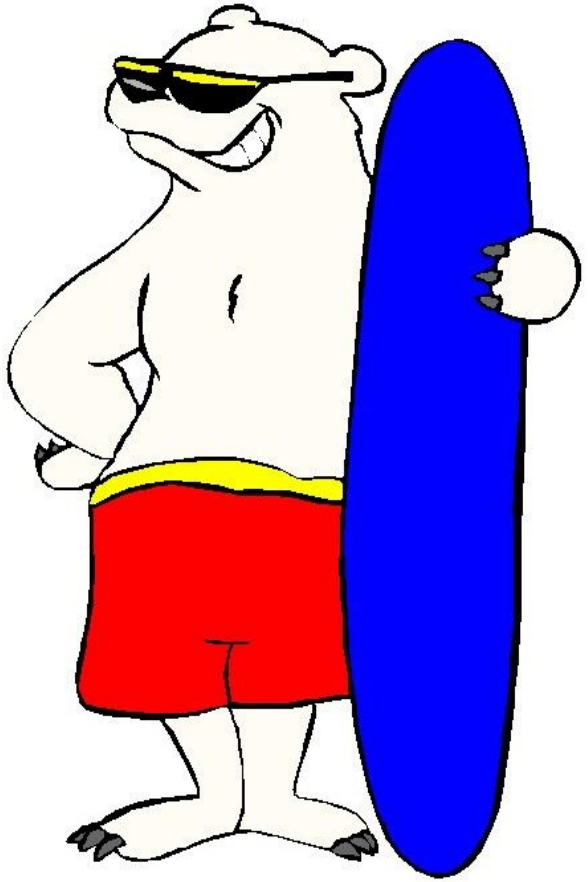
Sea Ice Behaving Badly

Or Where will the Polar Bears Go?

James Overland, Muyin Wang

NOAA/Pacific Marine Environmental Laboratory, Seattle

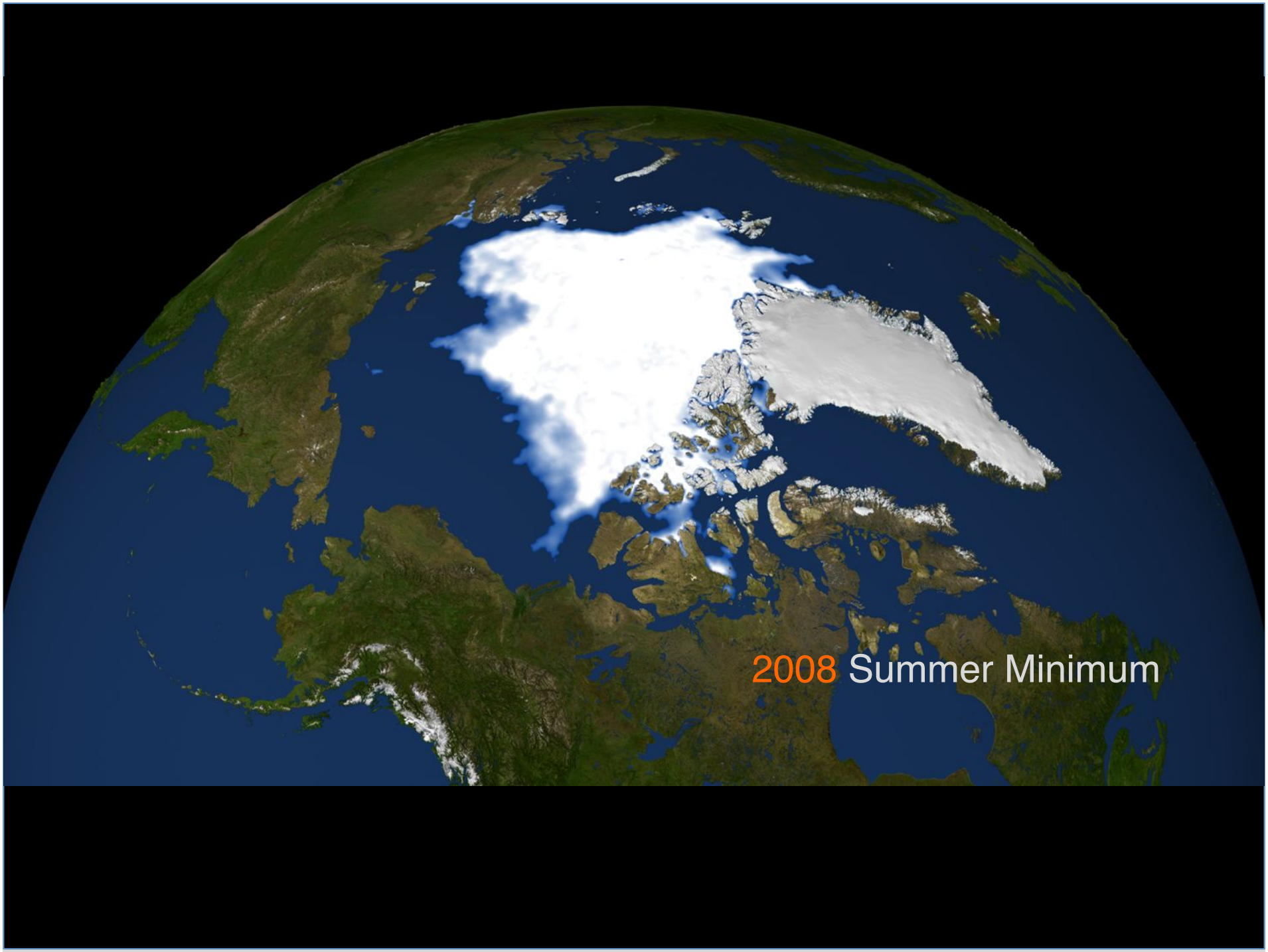


This year, something unusual happened in fall, with implications for the future

We expected the ocean to be freezing to the north of Alaska…

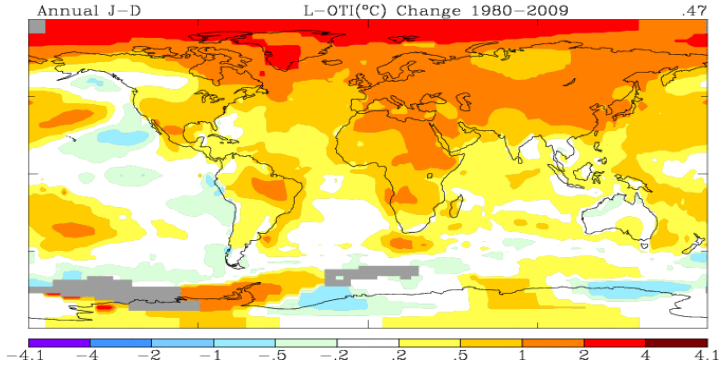
Chukchi Sea

But we found the ocean was warm


2008 Summer Minimum

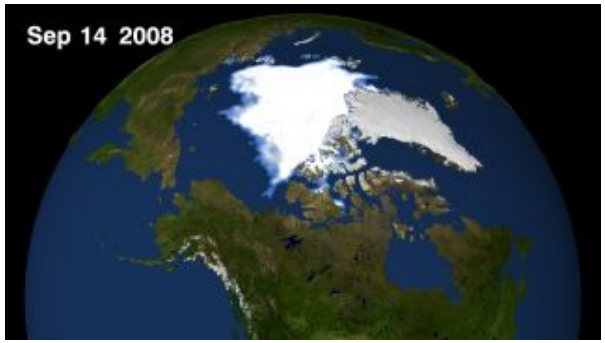
Understanding Arctic Climate Feedbacks & Its Global Implications

Global Warming



Arctic amplification

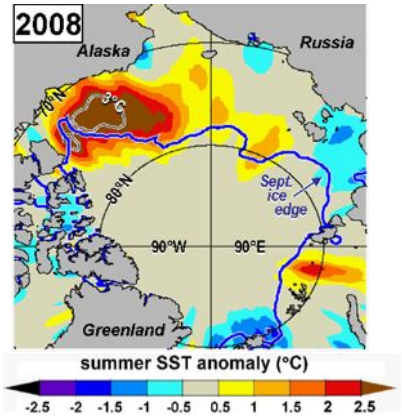
Reduction of Arctic sea Ice



Sept Sea Ice Extent

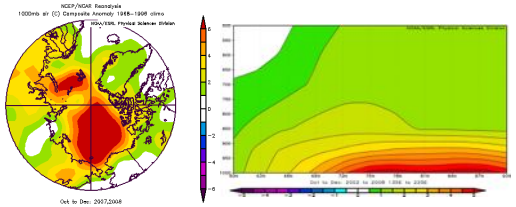
Surface albedo decrease

Ocean absorbs more heat



Heat releases to atmosphere in the fall.

