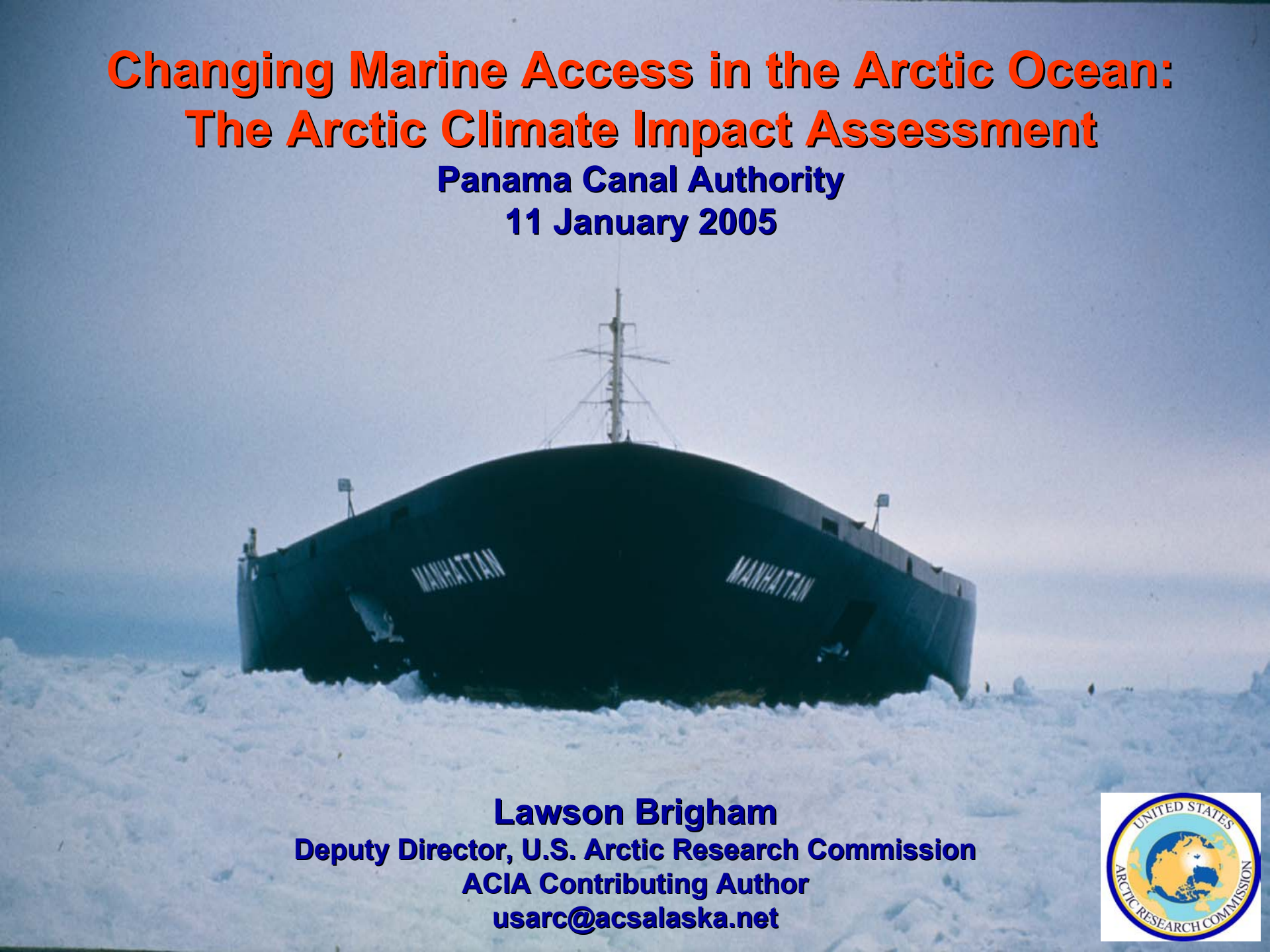
Changing Marine Access in the Arctic Ocean: The Arctic Climate Impact Assessment

Panama Canal Authority

11 January 2005



Lawson Brigham

Deputy Director, U.S. Arctic Research Commission

ACIA Contributing Author

usarc@acsalaska.net

Outline

- Icebreaker Access in the Central Arctic Ocean 1977-2004
- Arctic Climate Impact Assessment (ACIA)
- ACIA Sea Ice Projections 2000-2100
- Canadian Archipelago/Northwest Passage
- Northern Sea Route
- Summary Points

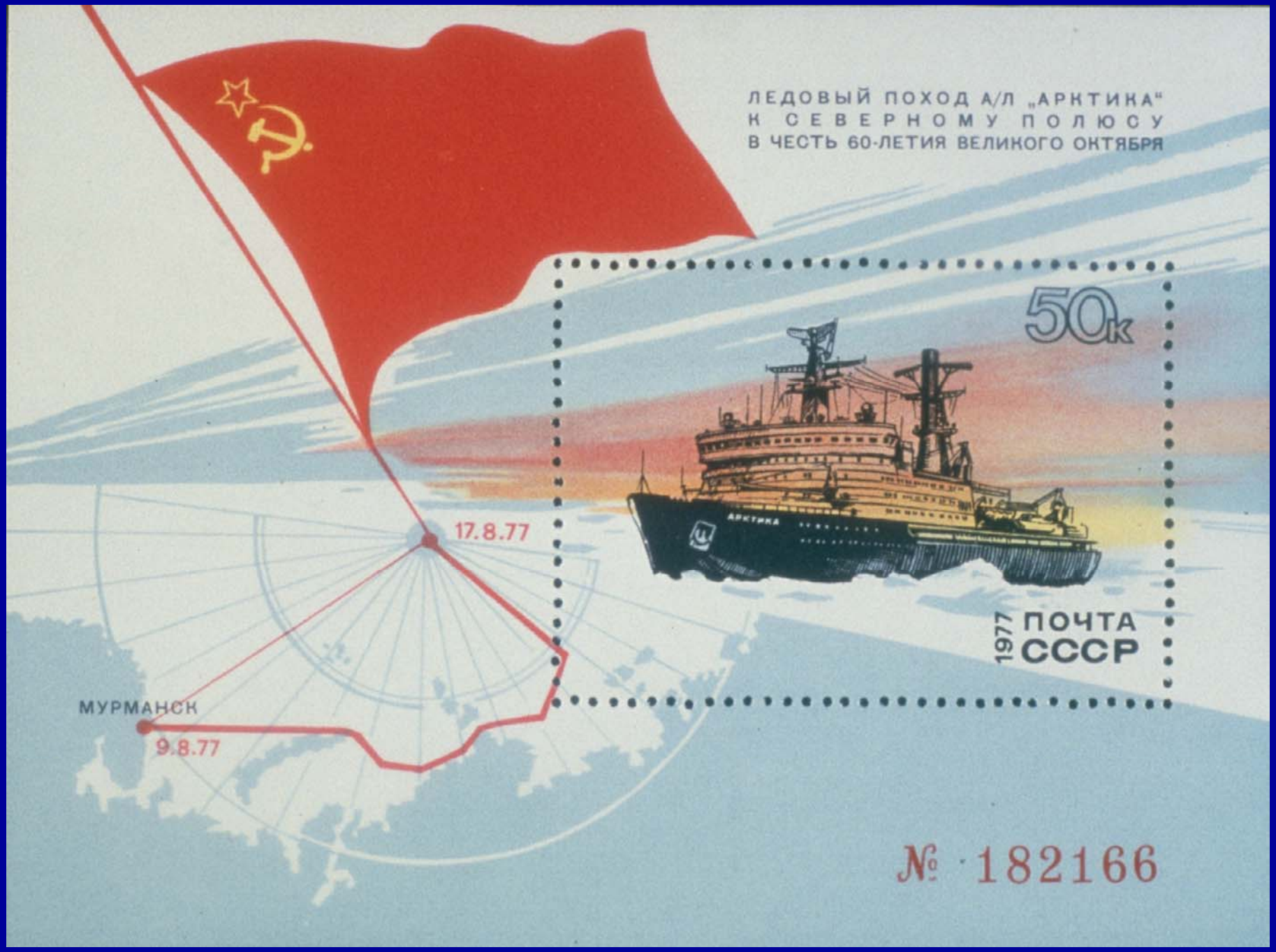
Icebreaker Transits to the North Pole and Trans-Arctic Voyages 1977-2004

- 52 transits to the North Pole

  (42 Russia, 4 Sweden, 2 Germany, 2 USA, 1 Canada, 1 Norway)

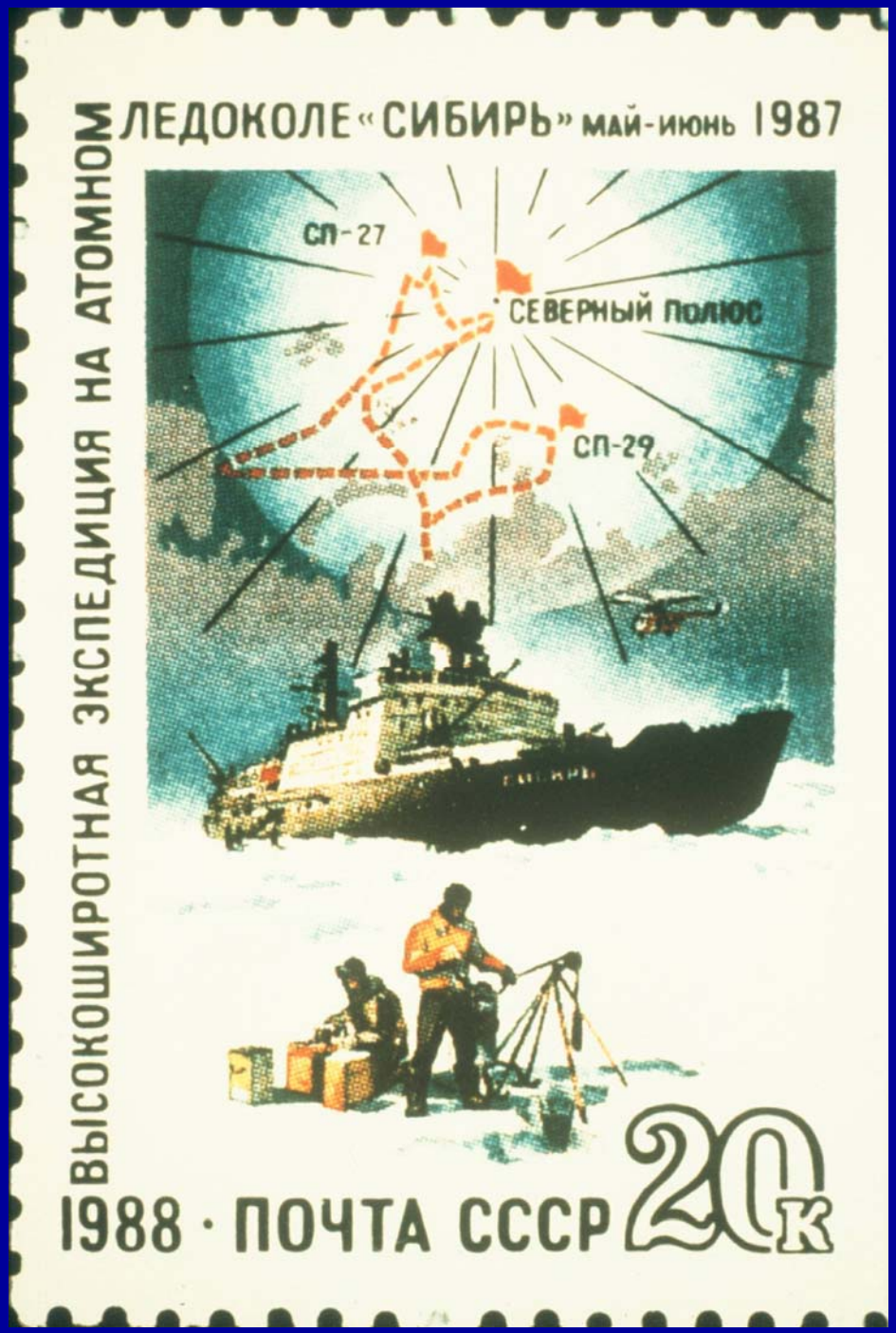
- 5 trans-Arctic voyages

  (1991, 1994, 1996)

