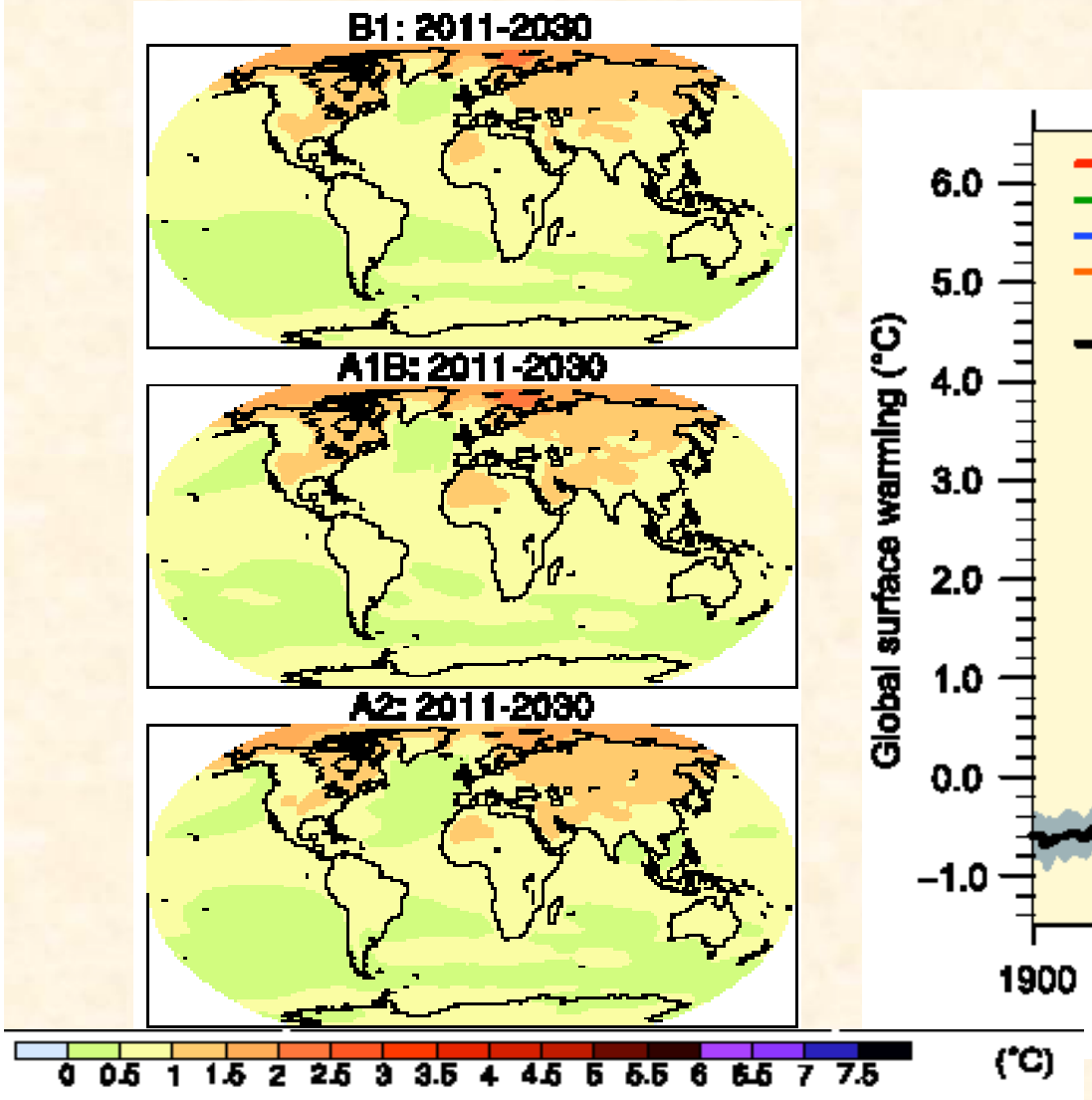
Forecast 2030:
Planning for a changing climate

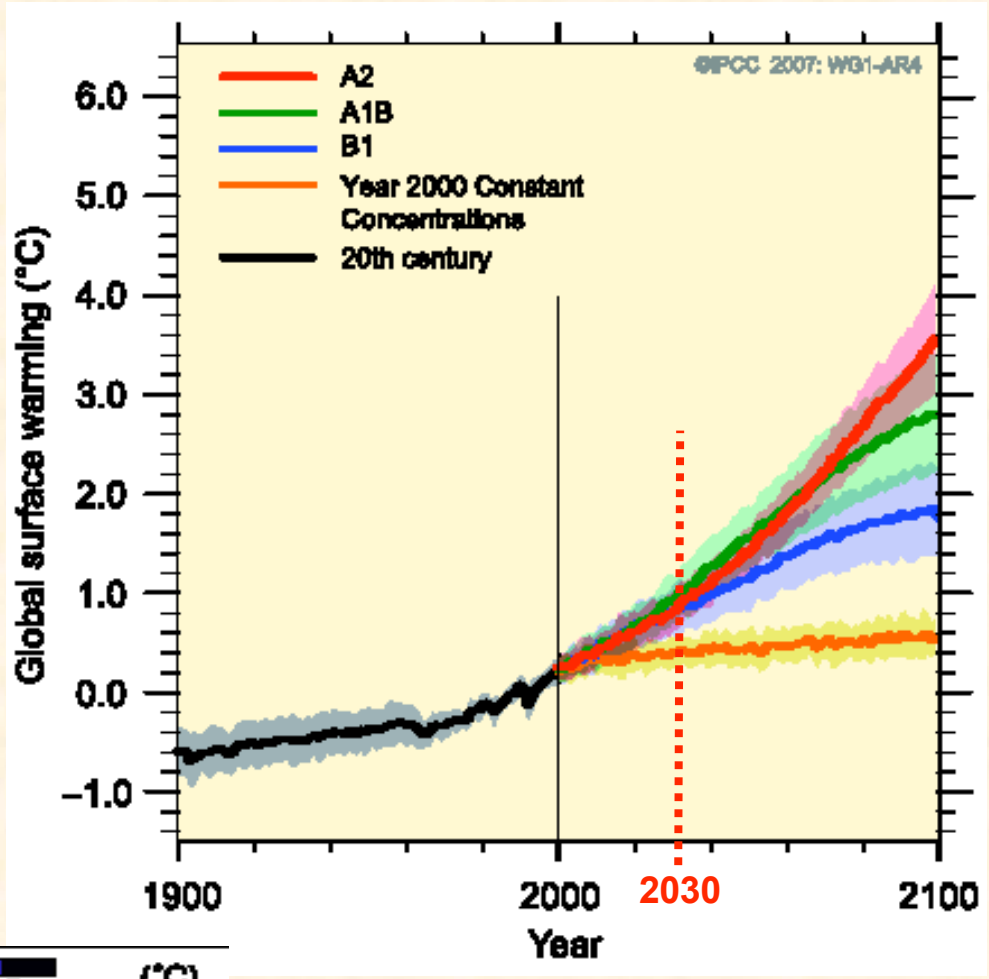
The roles of natural variability & human-driven change in near-term climate prediction

SPEAKER: Dr. Lisa Goddard, Research Scientist
International Research Institute for Climate & Society
at Columbia University

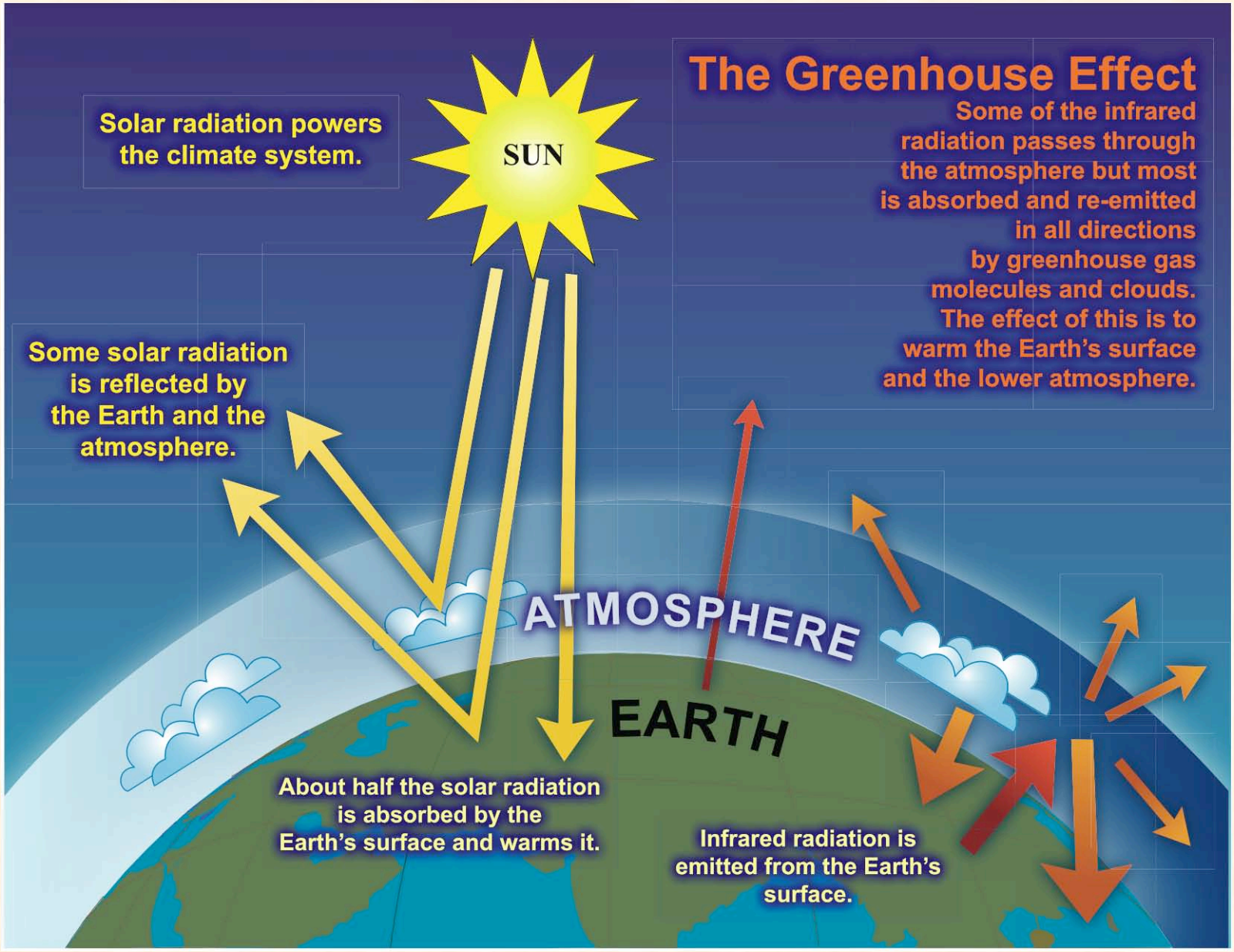
A Walter Orr Roberts Memorial Public Lecture presented by
THE ASPEN GLOBAL CHANGE INSTITUTE