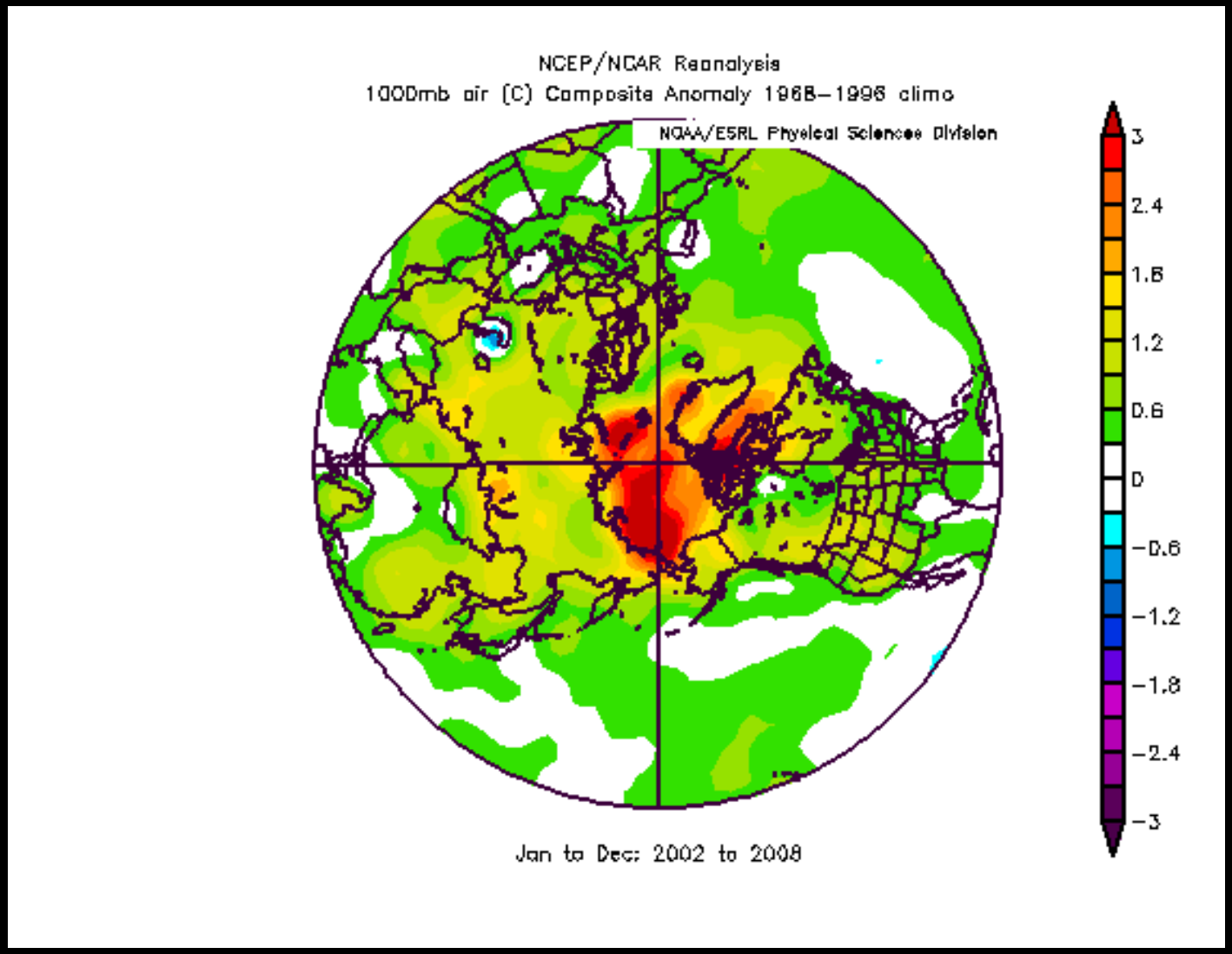
Atmosphere warming



OND Temp Anomaly

Teleconnection and circulation pattern change

The Arctic is Earth's fastest-warming region as climate models predicted



2002-2008 Air Temperature Anomalies Relative to 1968-1996

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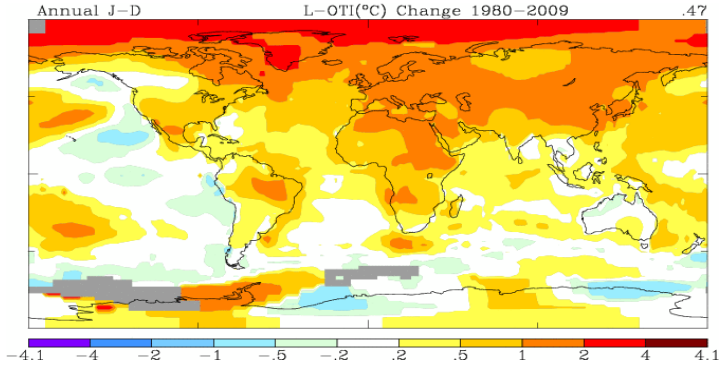

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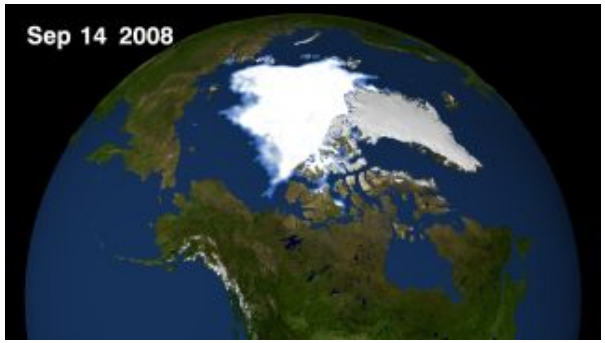

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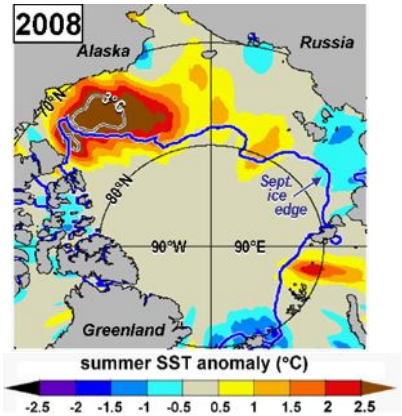

