Preconditioning of Arctic Sea Ice for Summer Minima

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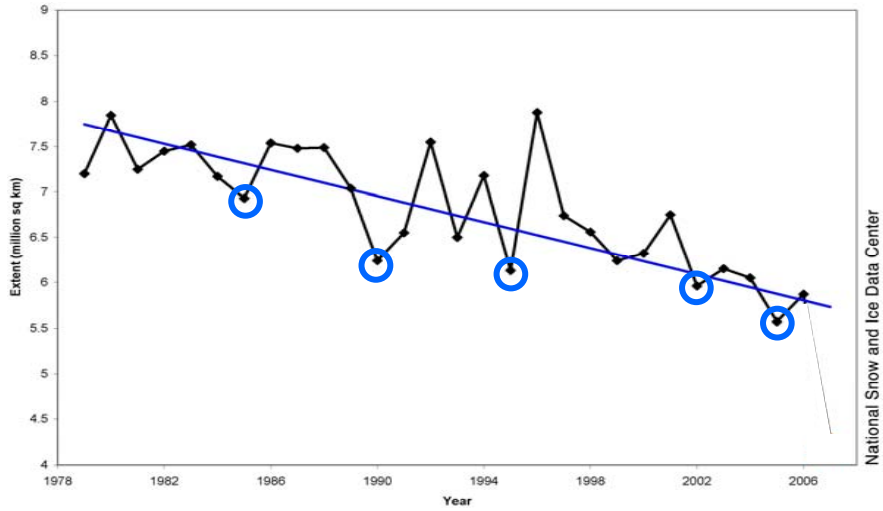
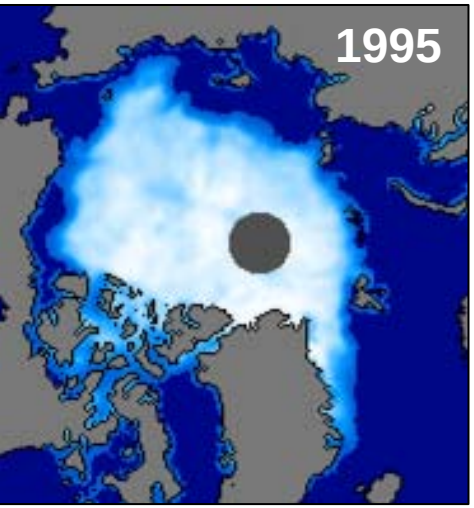
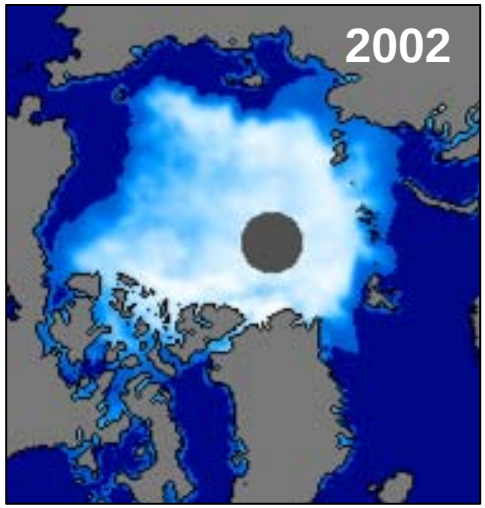
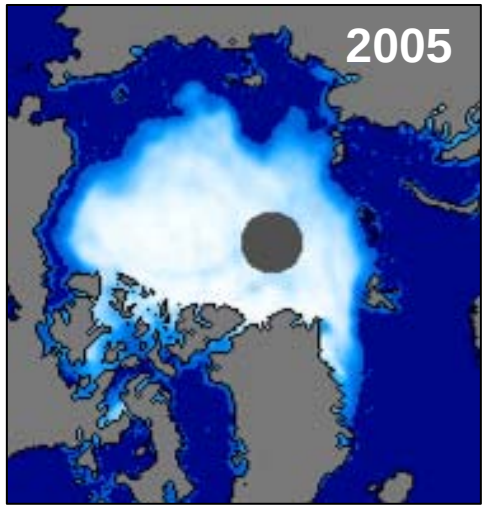
Trends in Arctic Summer Sea Ice Extent

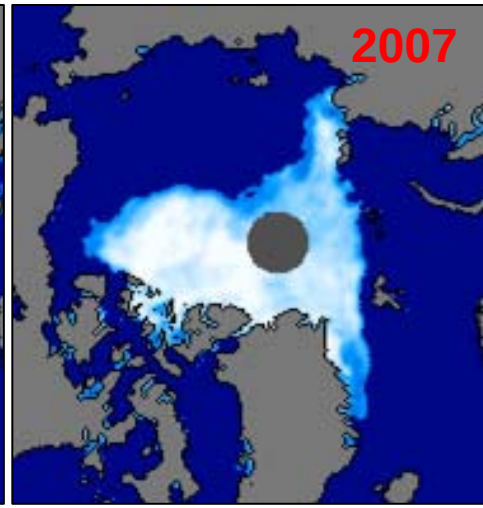


○ = record lows









Adapted from http://NSIDC.ORG

October 1, 2007

E-MAIL | FEEDBACK

Sea Ice in Retreat

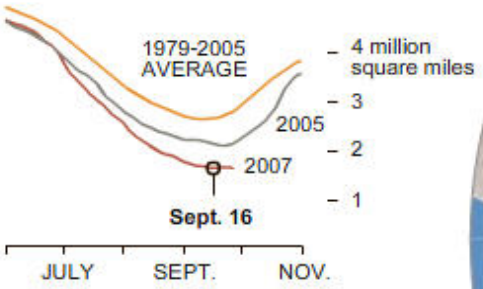
This summer saw a record-breaking loss of Arctic sea ice.

SUMMER SEA ICE | ATMOSPHERIC PRESSURE | AIR TEMPERATURE | CLOUD COVER | SOLAR HEATING

SUMMER SEA ICE

This summer saw a record-breaking loss of Arctic sea ice. Experts attribute the changes to the interaction of wind, weather, ice drift, ocean currents and greenhouse gases.

SUMMER SEA ICE EXTENT*



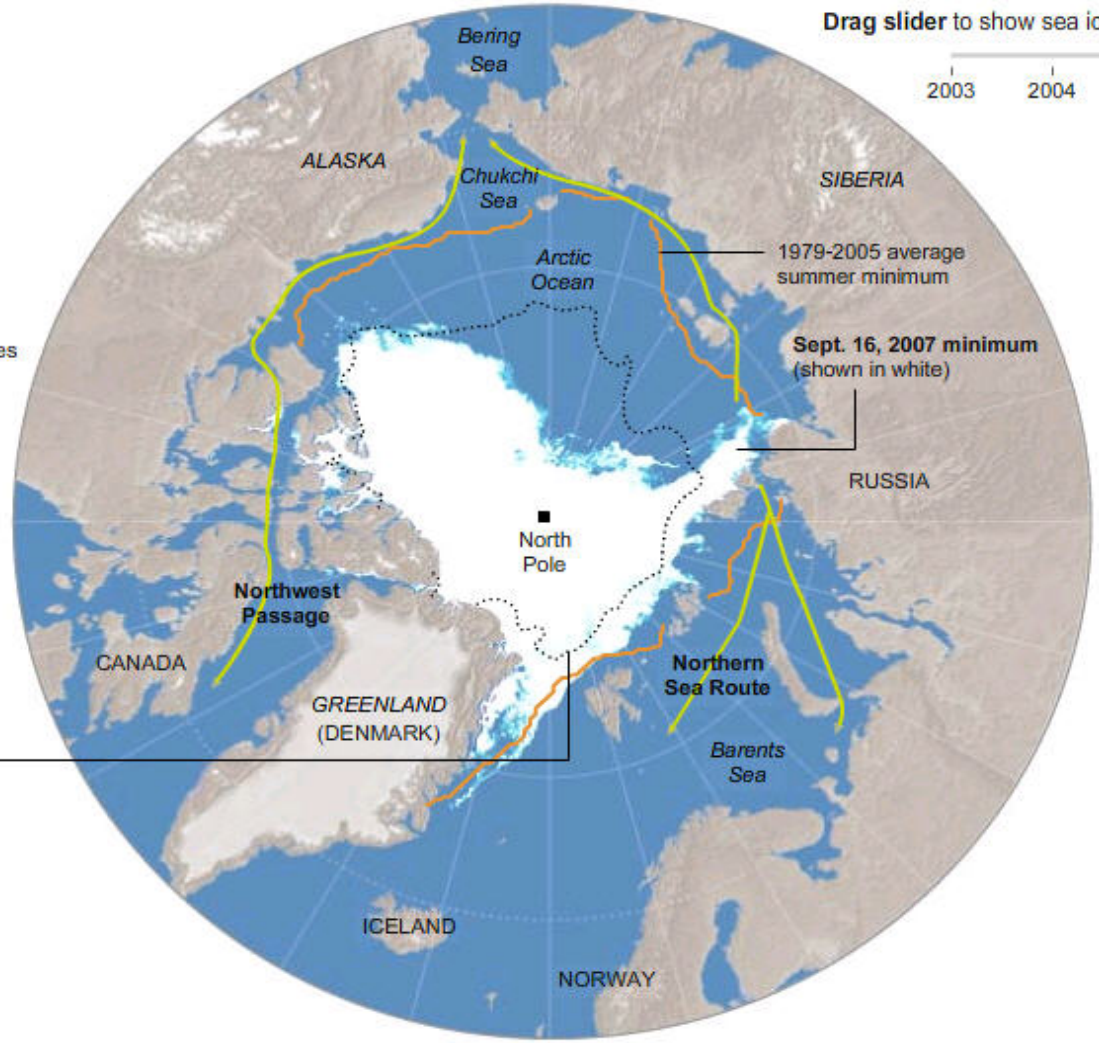
Sea ice extent is the area of ocean covered by at least 15 percent ice.

