The New Arctic Reality

Present and Future

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Global Warming in the Arctic:

How do we know we are not wrong?

Methods of Scientific Validation :

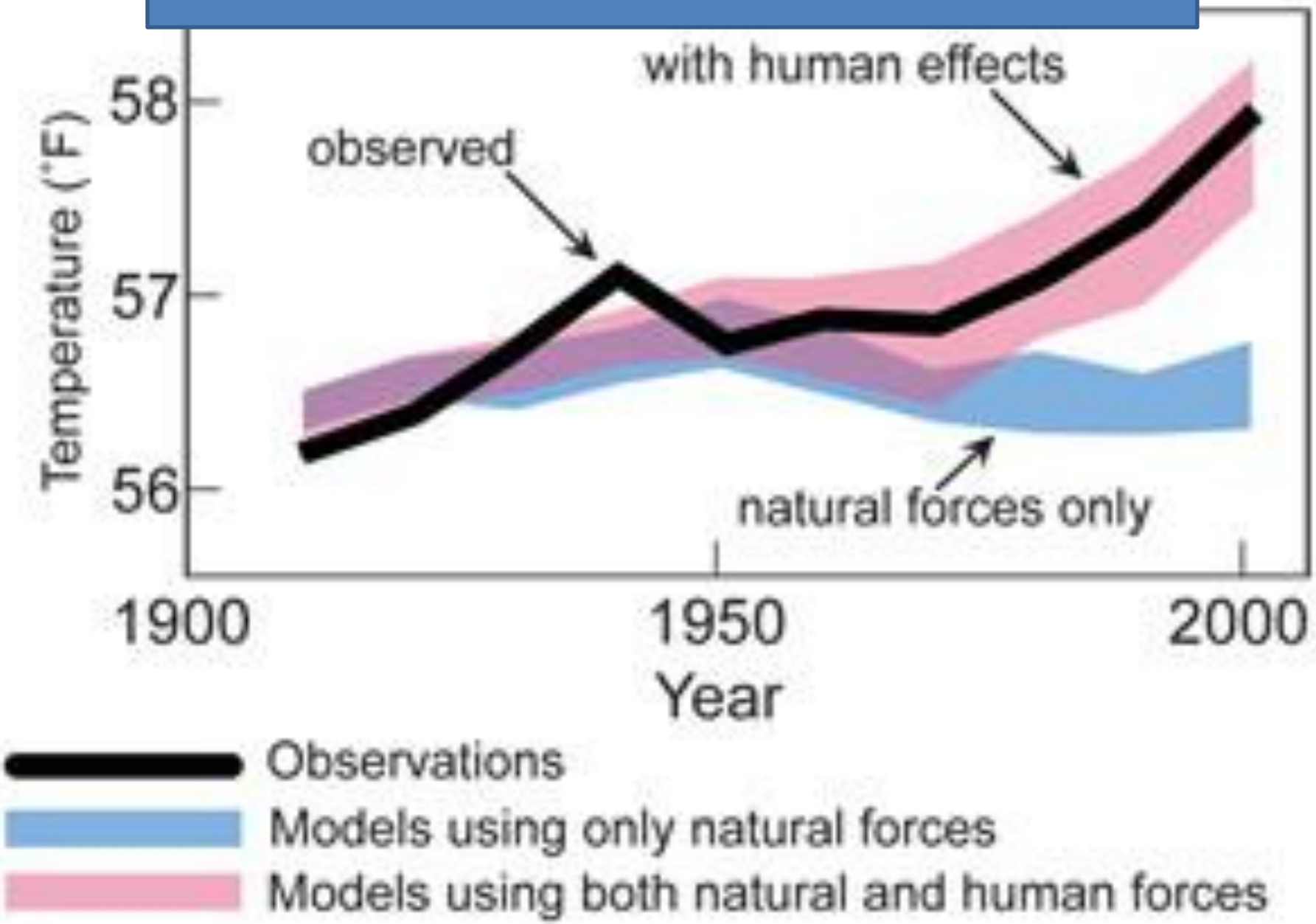
Deduction

Predictions

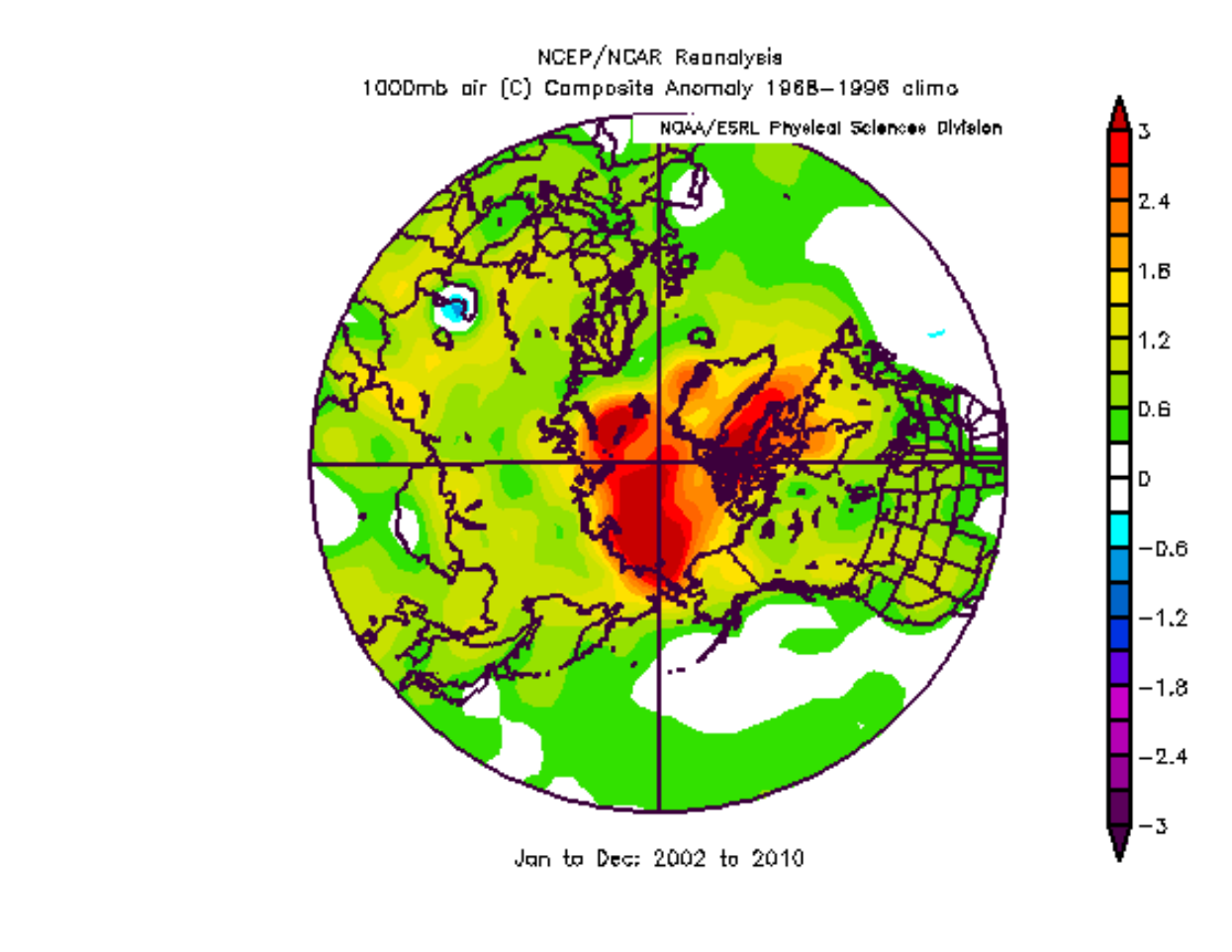
Consistence of multiple observations

Most reasonable explanation among competing hypotheses

Deduction: Climate Model Indications and the Observed Climate



Prediction : ARCTIC AMPLIFICATION
The Arctic is Earth's fastest-warming region as climate models predicted