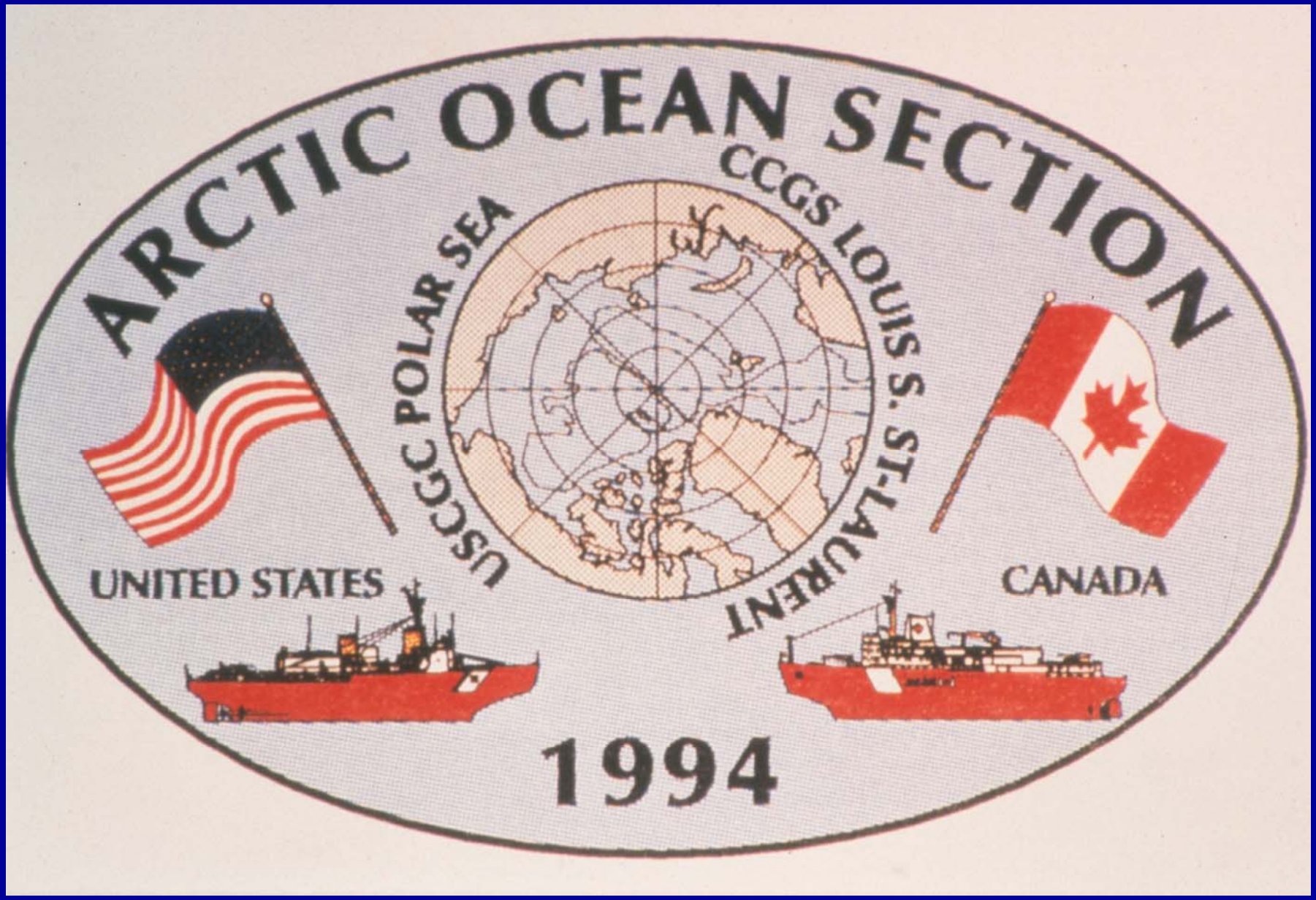

ЛЕДОВЫЙ ПОХОД А/Л „АРКТИКА"
К СЕВЕРНОМУ ПОЛЮСУ
В ЧЕСТЬ 60-ЛЕТИЯ ВЕЛИКОГО ОКТЯБРЯ
50к
АРКТИКА
17.8.77
МУРМАНСК
9.8.77
1977
ПОЧТА
СССР
№ 182166

8 May-19 June 1987

- Most demanding icebreaker operation to date.
- Near-maximum thickness of Arctic sea ice.

