National Snow and Ice Data Center

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Moving Toward an Ice-Free Arctic Ocean

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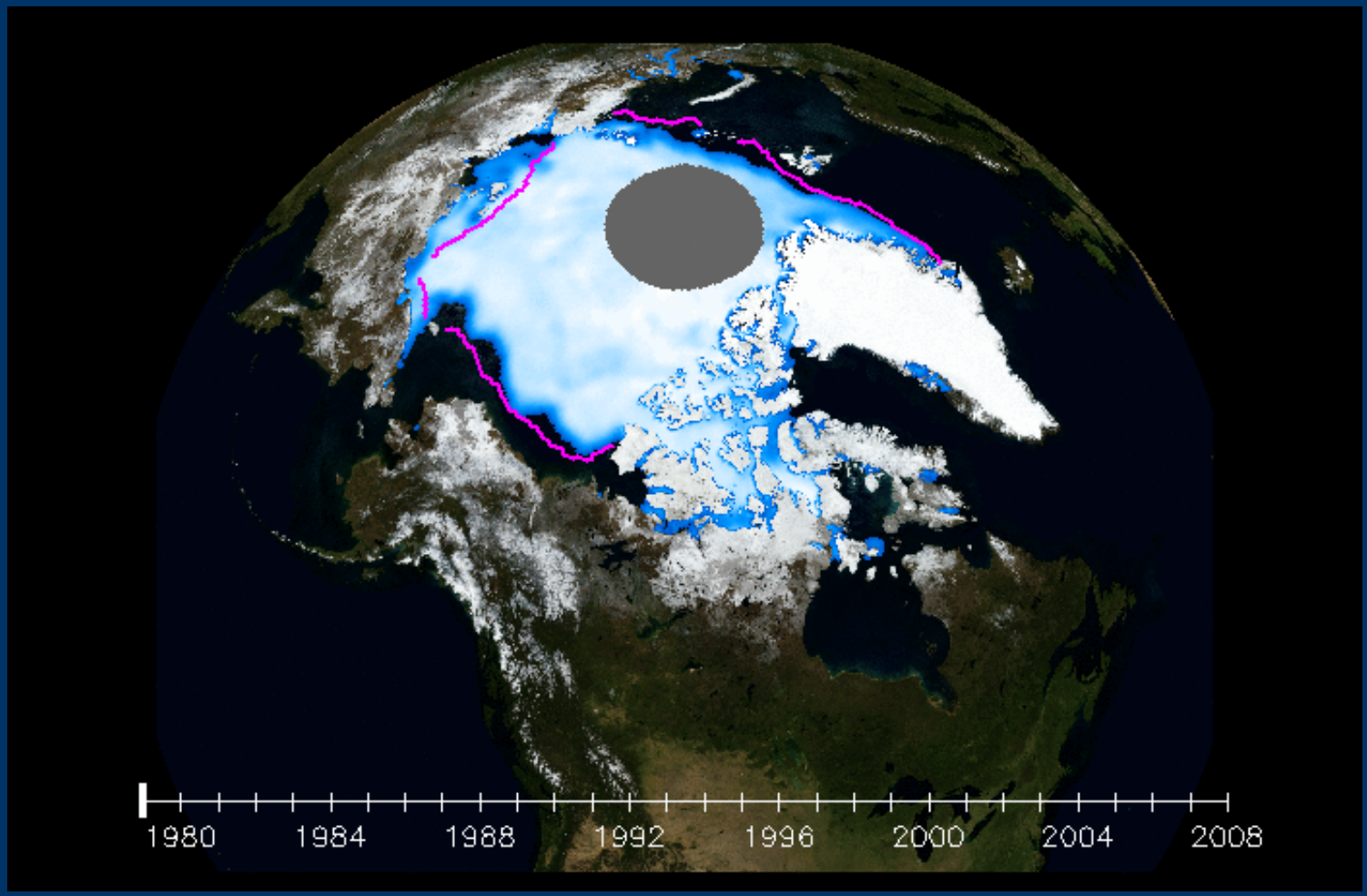
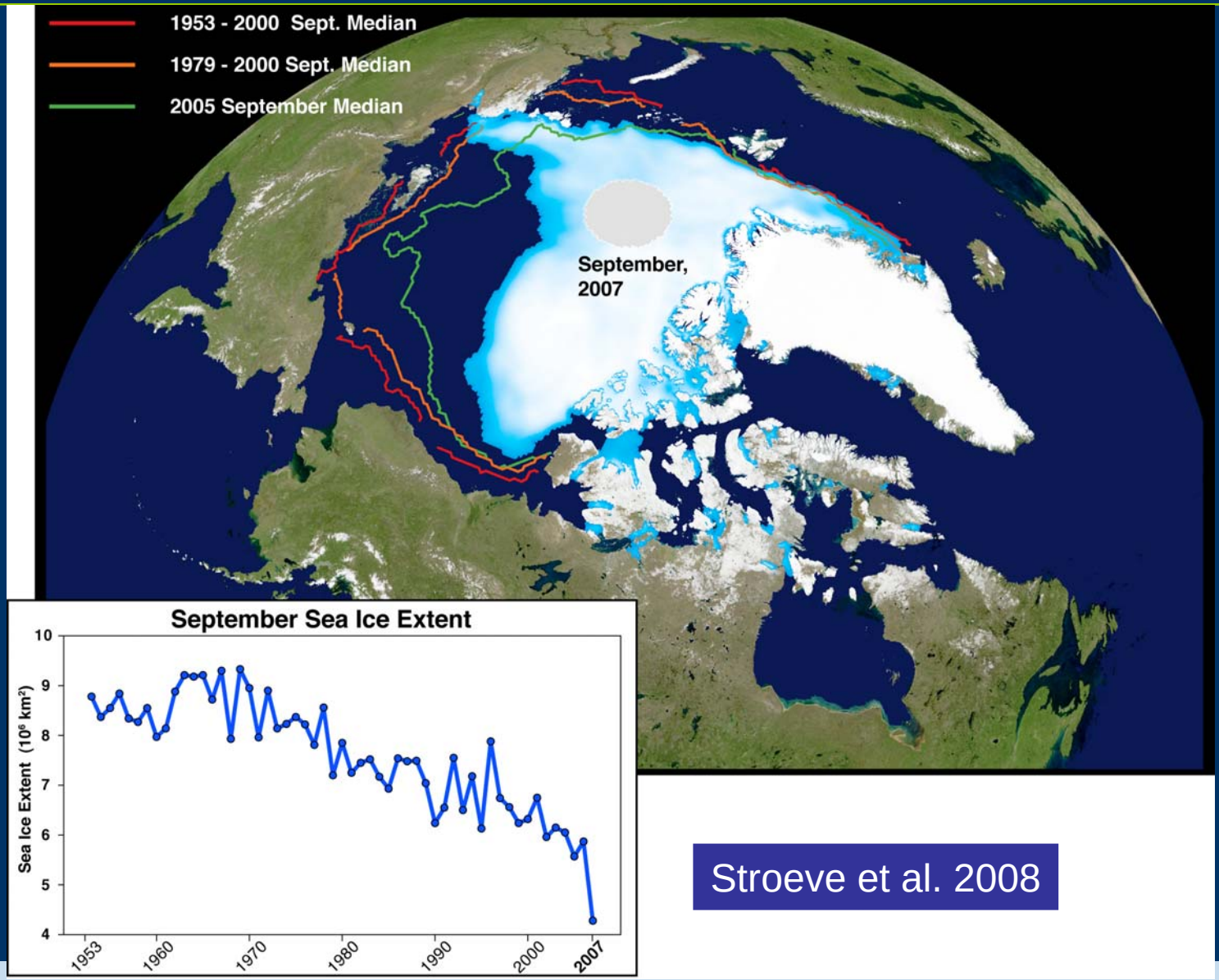
We're Losing the Ice Cover Fast



September sea ice from 1979 to 2008

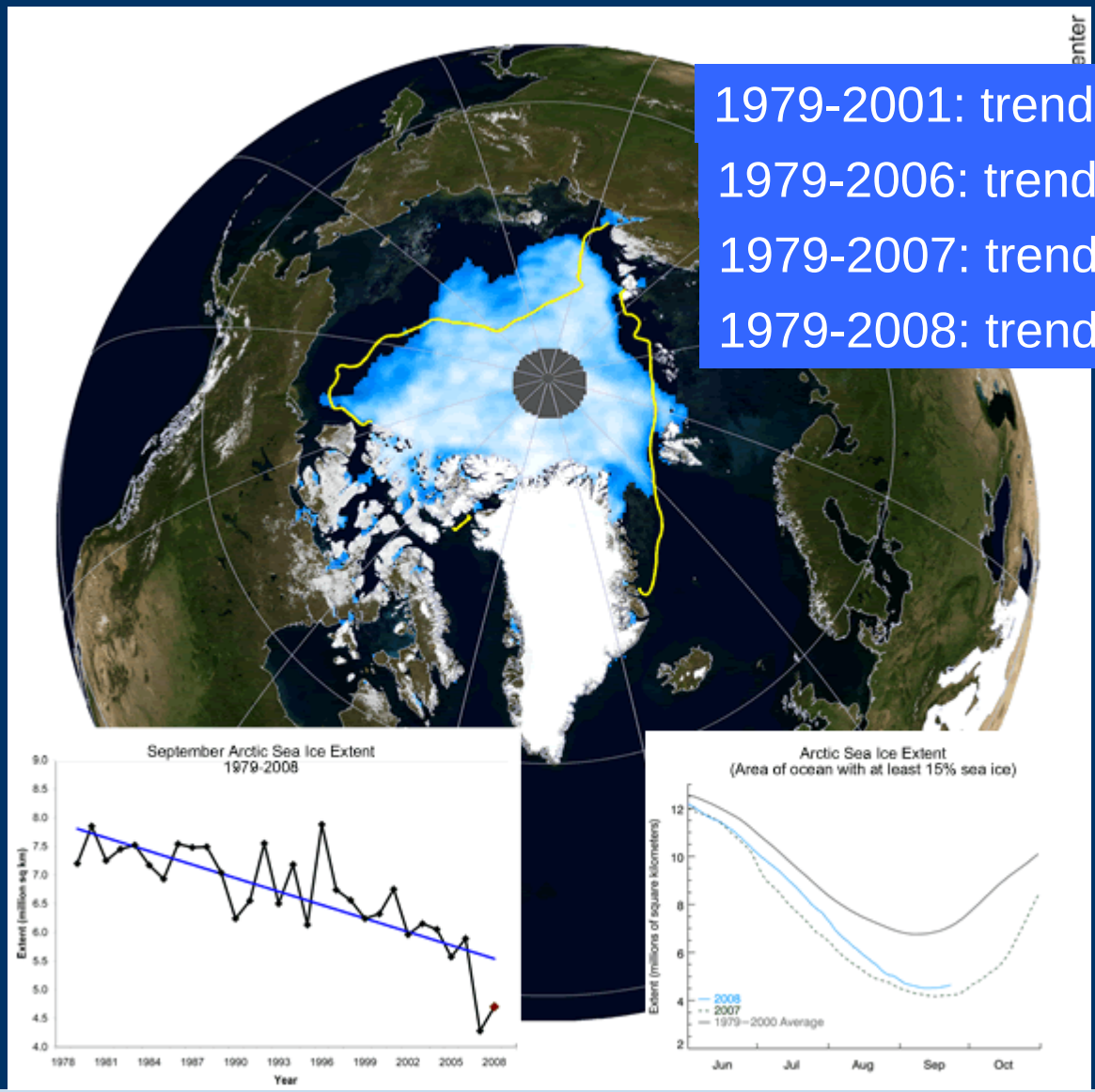
Climatology (1979-2000)