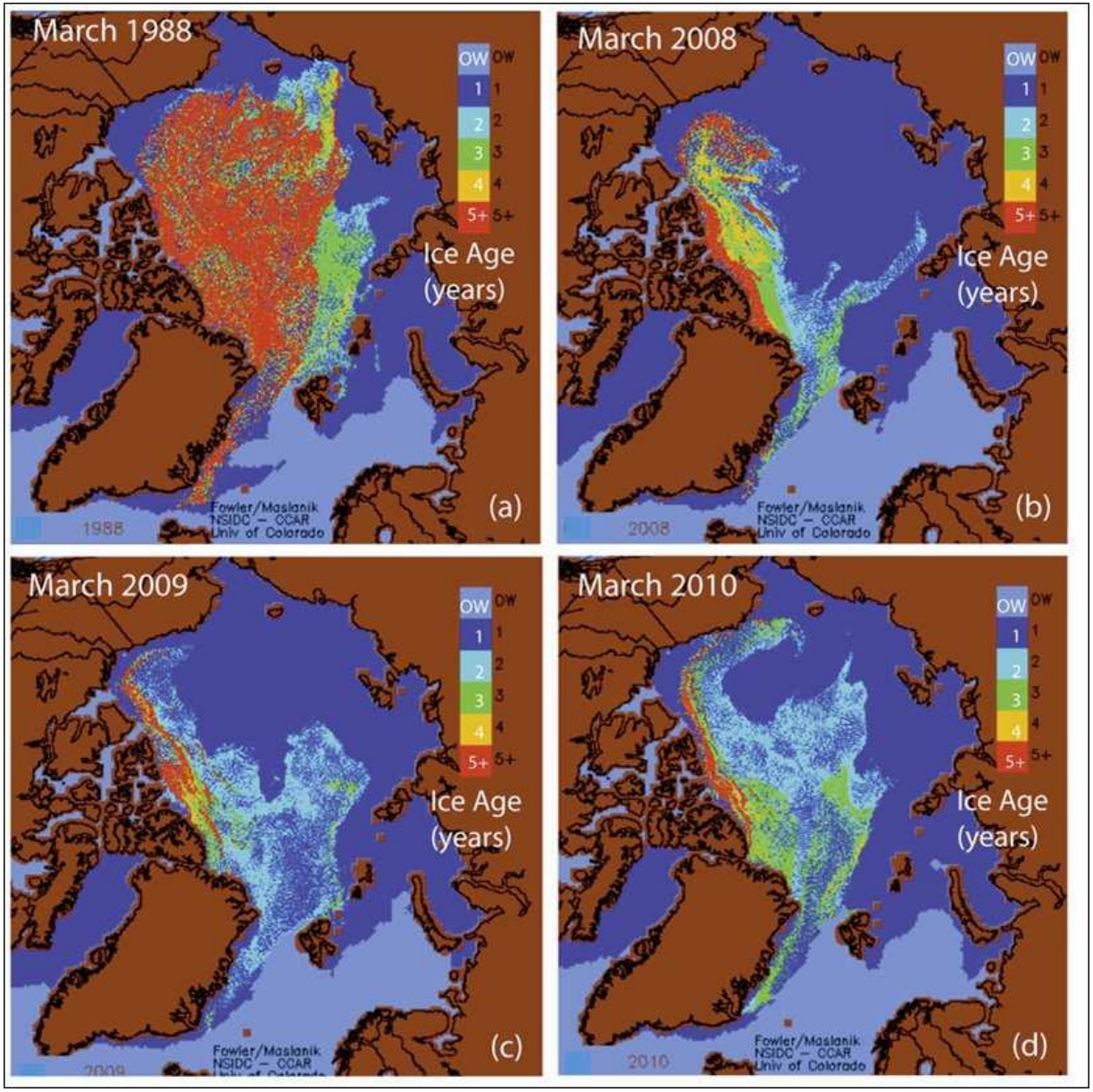


2002-2010 Annual Air Temperature Anomalies Relative to 1968-1996

Multiple Lines of Evidence : Surprise #1

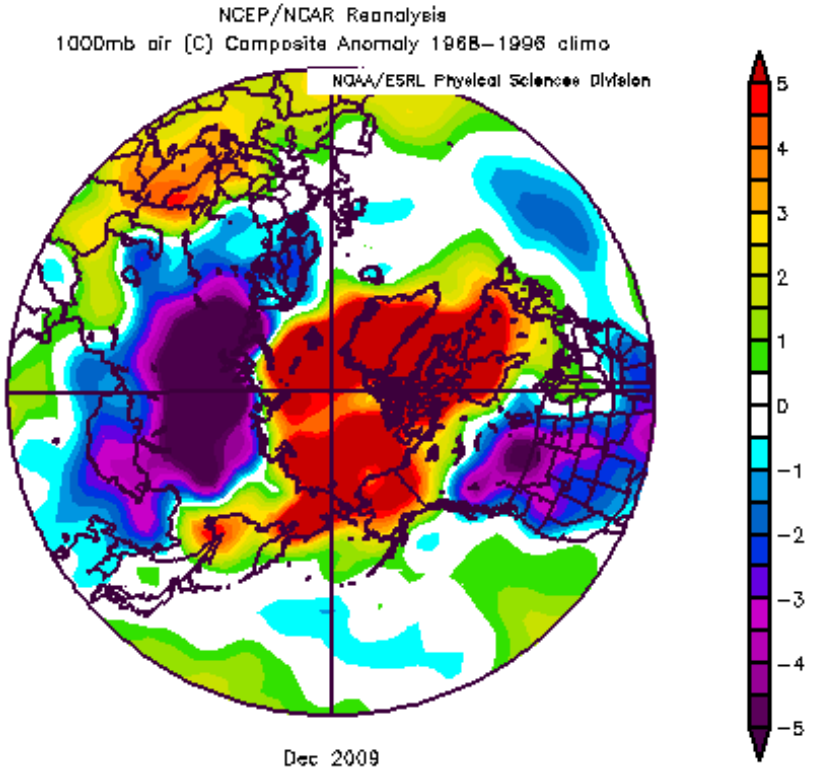
42 % Loss of Multi-year (thick) Sea Ice between January 2004 and 2008