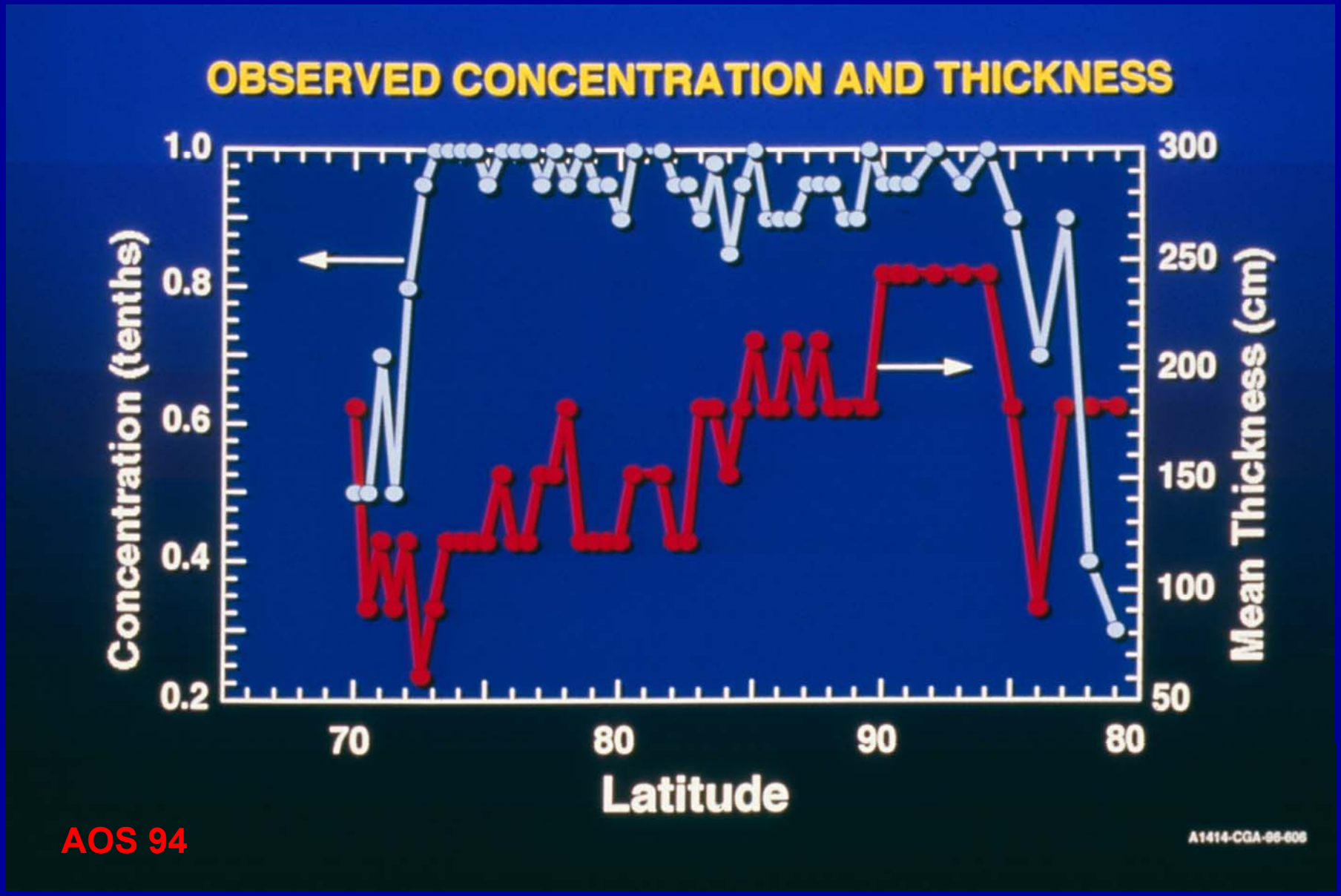


СИБИРЬ
North Pole
25 May 1987

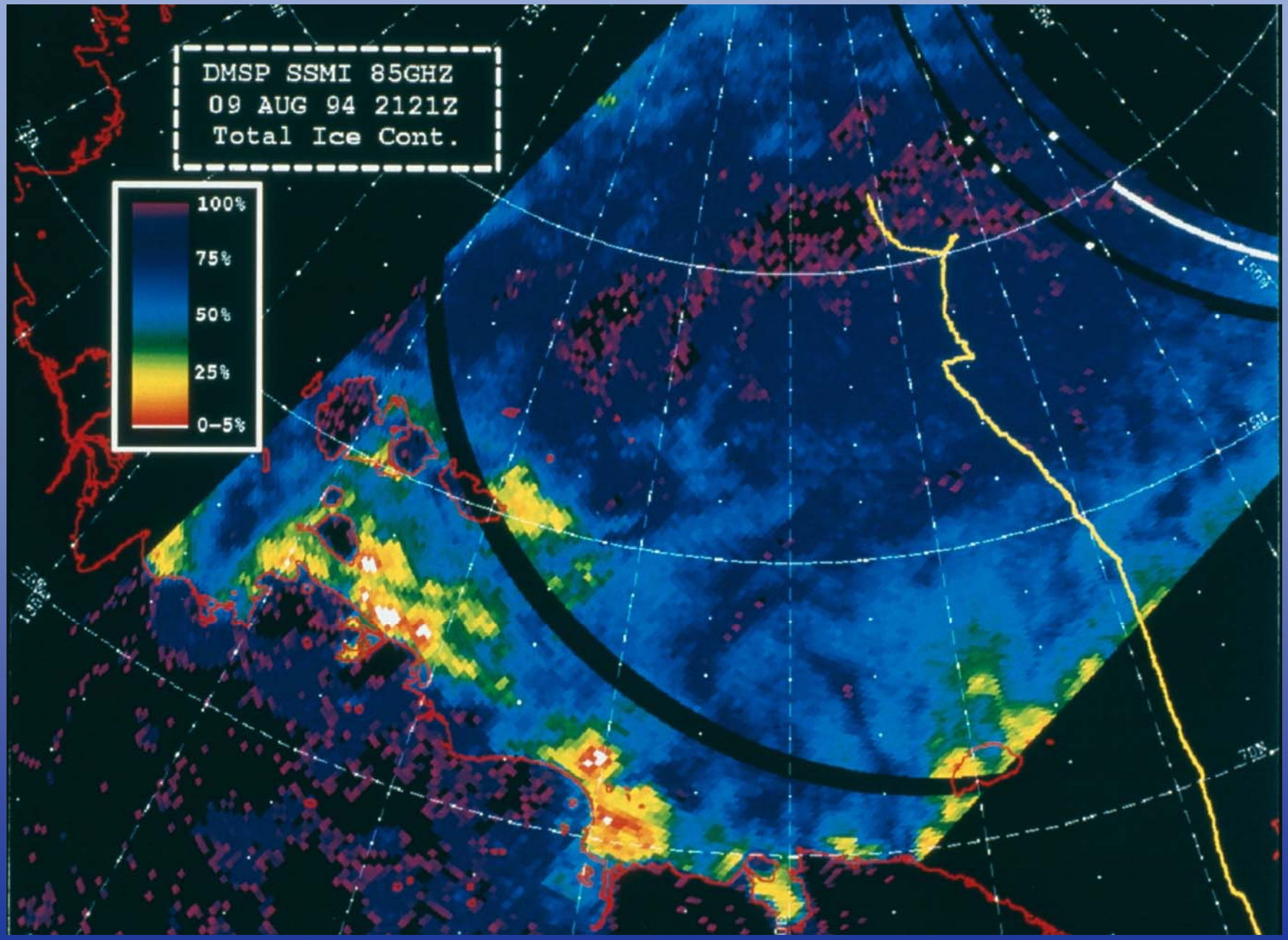


July – August 1994

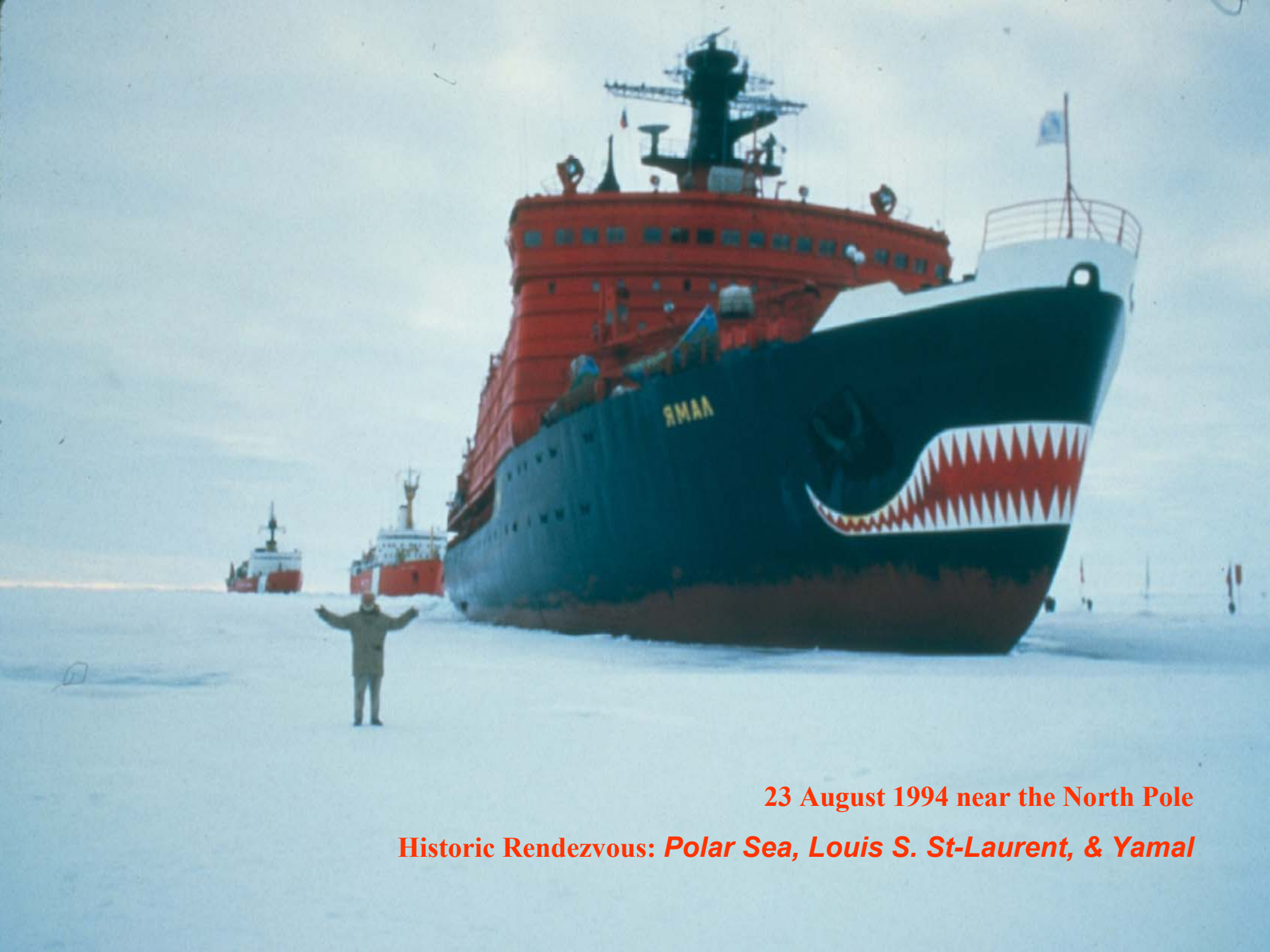
AOS 94
90°E
Russia
70o
Barents Sea
2000 m
LOR
NGR
NB
AB
2000 m
31
38
24
20
35
FS
0°
39
MB
AMR
7
BS
CB
2000 m
Alaska
Greenland
2000 m
Canada
90 W


OBSERVED CONCENTRATION AND THICKNESS
Concentration (tenths)
1.0
0.8
0.6
0.4
0.2
Mean Thickness (cm)
300
250
200
150
100
50
70
80
90
80
Latitude
A1414-CGA-96-606

AOS 94



Polar Sea real-time satellite imagery AOS 94



23 August 1994 near the North Pole

Historic Rendezvous: ***Polar Sea, Louis S. St-Laurent, & Yamal***

Arctic Climate Impact Assessment (ACIA)

- Overview released Nov 2004/Science Report ~ Mar 2005
- Partnership: Arctic Council & International Arctic Science Committee
- Principal Funding: US National Science Foundation
  - Contributions from the Arctic nations
  - Secretariat at University of Alaska
- 4-year effort; 300 researchers (~30% USA)
- Projections based on greenhouse gas emissions/scenarios (B2)
- Will be fed into the next UN IPCC Assessment
- Historic, robust scientific assessment (consensus of the international Arctic research community)

The Arctic is a Preview
of Earth's Future Climate
10 Years of Change in Arctic =
25 Years in Rest of the world.

"The Arctic's Response to Climate Change" (from ACIA)

- ✓ Increases in winter surface air temperatures
- ✓ Increases in precipitation
- ✓ Thawing of previously permanently frozen ground
- ✓ Reductions in Arctic sea ice extent and thickness
- ▪ Variations in the ranges of animals and ecosystems
- ✓ Increases in storm surges and coastal erosion
- ▪ Increases in Siberian river outflows to the Arctic Ocean
- ✓ Warming of Arctic oceanic waters
- ▪ Record low levels of stratospheric ozone
- ▪ Increases in ground levels of ultra violet radiation

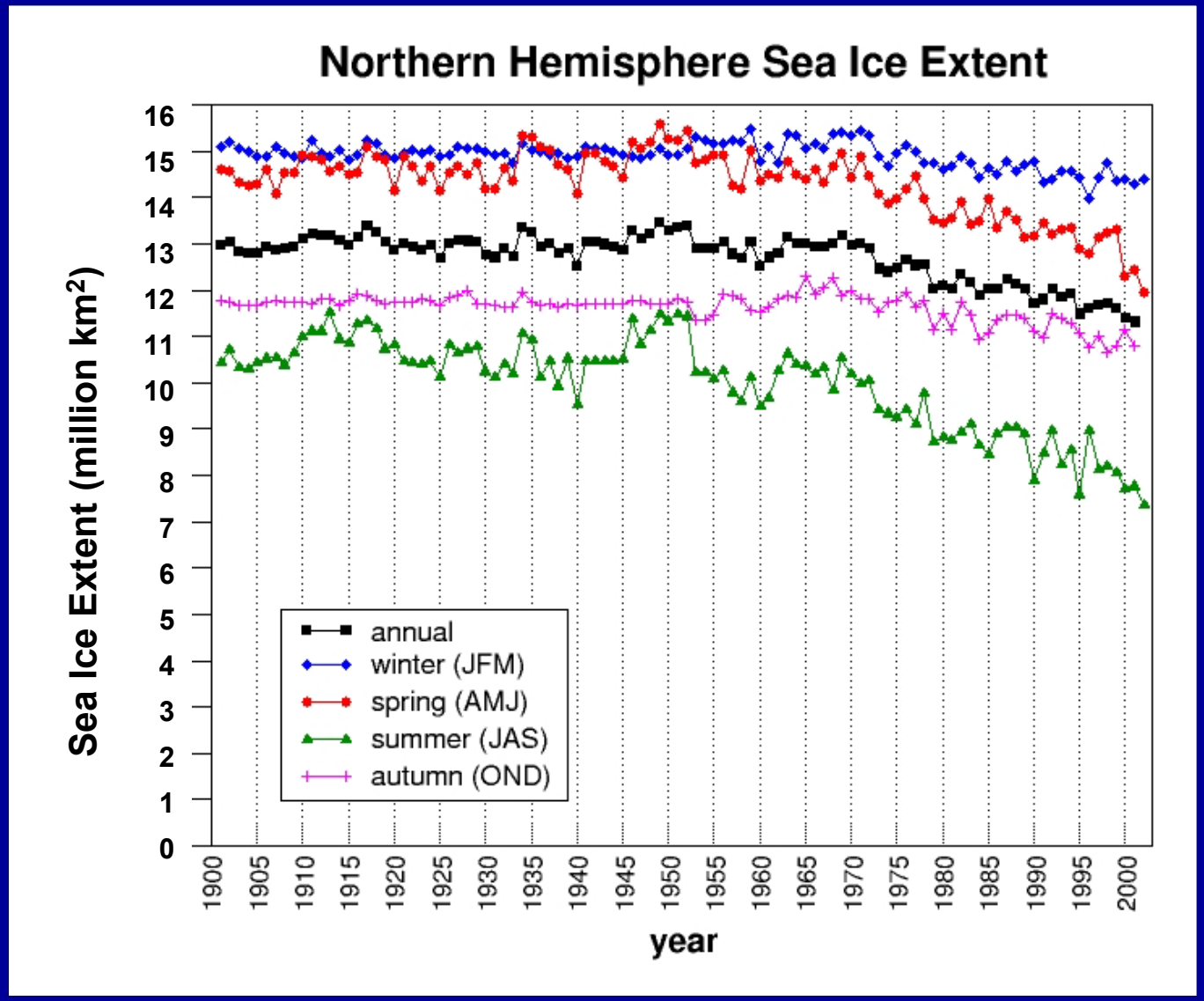
Arctic Sea Ice Transformations Significant to Marine Transport

- Extent: ~3% decrease per decade
- Multiyear Ice/Perennial Pack Ice:
  ~7% decrease per decade
- Thickness: 14 to 32% reductions reported
- General increase in the length of the ice melt season