Global Climate Change Projections





Source: IPCC 4th Assessment Report, Working Group 1: The Physical Science Basis for Climate Change
http://ipcc-wg1.ucar.edu/wg1/wg1-report.html



http://ipcc-wg1.ucar.edu/wg1/FAQ/wg1_faq-1.3.html

Climate Variability & Change Globally

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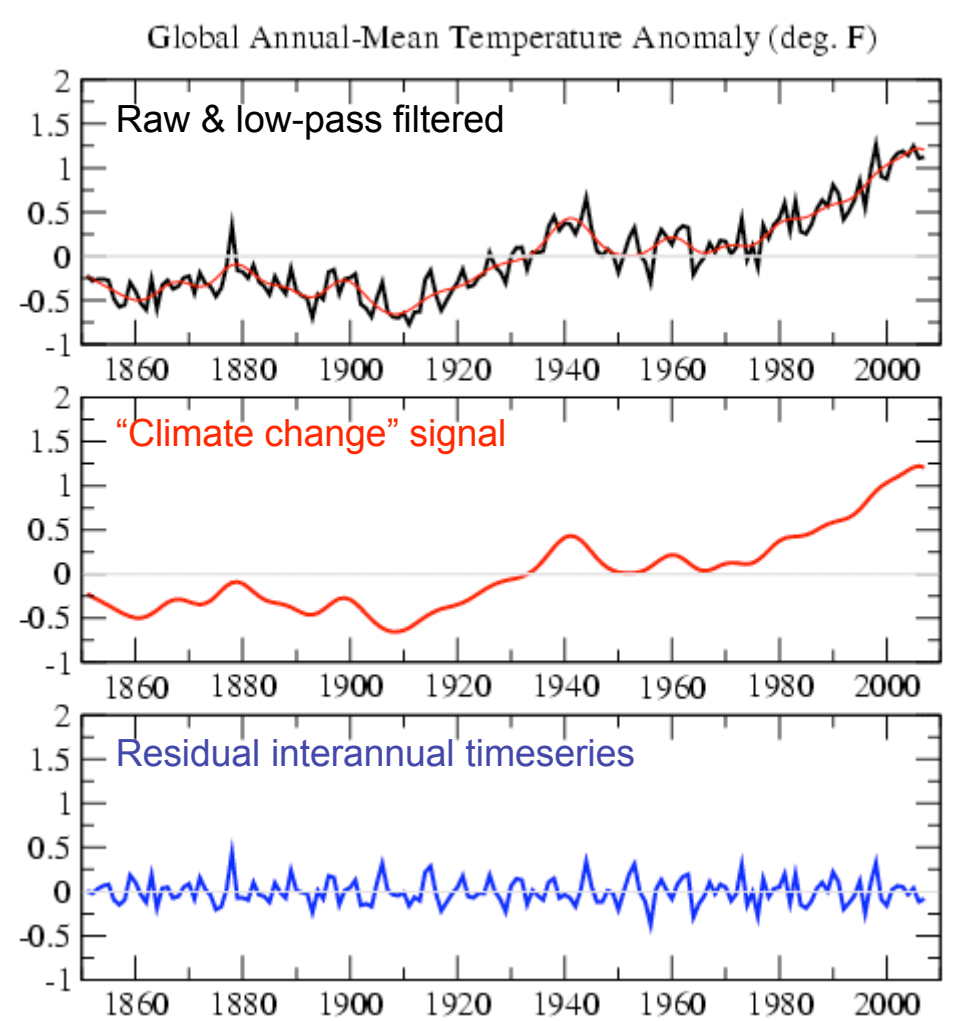

Most of the variability in the globally-averaged temperature is contained in the slowly varying "climate change" component.

Climate Variability & Change in CO

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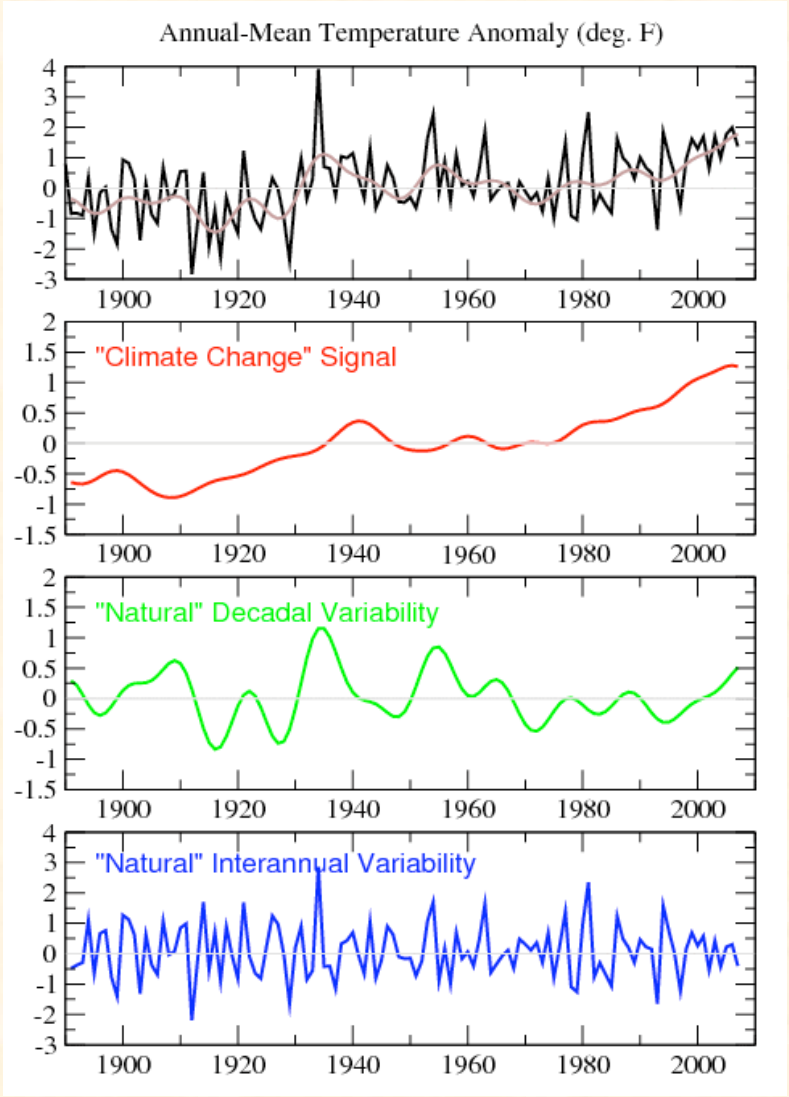

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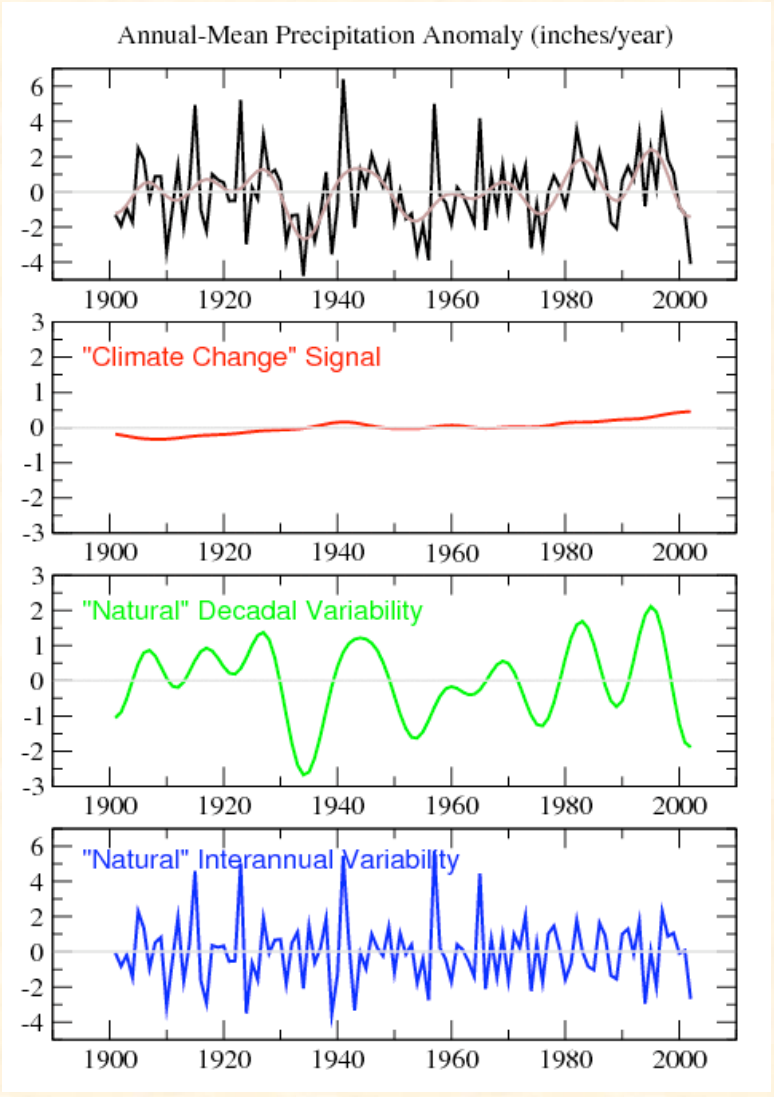

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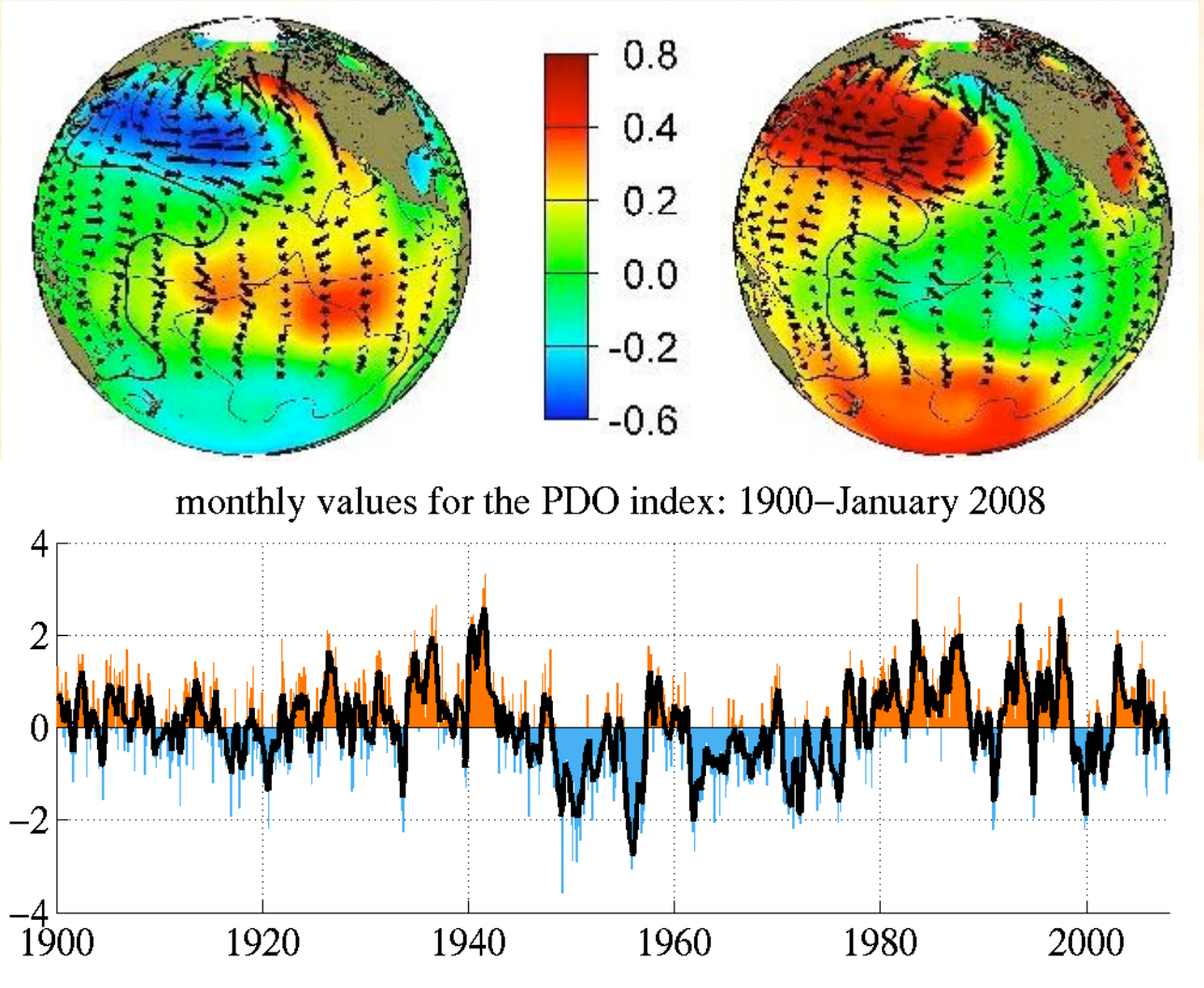
“Natural” Slowly-Varying Climate