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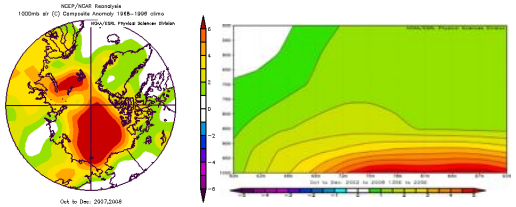
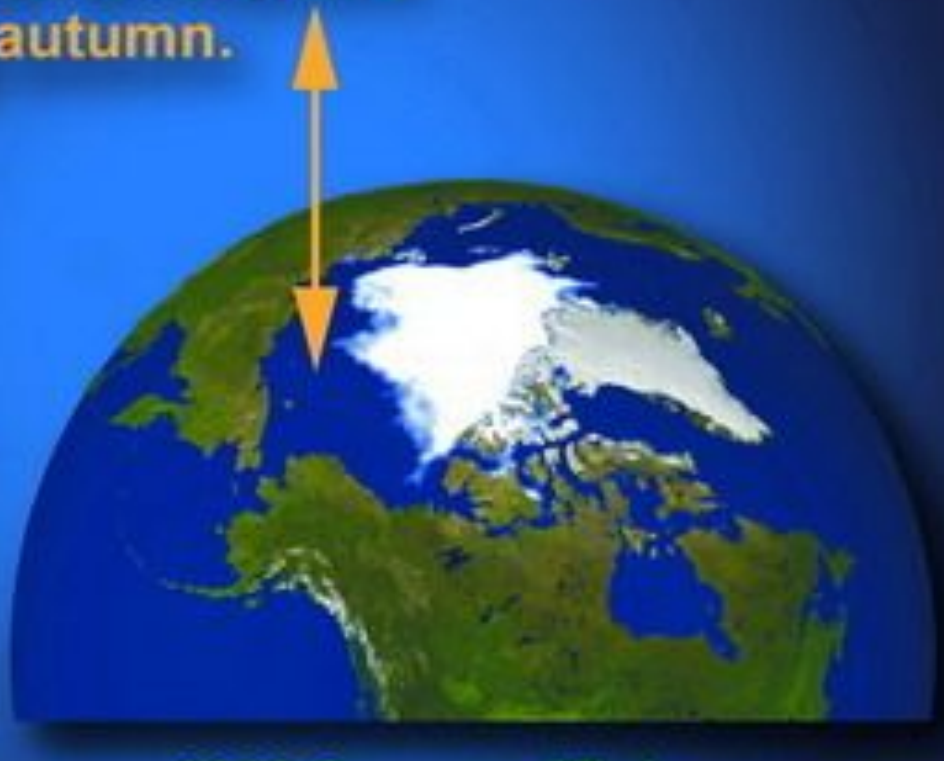


OND Temp Anomaly

Teleconnection and circulation pattern change

Increased heat stored in the ocean
in ice-free regions in summer is
released to the atmosphere
the following autumn.



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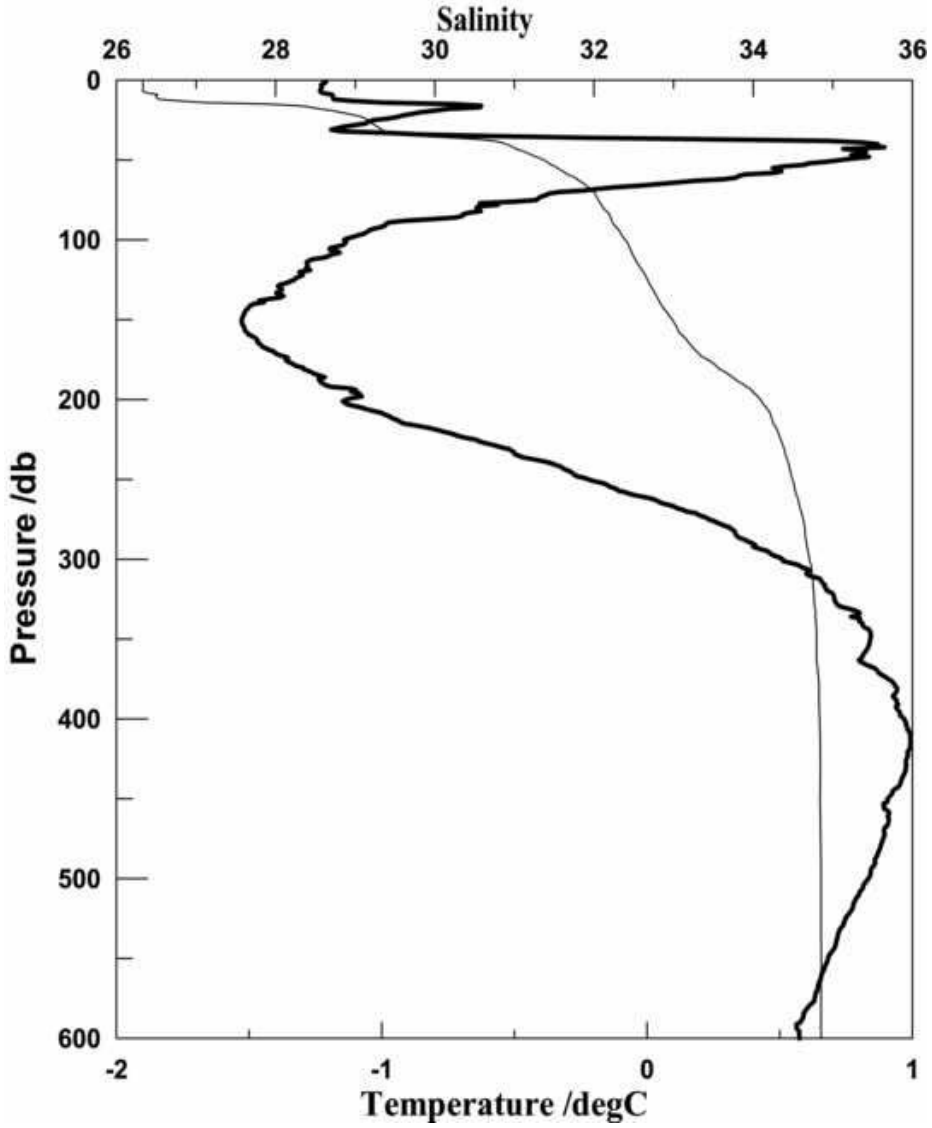
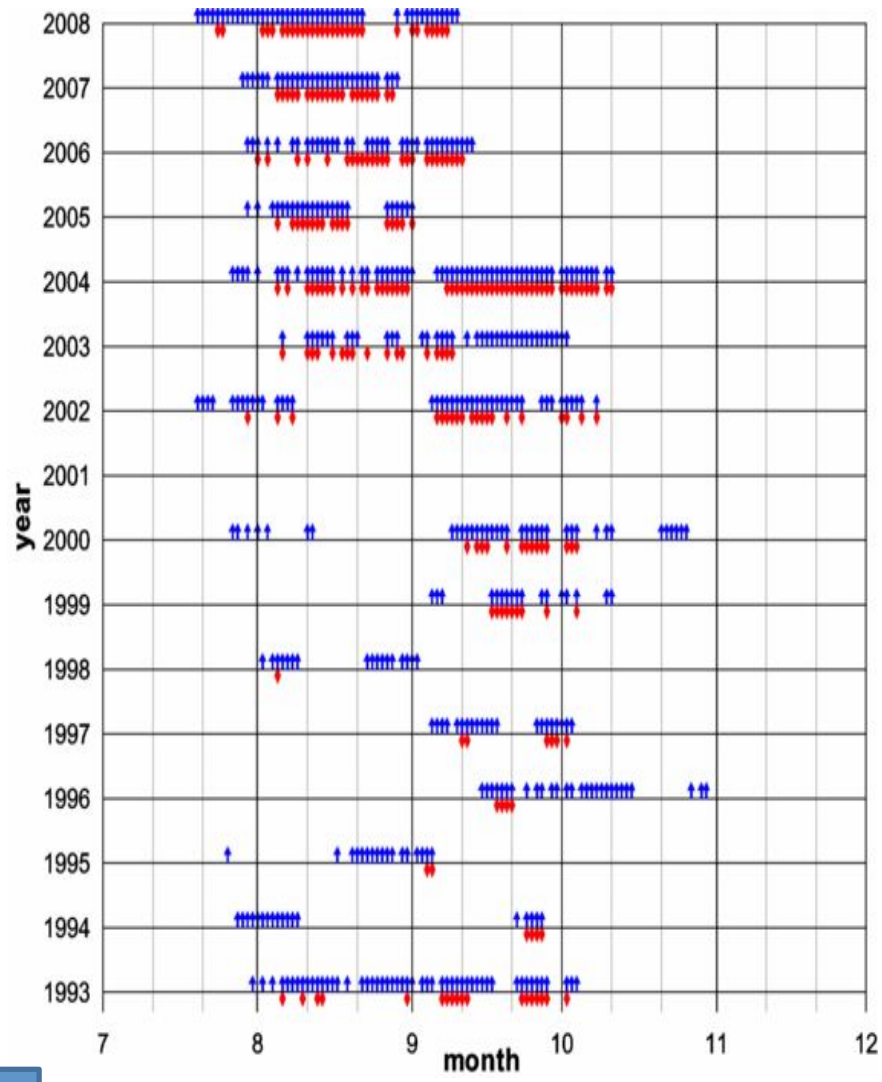
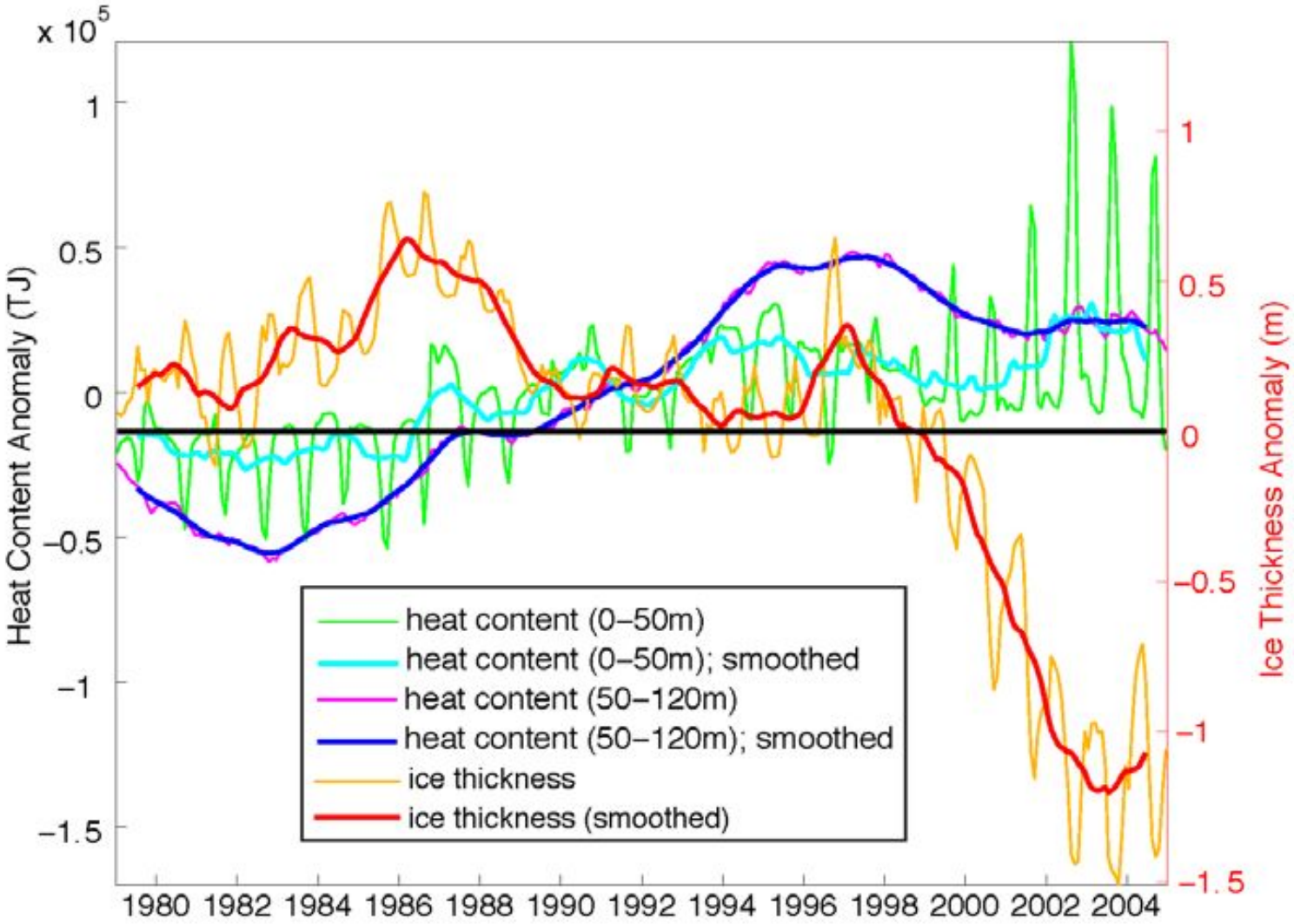