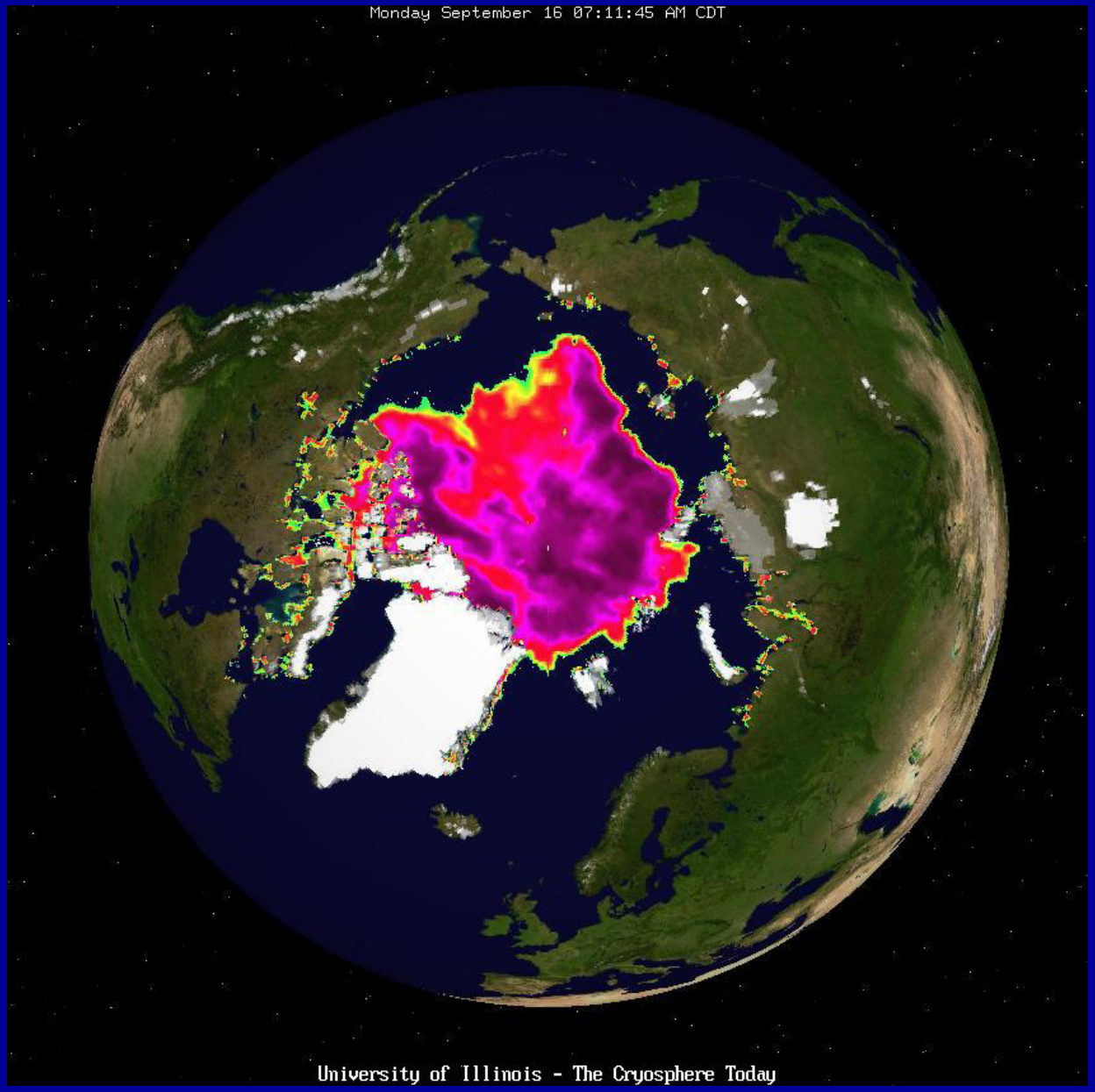
Sea Ice

Observational data show a decrease of coverage

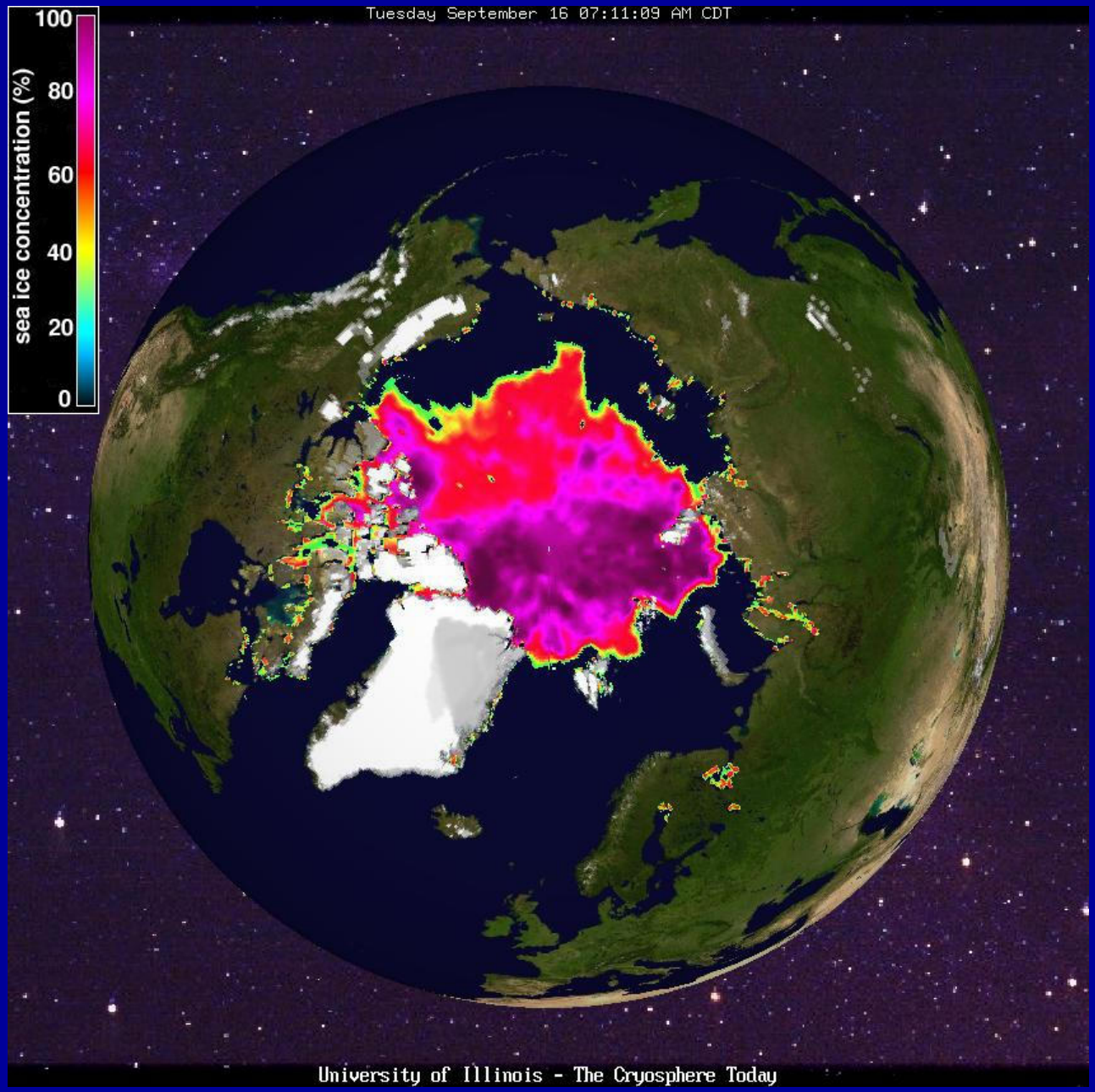
- Decrease is largest in summer
- Decrease is largest since late 1980s