PERENNIAL SEA ICE

Ocean within this boundary had been covered with ice year-round since satellite records began in 1979. This summer was the first time that part of the perennial sea ice was open water.

Drag slider to show sea ice on Sept. 16 of each year

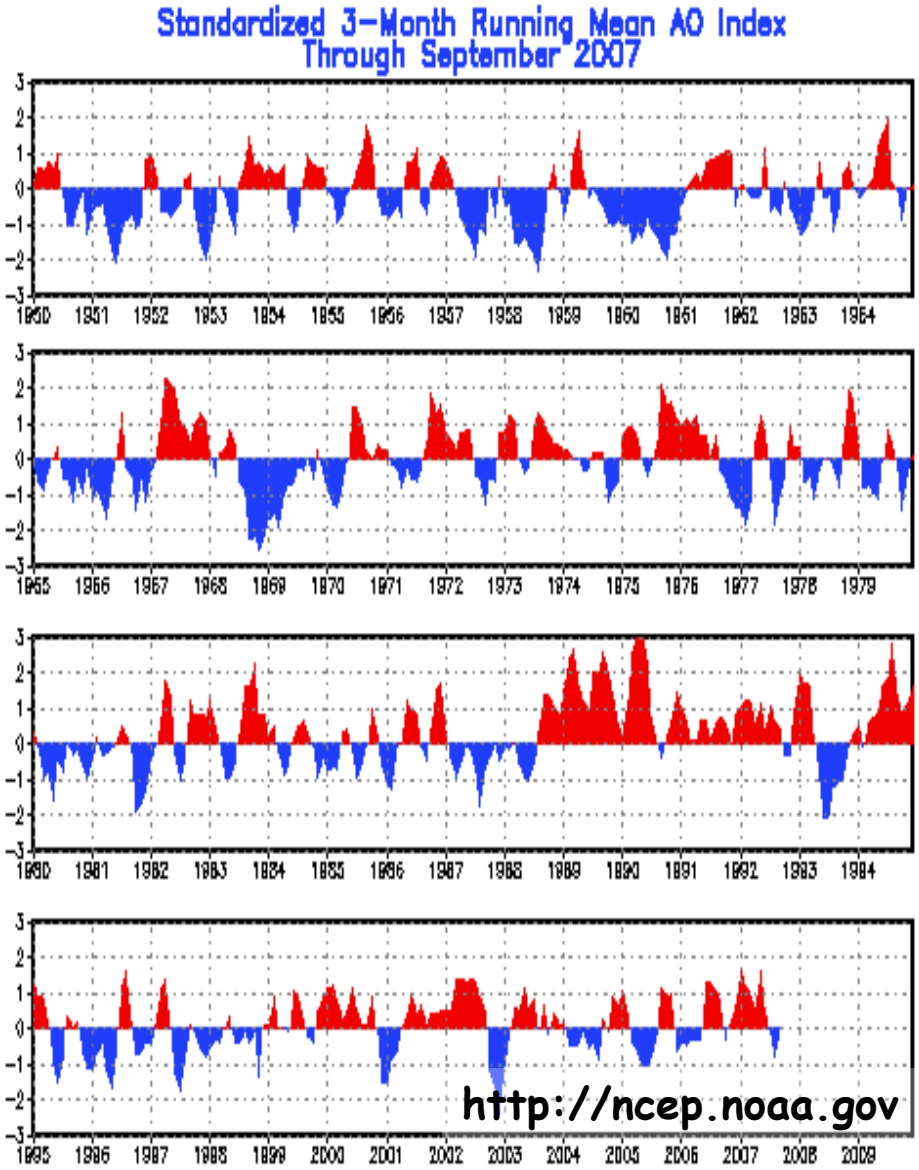
2003 2004 2005 2006 2007



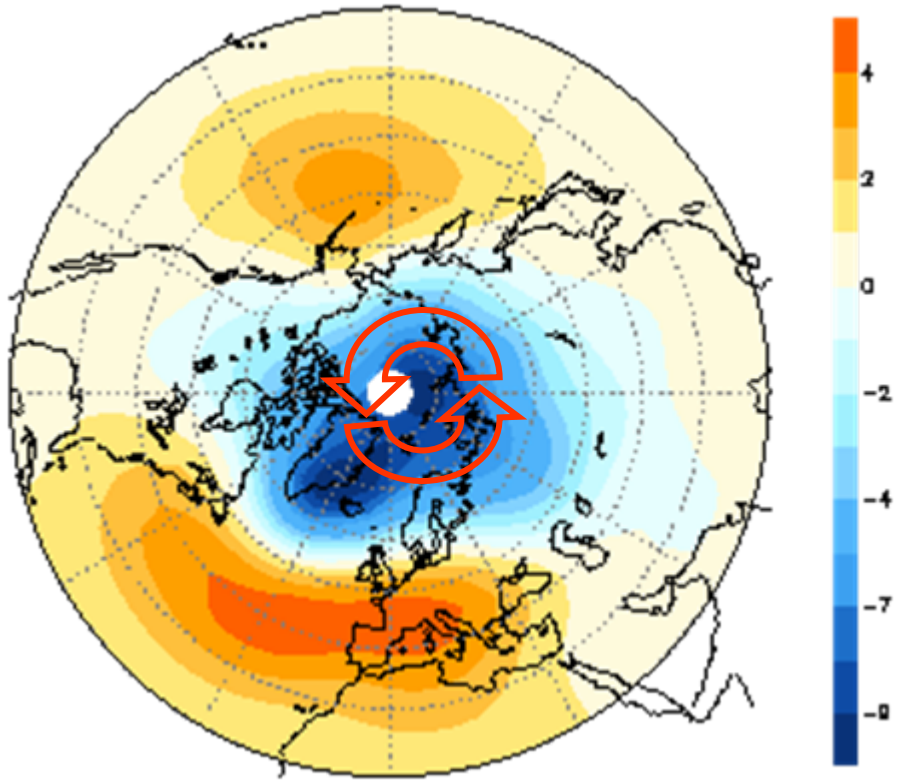
Sources: National Snow and Ice Data Center; National Oceanic and Atmospheric Administration; William Chapman, University of Illinois at Urbana- Champaign; Donald K. Perovich, U.S. Army Cold Regions Research and Engineering Laboratory; Institute of Environmental Physics

Erin Aigner, Jonathan Corum, Vu Nguyen/The New York Times

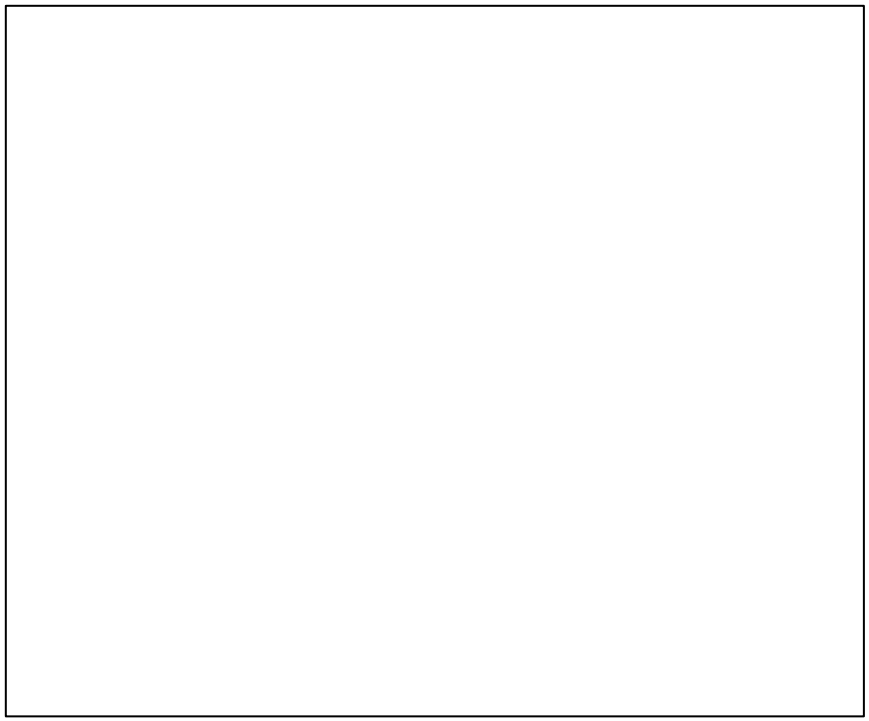
Arctic Oscillation (AO) & Arctic Climate



