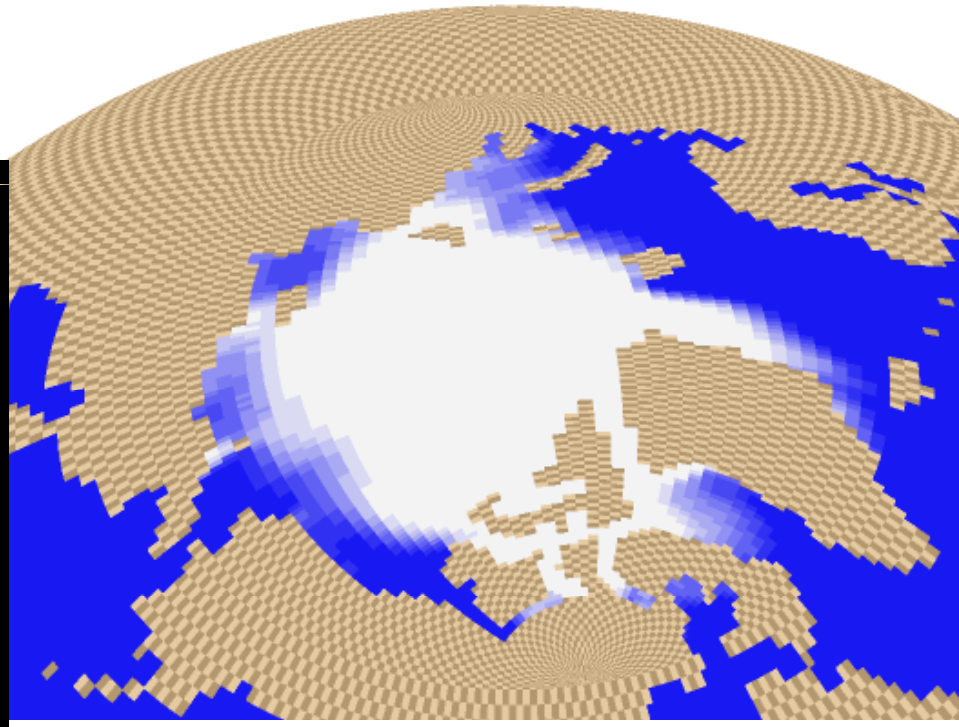

Questions?

Backup Slides

Planned improvements in sea ice model component of GFDL's global climate model

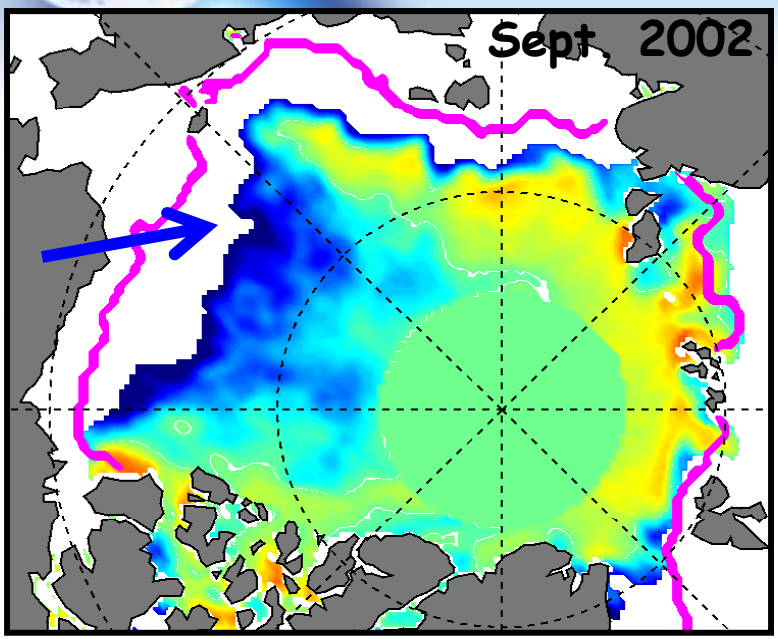


Next generation GFDL Model? running test cases now ("workhorse" circa 20??)