In 2007 a New Record Low



Stroeve et al. 2008

Acceleration of the Downward Trend



1979-2001: trend = -7%/decade

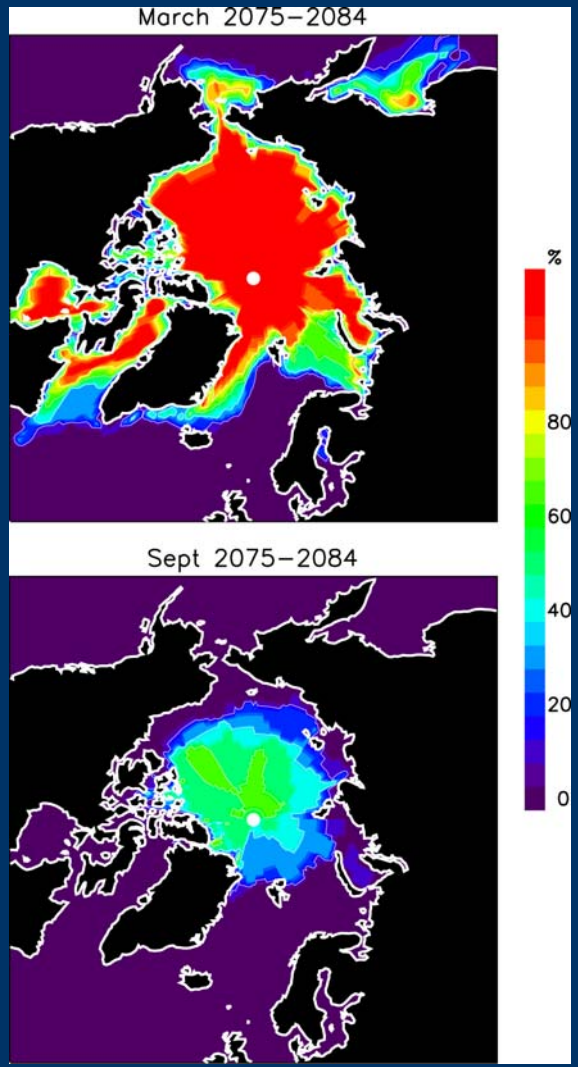
1979-2006: trend = -8.9%/decade

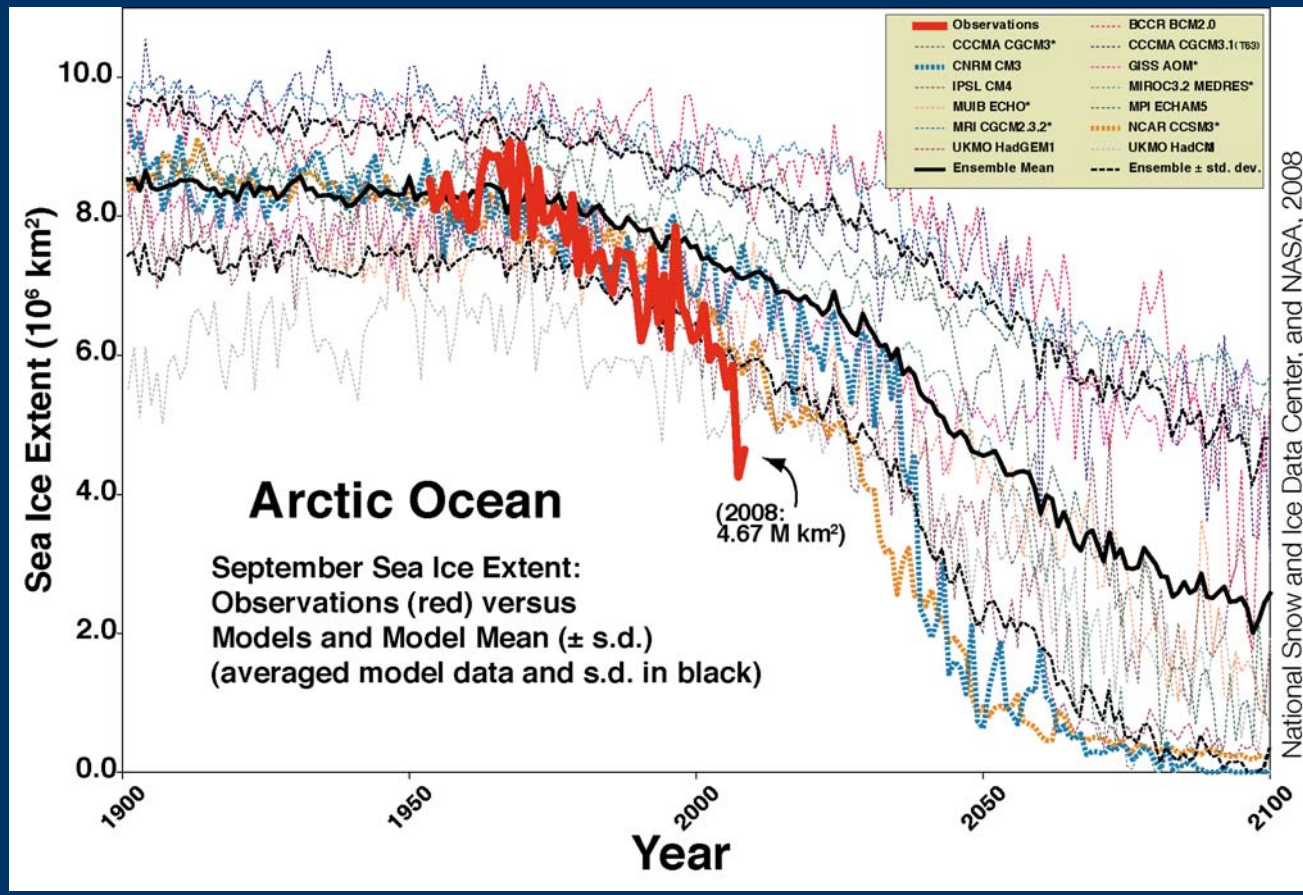
1979-2007: trend = -10.7%/decade

1979-2008: trend = -11.8%/decade

Are IPCC-AR4 Simulations Conservative?

Modeled and observed Sept. ice extent time series (right) and % models with ice for 2075-2084 (left)