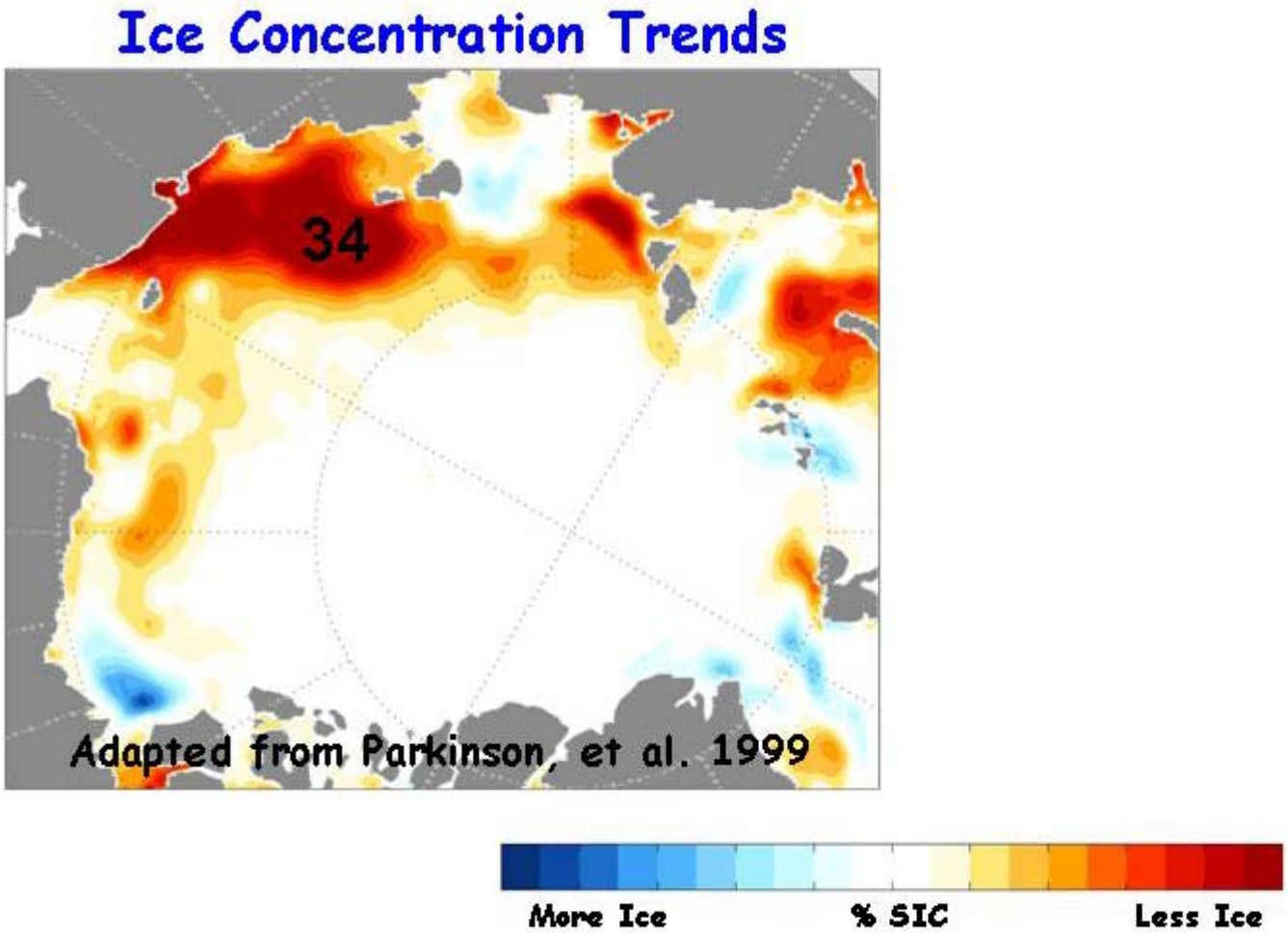
Covariance of Sea Level Pressure with AO index (hPa/30 years)



(Provided by D. Thompson)



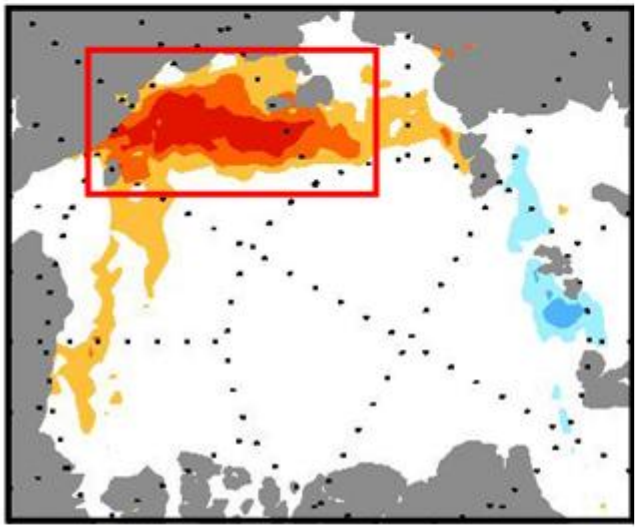
Trends in Summer Ice Concentration are correlated with the prior winter AO



(Rigor et al. 2002)