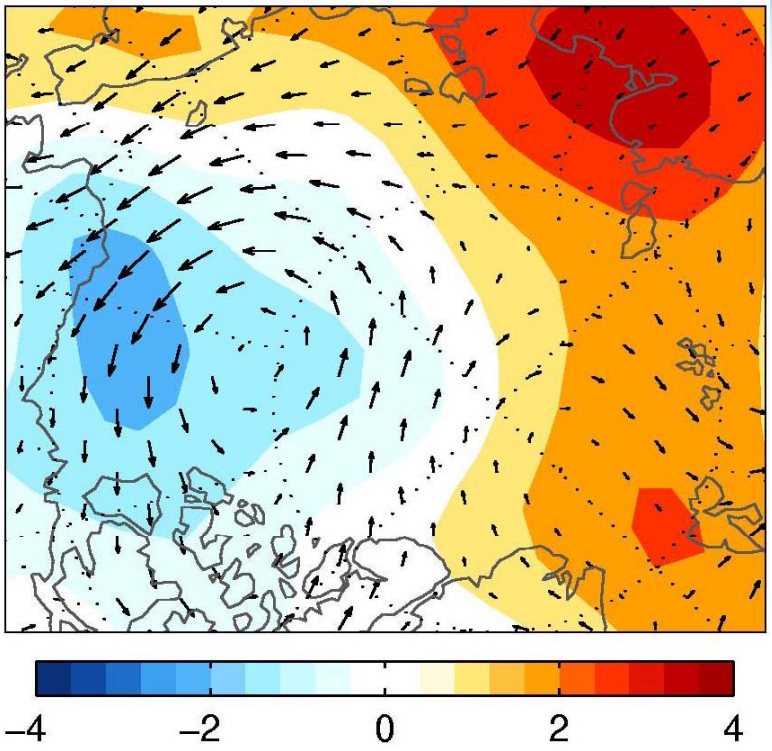


Current "workhorse" GFDL CM2.1 Model (circa 2005)

Effects of Summer Winds on Sea Ice Extent



(From http://nsidc.org)



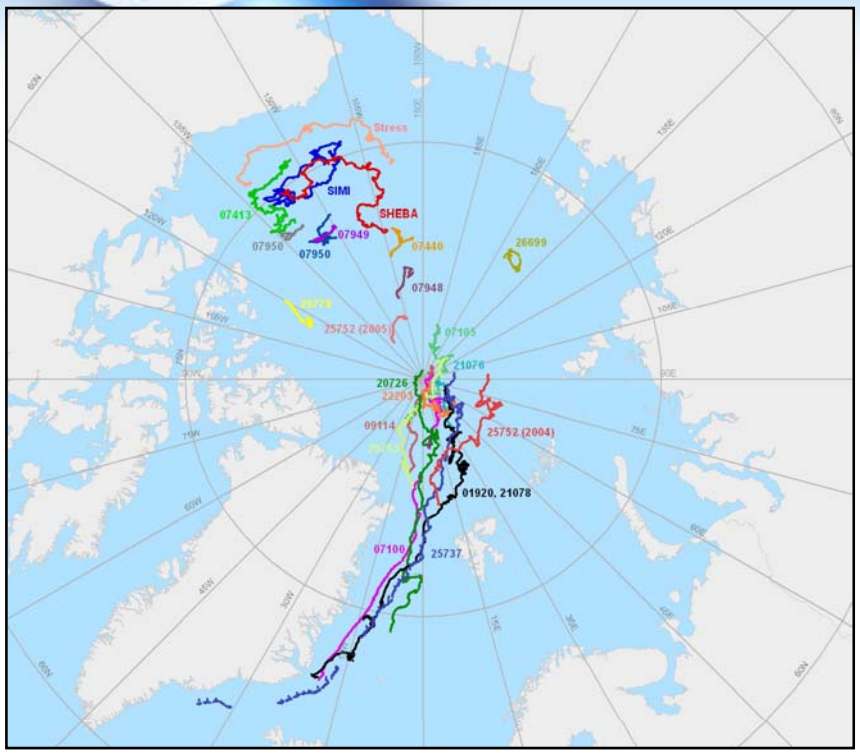
This condition is typically associated with winds from the SE blowing ice away from the coast and warm air (e.g. Drobot and Maslanik, 2003)

But it was colder and the winds blew the ice towards the coast during the summer of 2002?