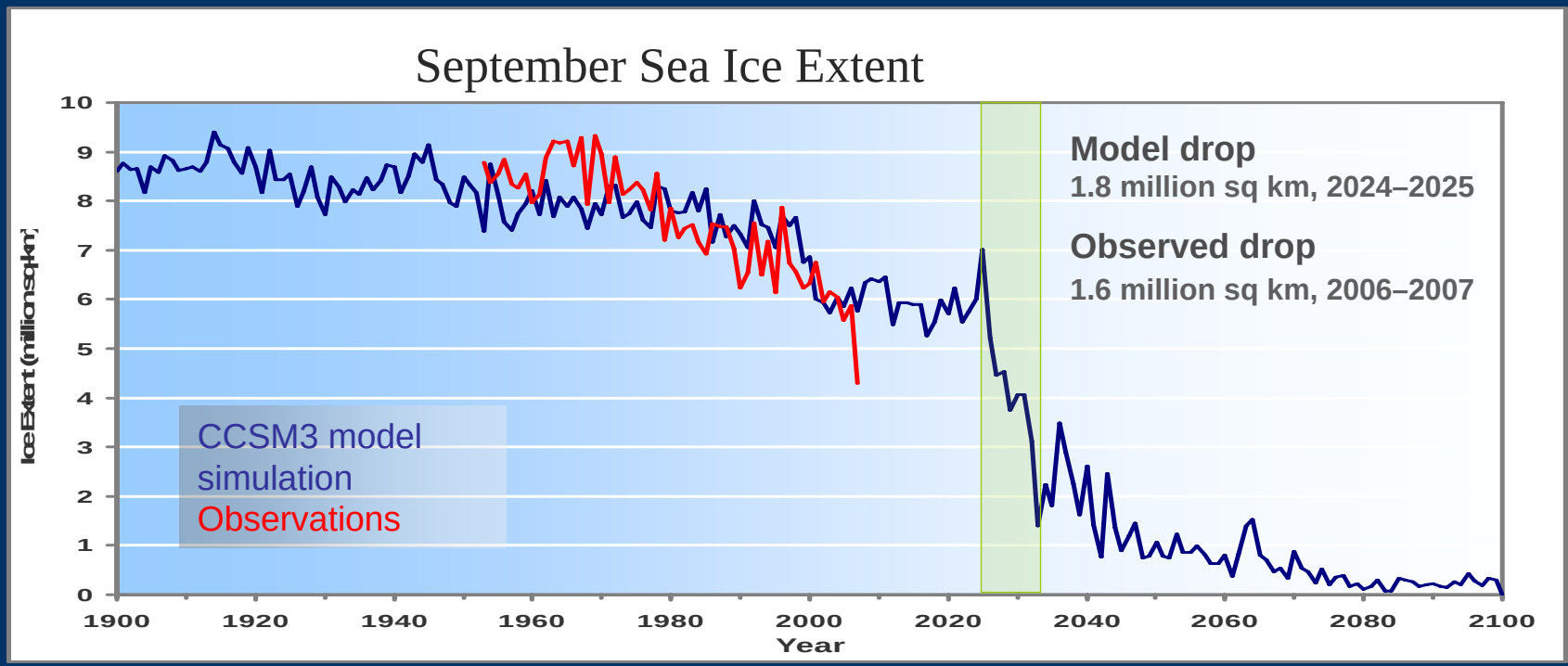




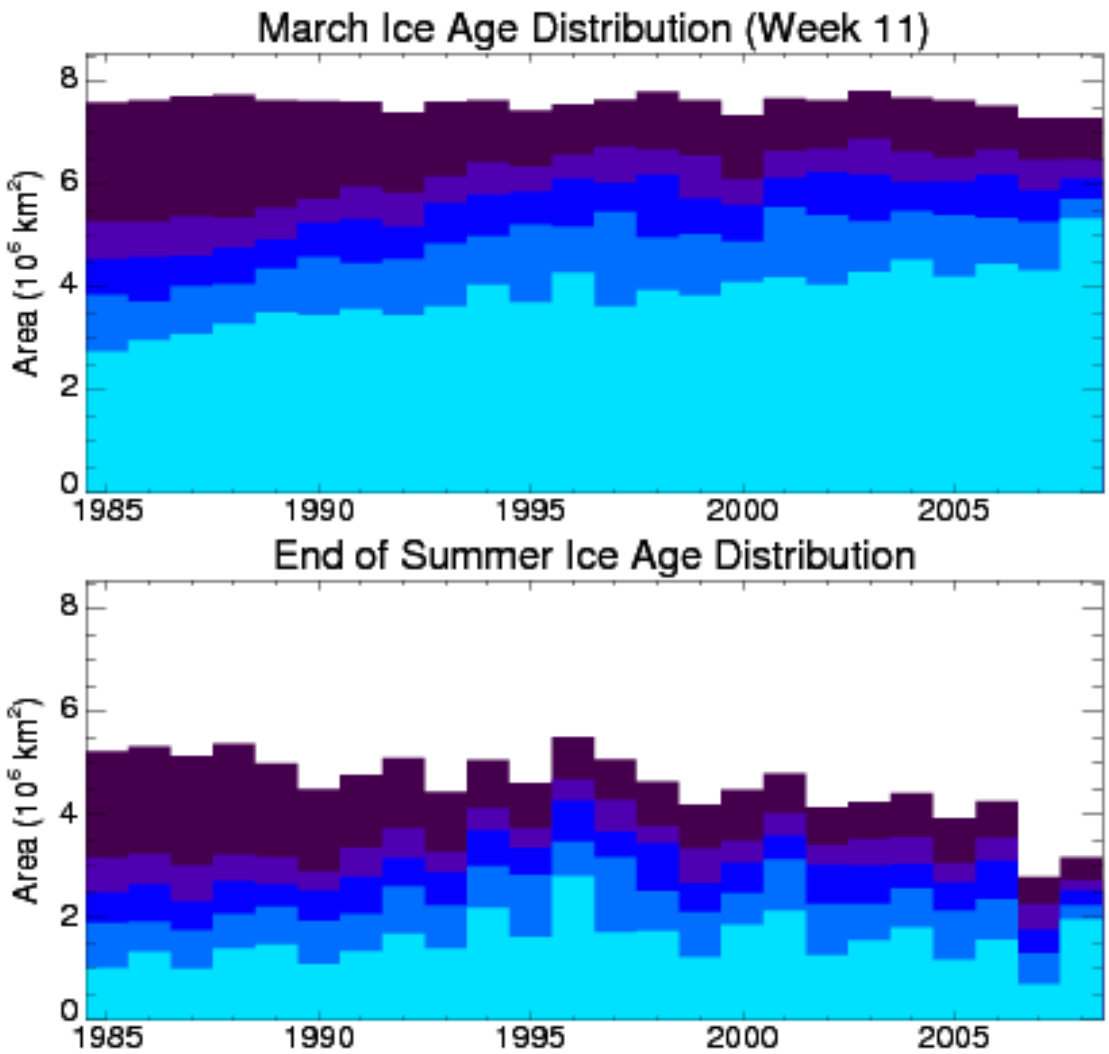
Serreze et al., 2007 (left); updated from Stroeve et al., 2007 (right)

Why is the Trend Accelerating?

- The ice cover is not just shrinking it is also thinning.



Change in Distribution of Ice Age Classes



First-year ice

2nd year ice

3rd year ice

4th year ice

5 year or older ice

Using data from Maslanik et al., 2007

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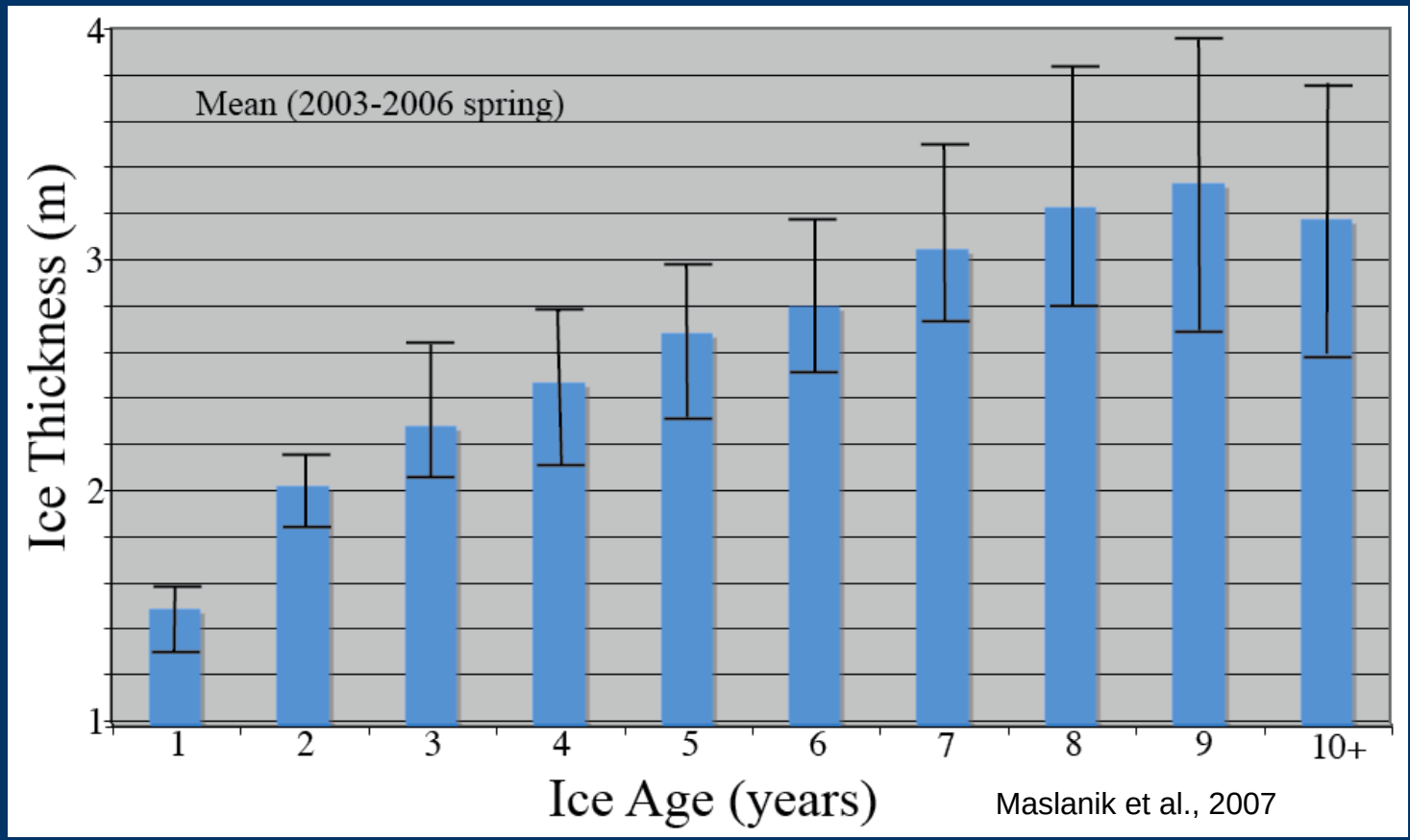
Younger Ice is Thinner Ice