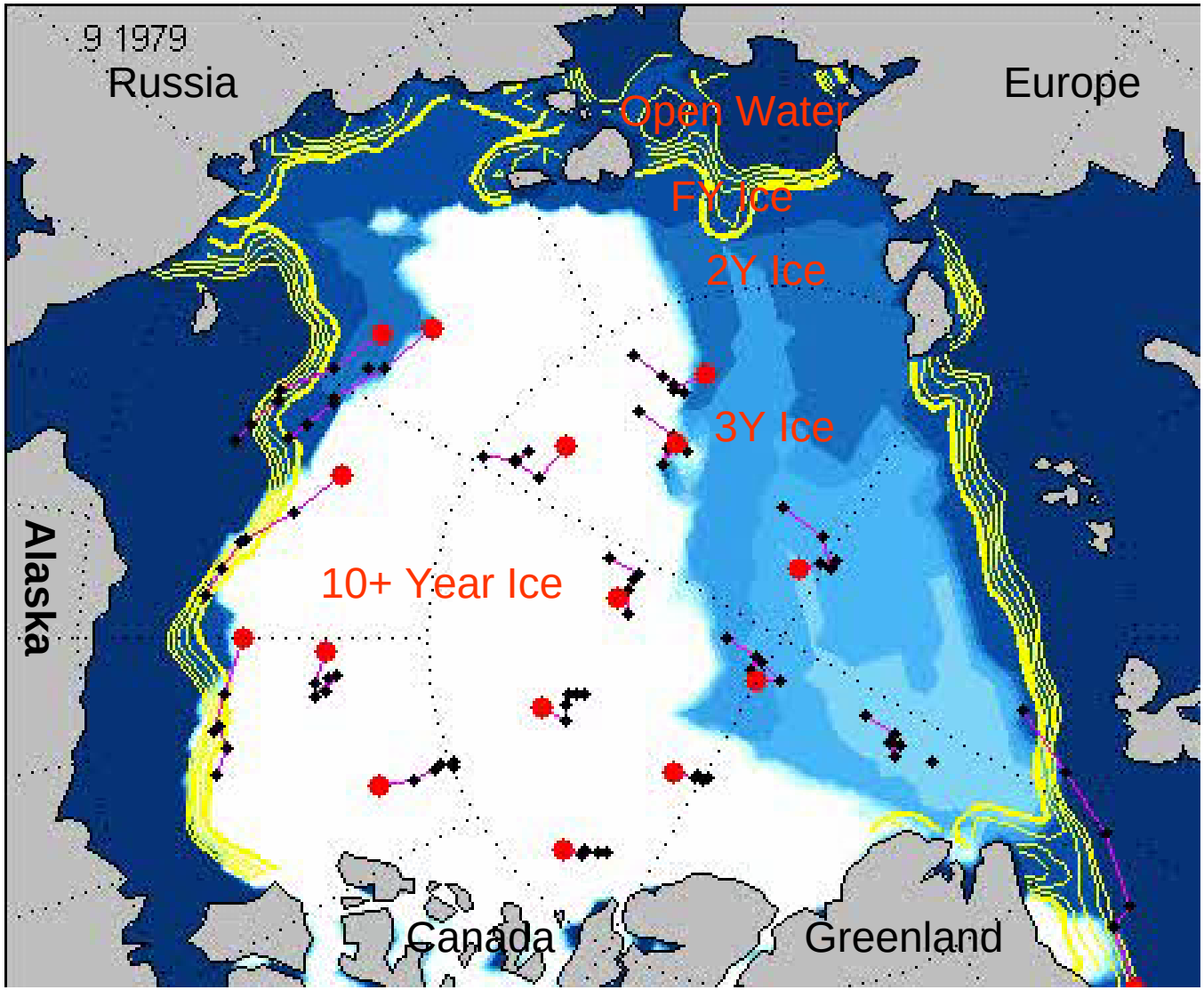
During High AO winters…

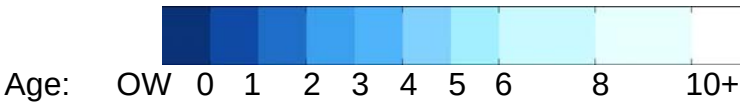
Covariance(AO_{DJFM}, SIC)



(Rigor et al. 2005)

Decadal Changes in Age of Arctic Ice





Low AO: ice in large Beaufort Gyre circulates for over 10 years (1980's), thicker.

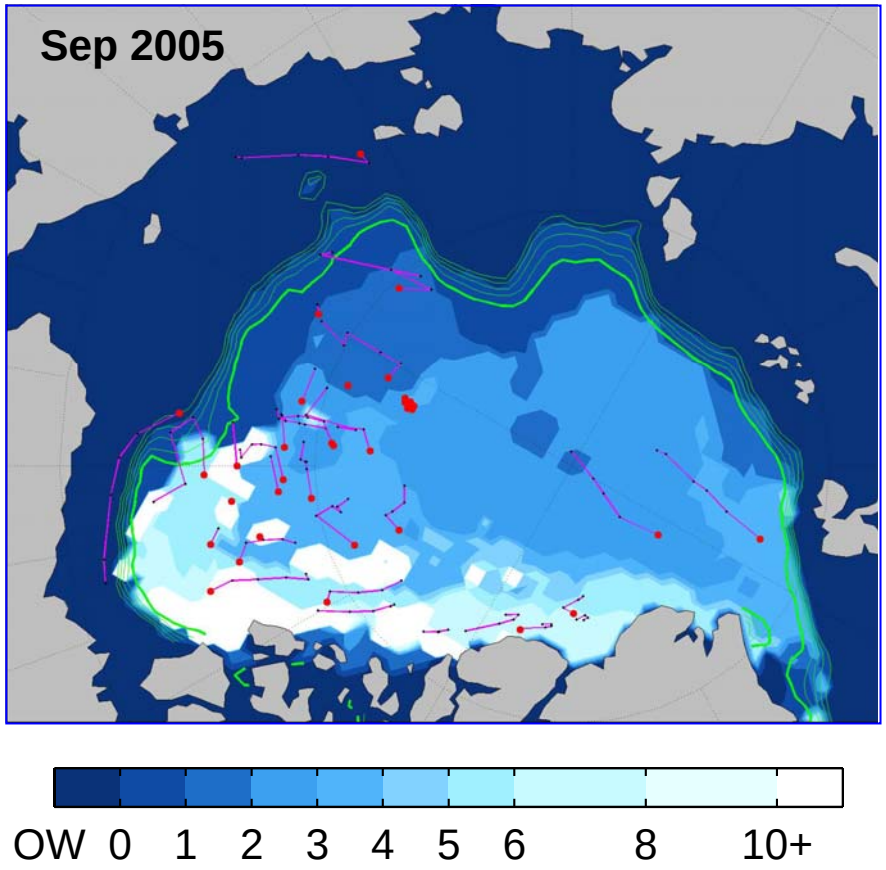
High AO: recirculation time decreases to 3–4 years (1990's), thinner.

Extreme High AO conditions in early 1990's flushes most of the older, thicker ice out of the Arctic.

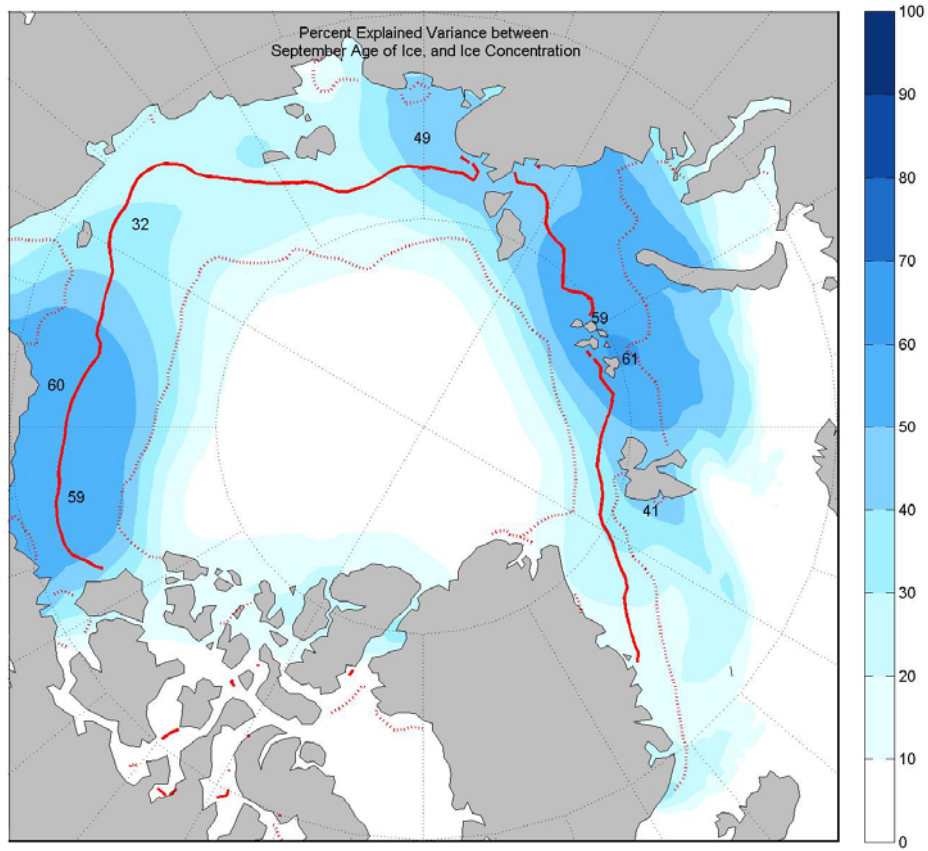
(Rigor & Wallace 2004)