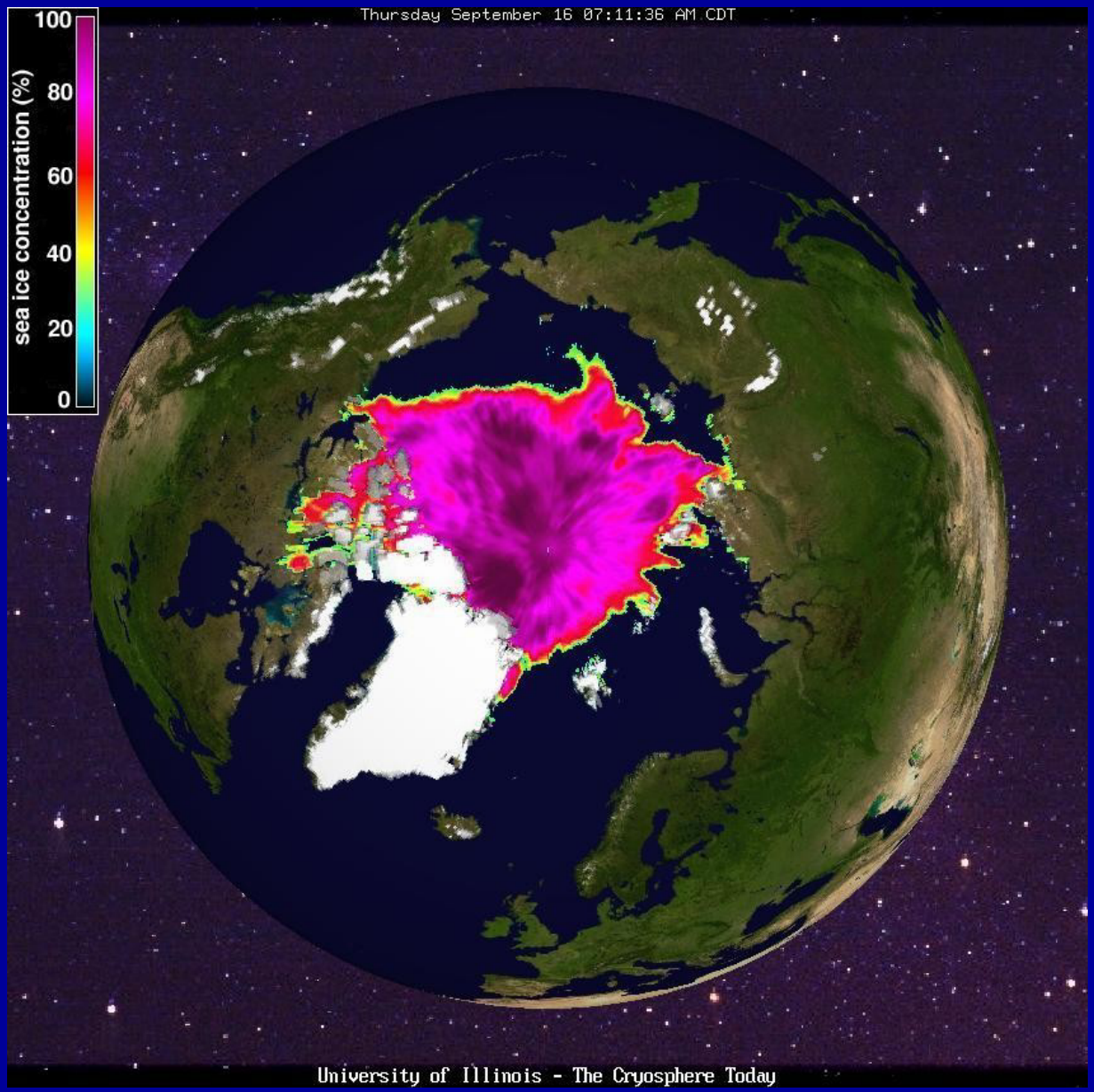
16 September 2002



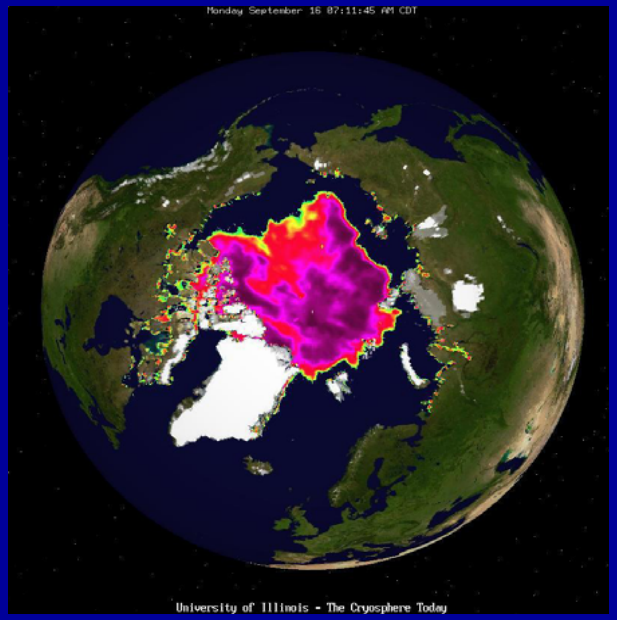
16 September 2003



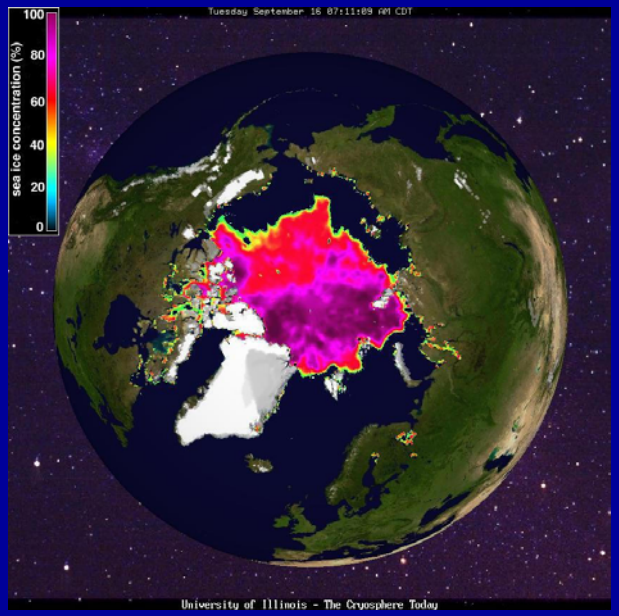
16 September 2004



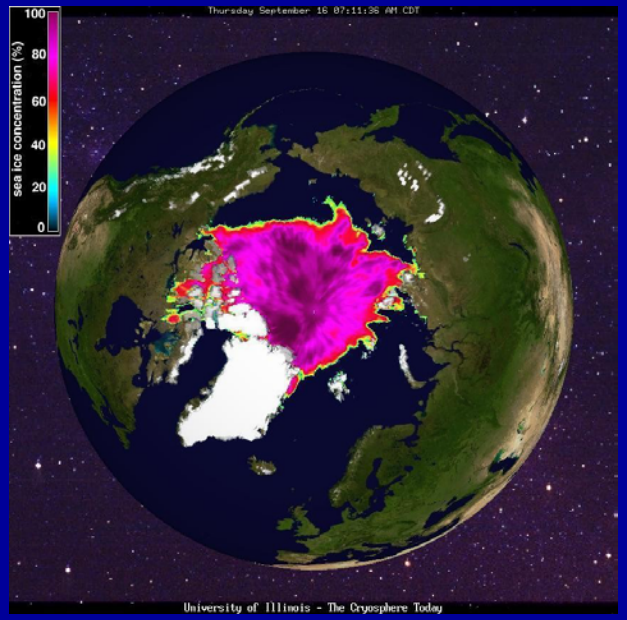
16 September 2002



16 September 2003

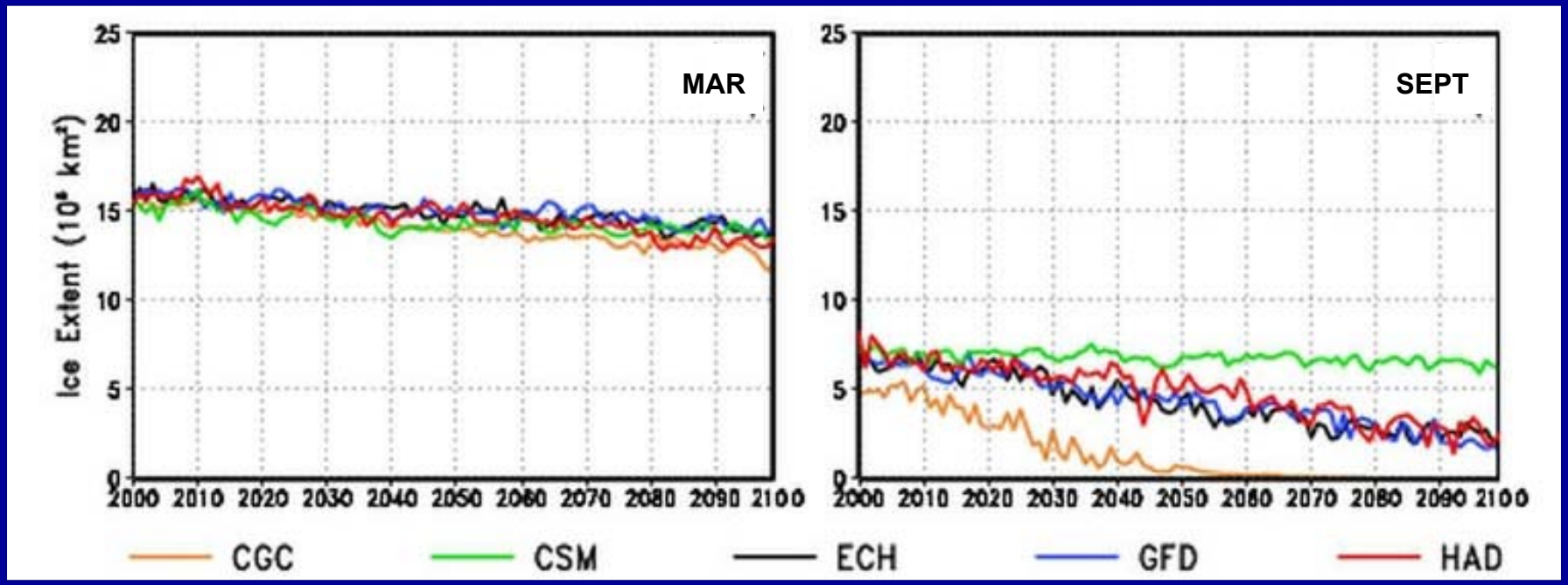


16 September 2004

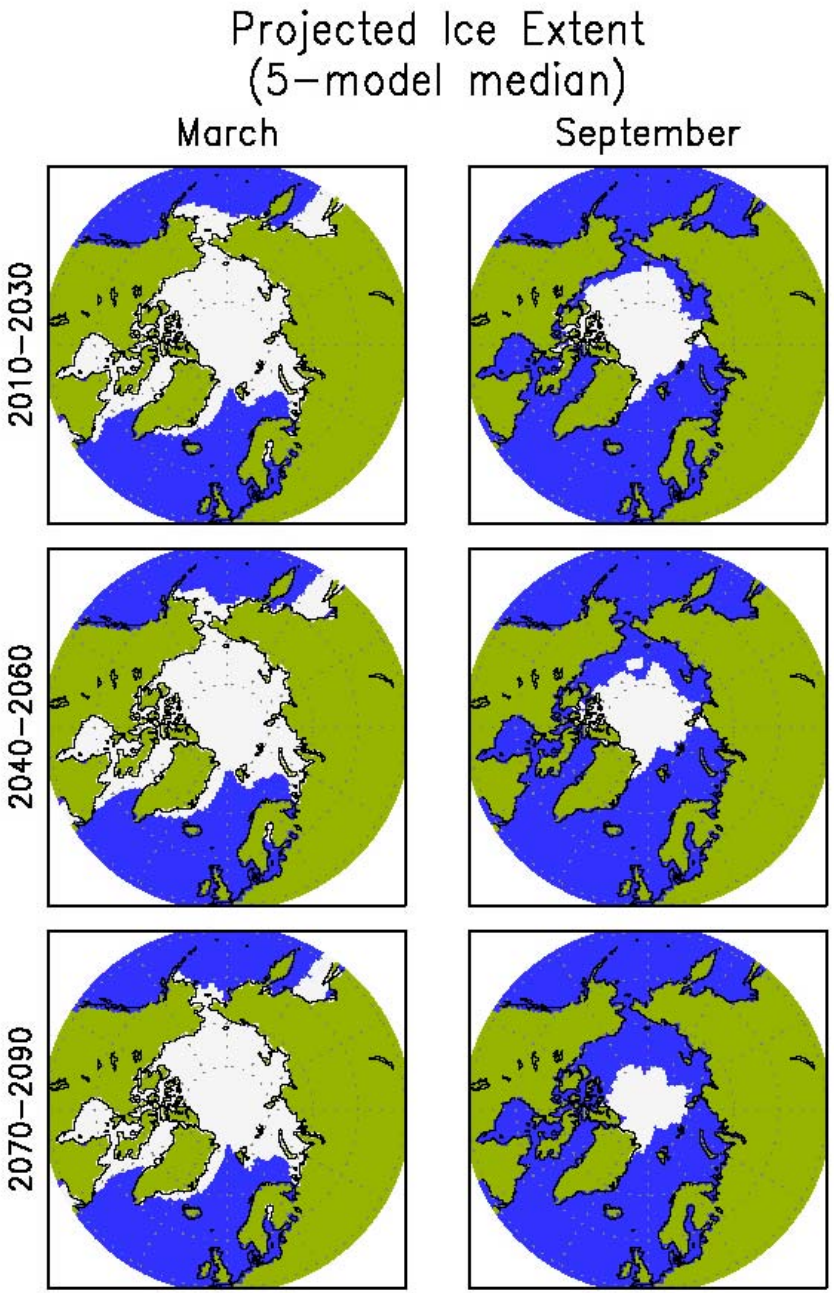


Arctic Climate Impact Assessment
Climate model projections of sea ice extent: 2000 - 2100

March September



Arctic Climate Impact Assessment

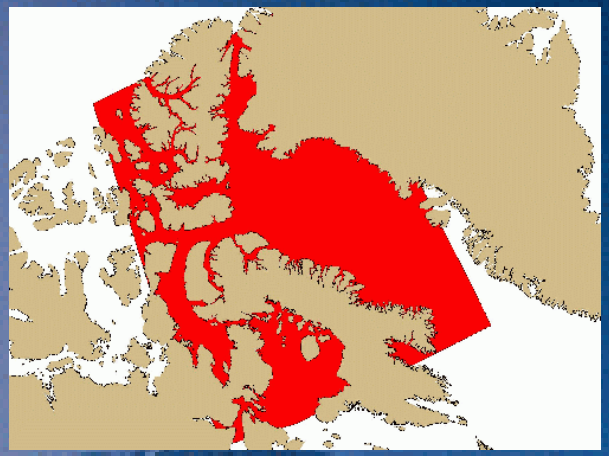


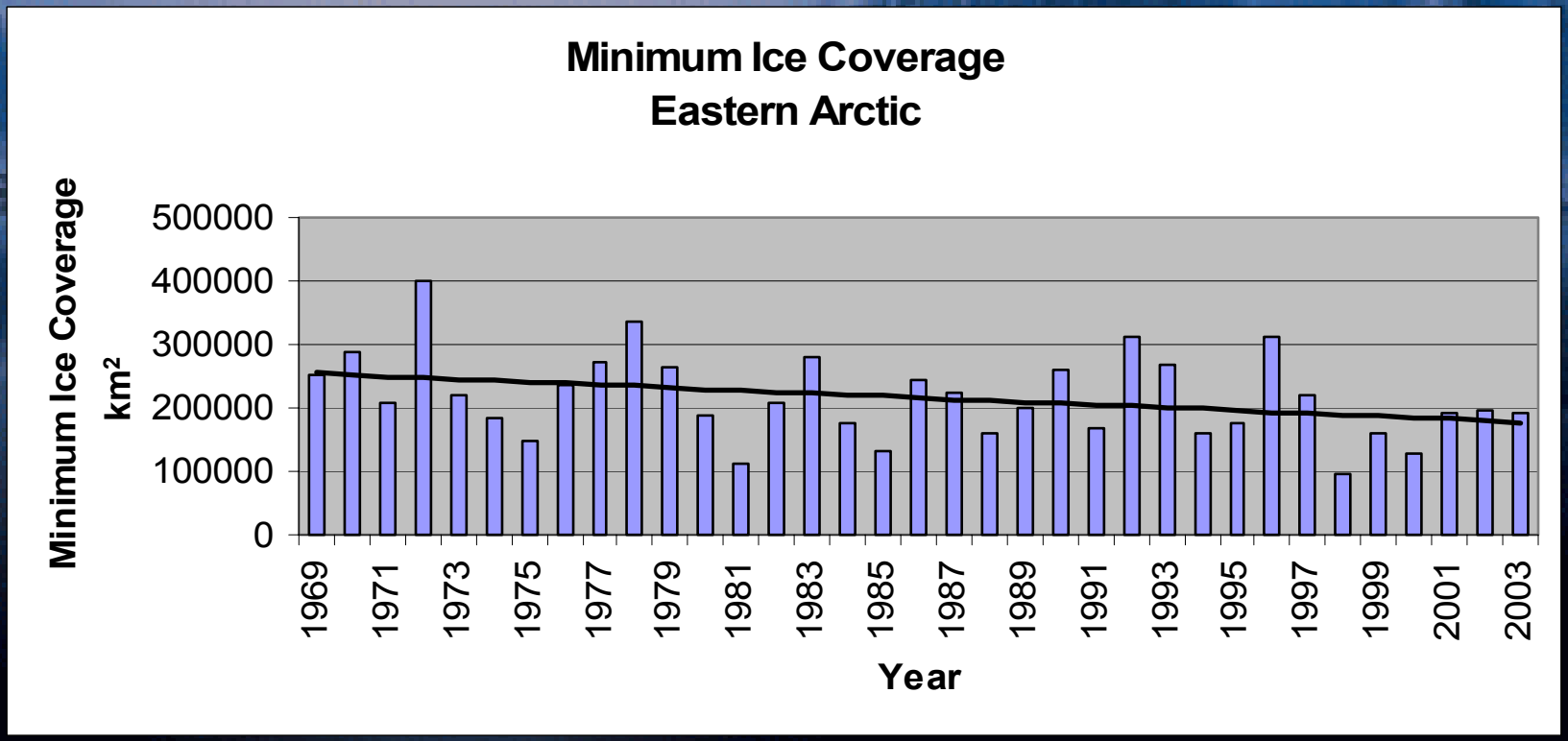
Challenges of the Canadian Archipelago and the Northwest Passage

- GCM resolution constraints
- High inter-annual variability of sea ice coverage

Regional Eastern Arctic

- Loss of Sea Ice Coverage
- Large Inter-annual Variability

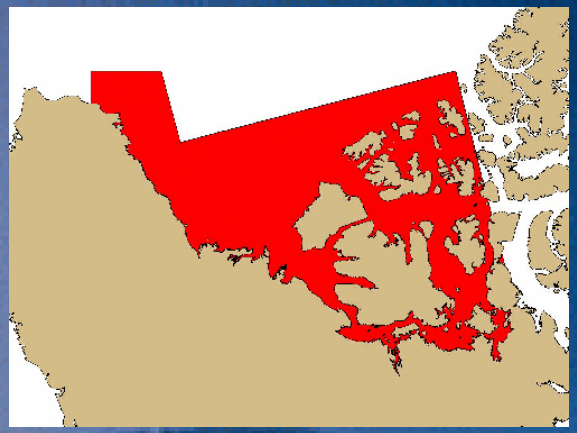


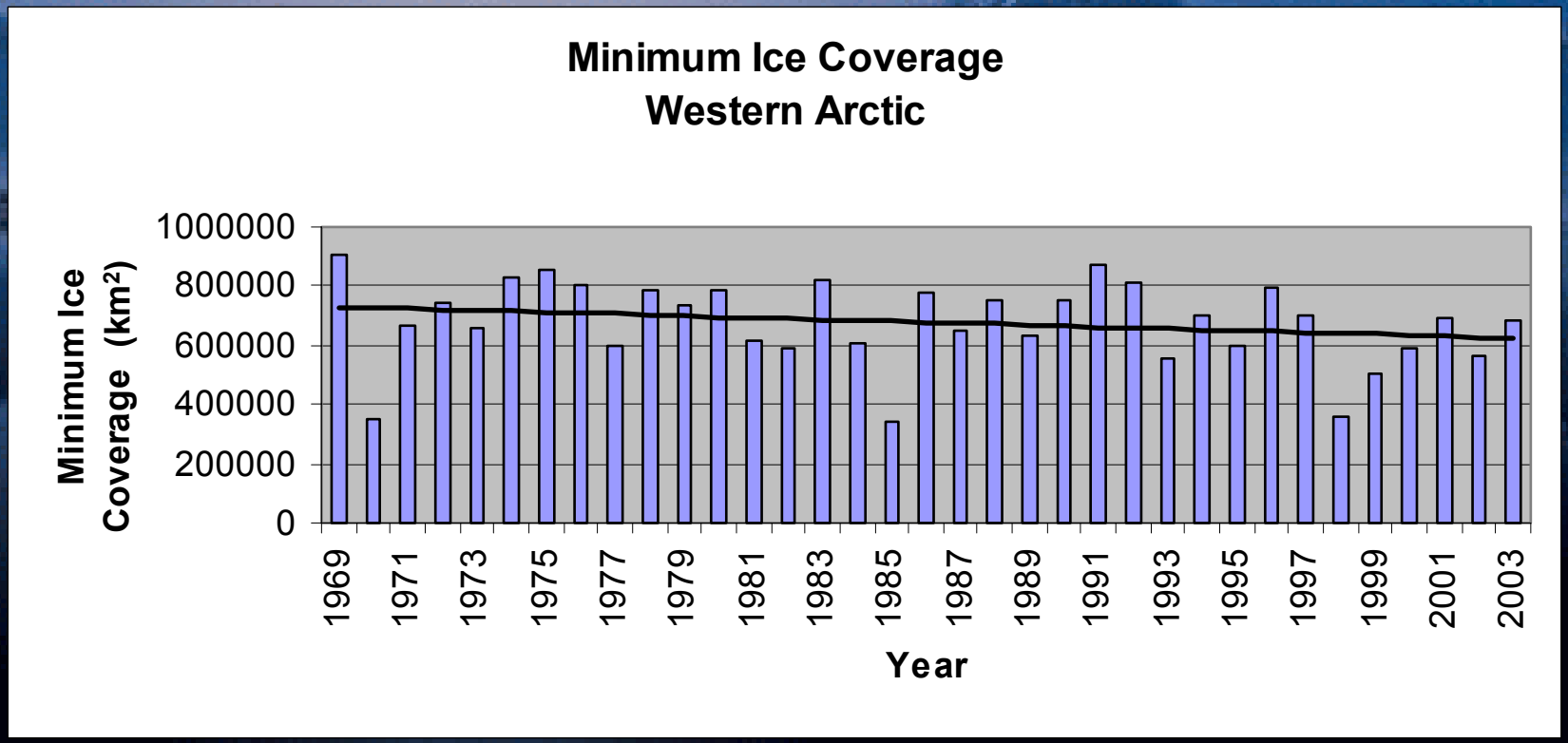


Canadian Ice Service (2004)