From Ignatius Rigor - UW/APL

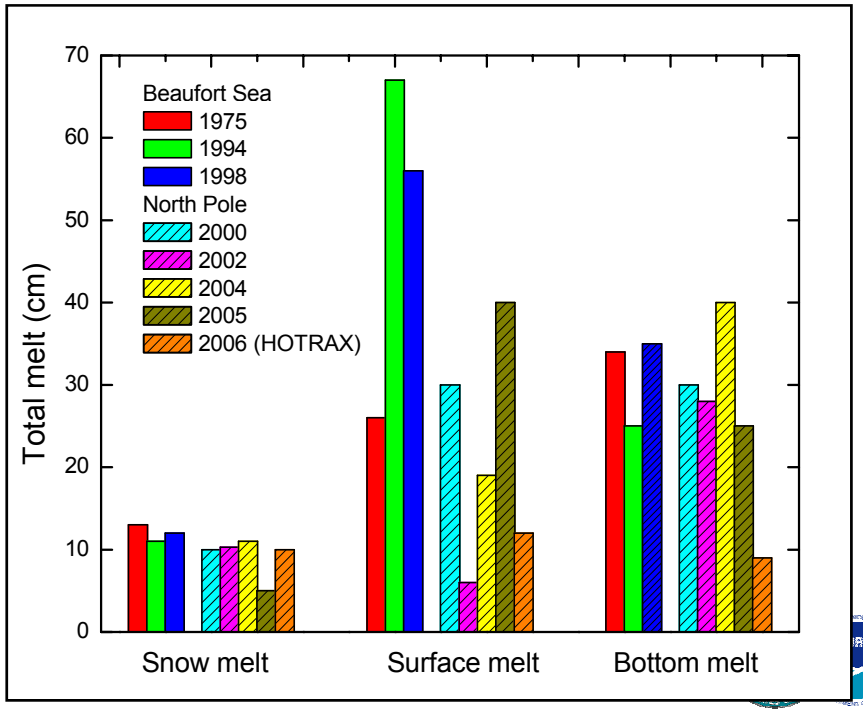
Ice Mass Balance Buoy Network

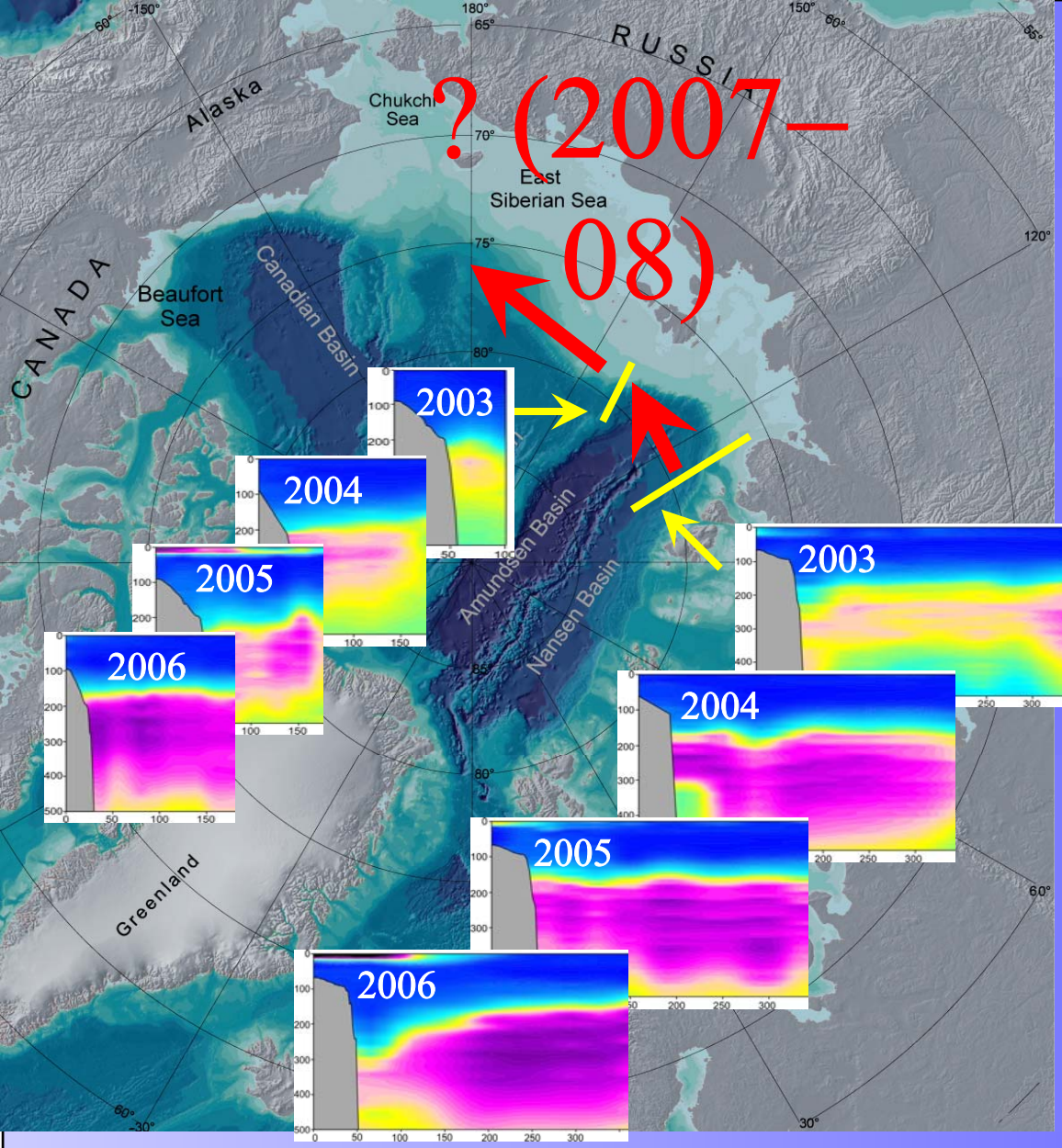
2000 - 2006



- Repeated installations:
  - North Pole Environmental Observatory
  - Beaufort Gyre
- IPY deployments as part of Arctic Observing Network