Percent of Variance of SIC Explained by the Age of Sea Ice

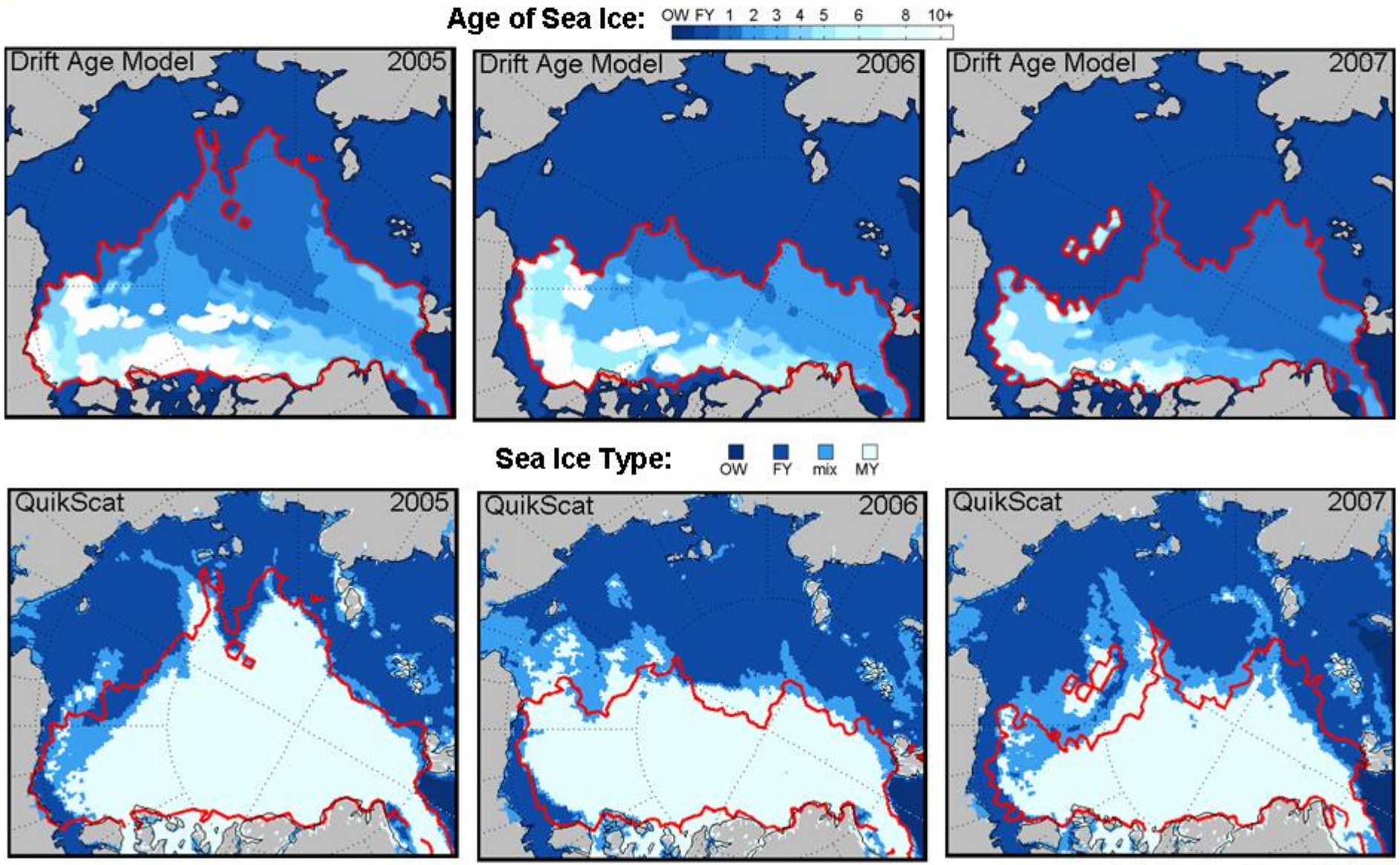
Age of Ice in September 2005



Variance Explained

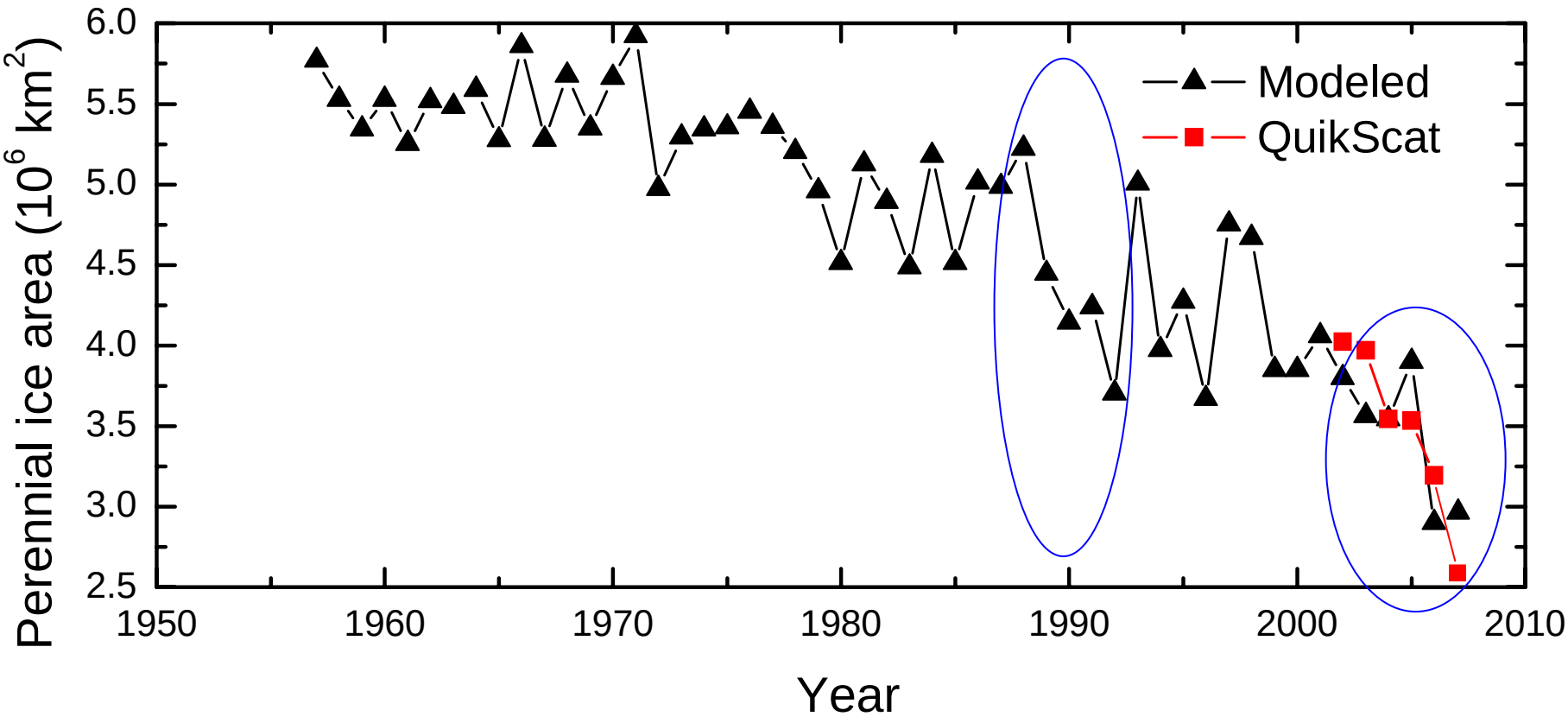


Sea Ice Age: Buoys vs. QSCAT



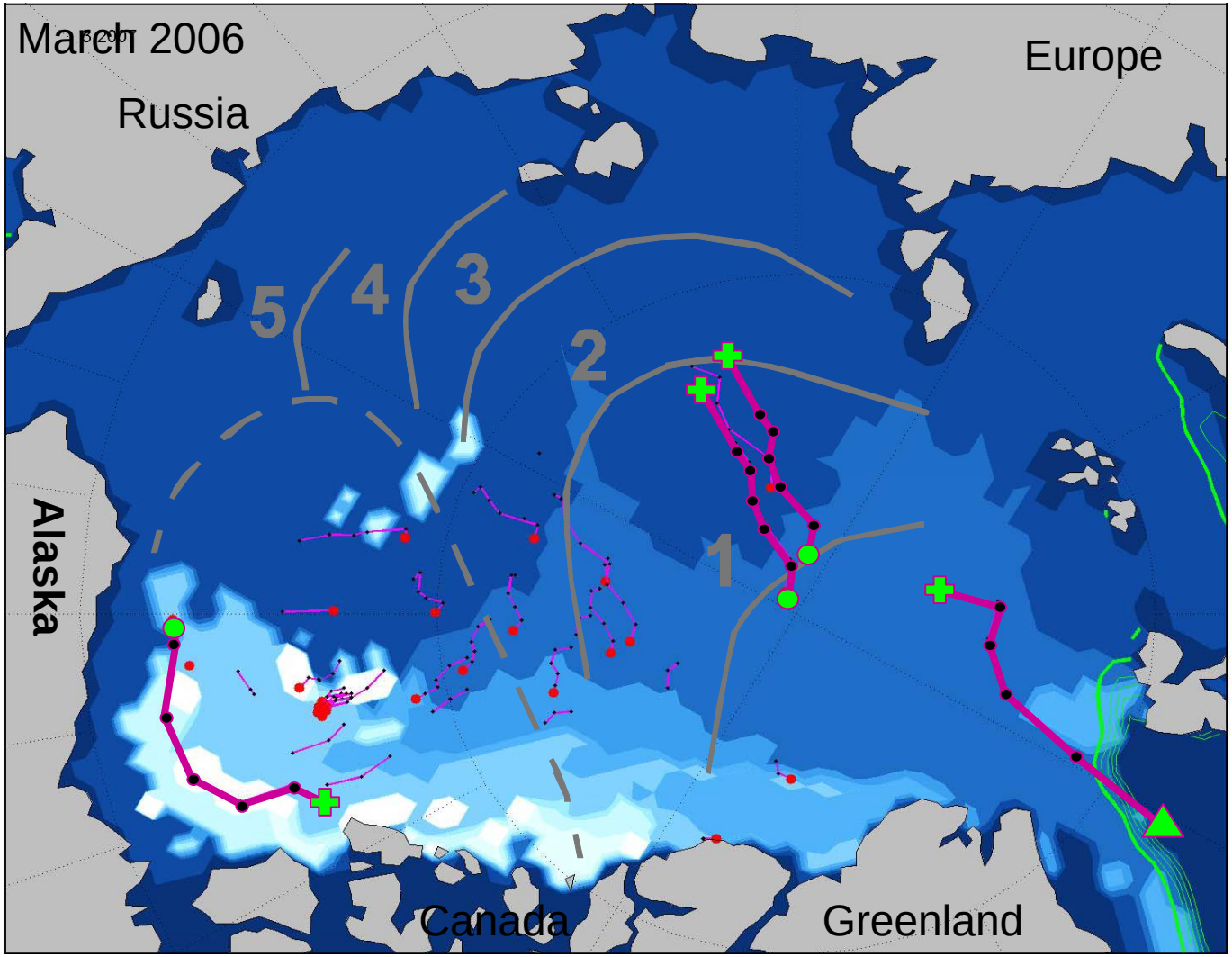
(Nghiem Etal 2007)