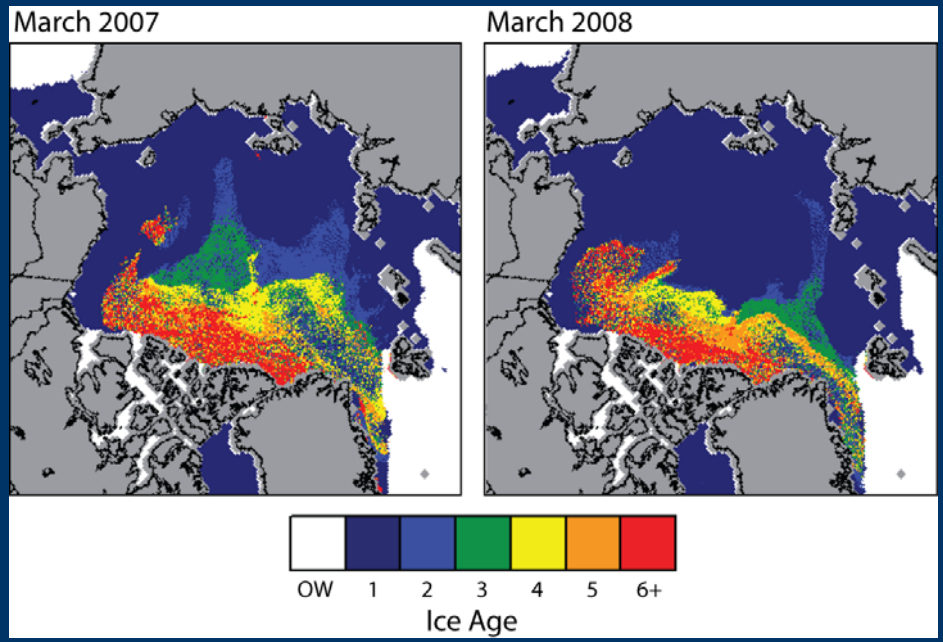
Comparison between ice age and ice thickness from ICESat GLAS data

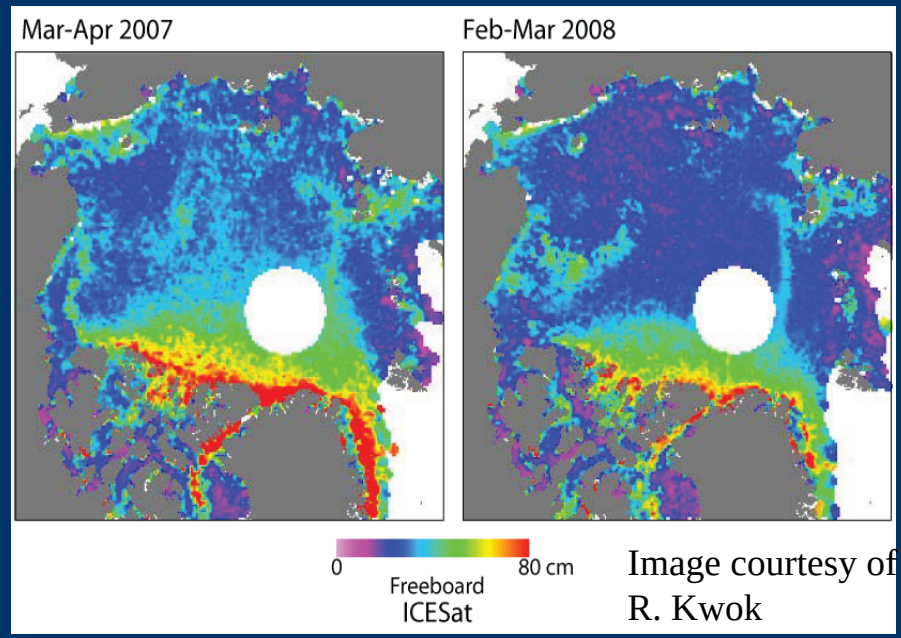


- Results suggest a decrease in mean thickness of 2.6 m in March 1987 to 2.0 m in March 2007

A Vulnerable Spring Ice Cover

In 2008, first-year ice covered 73% of the Arctic Basin, whereas in 2007 it covered 59% (and in 1985 it covered 36%).





In Spring 2008, the western Arctic was an average 50cm than in 2007.

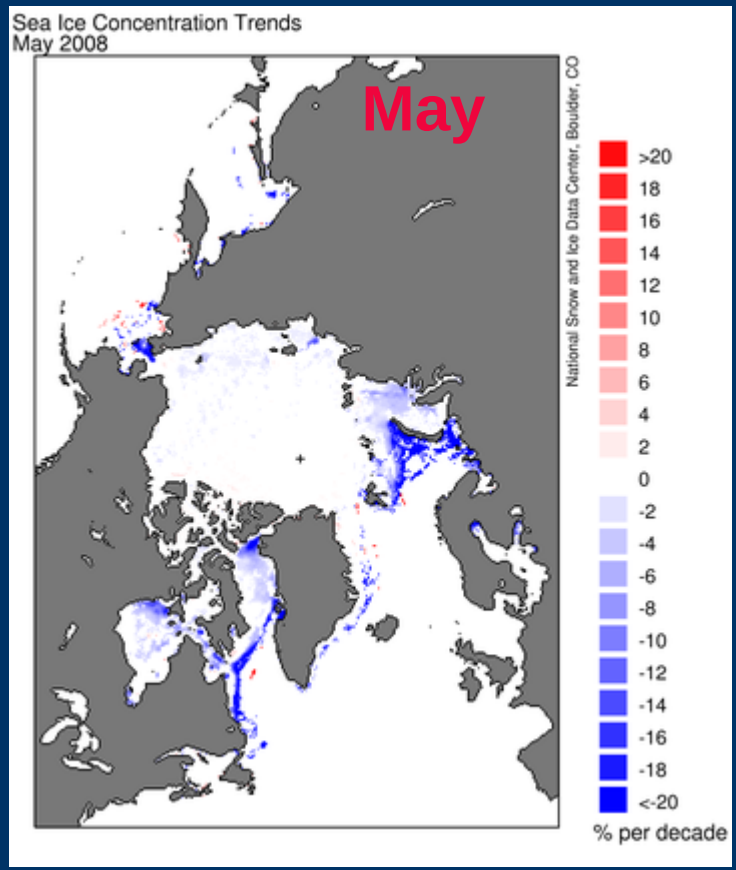
Thinner Ice is More Vulnerable to Melting Out

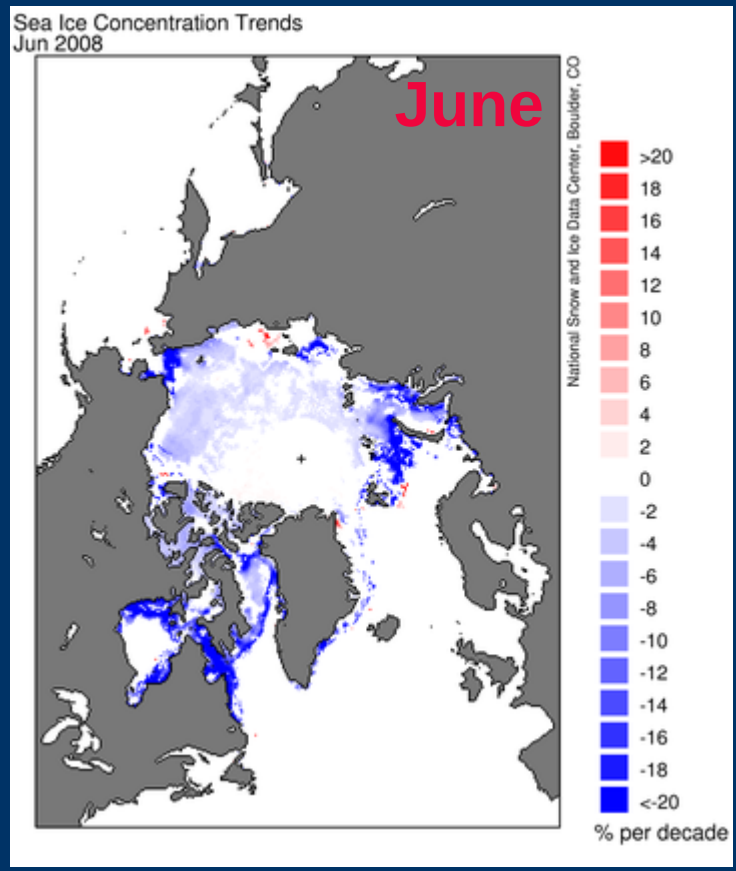
- When you have a broad distribution of ice age (and hence thickness), an unusually warm summer can lead to a lot of ice melt and ice volume changes, but little change in overall extent of the ice cover.

- With the shift towards a younger and thinner ice cover, now an unusually warm summer can lead to large decreases in ice extent.