Decadal to Multi-decadal fluctuations in climate

* Pacific Decadal Oscillation
  (PDO or PDV)
* Atlantic Multi-decadal Oscillation
  (AMO or AMV)

→ *What are they?*
→ *How do they effect regional climate?*
→ *What is our ability to predict these fluctuations?*

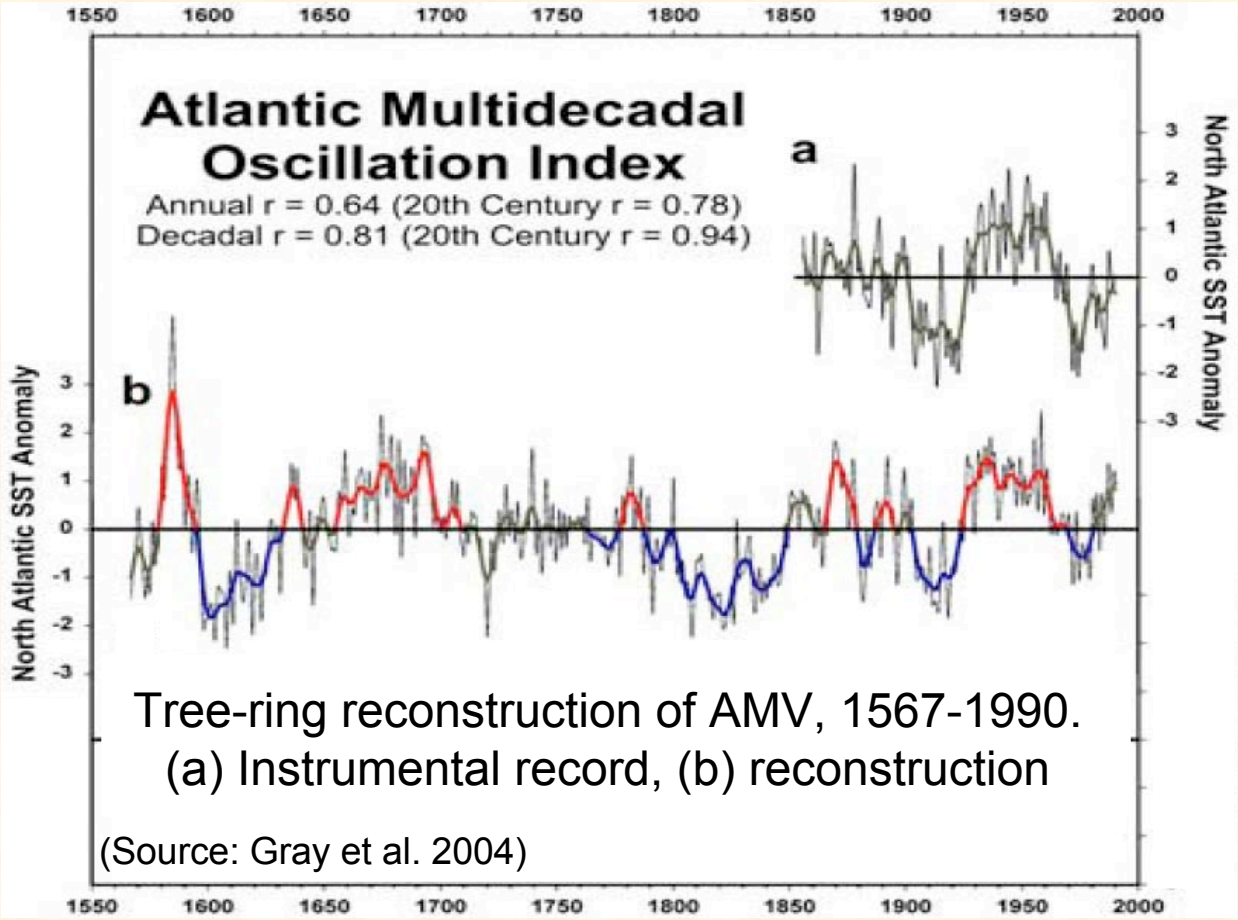
Pacific Decadal Oscillation (PDO)



(Source: http://jisao.washington.edu/pdo)

Atlantic Multi-decadal Oscillation (AMO)

Has Existed for Centuries… at least

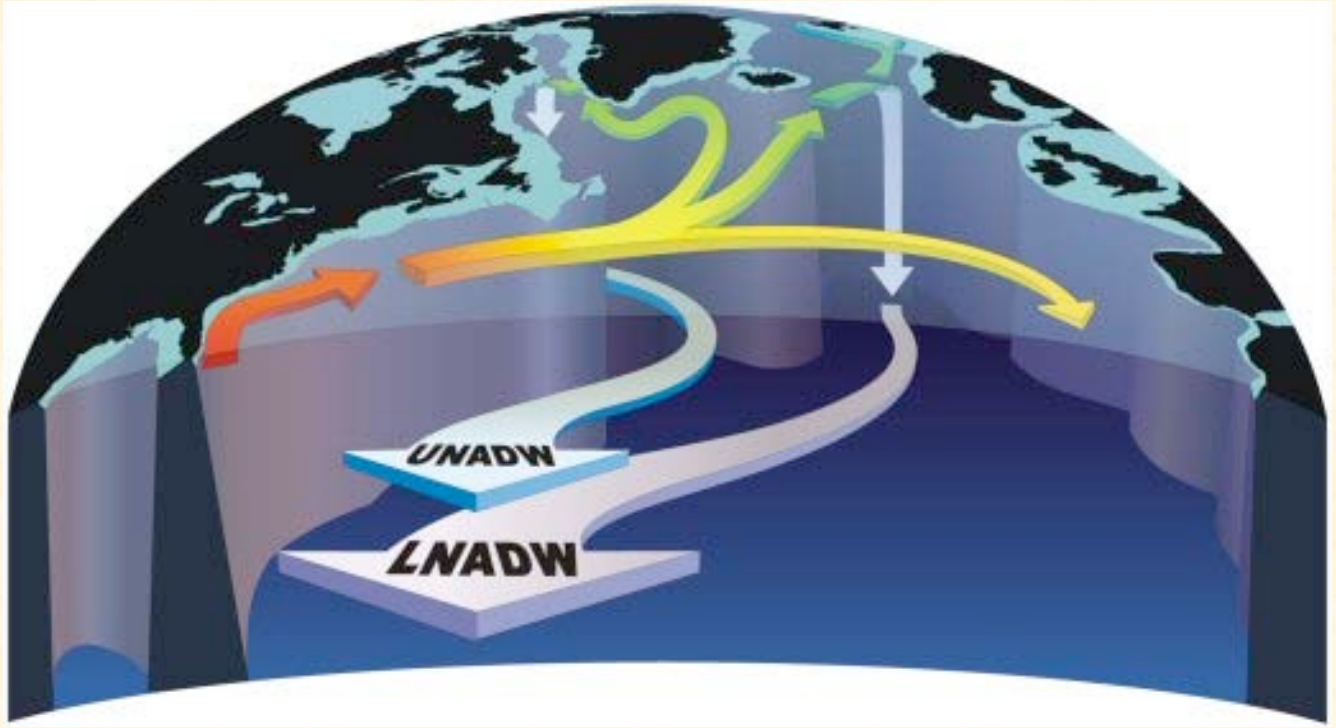


Tree-ring reconstruction of AMV, 1567-1990.
(a) Instrumental record, (b) reconstruction

(Source: Gray et al. 2004)

Thermohaline Circulation in Atlantic Ocean

(Atlantic part of Ocean Conveyor Belt Circulation)



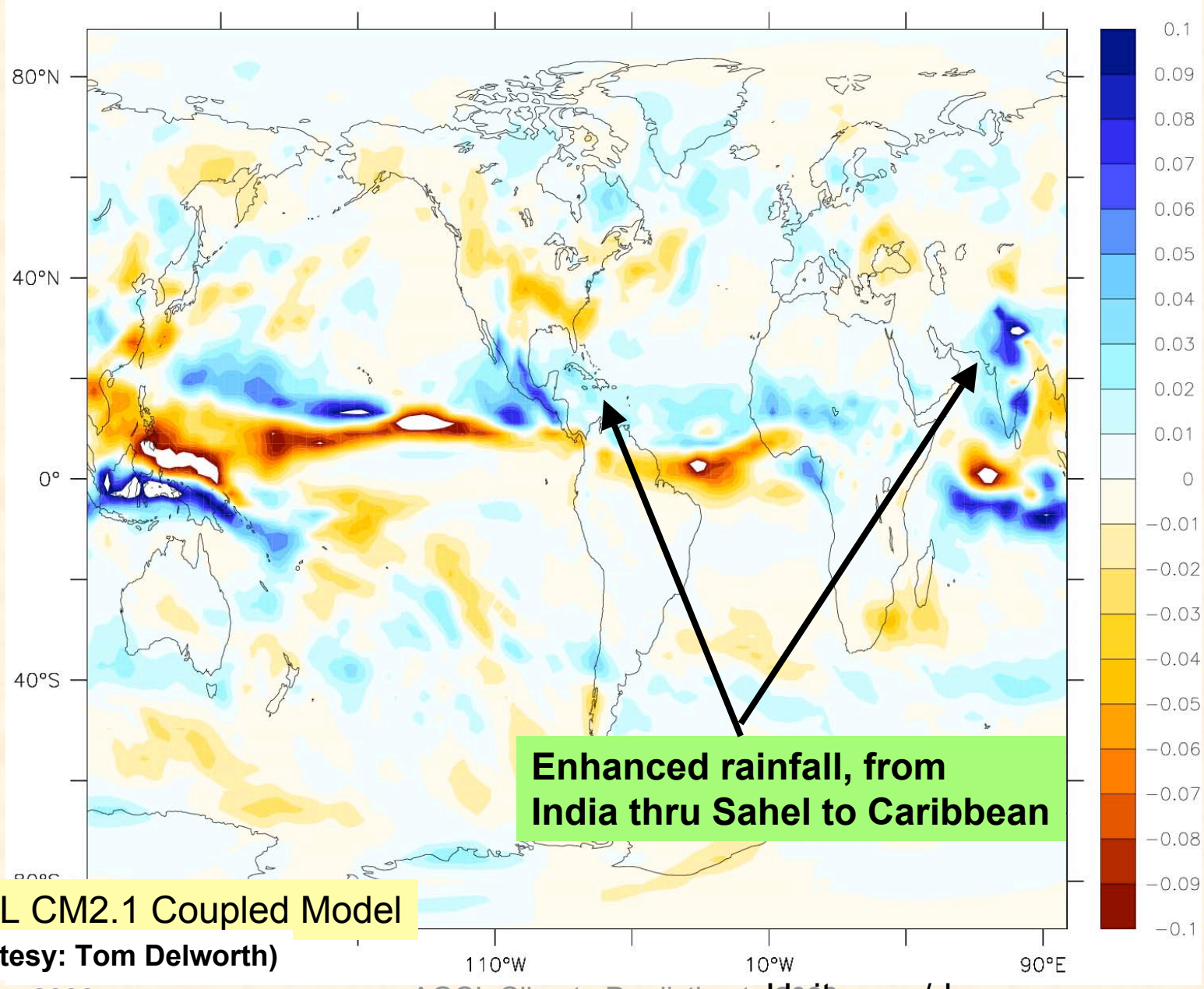
Density driven "Overturning" circulation