Perennial Sea Ice



- *Continued decrease in area of older ice*
- *Occurs in episodic, wind driven events*

Faster Ice Drift



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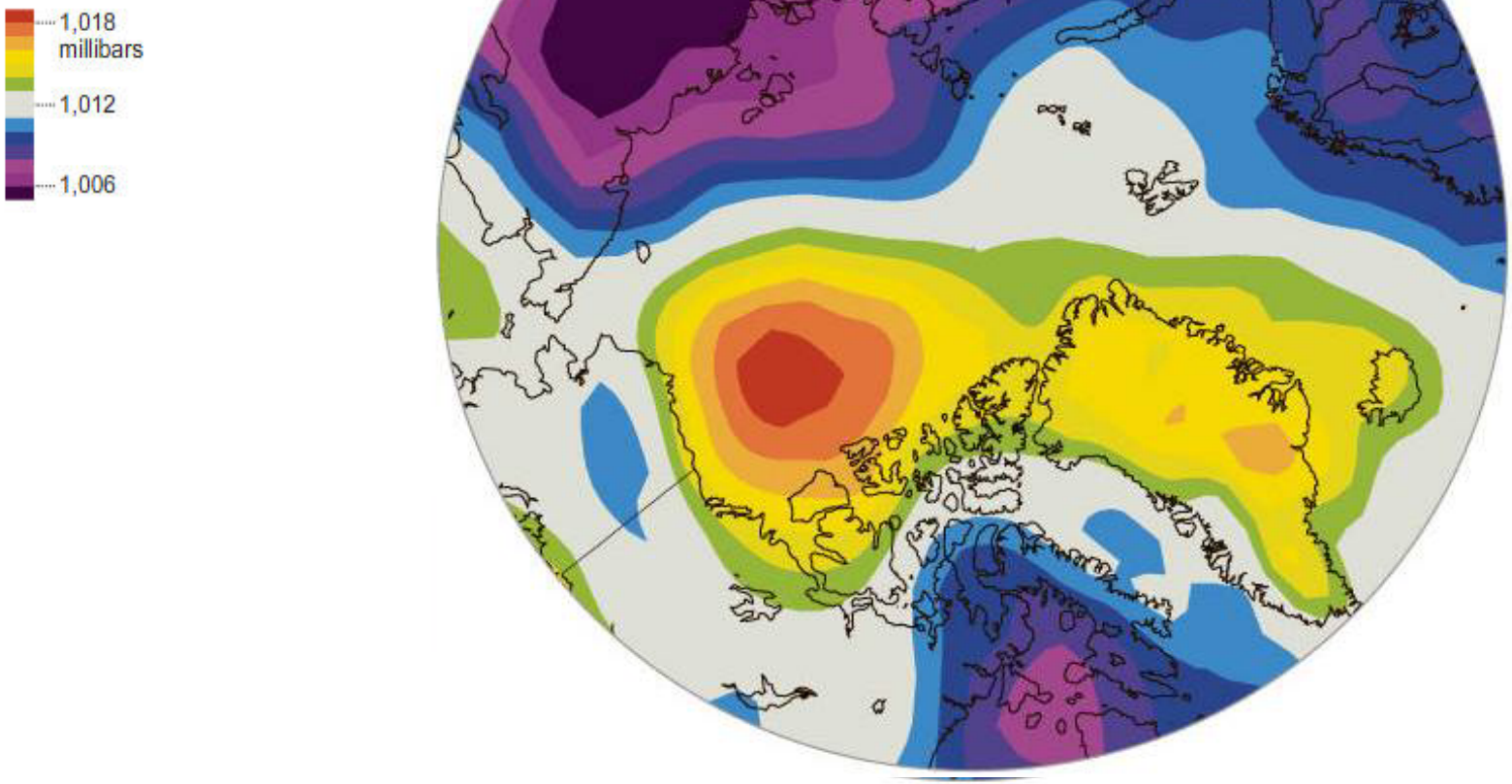
ATMOSPHERIC PRESSURE

High pressure over the Arctic and low pressure over Siberia caused sustained winds from southern latitudes.

Air pressure at sea level, June–Aug. 2007



Sources: National Snow and Ice Data Center; National Oceanic and Atmospheric Administration; William Chapman, University of Illinois at Urbana- Champaign; Donald K. Perovich, U.S. Army Cold

Erin Aigner, Jonathan Corum, Vu Nguyen/The New York Times

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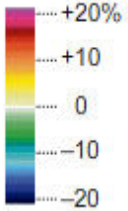
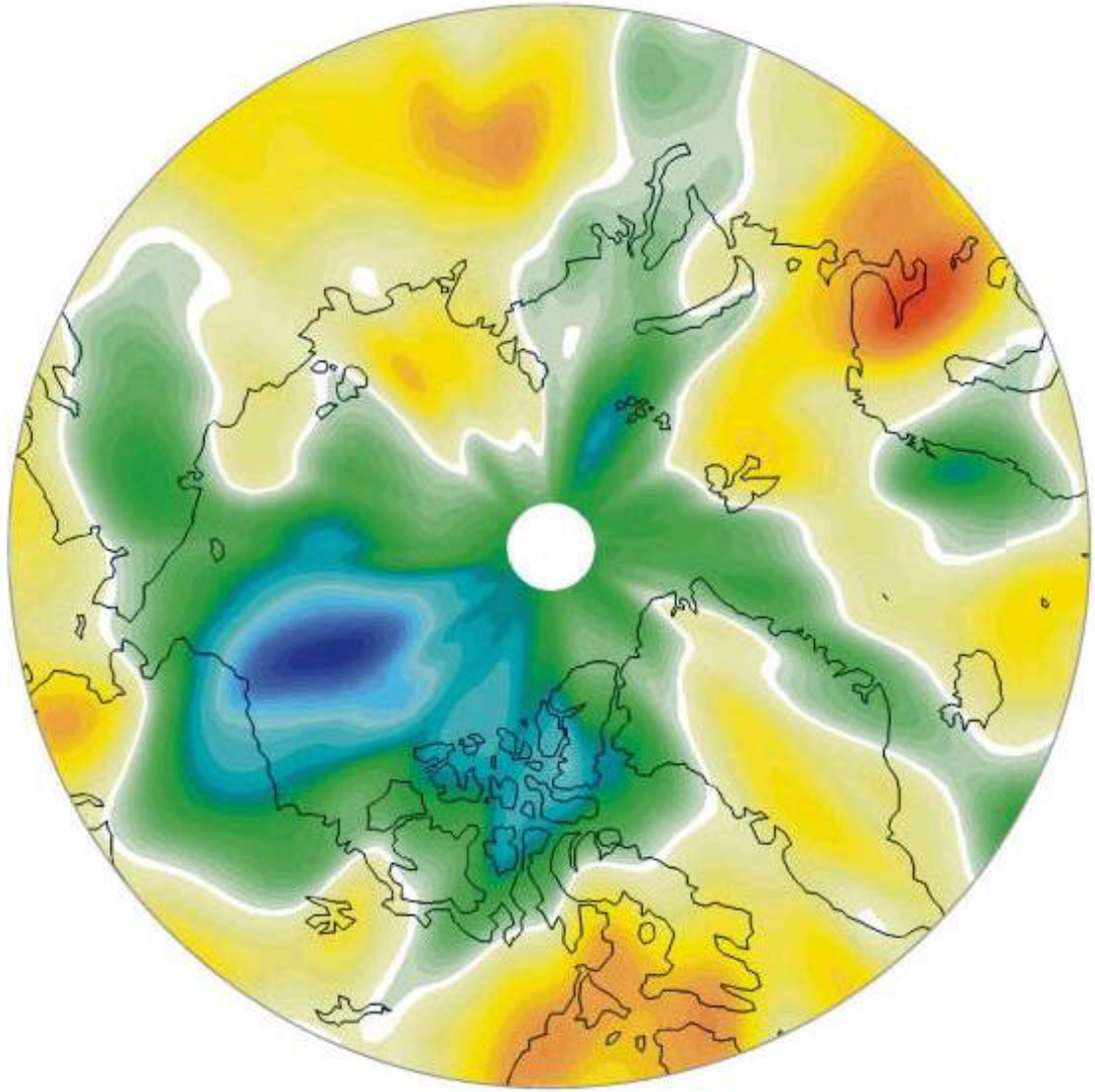
CLOUD COVER

High pressure also helped create a broad patch of clear sky over the Arctic, allowing more sunlight to heat the ocean.