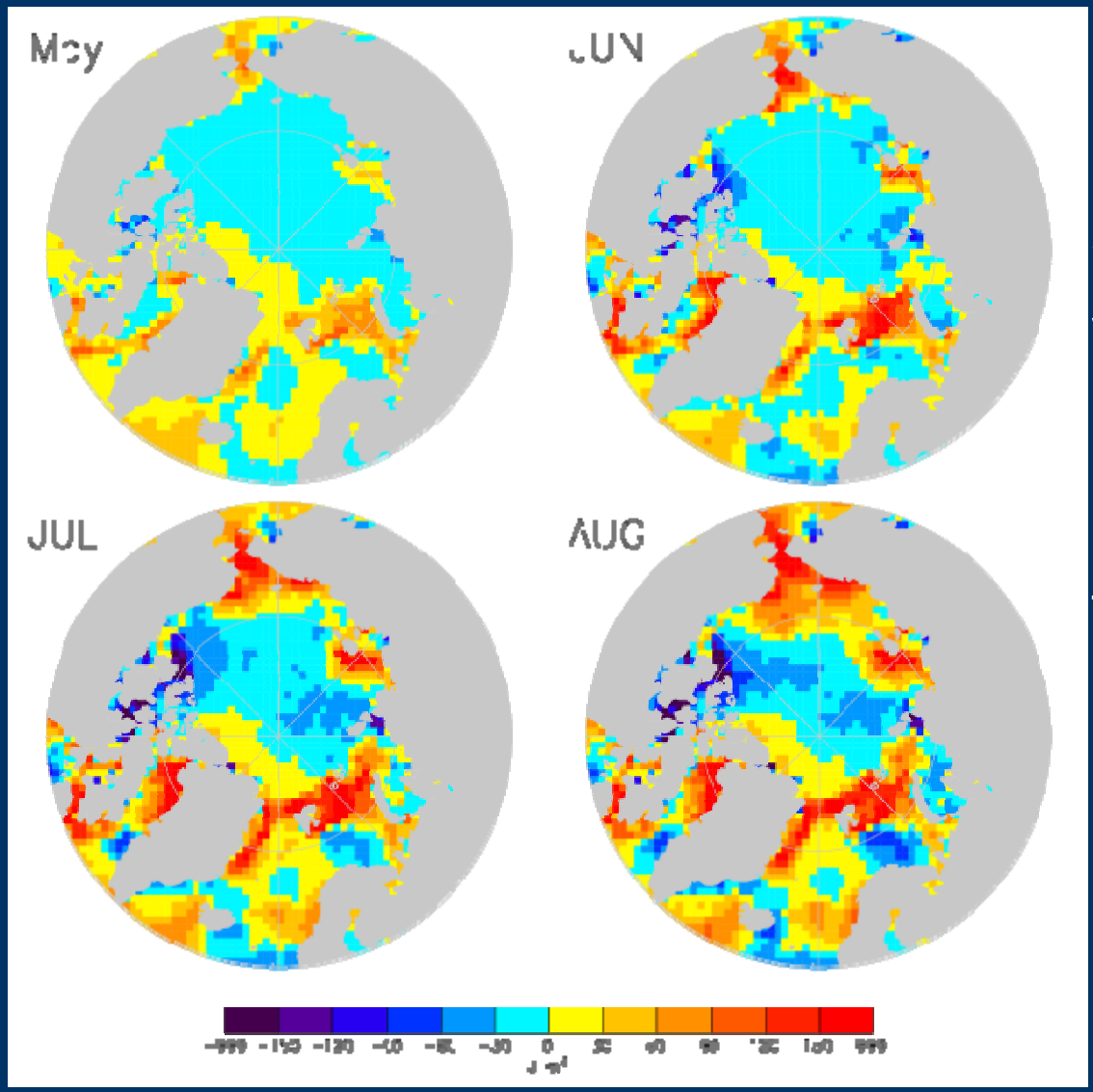
Open Water Areas Develop Earlier and Persist Longer

Ice Concentration Trends (1979-2008)





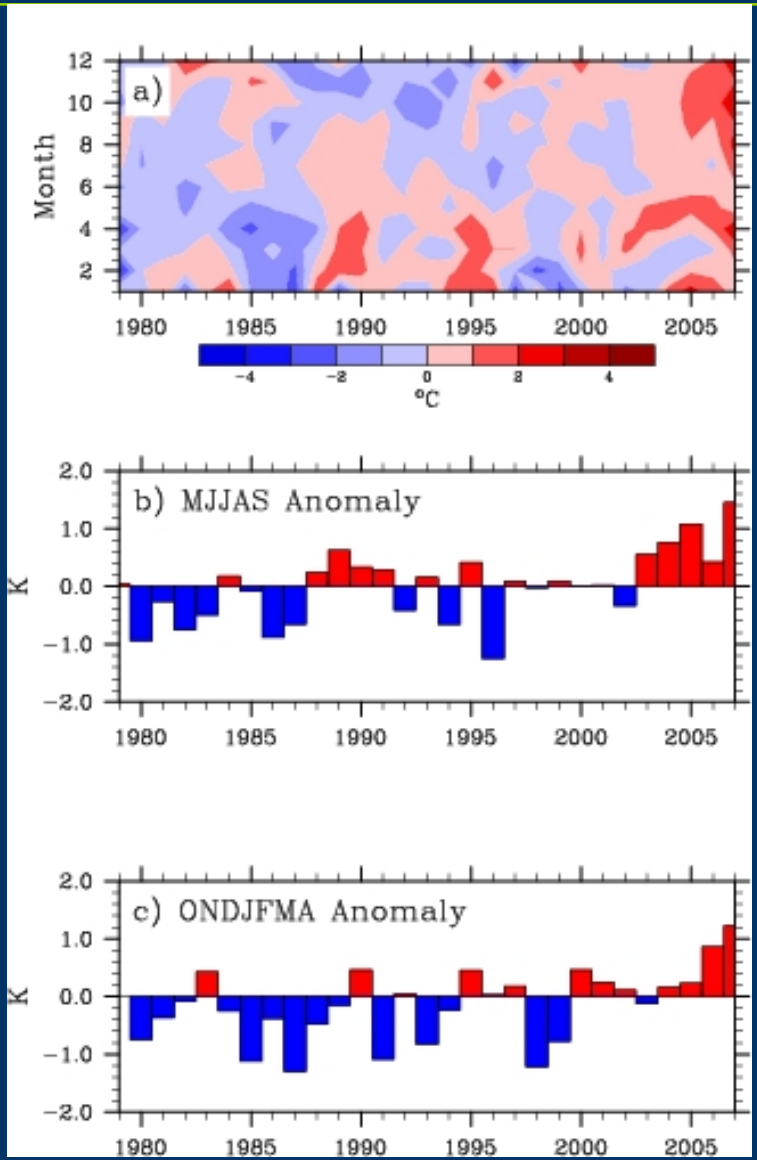
A Growing Albedo Feedback



Cumulative anomalies in absorbed solar radiation from JRA-25, 2002-2007, relative to 1979-2007

Perovich et al. 2008 found anomalies of 500% in absorbed solar radiation in the Beaufort and Chukchi Seas in 2007.

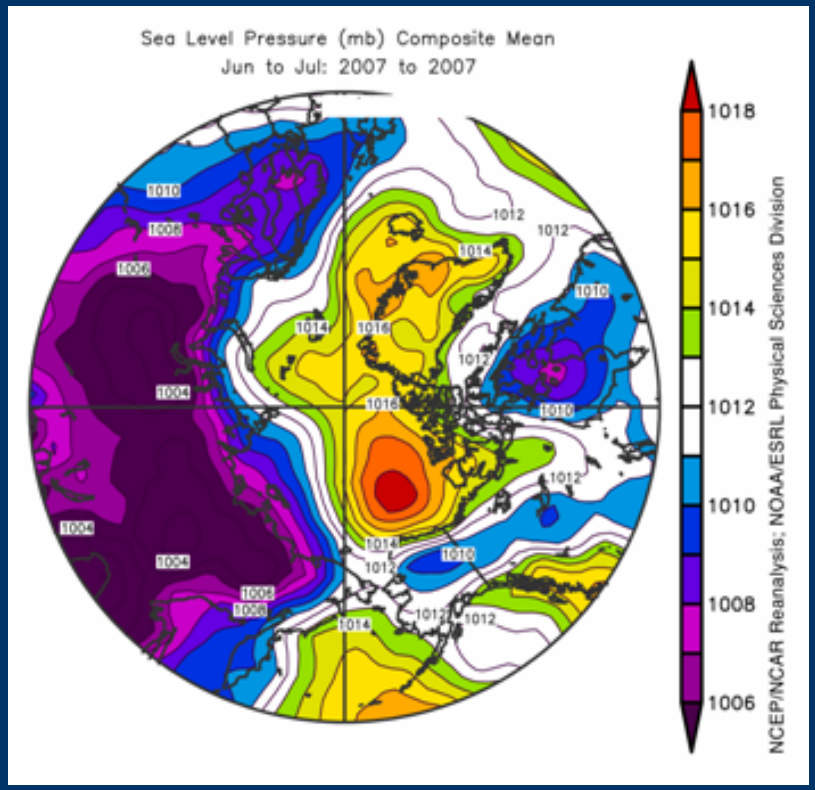
The Arctic is Warming in All Seasons

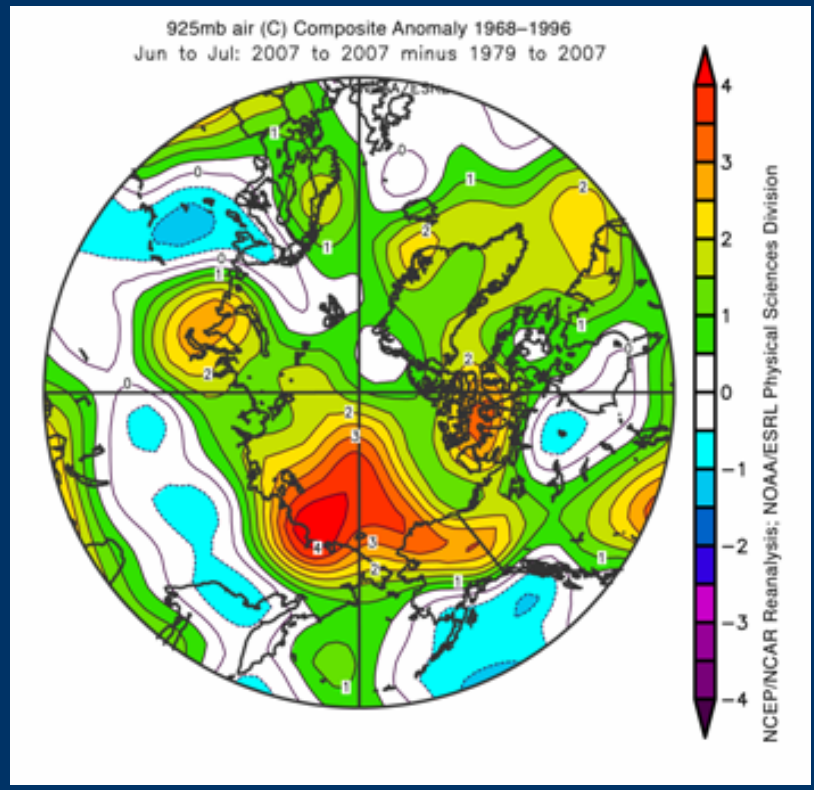


JRA-25 surface temperature anomalies by year and month (top) and by extended summer (middle) and extended winter (bottom)

Since about 2000, warming is happening in all months.