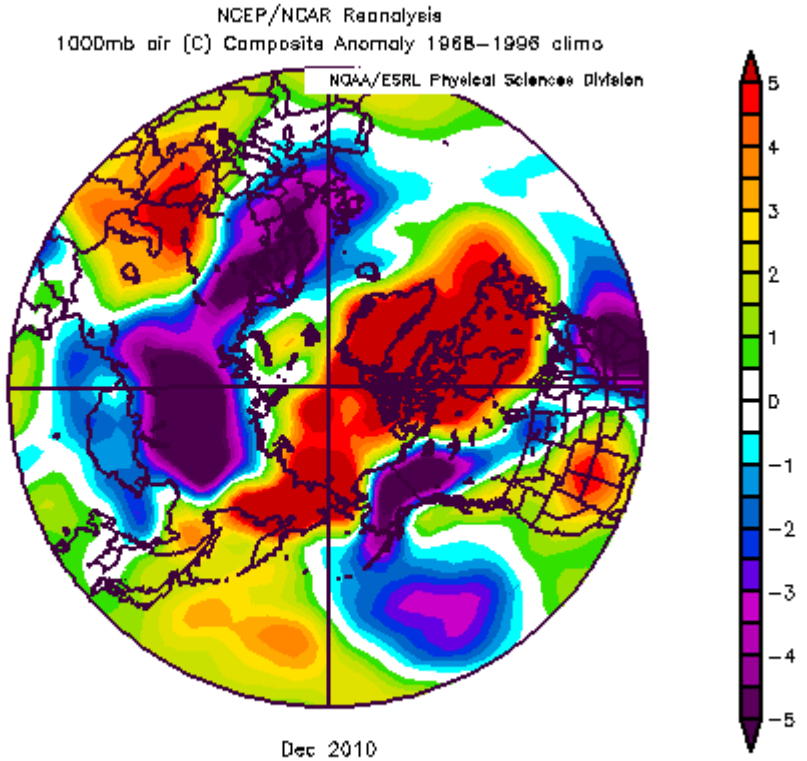
Ron Kwok (JPL)



Arctic Surprise #2 –Large Forest Fires

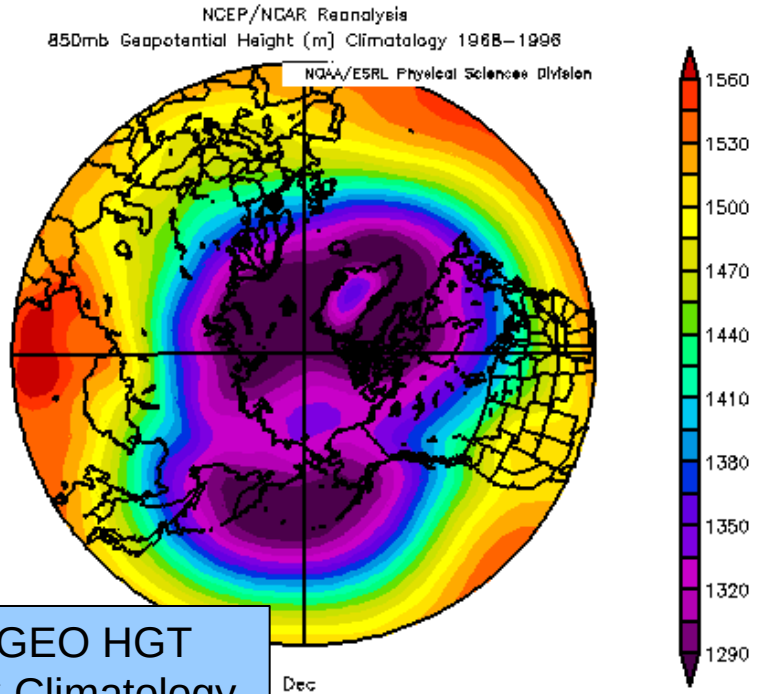
Surprise #3: the *Warm Arctic-Cold Continent Climate Pattern*