Regional Western Arctic

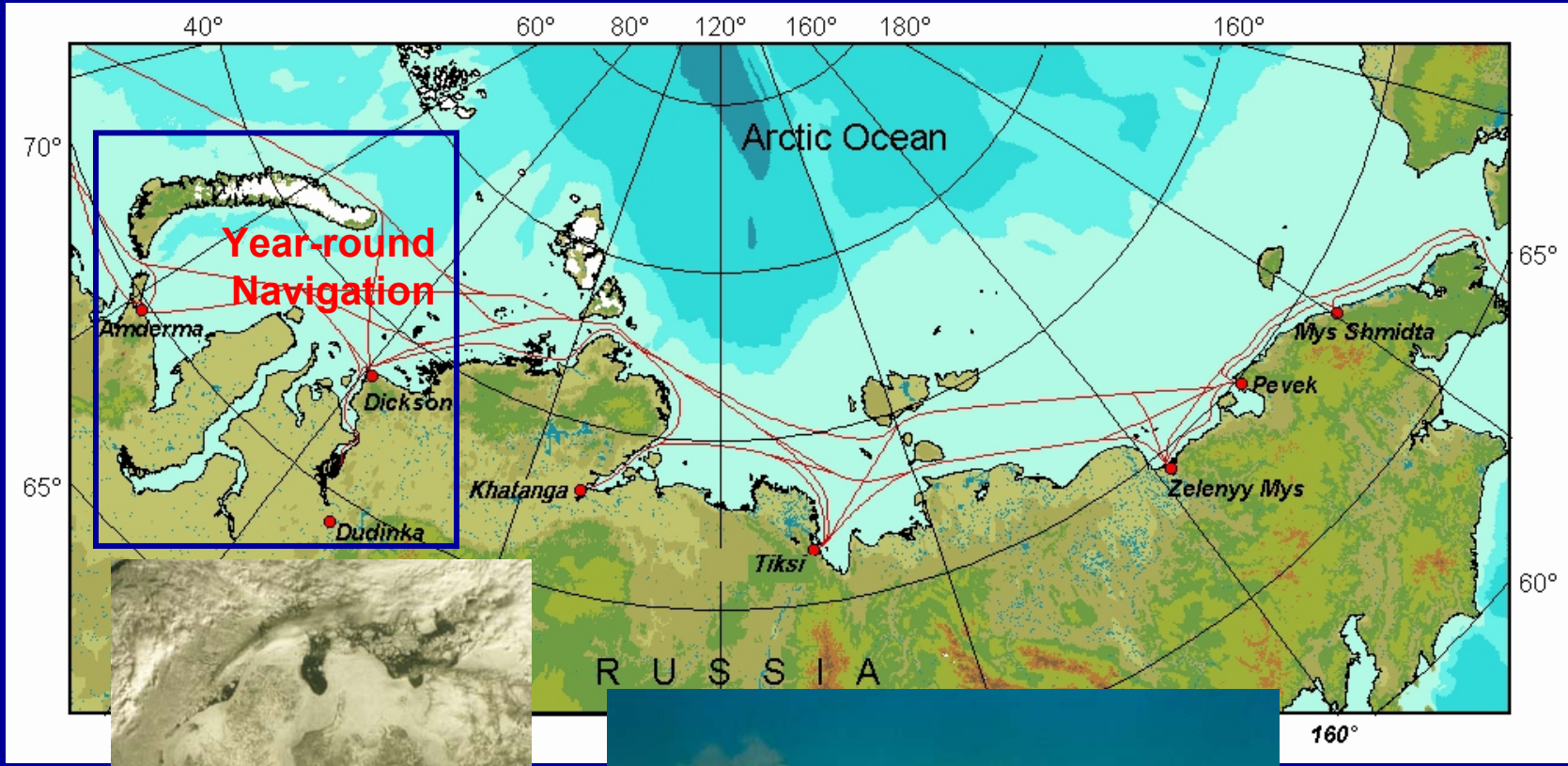
- Loss of Sea Ice Coverage
- Inter-annual Variability

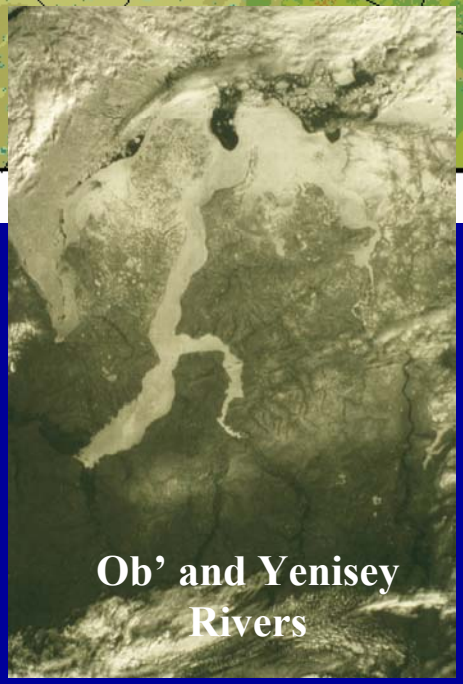




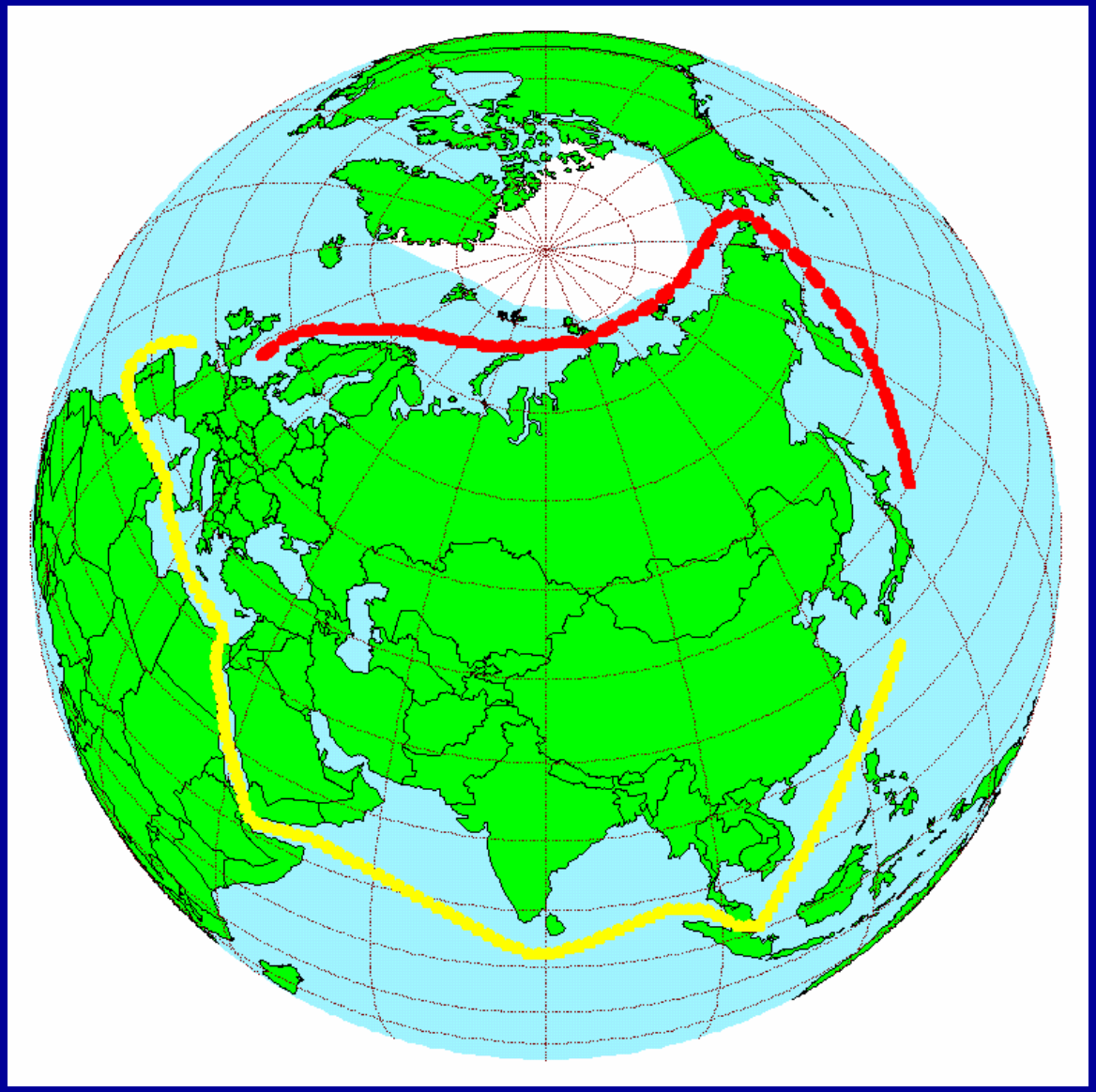
Canadian Ice Service (2004)

The Northern Sea Route





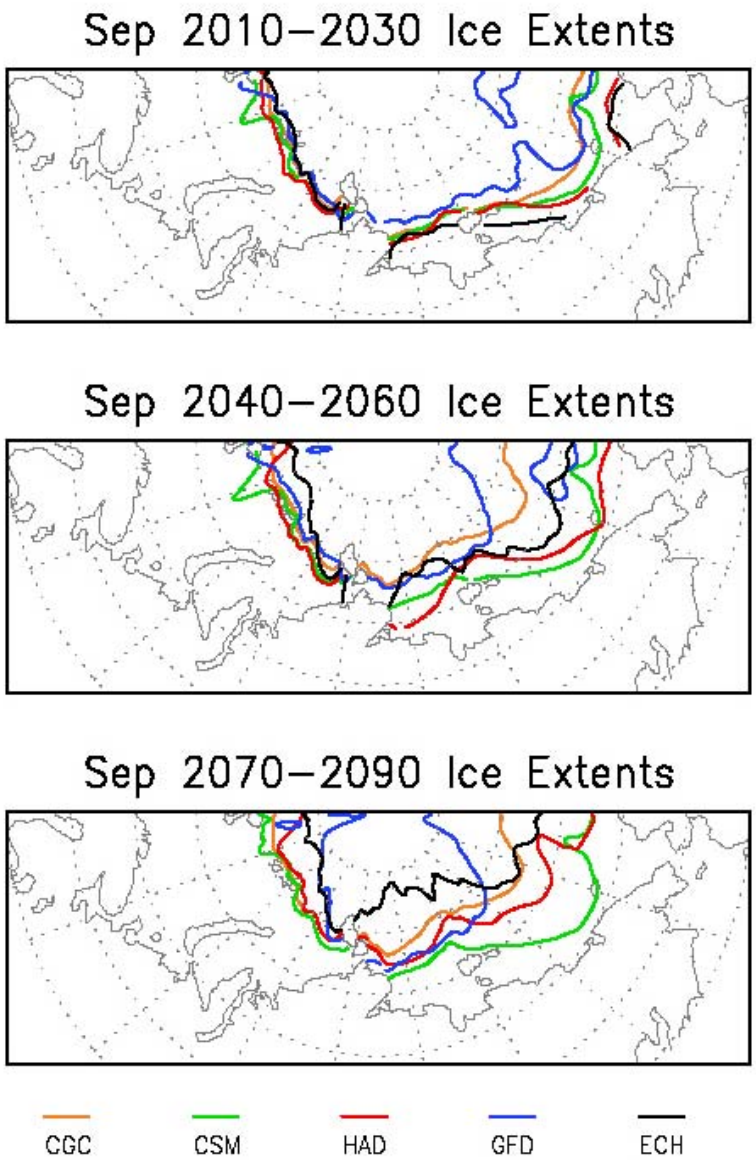
INSROP
(1999)