Natural Variability Remains Important





- High pressure over central Arctic Ocean
- Low pressure over Siberia

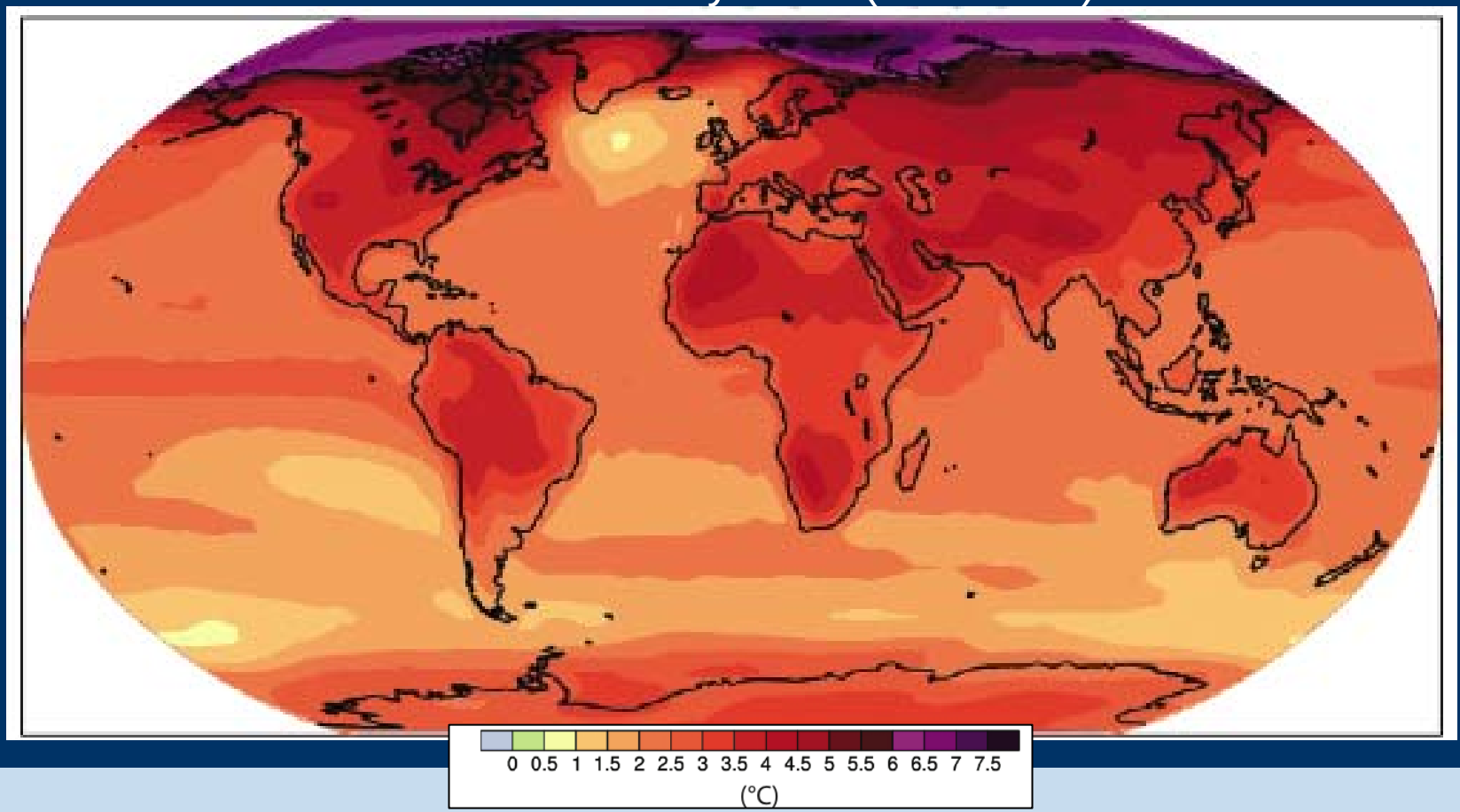
A very warm Arctic

Factors contributing to the 2007 record

Climate Impacts: Arctic Amplification

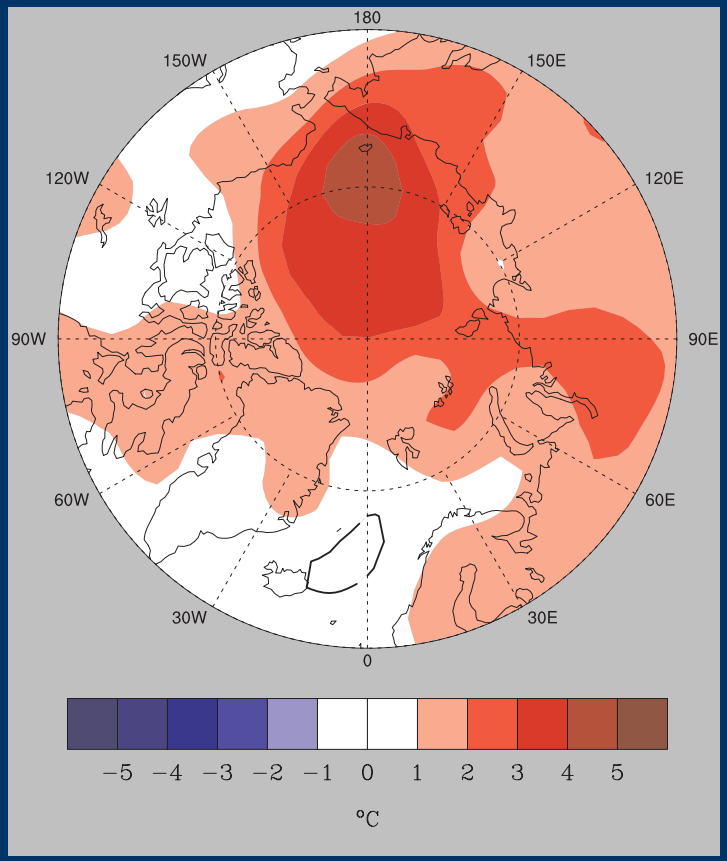
Air Temperature: A1B Scenario by 2100

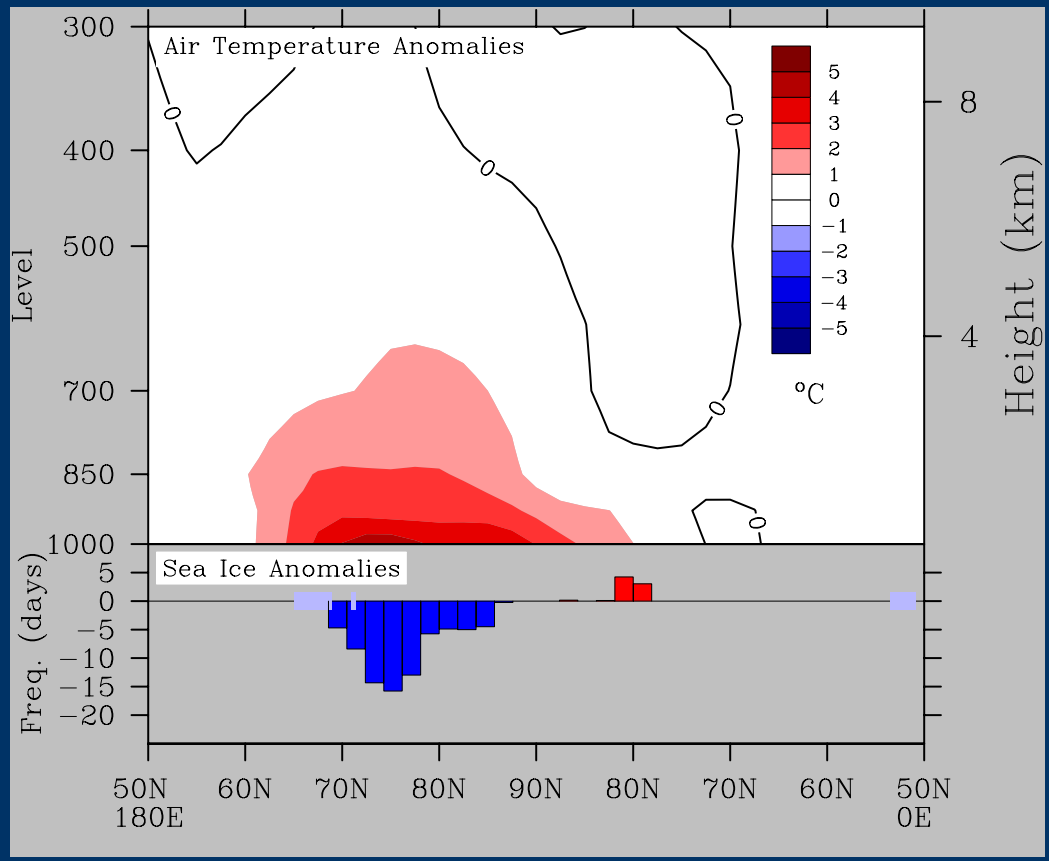
Global mean warming of ~2.8ºC (or ~5F);
Much of land area warms by ~3.5ºC (or ~6.3F)
Arctic warms by ~7ºC (or ~12.6F)