Typical temperature and salinity profiles with the in the Canadian Basin at 56°44.16'W, 75°35.64'N on Aug. 19, 2006. (Jinping Zhao and Yong Cao, Ocean University of China, in revision)



Observations with near surface warm water are shown by red marks.

Model heat content accumulating in the sub-surface ocean since mid-1990s may explain much of the sea ice thickness change (Maslowski and Clement Kinney, in revision)



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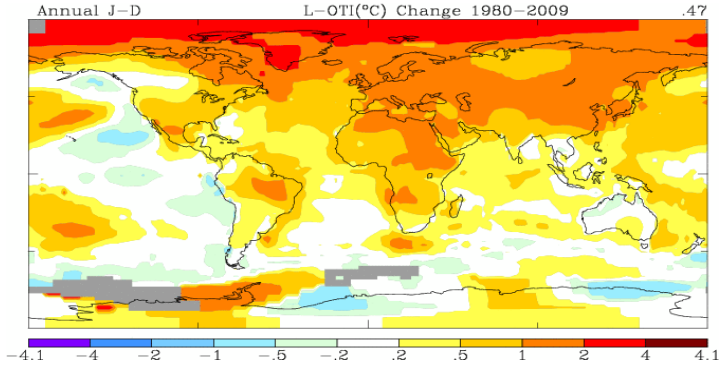

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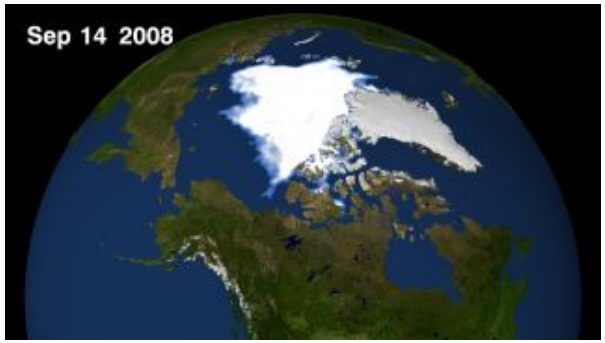

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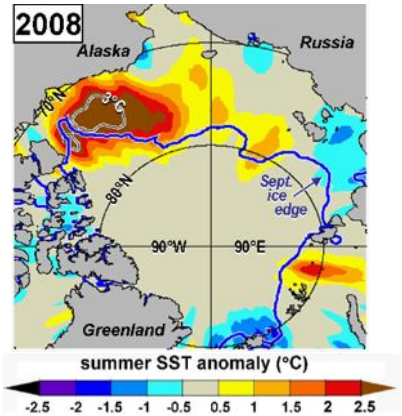

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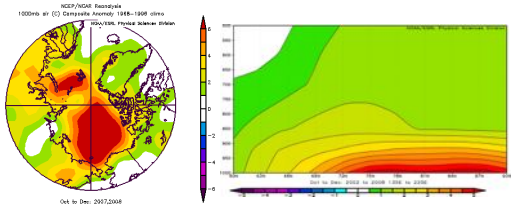