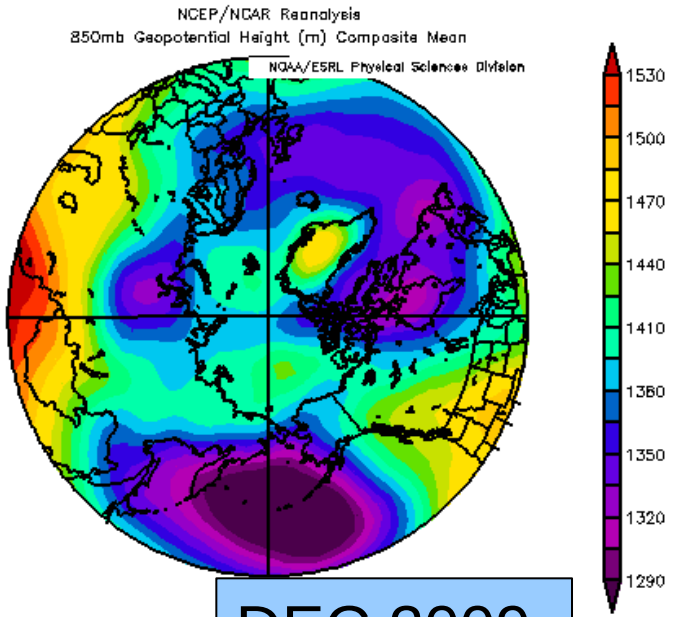
Air temperature anomalies
DEC 2009 and 2010

Normal “POLAR VORTEX” of west to east flowing winds traps cold air in the Arctic:



850 GEO HGT
DEC Climatology

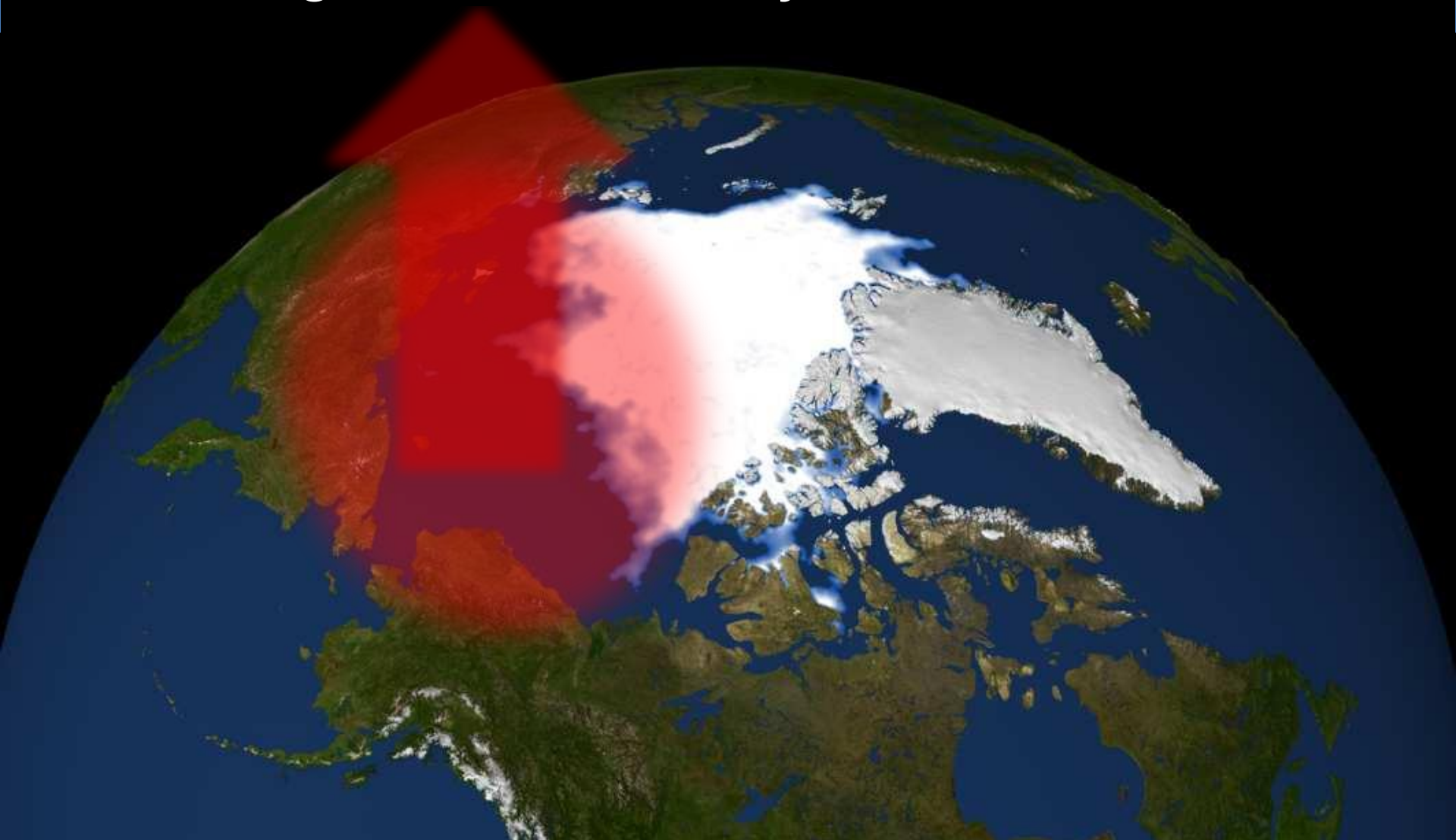
But this pattern broke down in December 2009 allowing cold air to spill southwards