Self-regulating Changes in Overturning:

T↑ Density↓ : Less sinking, less warm water from tropics, N. Atlantic cools

T↓ Density↑ : More sinking, more warm water from tropics, N. Atlantic warms

JJA Precipitation Anomalies Associated with Warm North Atlantic (+ AMO)

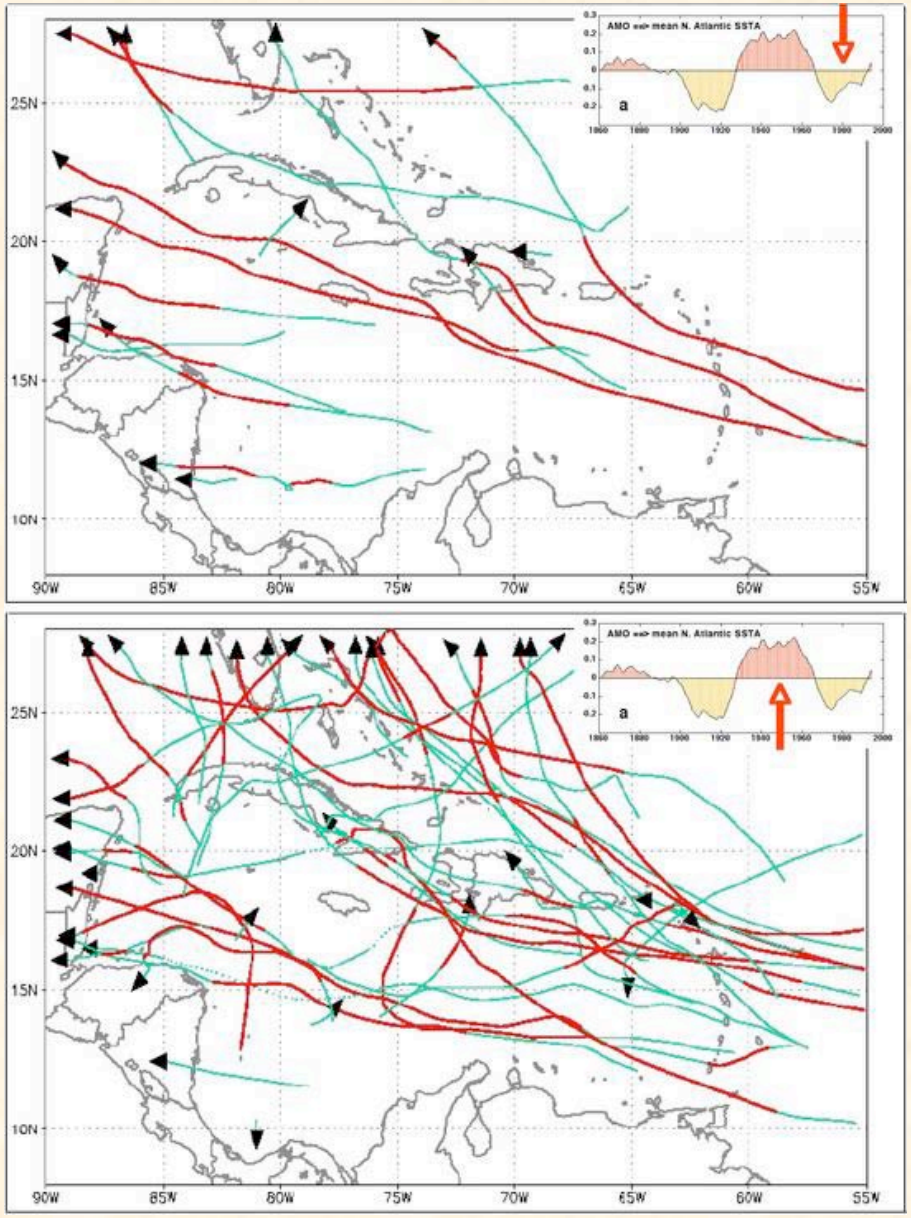


GFDL CM2.1 Coupled Model

(Courtesy: Tom Delworth)

Units: cm/day

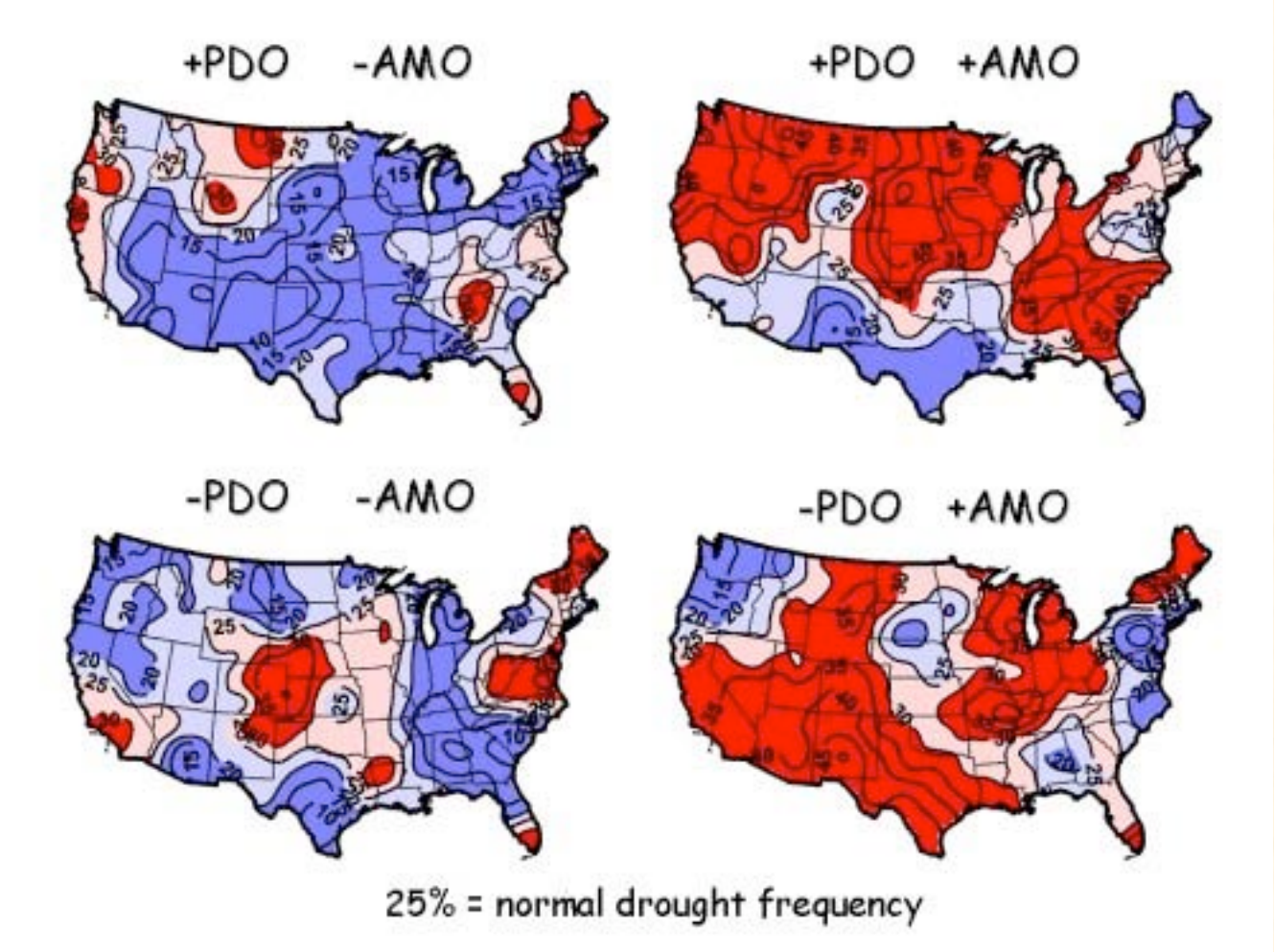
Hurricanes & AMO



During warm phases of the AMO, the numbers of tropical storms that mature into severe hurricanes is much greater than during cool phases, **at least twice as many**.

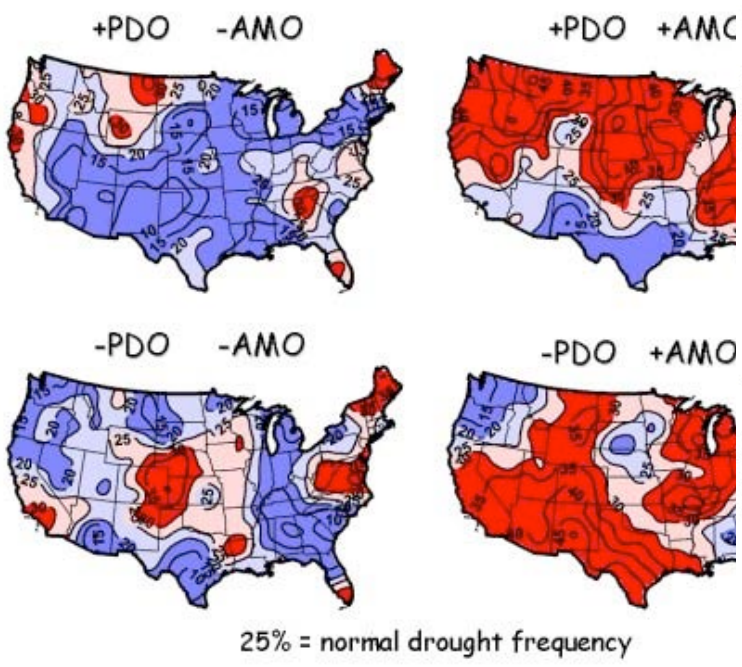
(Source: http://www.aoml.noaa.gov/phod/d2m_shift/amo_faq.php adapted from Goldenberg et al. 2001)