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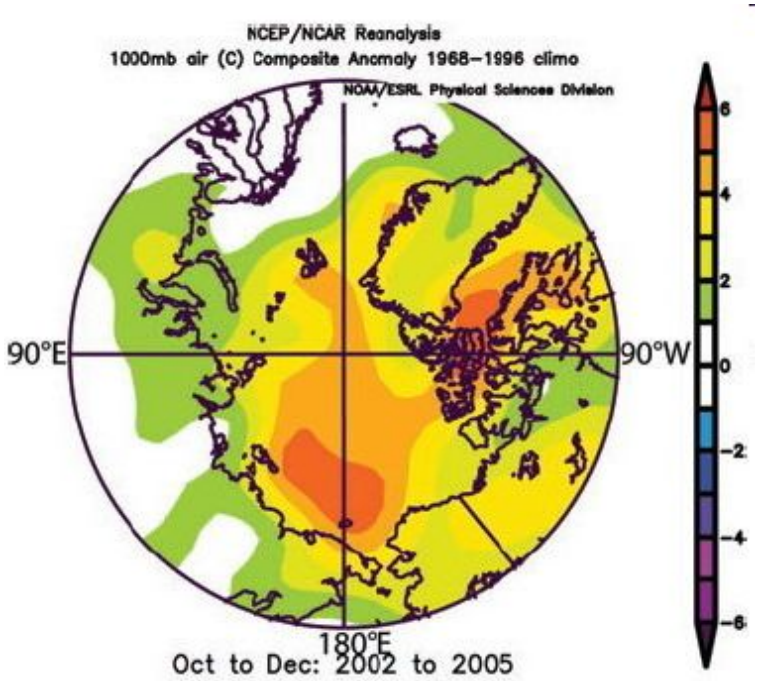
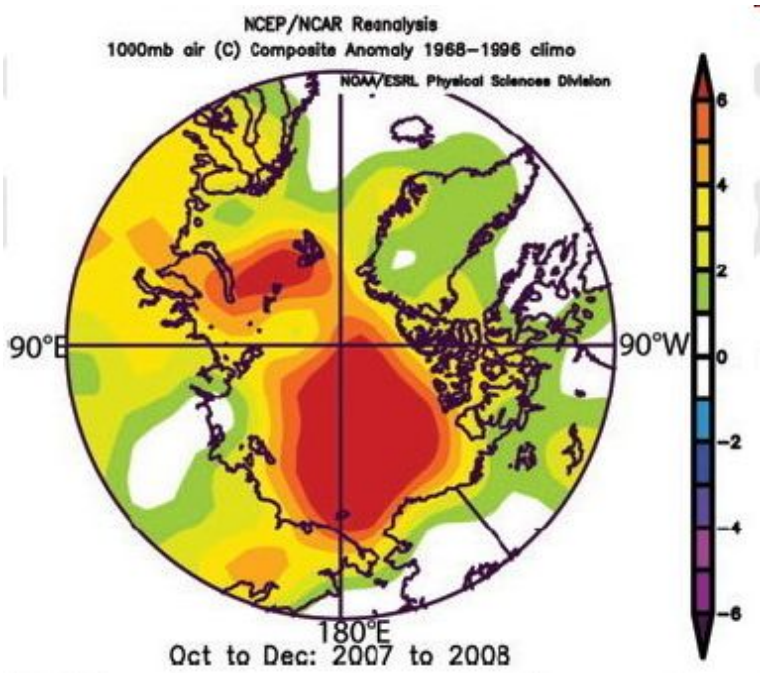

NCEP/NCAR Reanalysis
1000mb air (C) Composite Anomaly 1968–1996 climo
NOAA/ESRL Physical Sciences Division
90°E
90°W
180°E
6
4
2
0
-2
-4
-6
Oct to Dec: 2002 to 2005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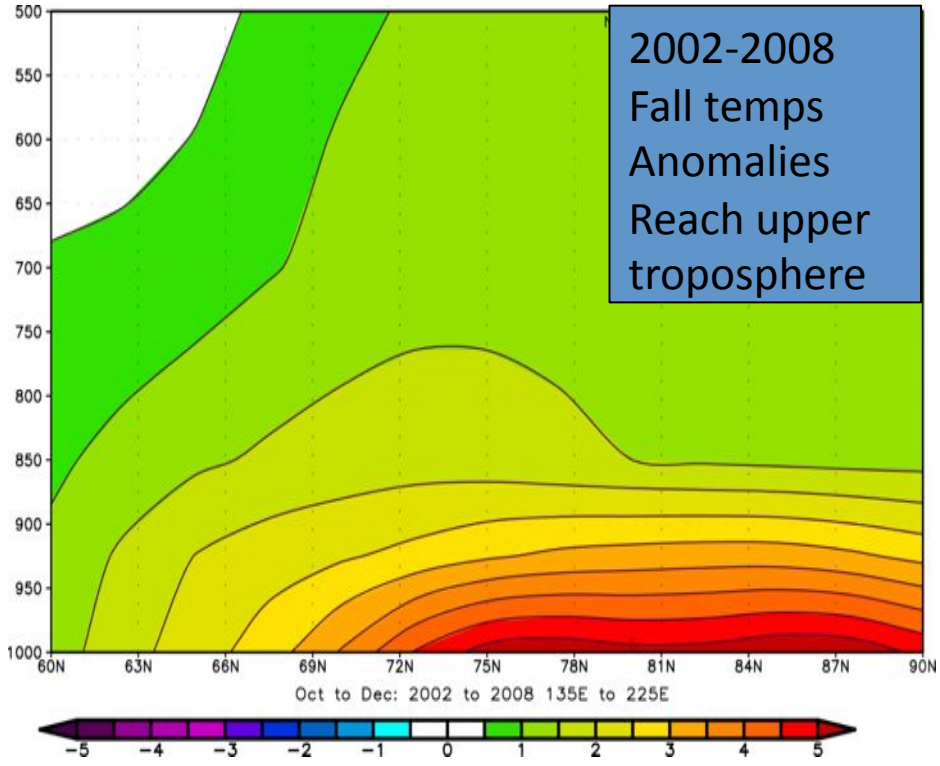
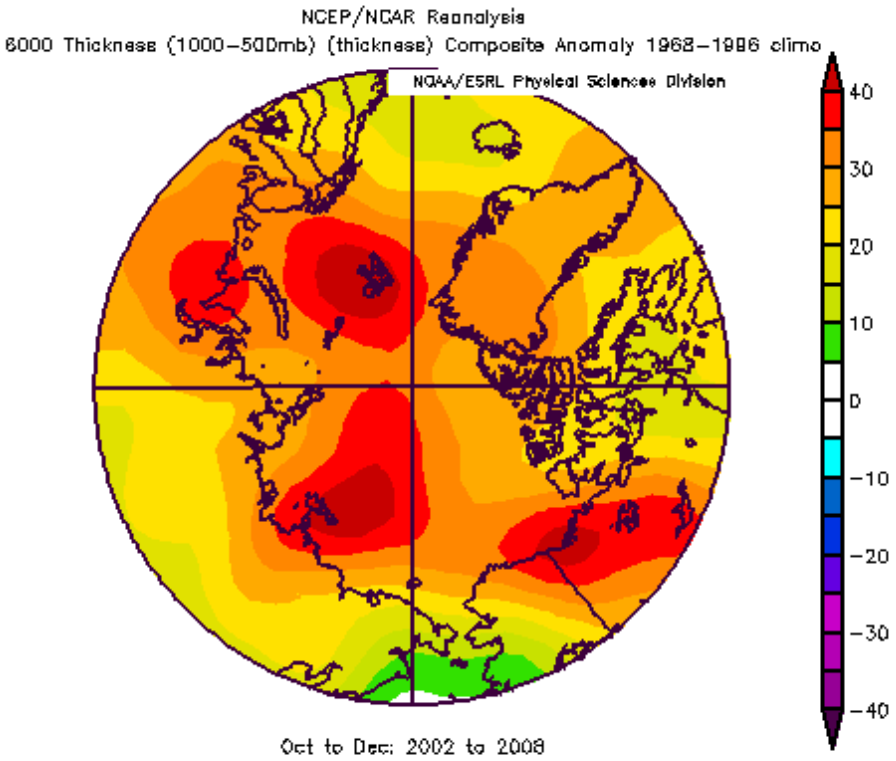
Loss of Sea Ice Impacts Larger Atmospheric Climate