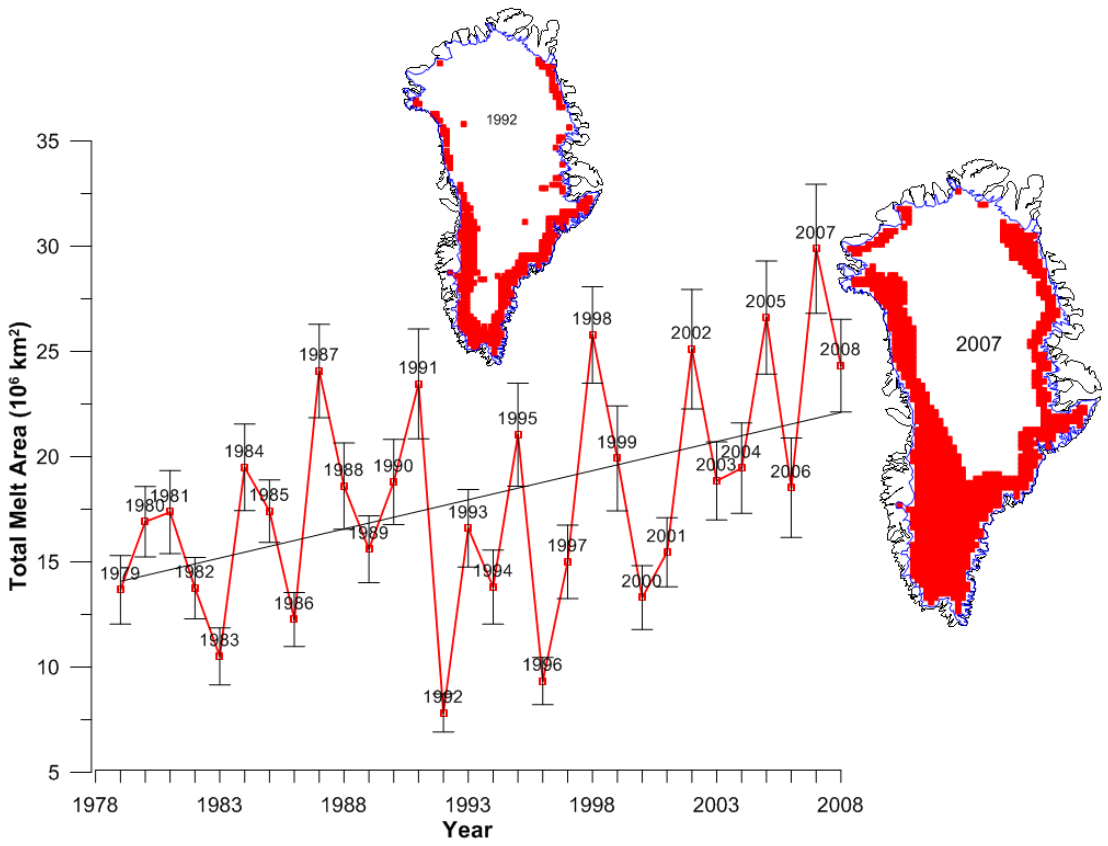


DEC 2009

Added Ocean Heat Storage and Heat Flux from New Sea Ice Free Areas

Works against the stability of the Polar Vortex





Surprise #4 Greenland ice-melt since 1979

Largest mass loss in 2010

Sea level rise of 0.9 to 1.6 m by 2100 (SWIPA Report)

THE SUMMER ARCTIC ICE PACK IS MELTING AT A RATE THAT EXCEEDS MOST EXPECTATIONS

WHY SO FAST?