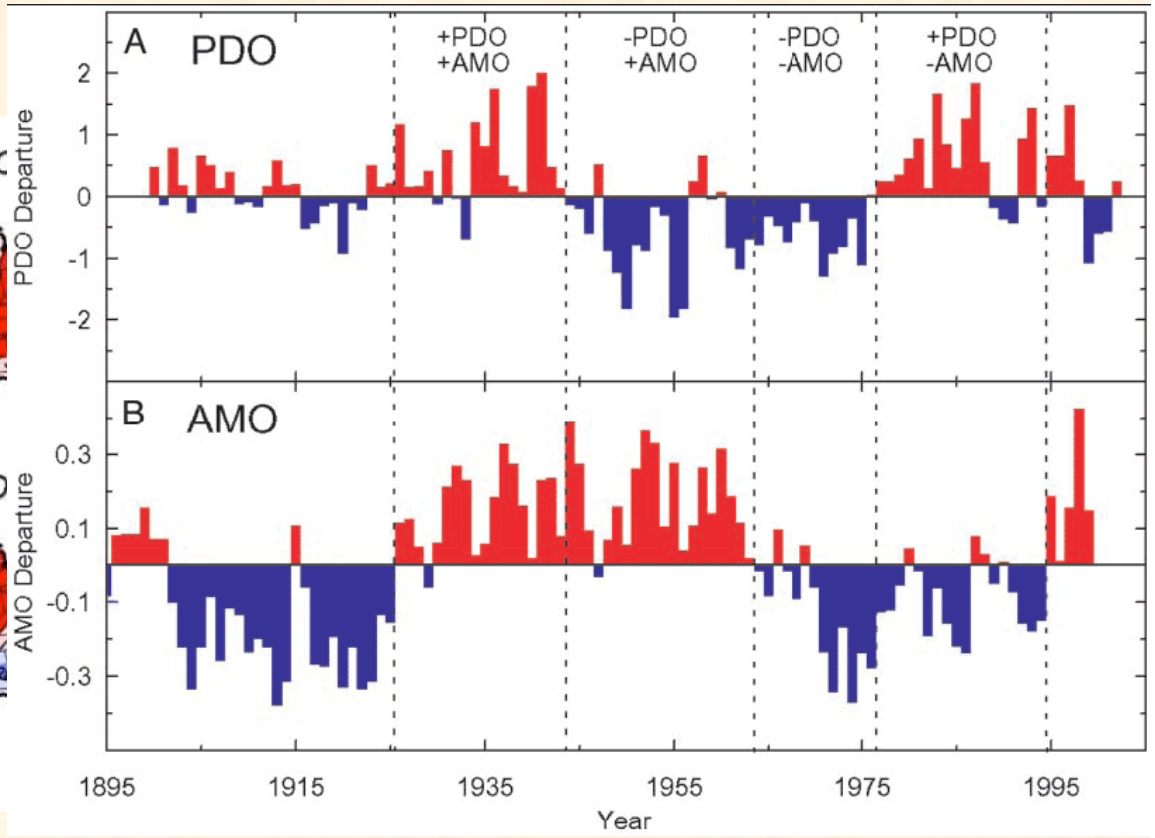
Pacific & Atlantic Impacts on U.S. Drought Frequency



(Source: McCabe et al, 2004)

Pacific & Atlantic Impacts on U.S. Drought Frequency

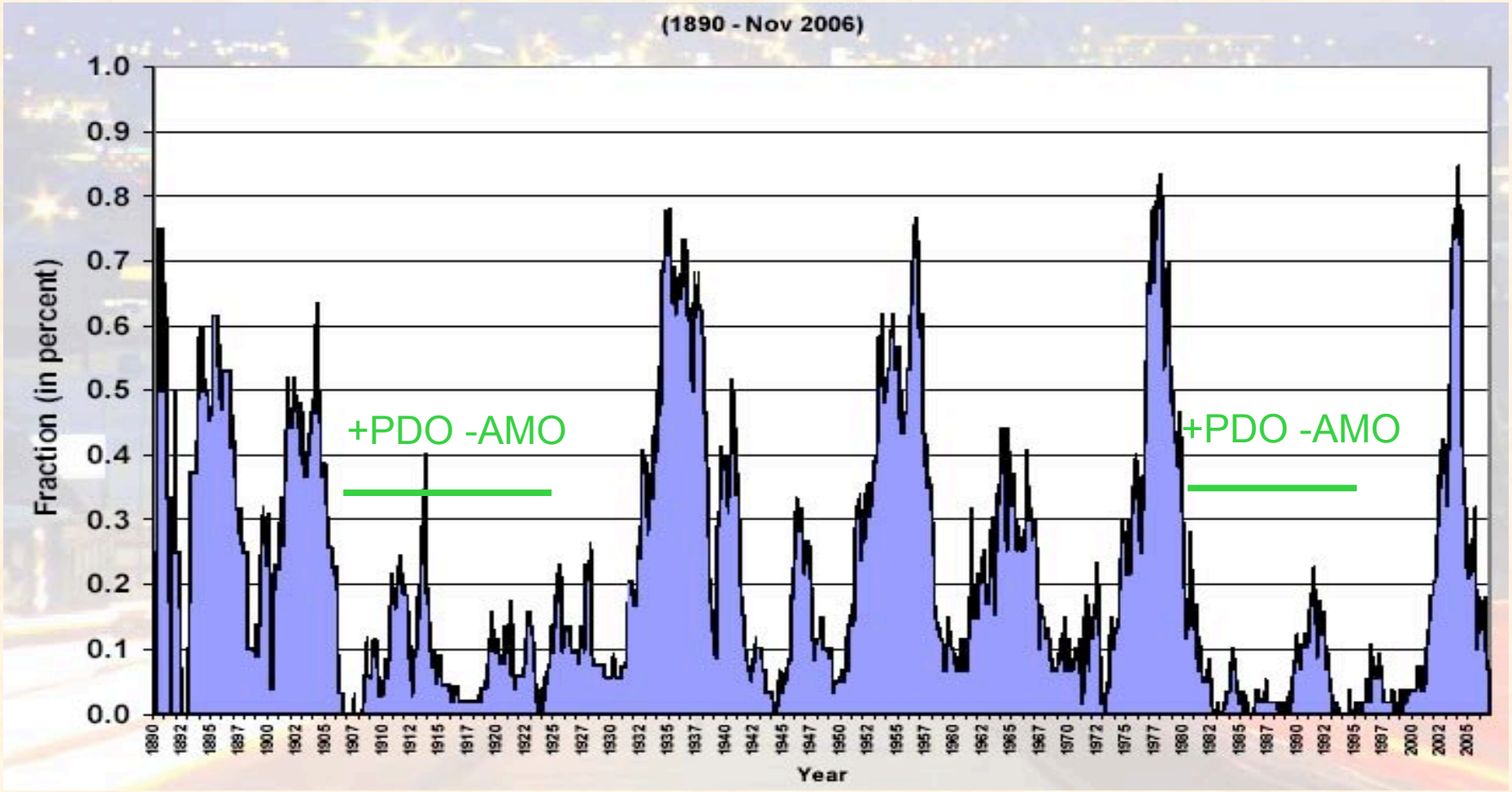




(Source: McCabe et al, 2004)

Fraction of Colorado Under Drought

(Averaged over 48-month period)



(Source: N. Doesken, CO State Climatologist)