Pacific Arctic



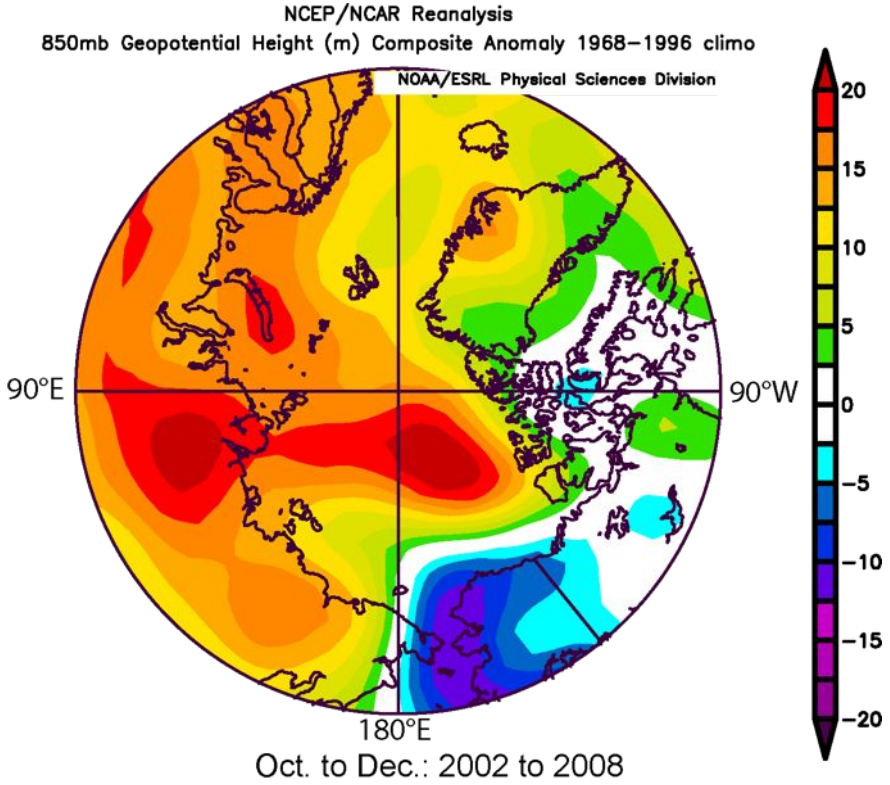
2002-2008
Fall temps
Anomalies
Reach upper
troposphere

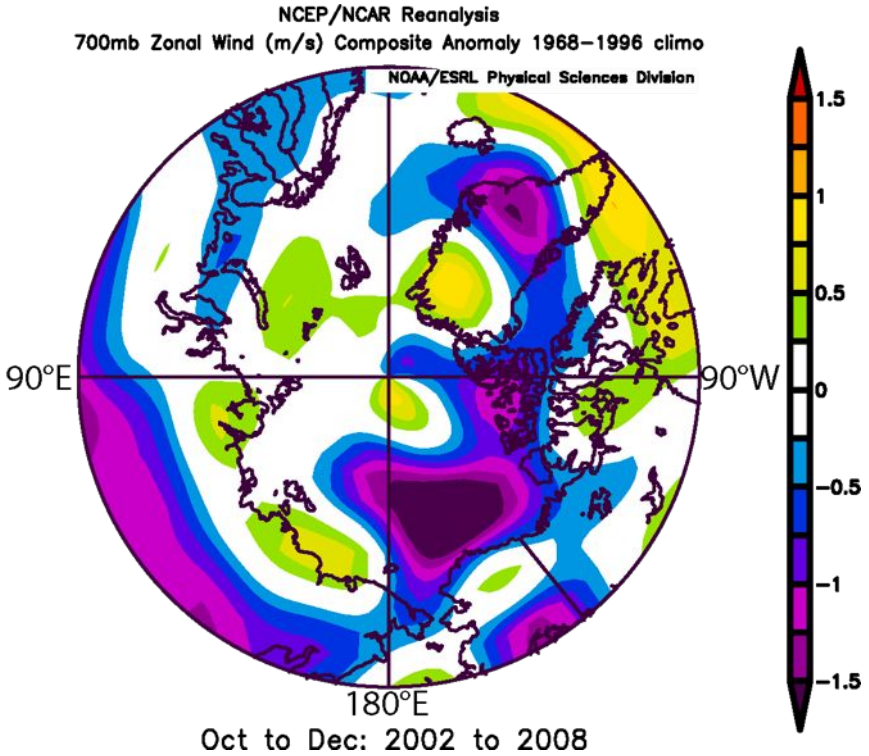


2002-2008 Fall 500-1000 mb
Thickness Anomaly

Thermal Wind Reduces Polar West Winds

Overland and Wang,
Tellus, 2010





40 % reduction in west wind component

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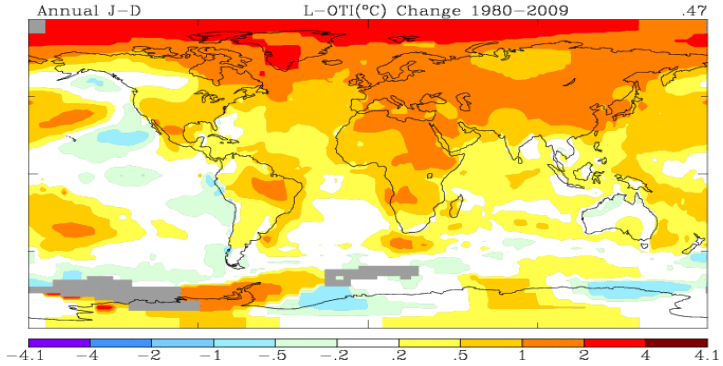

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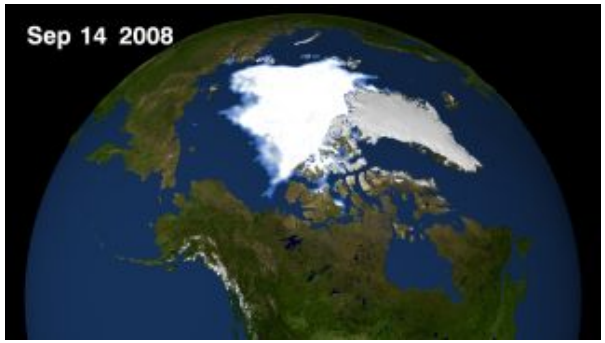

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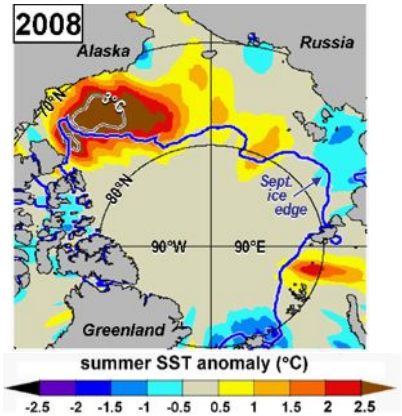

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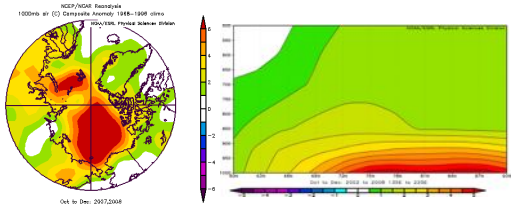