Anthropogenic (CO_2) + Unusual (Natural Variability)
Warm Climate Pattern the last 10 Years
+ Ice/ocean Feedbacks = NEW CLIMATE STATE
(ONE WAY TRIP)

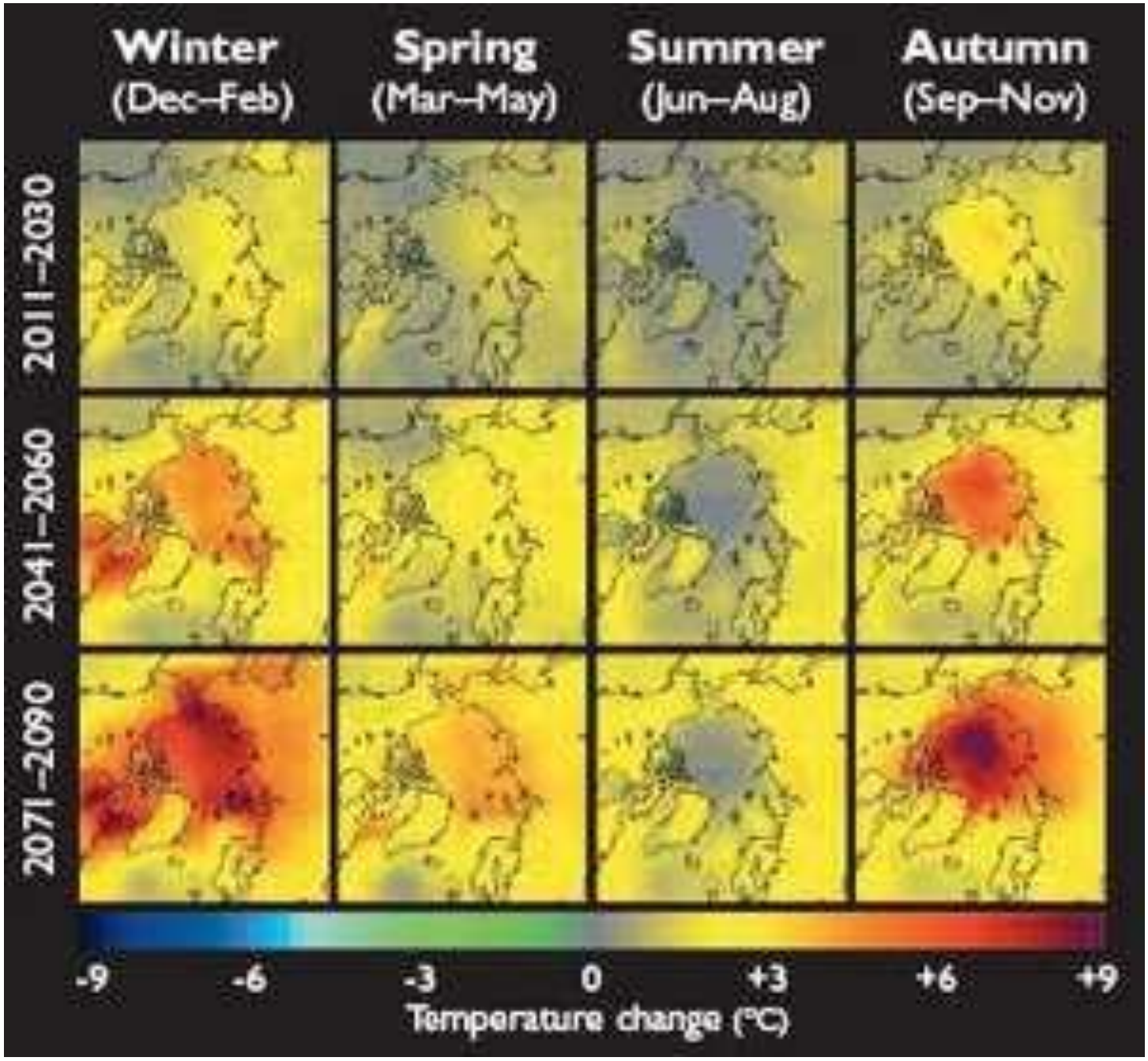
Three Main Conclusions from AMAP SWIPA Report 2011(Snow, Water, Ice and Permafrost in the Arctic):