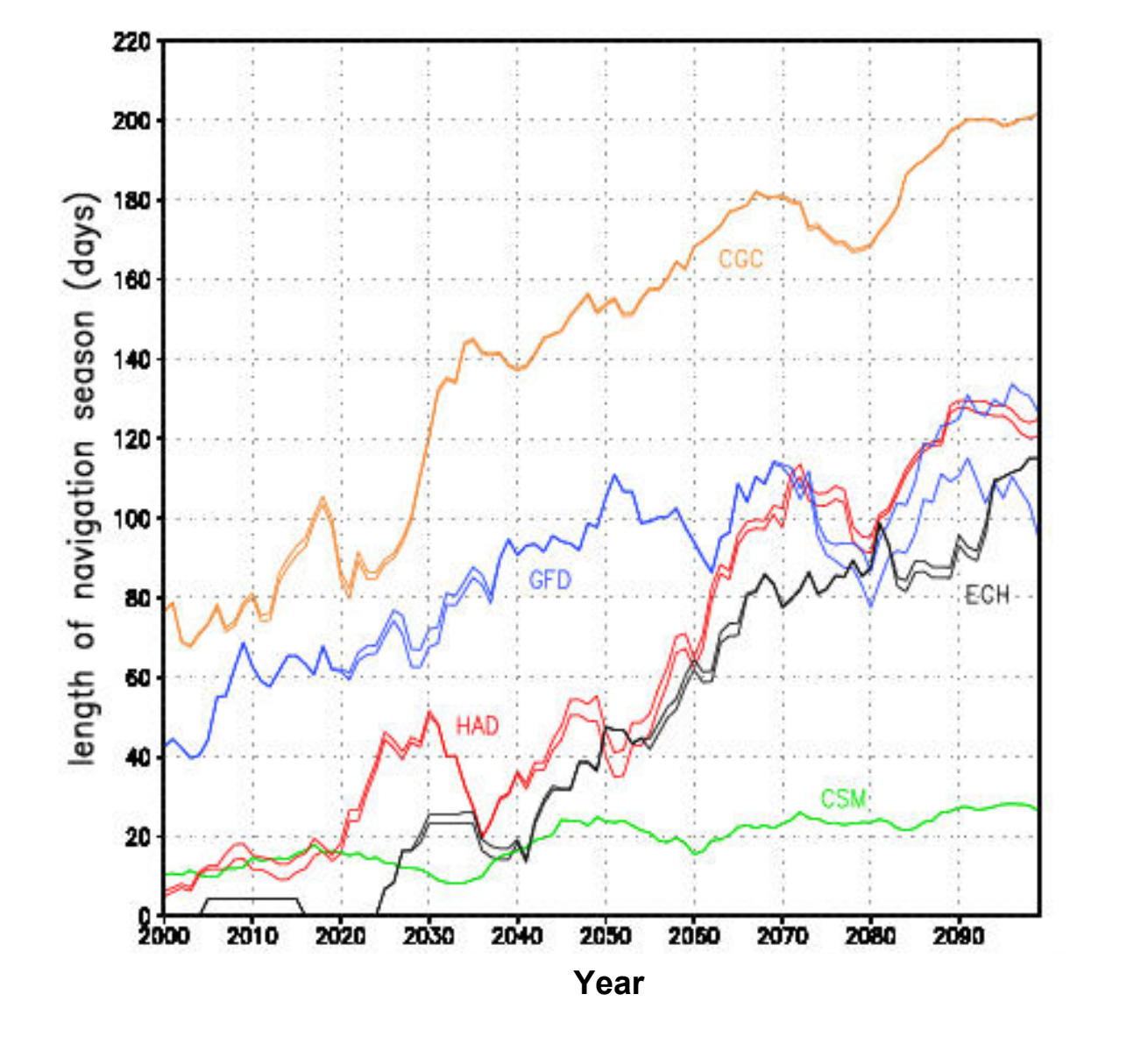
INSROP (1999)