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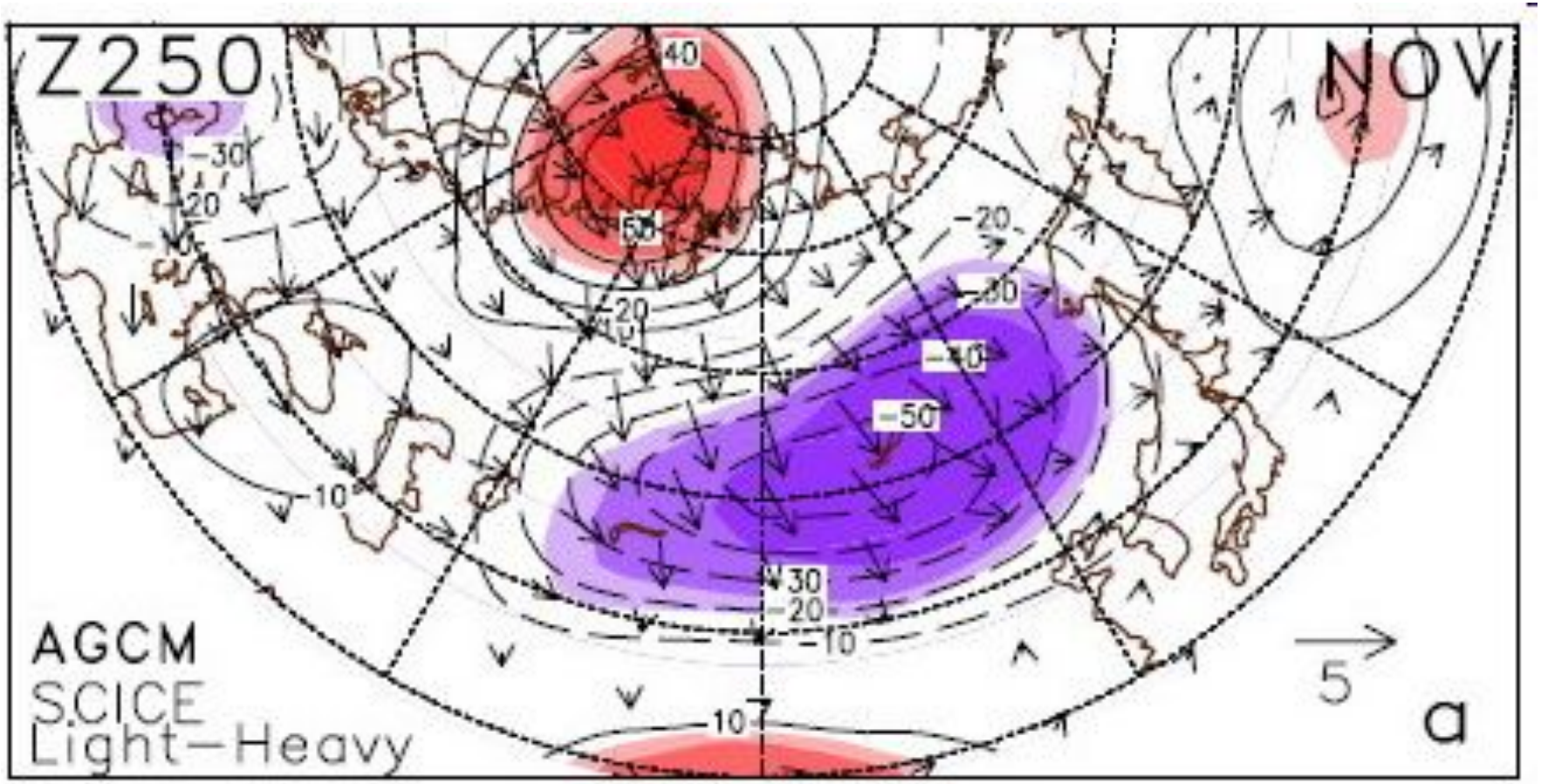
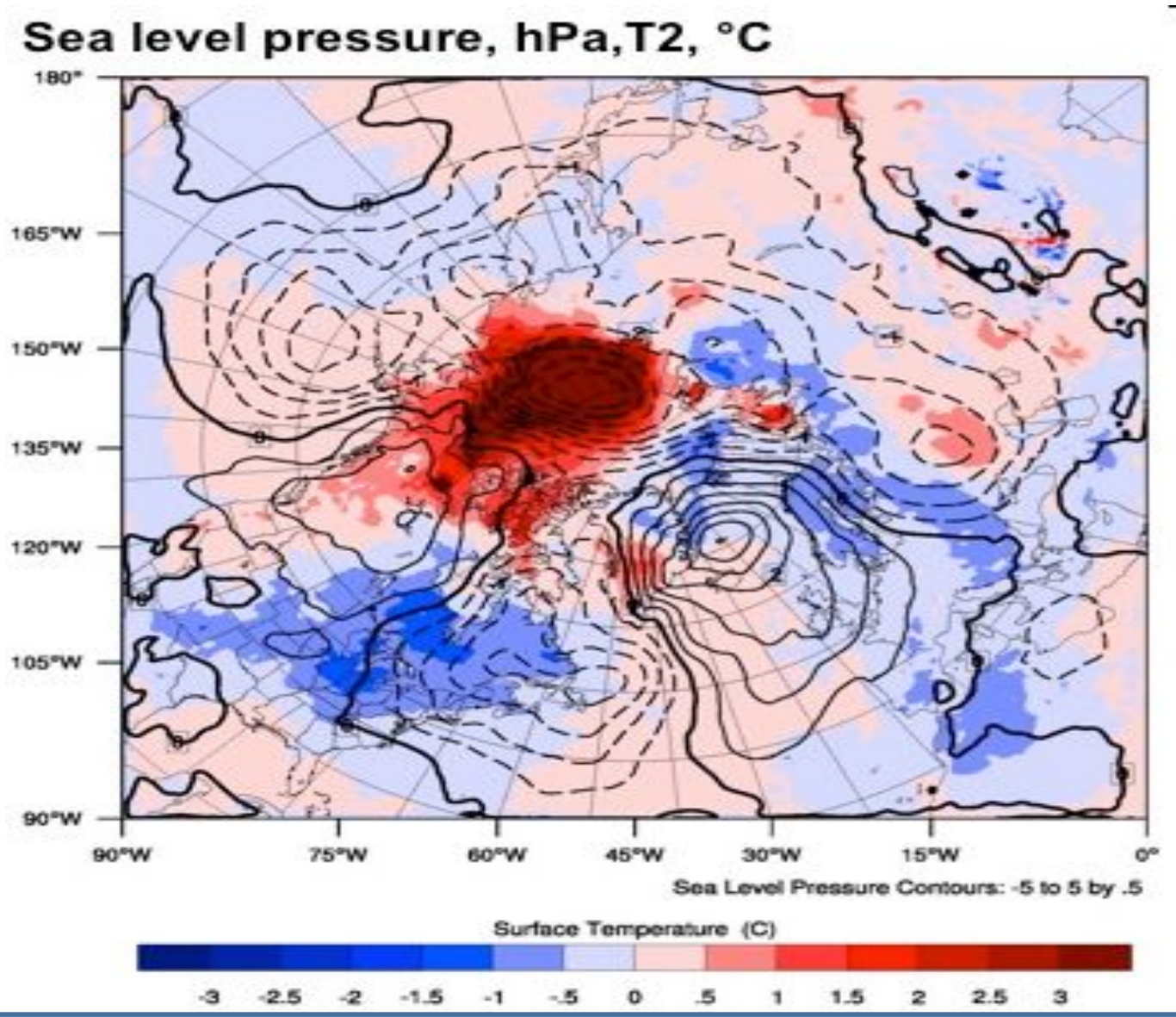