Arctic Amplification has Emerged

Autumn (SON) Temperature Anomalies

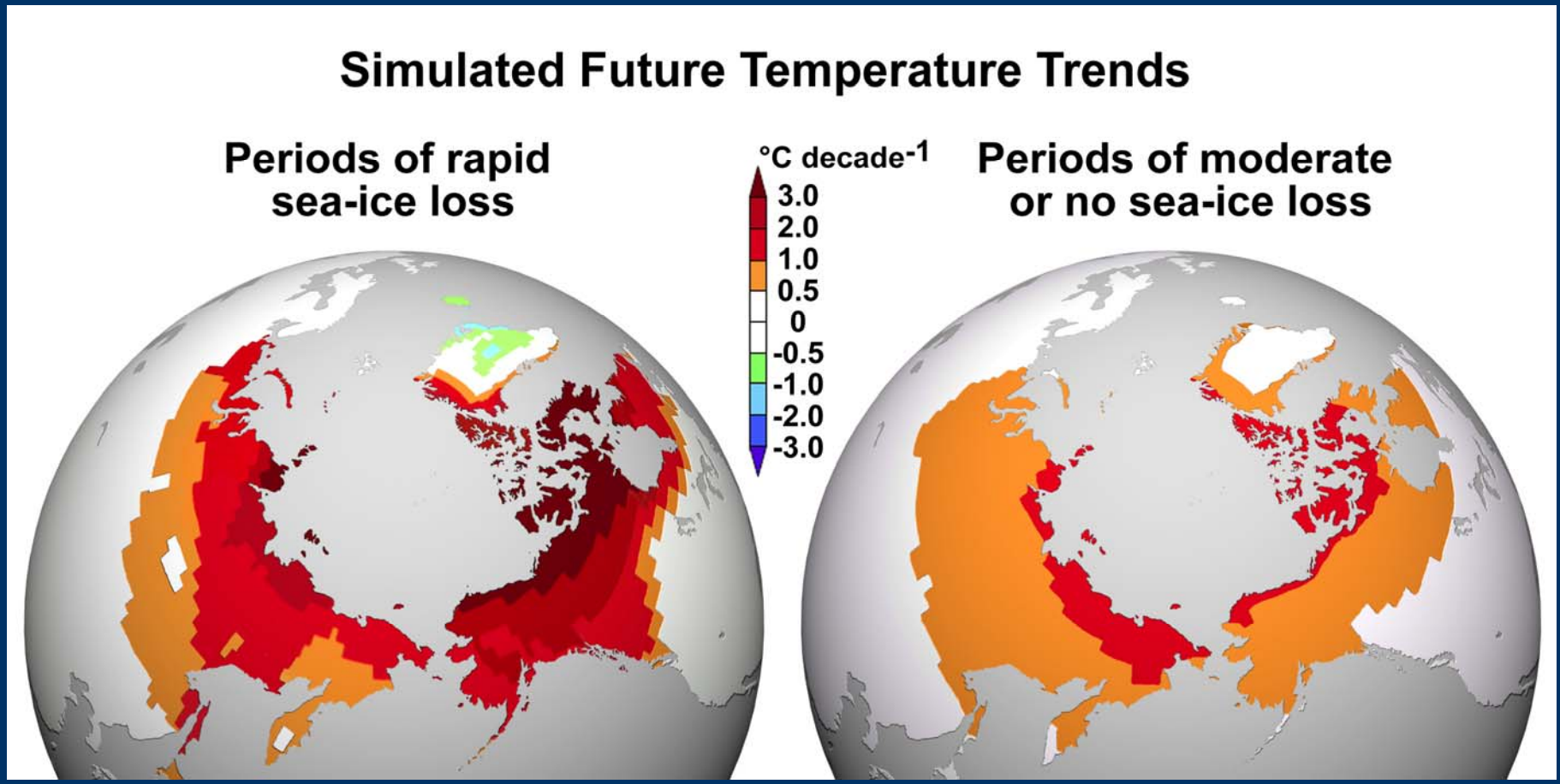




Air Temperature and Sea Ice Anomalies: 2004-2008 minus 1979-2008

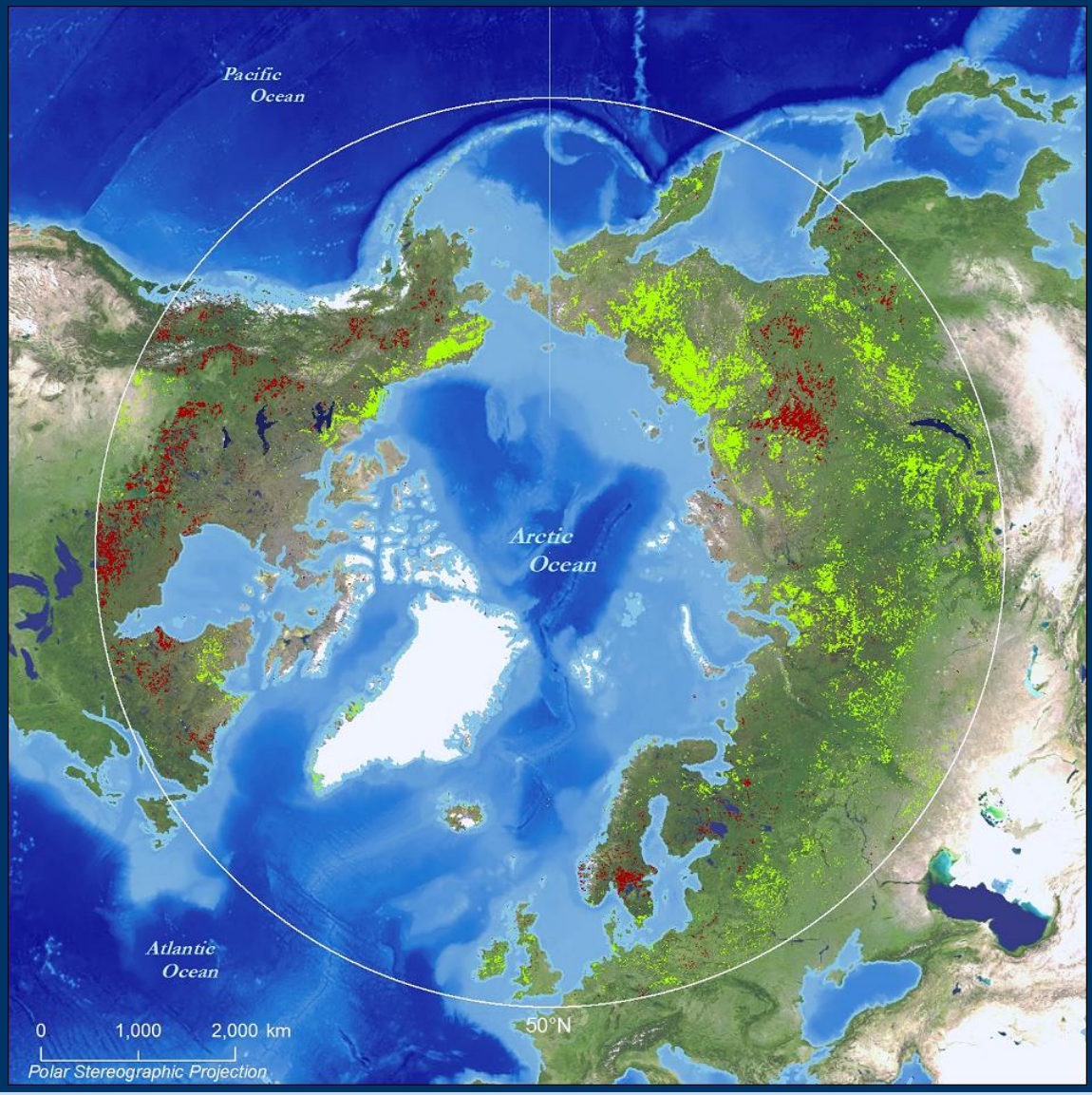
Updated from Serreze et al., 2008

Ice Loss Leads to Terrestrial Warming



Courtesy D. Lawrence and A. Slater

Further "Greening" of the Arctic



Trends in vegetation synthetic activity from 1982–2005
(GIMMS-G AVHRR Vegetation indices)

Significant positive trends

Significant negative trends

Courtesy Scott Goetz, Woods Hole

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A Net Carbon Release?

Burning methane over a thermokarst lake in Siberia (K. Walter)