*Snow and sea ice are interacting with the climate system to accelerate warming

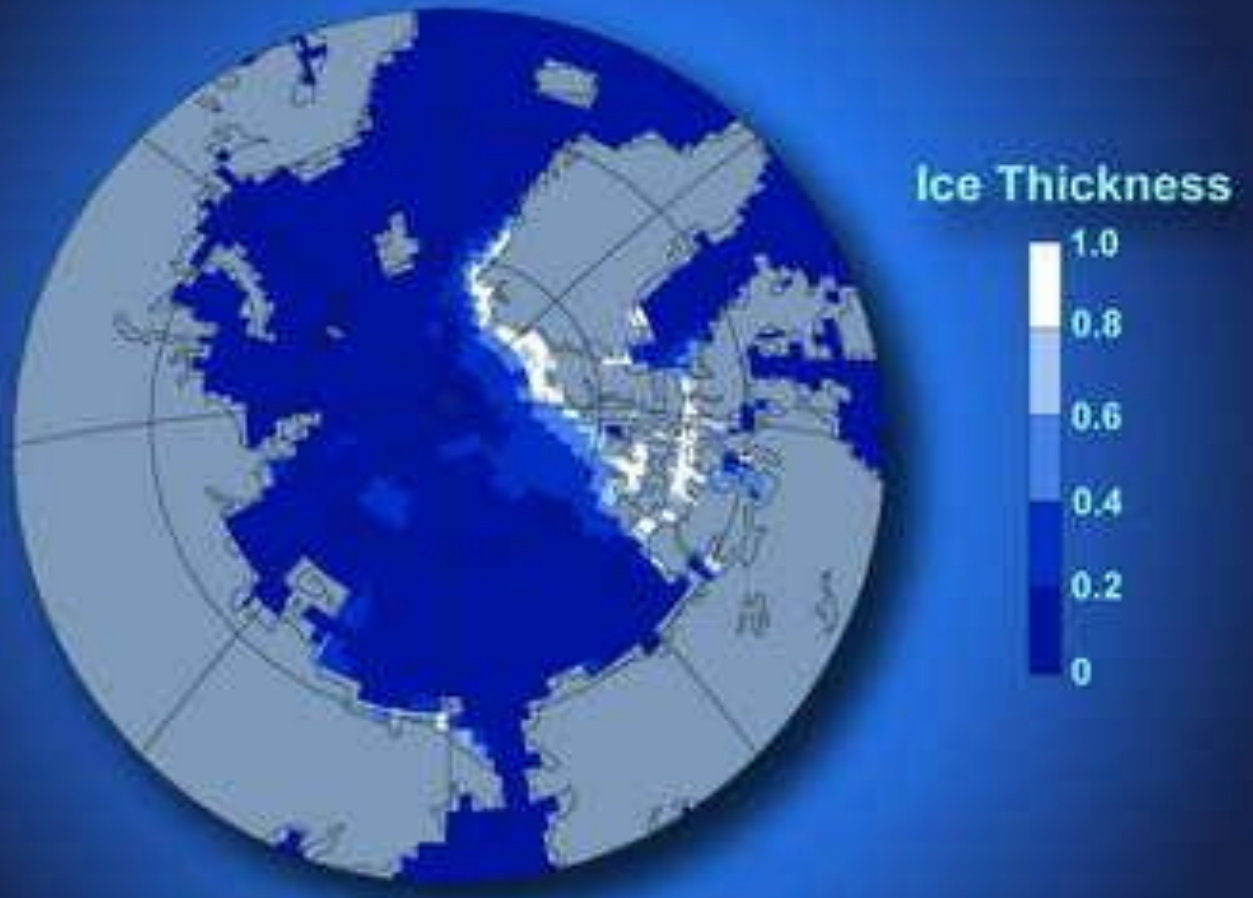
*23 Model projections from the IPCC 4th Assessment Report vary due to location, variable, model, and evaluation metric in non systematic ways
But are useful as they summarize the known physics

*Use a limited number of "better" models

http://amap.no/swipa/


Winter
(Dec–Feb)
Spring
(Mar–May)
Summer
(Jun–Aug)
Autumn
(Sep–Nov)
2011–2030
2041–2060
2071–2090
-9
-6
-3
0
+3
+6
+9
Temperature change (°C)

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



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***Changes and Impacts are happening now (20 years early)**

***Because of increased interactions of Arctic temperatures, ice, and land with global climate, the timing of future Arctic changes is more uncertain**

Arctic Websites

Arctic Report Card

www.arctic.noaa.gov/reportcard

Sea Ice Outlook

www.arcus.org/search/seaiceoutlook

Future of Arctic Climate & Global Impacts

www.arctic.noaa.gov/future

Arctic Theme Page

www.arctic.noaa.gov