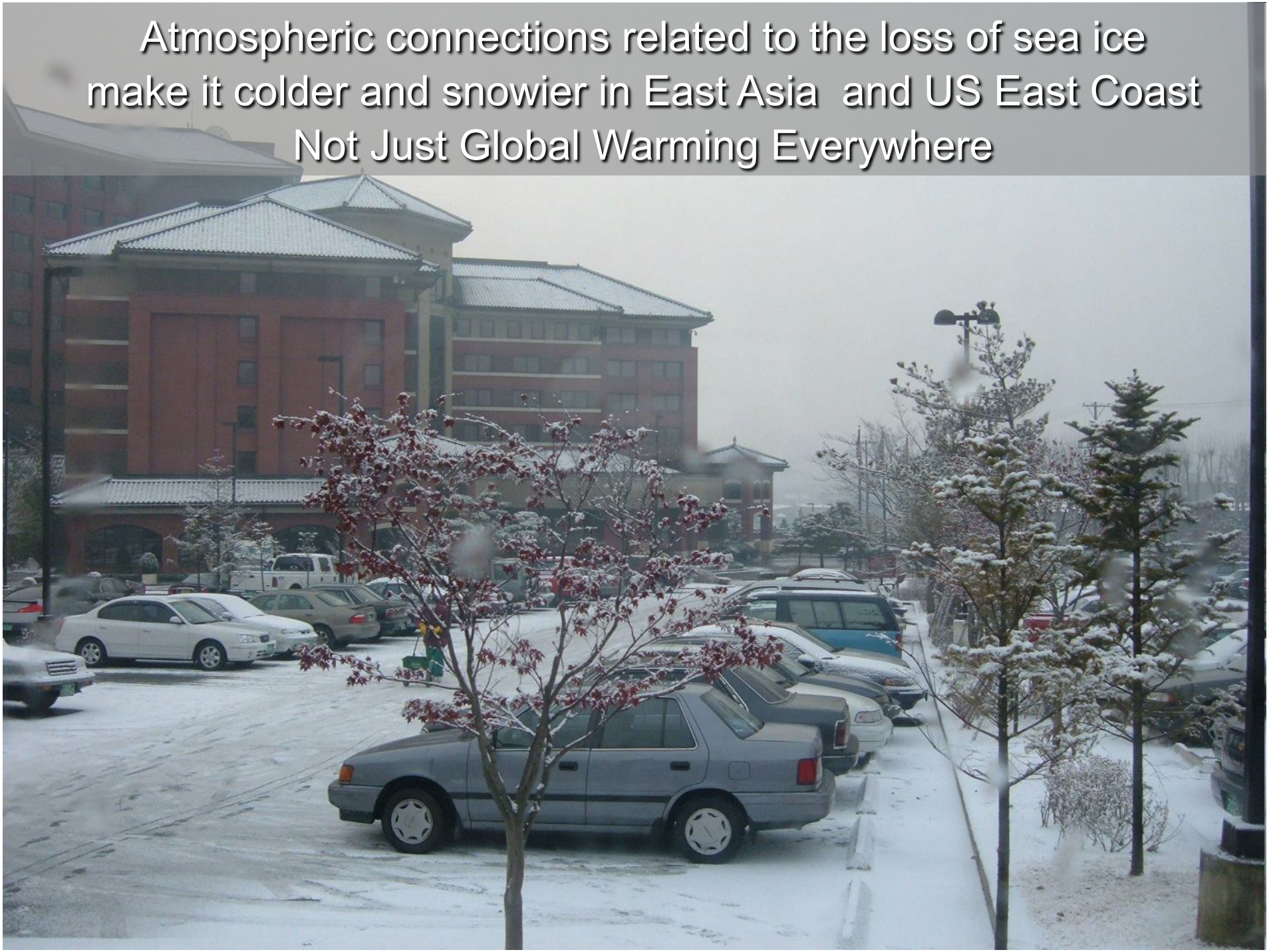
Honda, M., J. Inoue, and S. Yamane (2009): Influence of low Arctic sea ice minima on anomalously cold Eurasian winters. Geophys. Res. Lett., 36, L08707, doi:10.1029/2008GL037079.



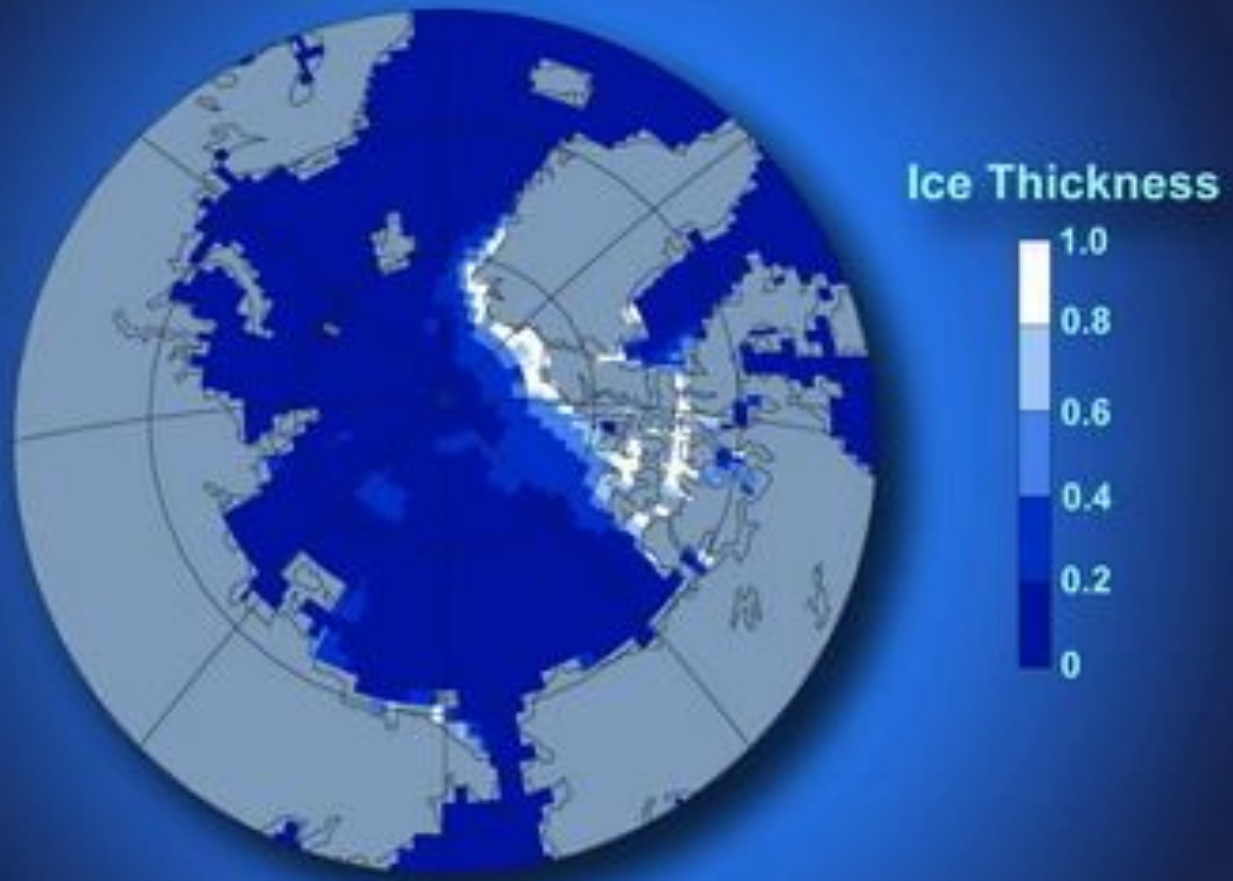
Strey, S.T., W. Chapman, and J. Walsh (2009): Effects Of An Extreme Arctic Sea Ice Minimum On the Northern Hemisphere Atmosphere During Late Autumn and Early Winter:, Eos Trans. AGU, 90(52)

Atmospheric connections related to the loss of sea ice make it colder and snowier in East Asia and US East Coast

Not Just Global Warming Everywhere



Computer models predict that by 2035, the Arctic could be nearly sea ice-free in summer.



Sea ice is a thermostat for global climate,
and it is no longer functioning the way it used to.

Increased connectivity between the Arctic and mid-latitudes

Expect more surprises