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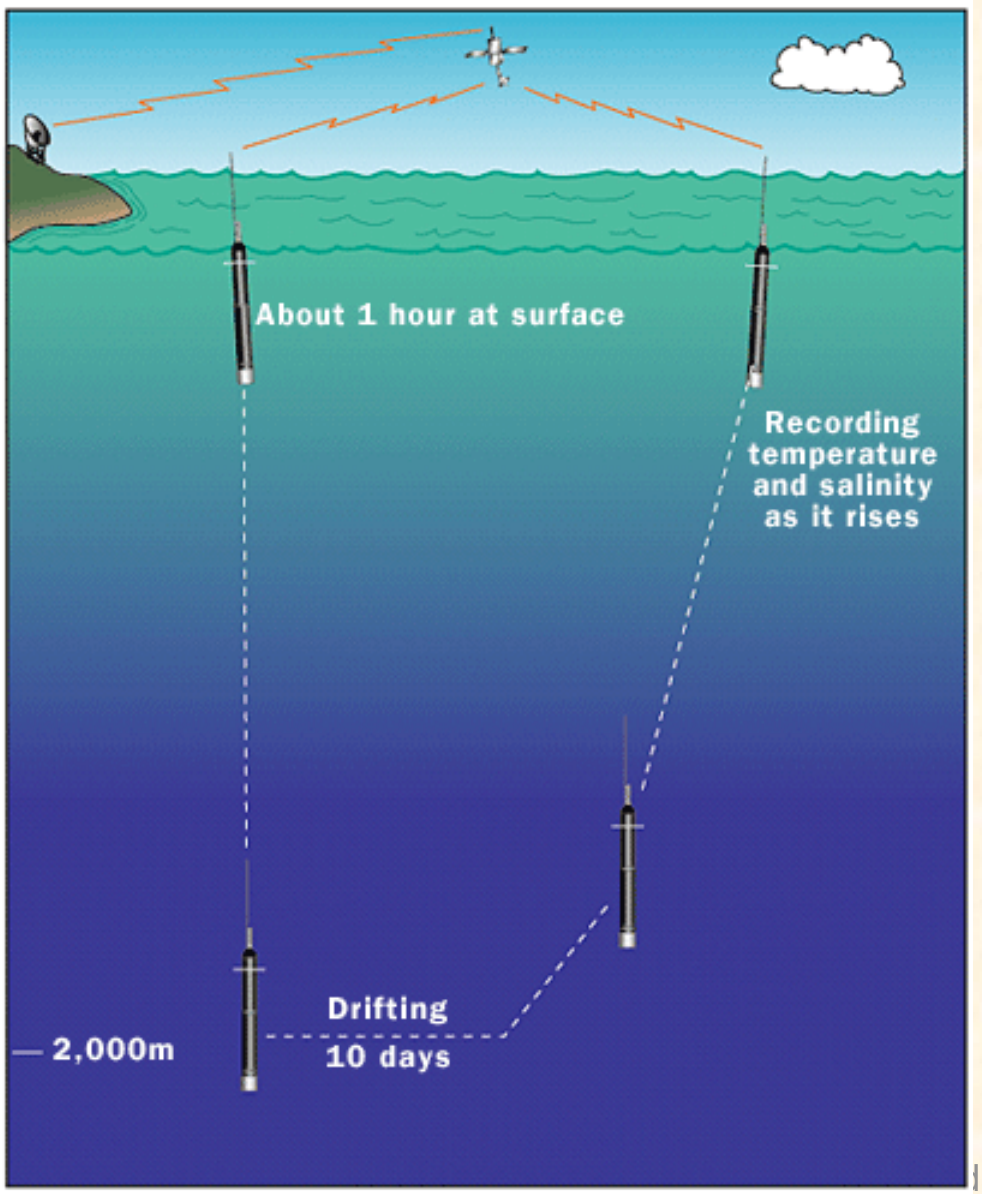
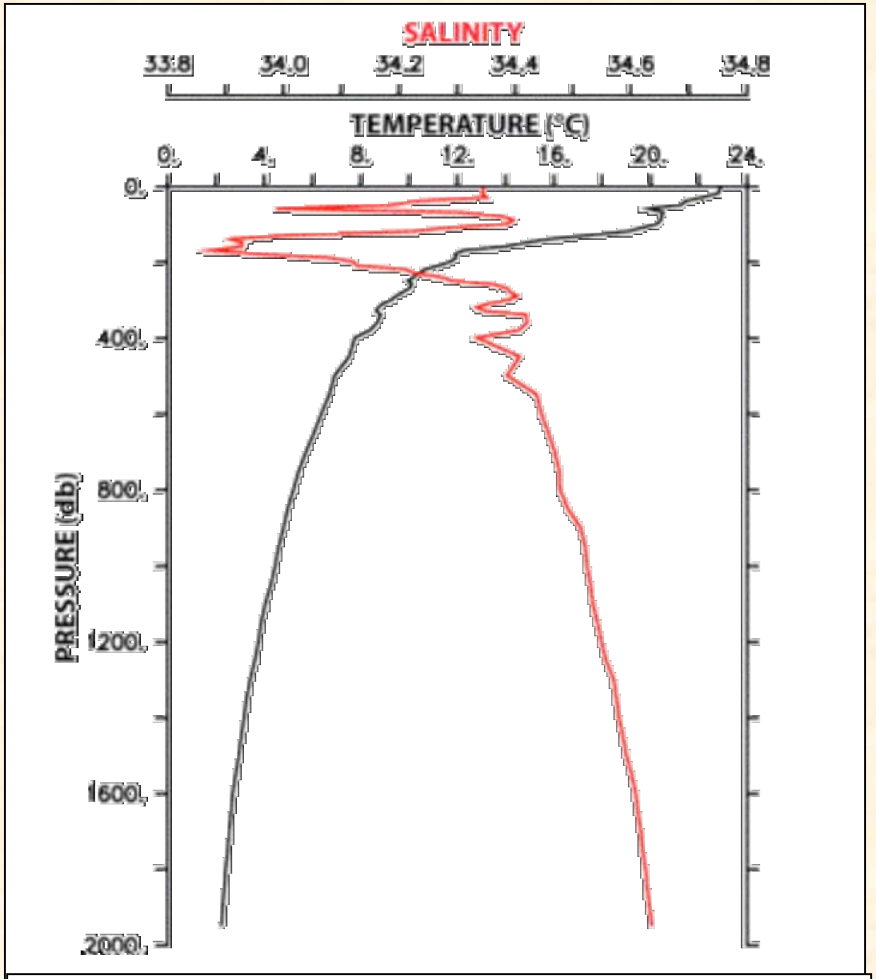
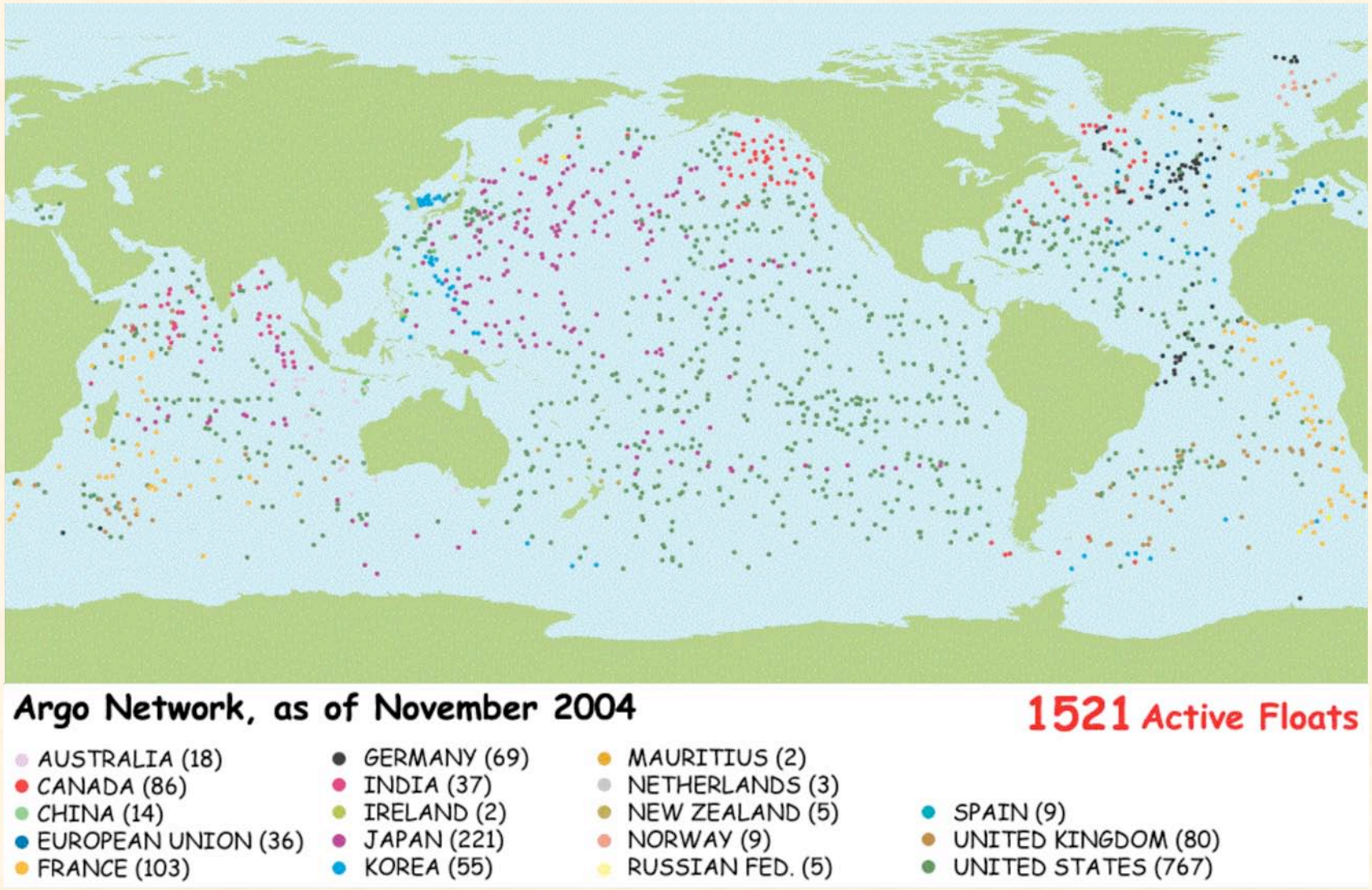
Ocean Observations: Argo Profiling Floats



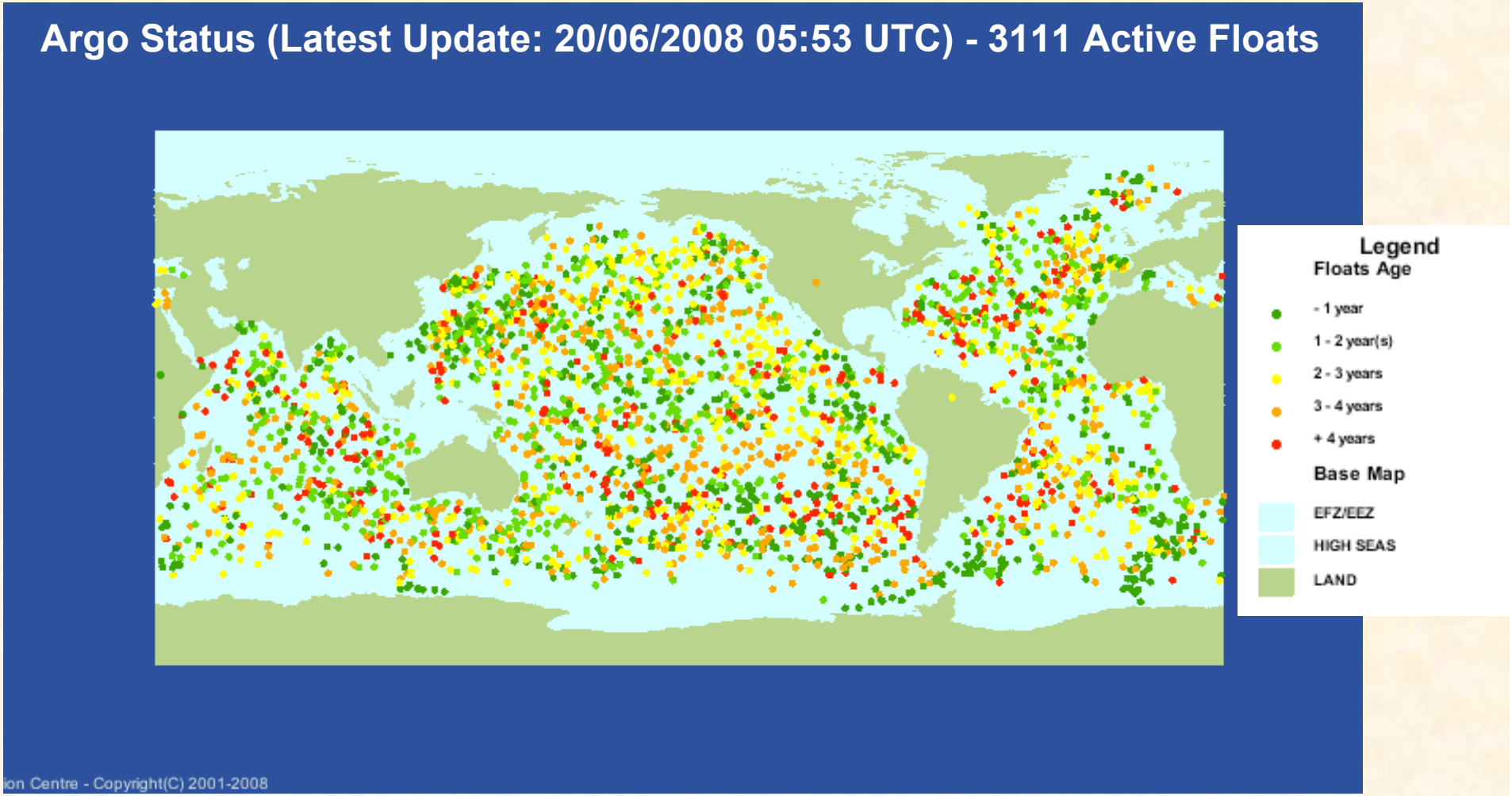


Argo profile from the subtropical North Pacific (20.25N 121.4W, May 15 2004).
This shows interleaving in the salinity data.

Ocean Observations: Network of Argo Floats



Ocean Observations: Network of Argo Floats



(Source: http://w4.jcommops.org/website/Argo)