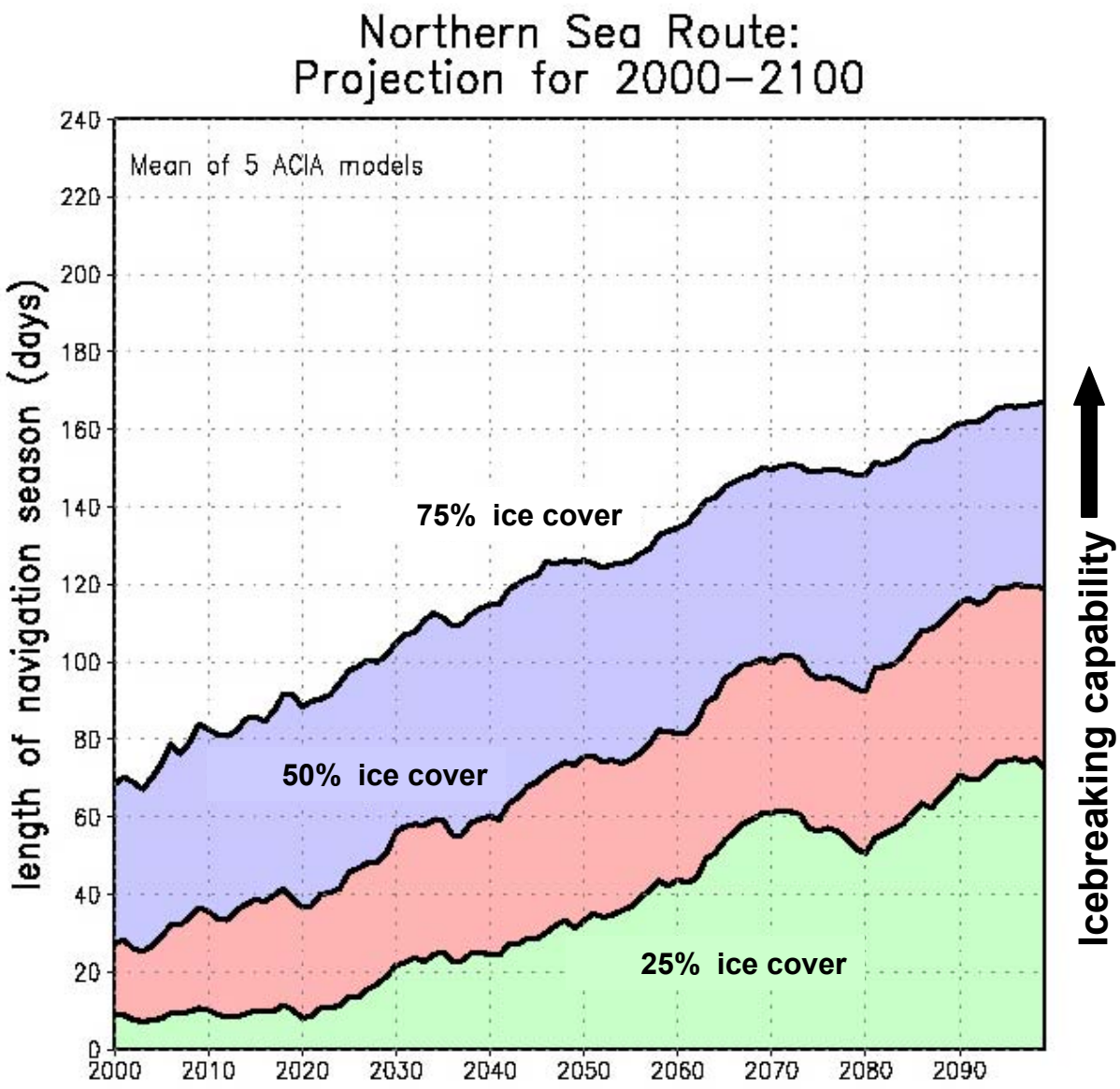
СОВЕТСКИЙ СОЮЗ

ACIA Regional NSR Sea Ice Projections

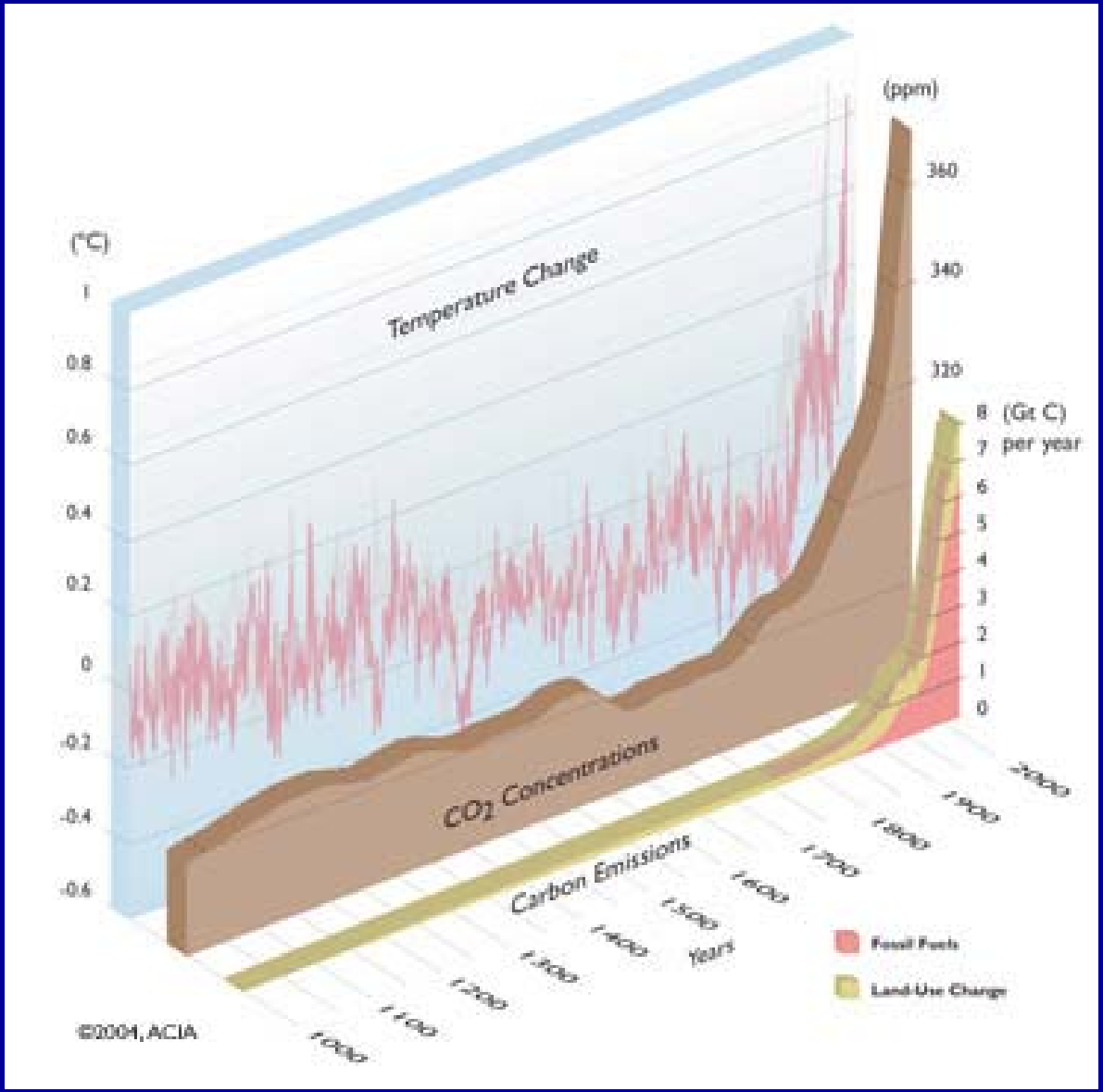


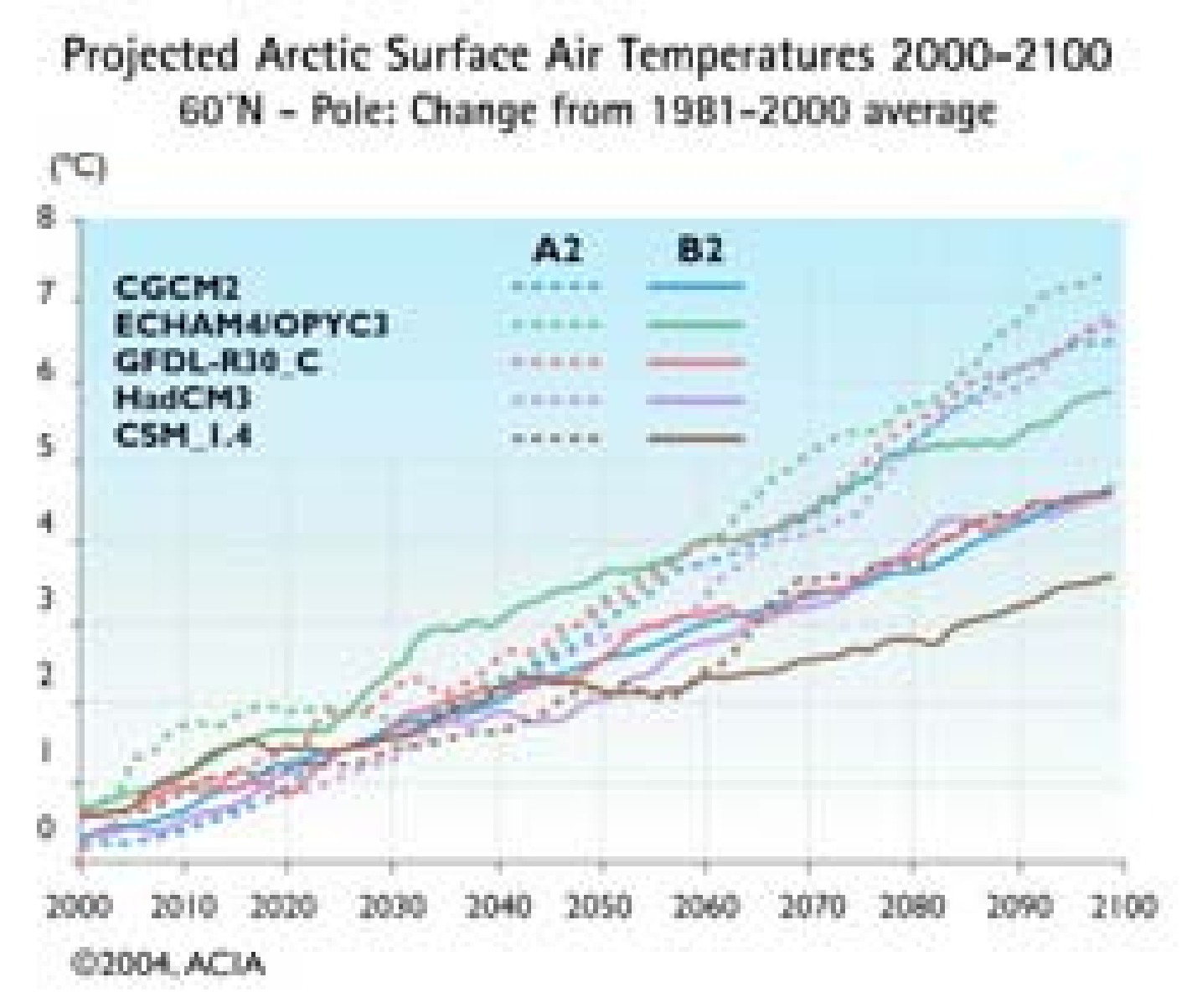
Northern Sea Route: Navigability Projected for 2000 – 2100 (50% ice cover)



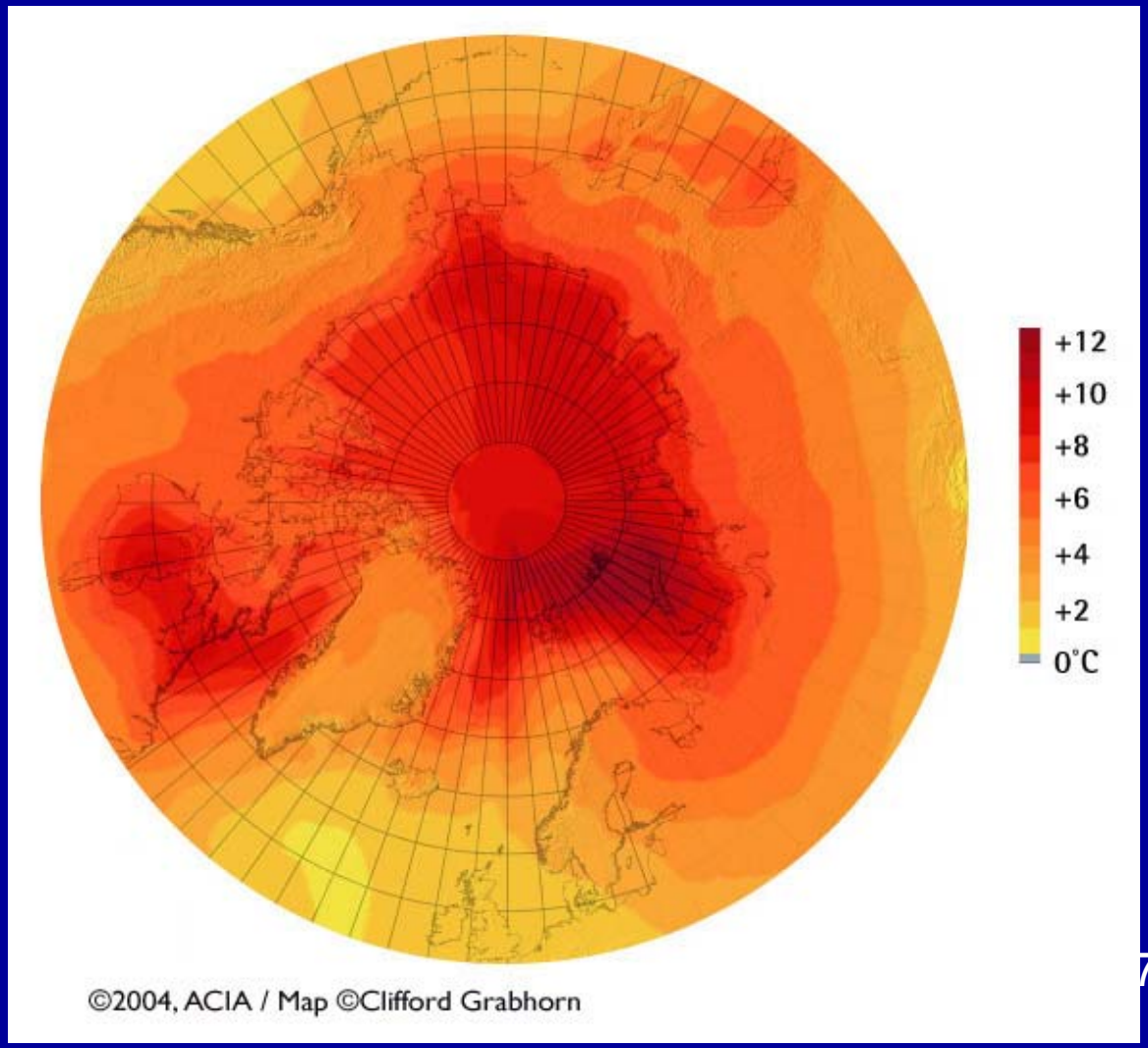

Northern Sea Route:
Projection for 2000–2100
Mean of 5 ACIA models
length of navigation season (days)
0
20
40
60
80
100
120
140
160
180
200
220
240
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
75% ice cover
50% ice cover
25% ice cover
Icebreaking capability

Rising Global Air Temperatures

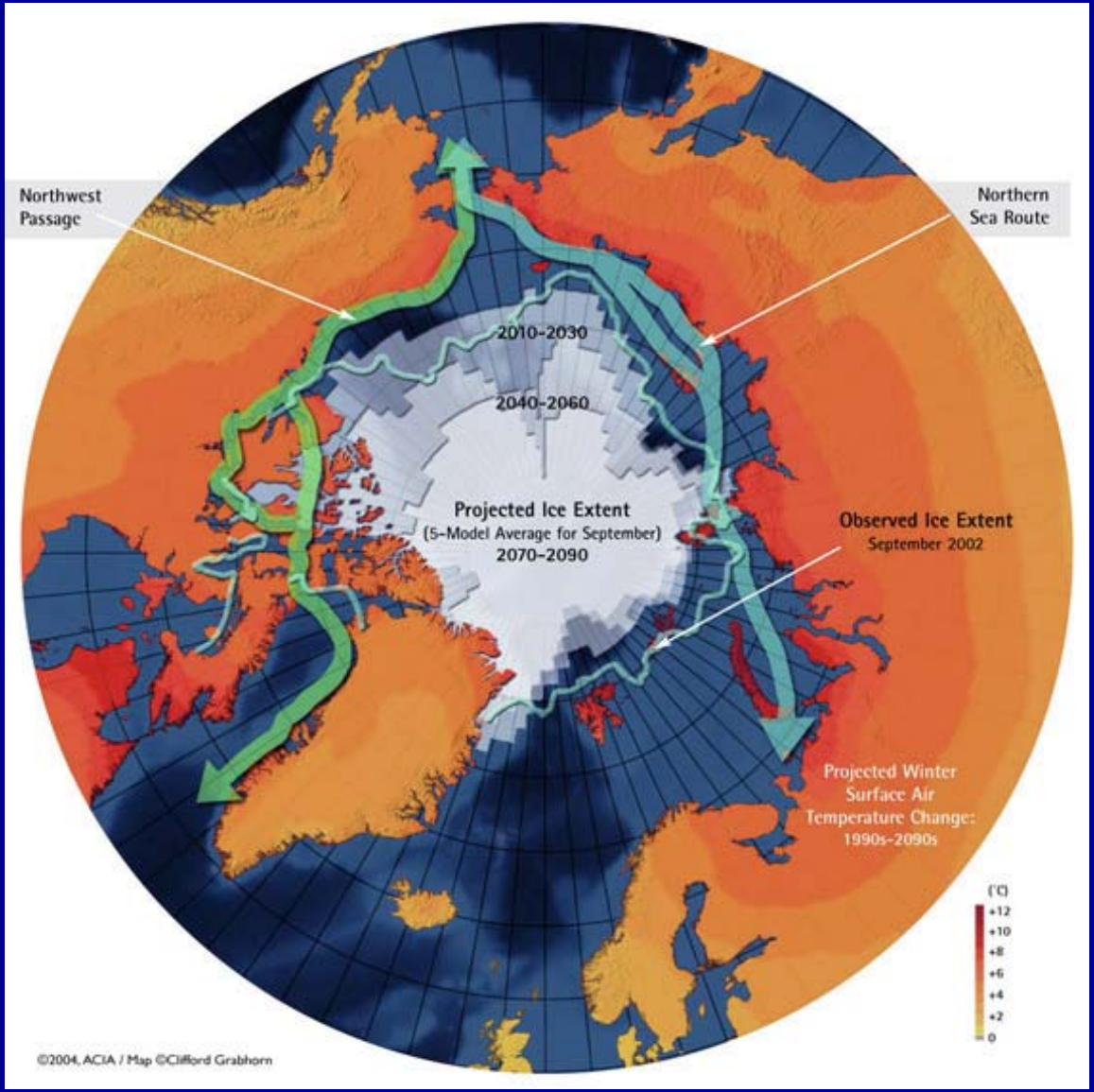



Projected Arctic Surface Air Temperatures 2000-2100
60°N - Pole: Change from 1981-2000 average
(°C)
A2
B2
CGCM2
ECHAM4/OPYC3
GFDL-R30_C
HadCM3
CSM_1.4
0
1
2
3
4
5
6
7
8
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
©2004, ACIA

Projected Surface Air Temperature Change: 1990s -2090s Winter



ACIA Key Finding #6: Reduced sea ice is very likely to increase marine transport and access to resources.



Summary Points

- Observed retreat of Arctic sea ice is real.
- Icebreakers have operated in the Central Arctic Ocean during summer since 1977.
- Extensive & increasing open water areas in **summer** around the Arctic Basin (and Alaska) projected throughout the 21st Century; increasing regional marine access.
- Small decrease in **winter** Arctic sea ice coverage projected throughout the 21st Century.
- Very high inter-annual variability of sea ice in the Northwest Passage observed in recent decades.

Summary Points (continued)

- ACIA sea ice projections for Russia's Northern Sea Route indicate an increasing length of the navigation season.

- Possibility for regular marine surface navigation in the Central Arctic Ocean in **summer** by 2050 (indicated by GCM sea ice projections).

- Quantification of Arctic marine access/navigation proving challenging; testing the limitations of GCMs; recognition of the need for Arctic regional models.

- Arctic Climate Impact Assessment: guide to current and future Arctic climate trends & consequences… a ‘strategic’ planning tool.