Methane bubbles trapped in lake ice

Lake bubbling with methane in the Arctic

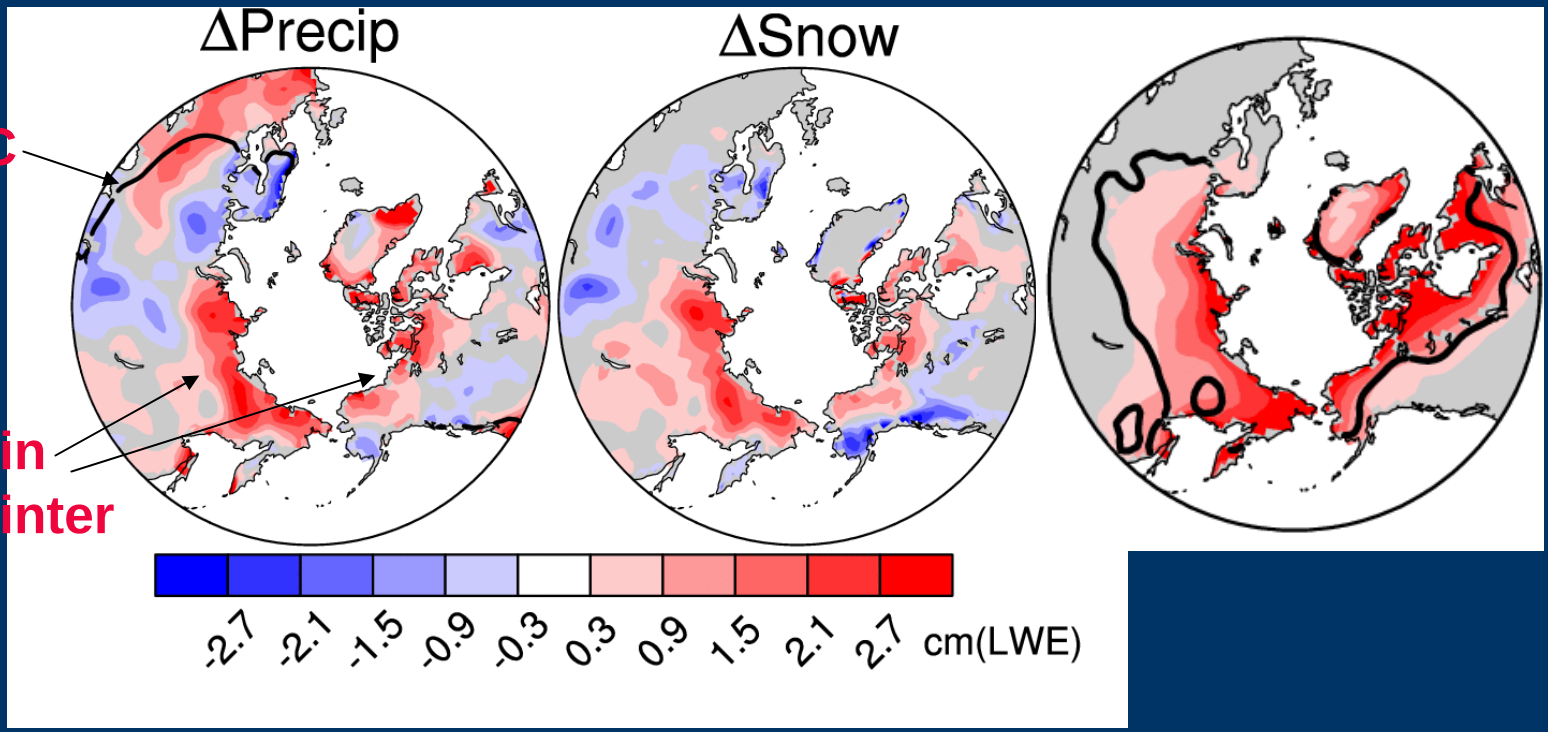
Courtesy K. Walter

Projected Impacts on Precipitation

Accumulated Oct-Mar Precipitation

March Snow Depth

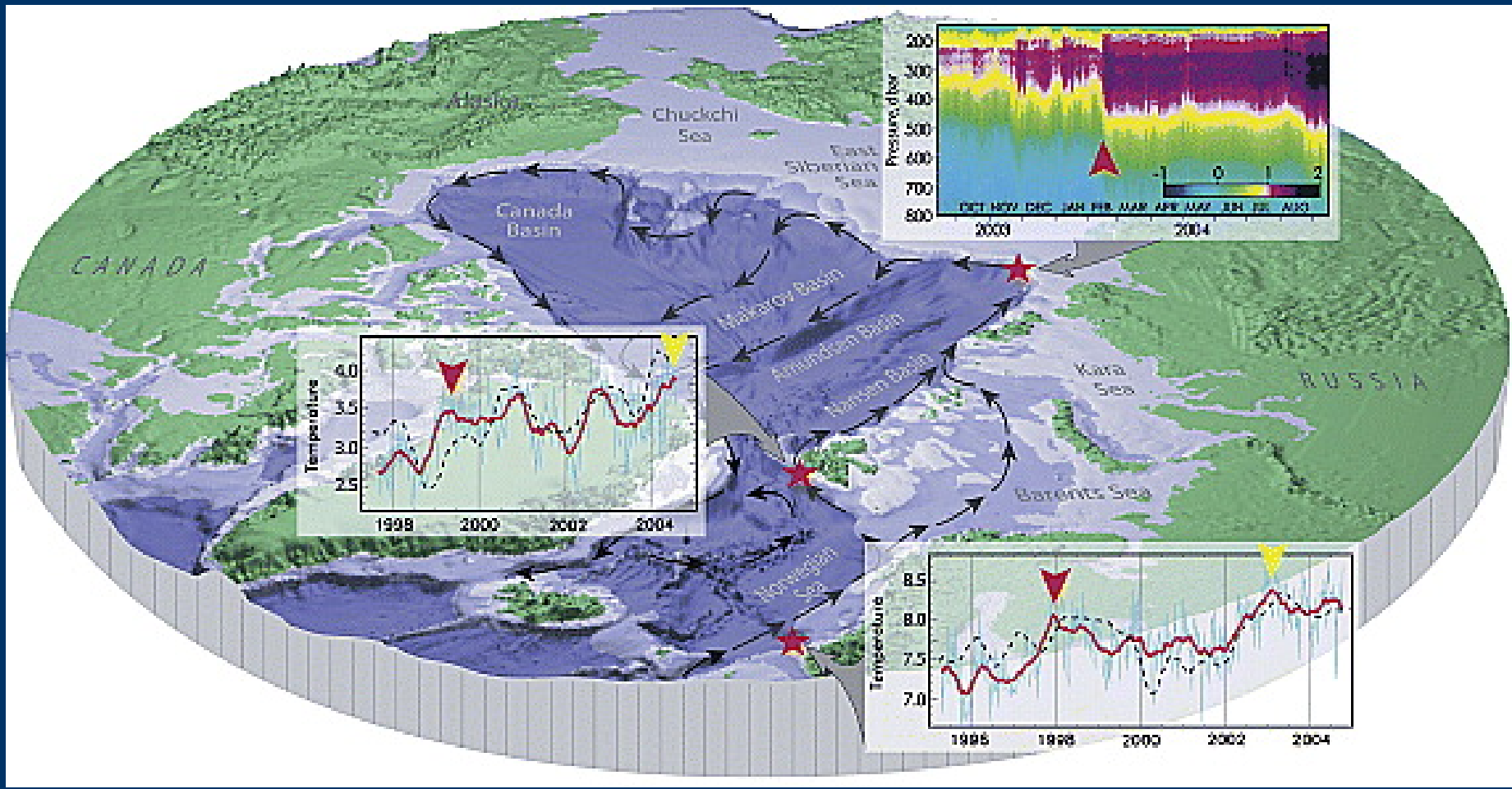
Air T



From Deser et al. (submitted)

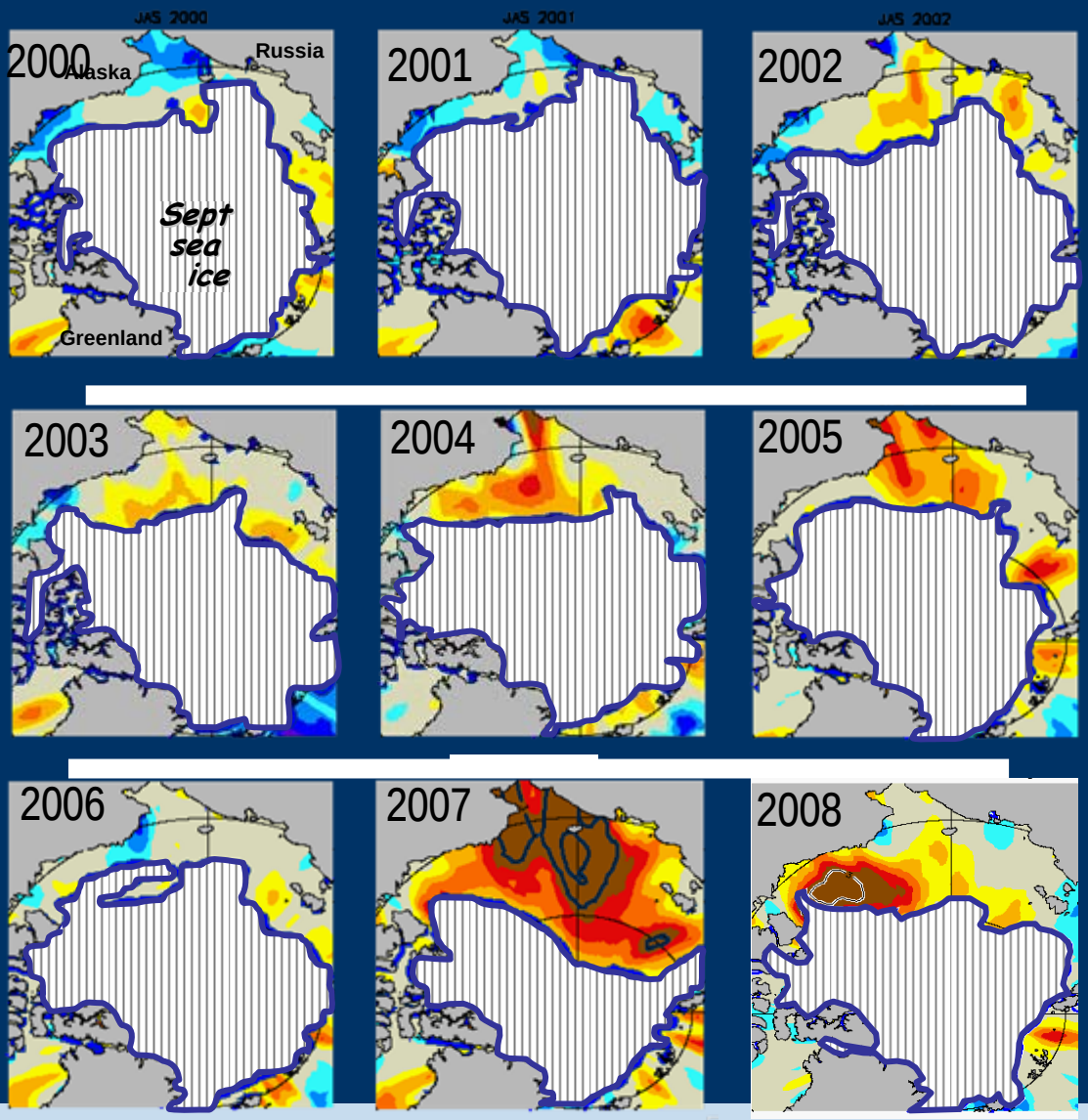
A Puzzle: Warming of Atlantic Inflow

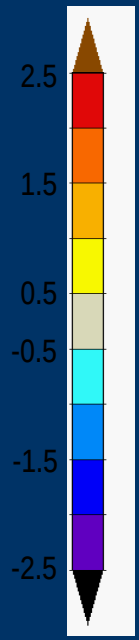
Moorings at Svinoy and Fram Strait



Polyakov et. al., 2005

Warmer SSTs





Anomaly of Summer Sea Surface Temperature (°C)

(relative to 1982-2007 mean)

Summer ≡ July 1 – September 30

SSTs from monthly mean AVHRR (Reynolds et al)

Courtesy of M. Steele

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Conclusions

- We are quickly losing the ice cover
  - Impacts are already being felt
- Ice-free summers by 2030? Earlier?
  - We seem to be in the fast lane
- Arctic amplification will be a big issue
  - Impacts on terrestrial warming and carbon cycle
  - Impacts on atmospheric circulation


Thank You
04.10.2008