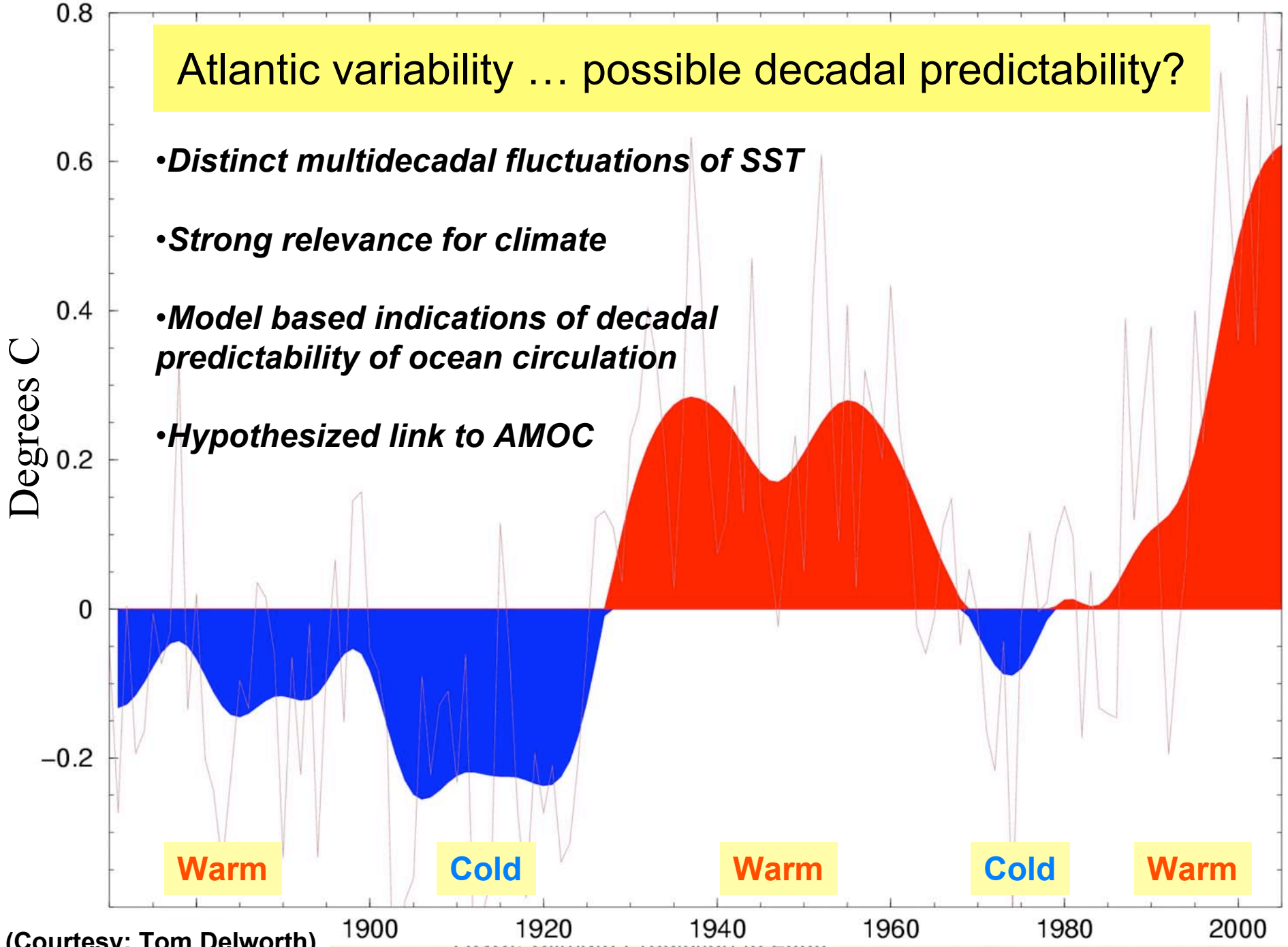
Summary

- Regionally, decadal variability can be as large, or larger than global climate change between now and 2030.
- Decadal variability influences our experience of climate change and also modulates year-to-year variability – increasing or decreasing the intensity or frequency of adverse climate.
- The slowly varying conditions in the Atlantic have a notable impact on US climate, and we believe we understand the dominant mechanism of the AMO.
- Ocean observations are crucial for the starting point of our predictions of decadal variability. They are also crucial for monitoring the global oceans and their variability.

Thank you
for your interest and attention

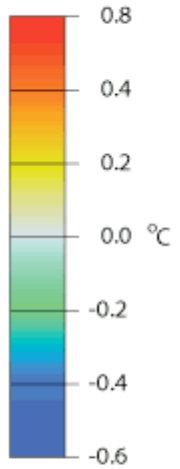
Atlantic variability … possible decadal predictability?

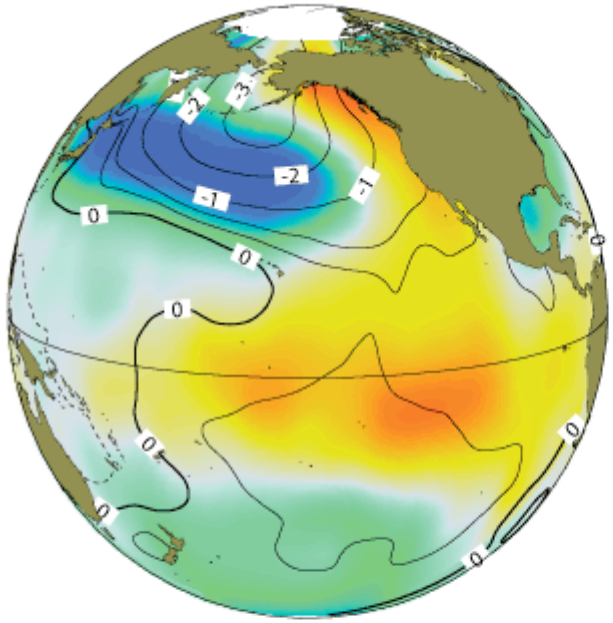
- ***Distinct multidecadal fluctuations of SST***
- ***Strong relevance for climate***
- ***Model based indications of decadal predictability of ocean circulation***
- ***Hypothesized link to AMOC***



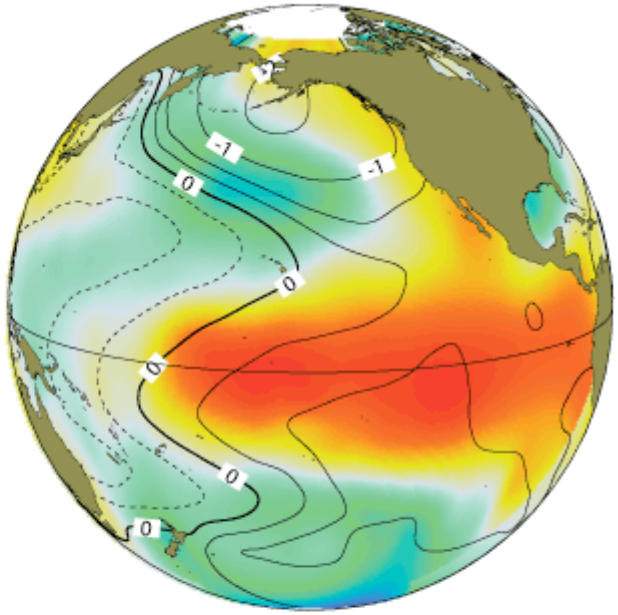
(Courtesy: Tom Delworth)

PDO ENSO





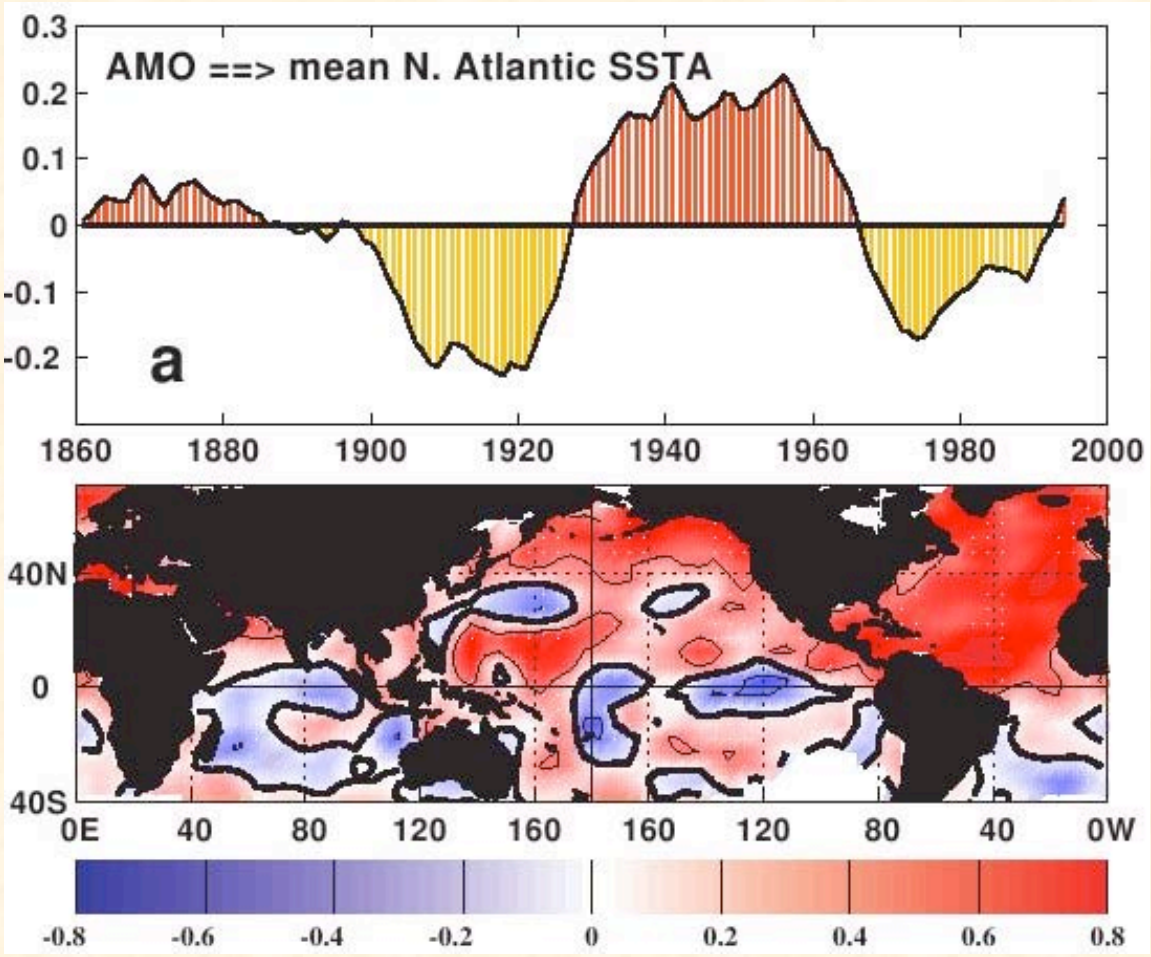
Warm Phase PDO



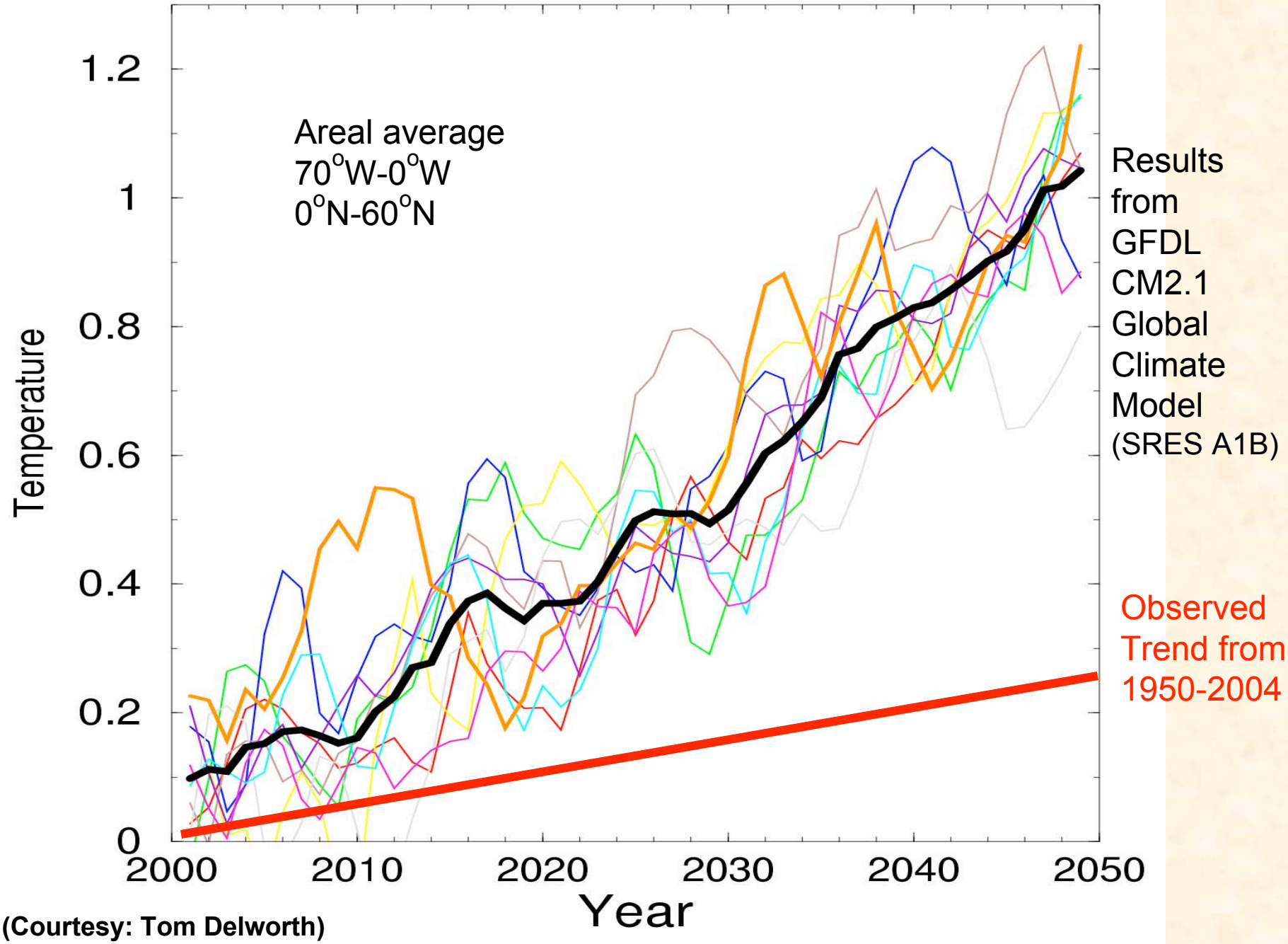
Warm Phase ENSO

Source: Climate Impacts Group, University of Washington

Atlantic Multi-decadal Oscillation (AMO)