Deviation from average cloud cover, June–July 2007





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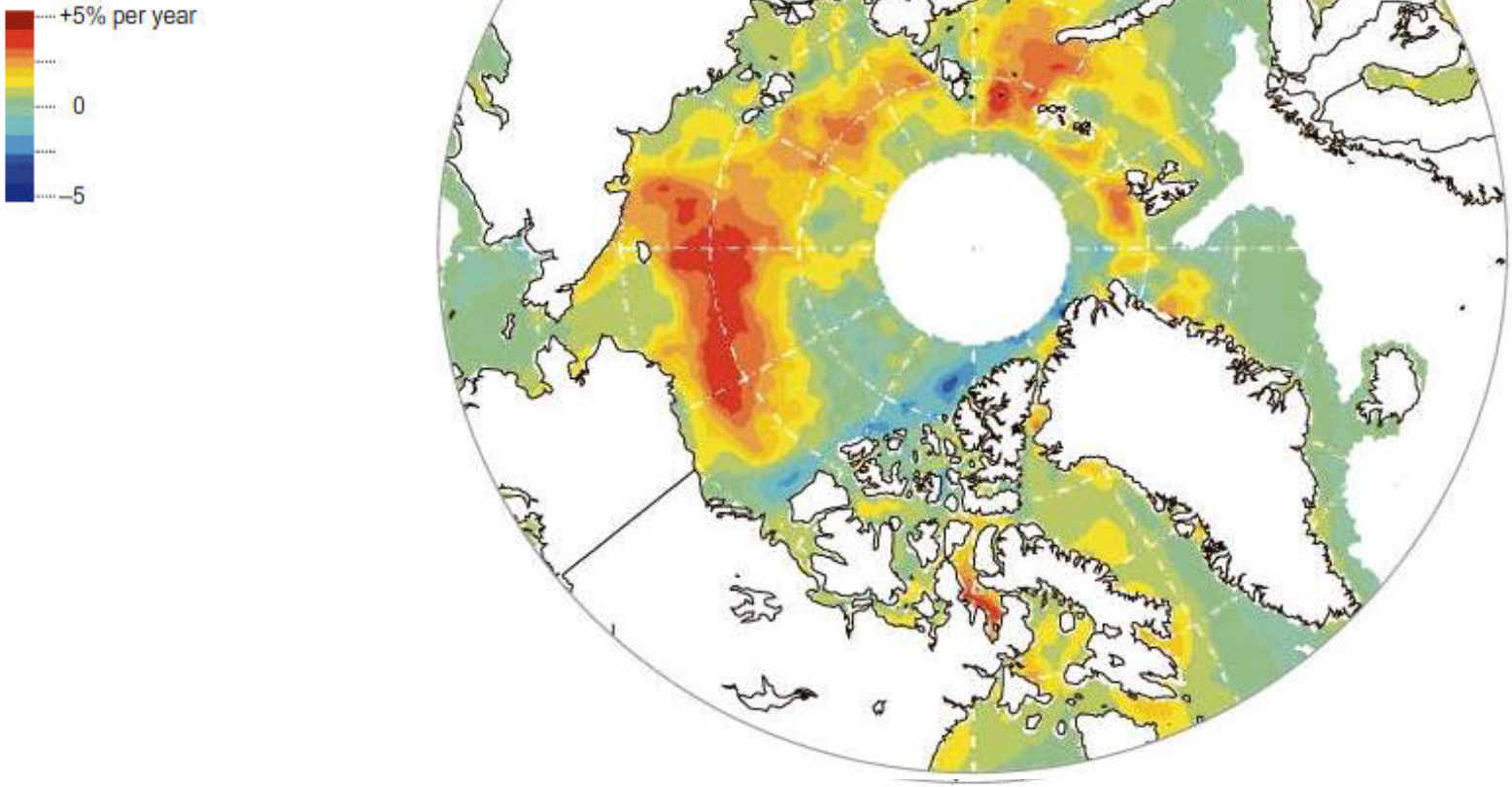
SOLAR HEATING

Open water reflects less sunlight and absorbs more heat than snow or ice. Heat absorbed this summer could slow the winter freeze.

Trend in solar heating of the ocean, 1979–2005



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Preconditioning of Arctic Sea Ice for Summer Minima

Summary:

- Area of perennial sea ice over the Arctic Ocean has decreased from over 5.6 million km^2 to 2.7 million km^2…
- …as sea ice drifted 2x faster.
- **Preconditioning may help explain the record minima in summer sea ice extent.**
- **Spring and summer weather may enhance summer "melt".**
- **Implies continued record/near-record minima in summer sea ice extent.**

Crew members of the USCG Healy returning to the ice breaker after deploying a buoy on a surprisingly rare floe of perennial sea ice in August 2007.

END

Sea Ice in Retreat

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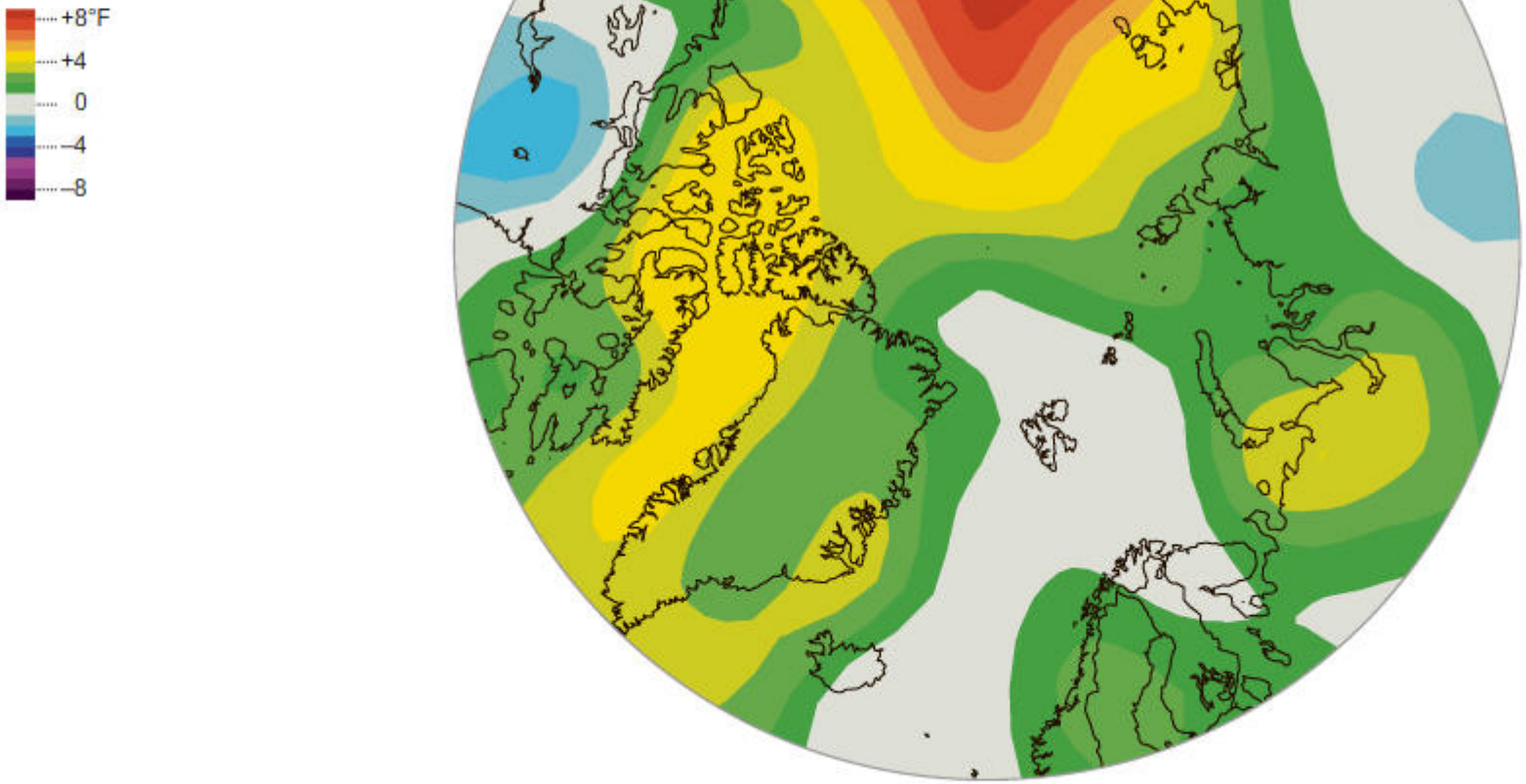
AIR TEMPERATURE

Warm air from northeastern Siberia brought heat to the region and pushed sea ice away from the coast.