- Observed regional variability
- Comparison of NP and BG
- Most pronounced difference in surface melt
- Consistent with solar input as function of latitude





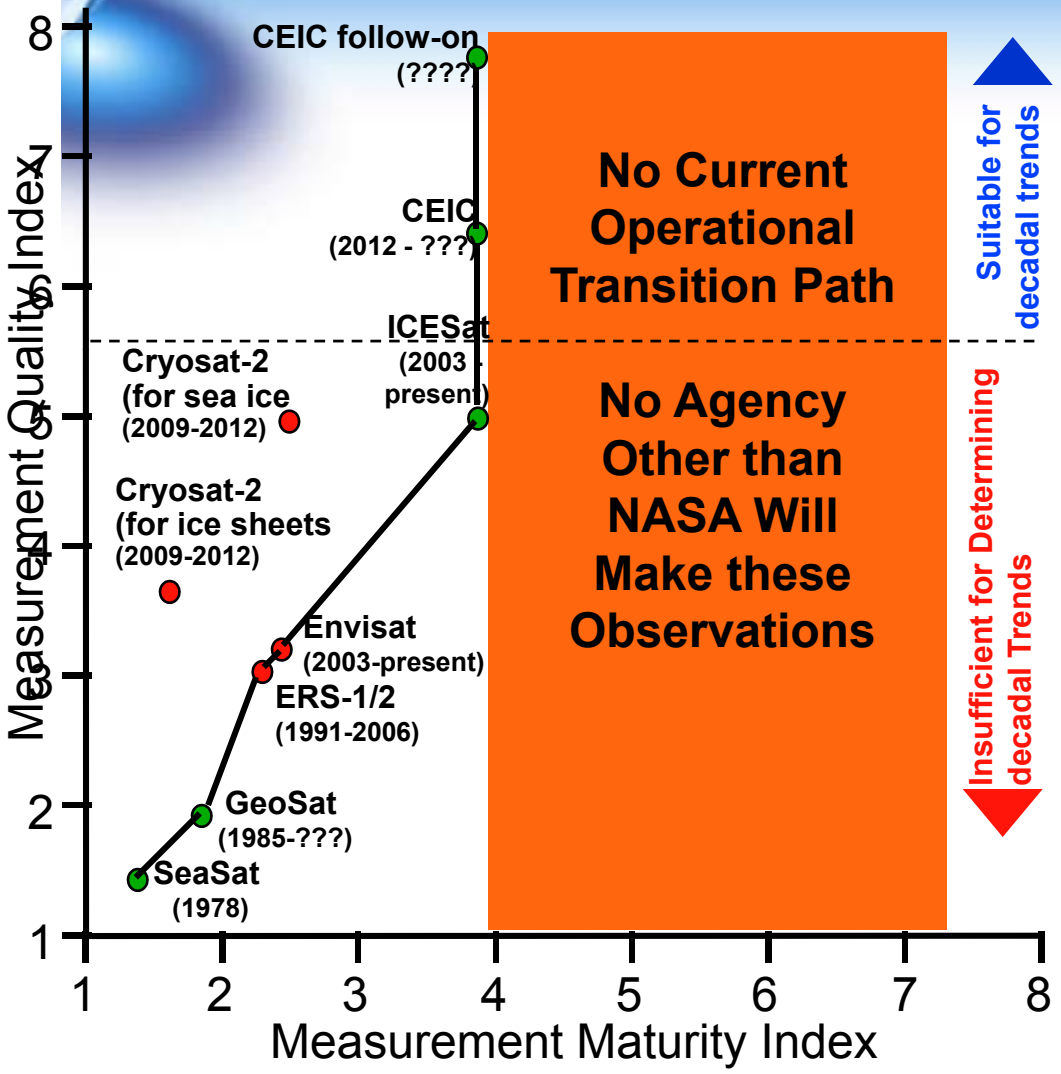
NABOS observations capture propagation of warm water anomalies further eastward, towards Alaskan backyard – how far will it go?

How will this warm water affect sea ice?

Arctic Ocean freshwater content changes and their causes

From Igor Polyakov UAF/IARC

Heritage Altimetry Missions/Measurement Progress



Key

Maturity Index *
1 = no known use for measurement
8 = Measured Operationally

Quality Index *
1 = potential science return
8 = approaches limits on performance

= domestic mission
= foreign mission

* See following page for further details

Note that ice measurements do not follow traditional Research-to-operations path, since no agency sees as its mandate to monitor ice sheets and sea ice thickness; thus MMI is limited to 4

Courtesy W. Abdalati - NASA/GSFC