Projected Atlantic SST Change (relative to 1991-2004 mean)



(Courtesy: Tom Delworth)

Smith et al (2005)

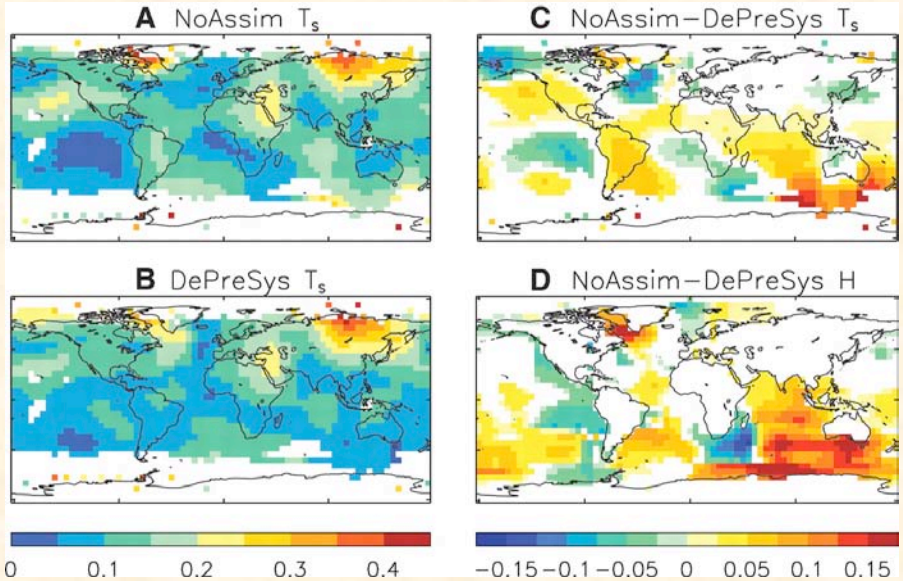


Figure 5

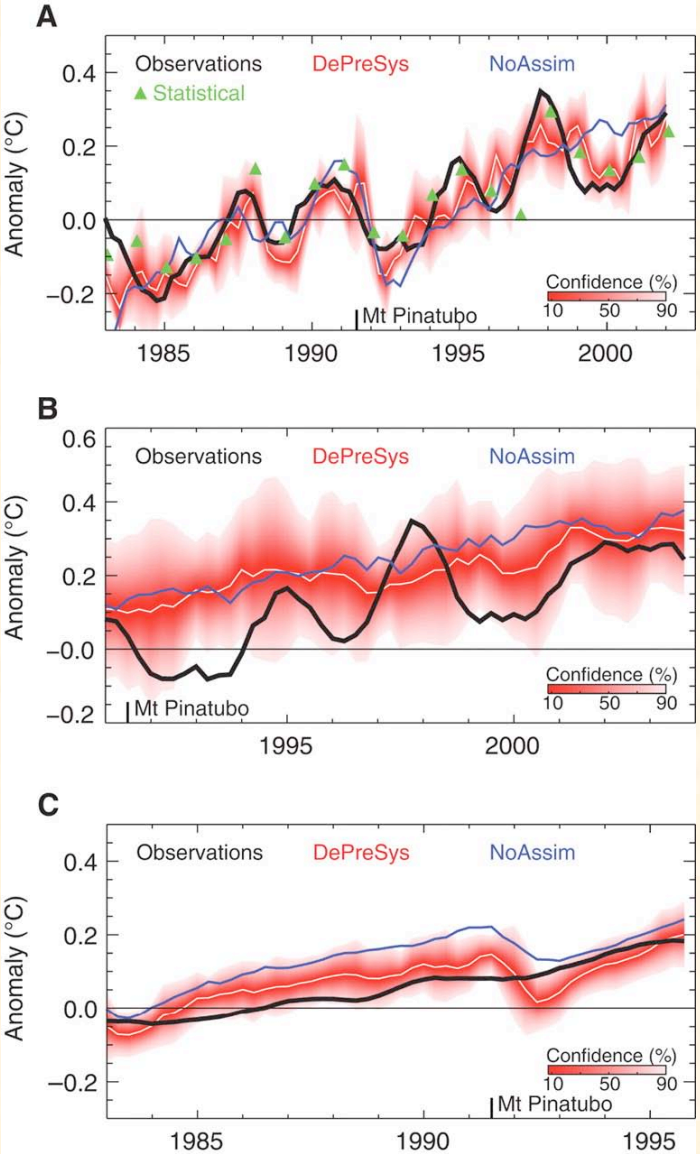
Regionality?

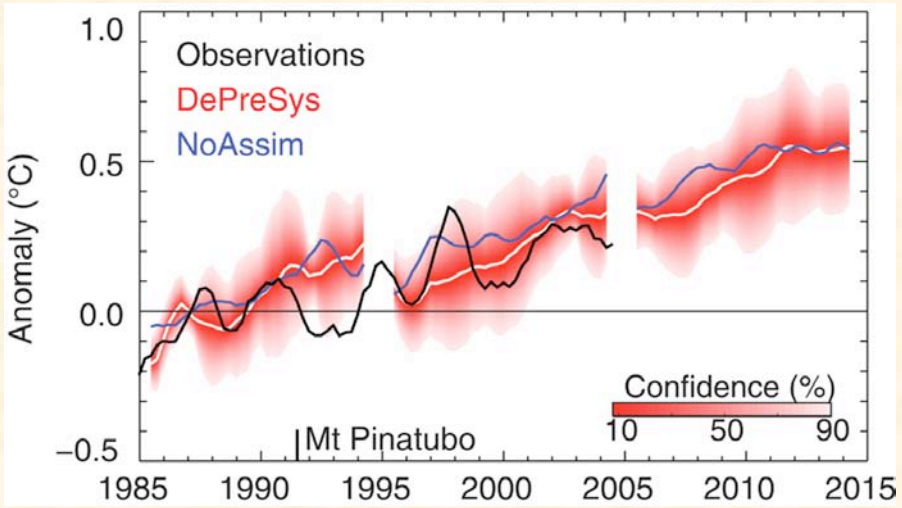
- T_s projections improved over many regions

Climate variability?

- T_s projection worse over N.Atlantic
- Much improvement in regional T is associated with improvement in regional H, which bears striking resemblance to regions where T is dominated by externally-forced signal.

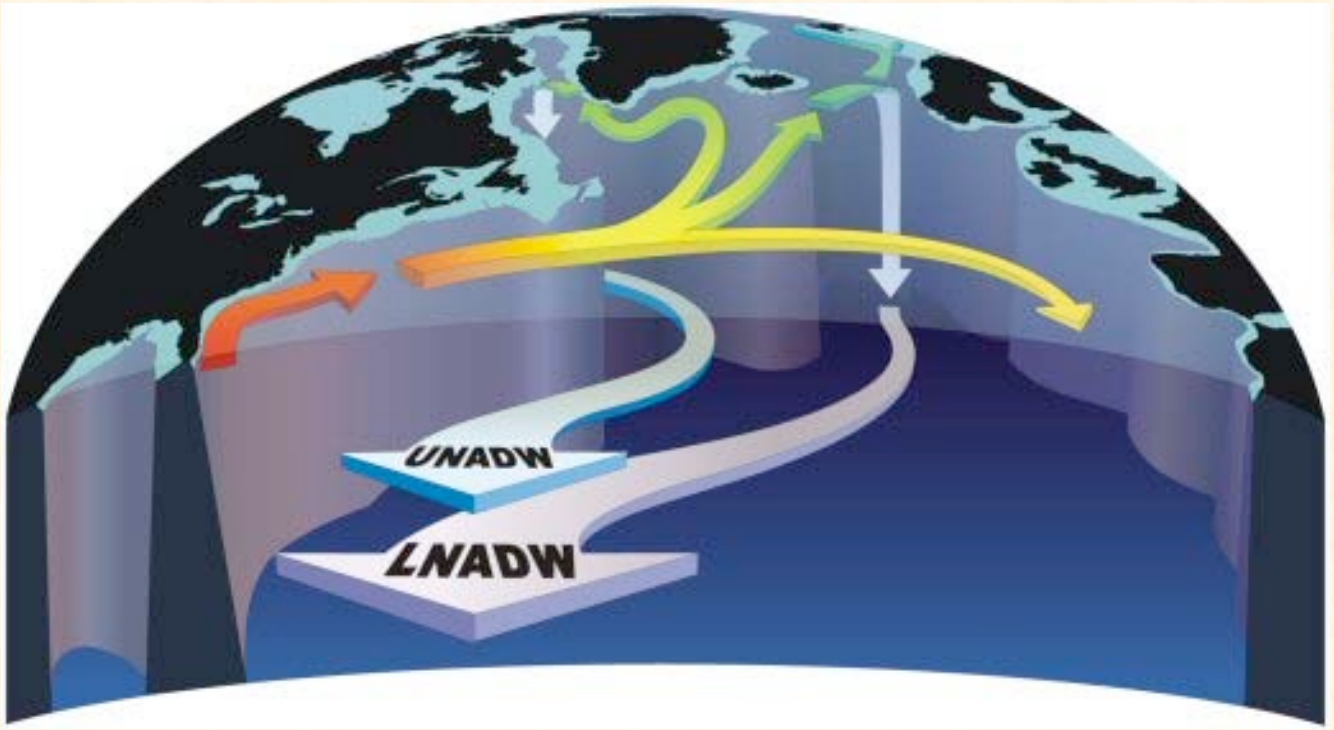
Smith et al (2007)





Thermohaline Circulation in Atlantic Ocean

(Atlantic part of Ocean Conveyor Belt Circulation)



Density driven "Overturning" circulation

Thermal part: Cooling (more dense) in high latitudes vs warming (less dense) in low latitudes

→ **Drives THC**

Haline (salt) part: More precipitation so fresher (less dense) in high latitudes vs more evaporation so saltier (more dense) in low latitudes

→ **Inhibits THC**