Deviation from average temperature, June–Aug. 2007



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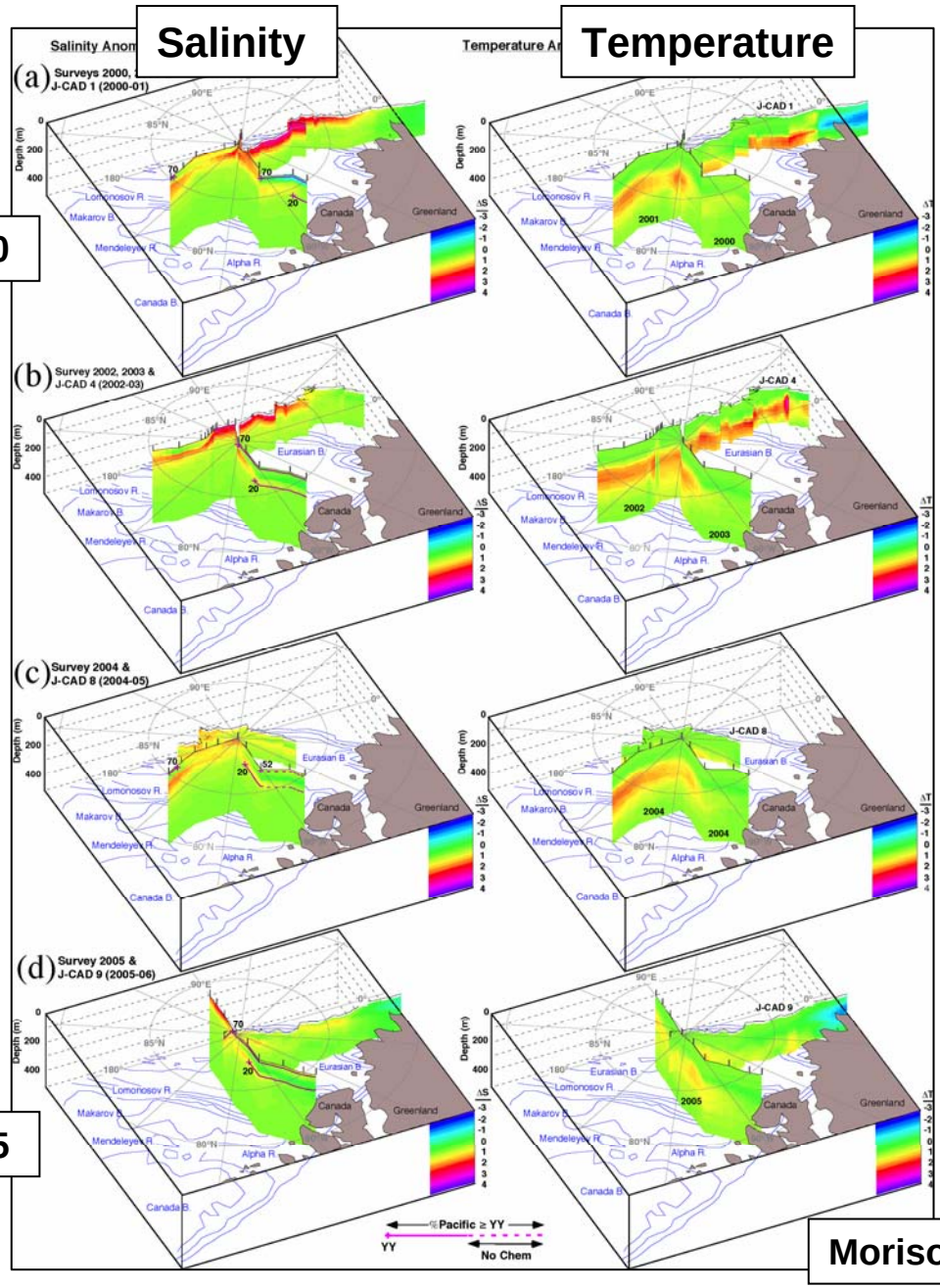
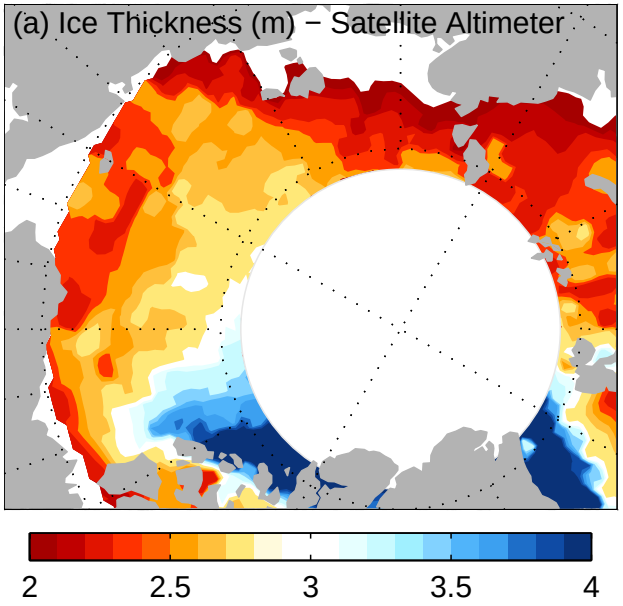
Ocean Temperature & Salinity: North Pole Region

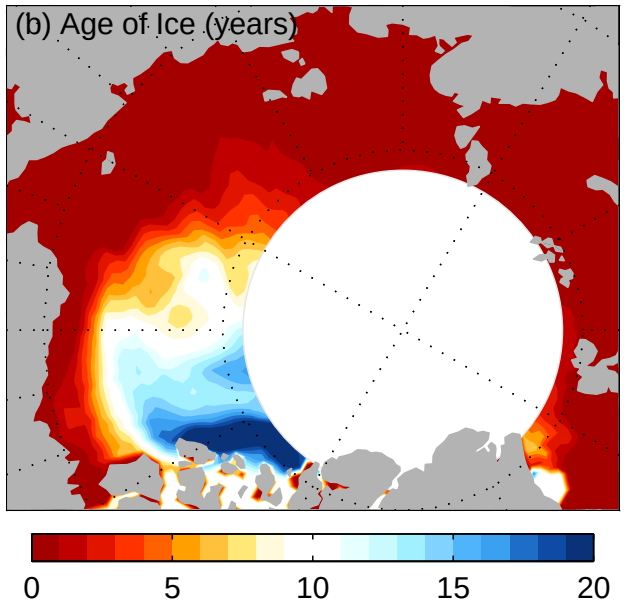


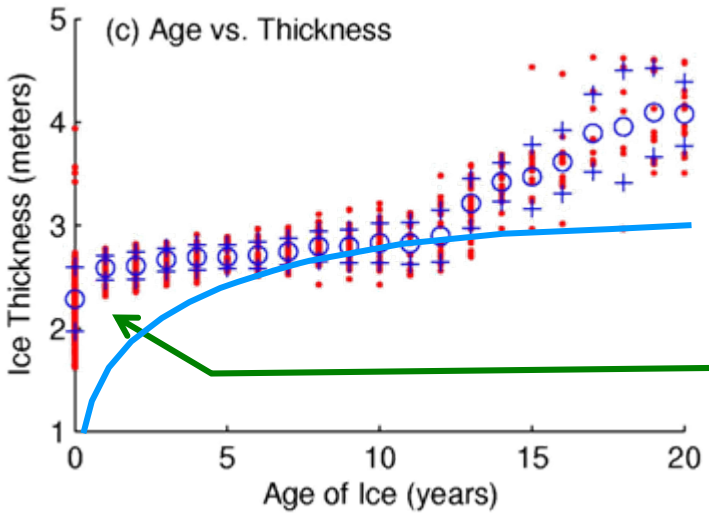
- **Anomalies relative to EWG climatology (1950-1980s)**
- **2000 – 2005: Relaxation to near pre-1990 climatology.**
- **Should promote recovery of sea ice???**

Morison et al., 2006a

Age vs. Ice Thickness (Winter)







RMS difference = 0.3 m
(Blue circles and red dots)

Thermodynamic Growth

Ridging and Rafting are also important

New Ice may be too thick?
(Laxon et al. 2003 remove estimates < 1 m from climatology = high bias)

(Rigor et al. 2005)