Advancing Climate Prediction Science – Decadal Prediction

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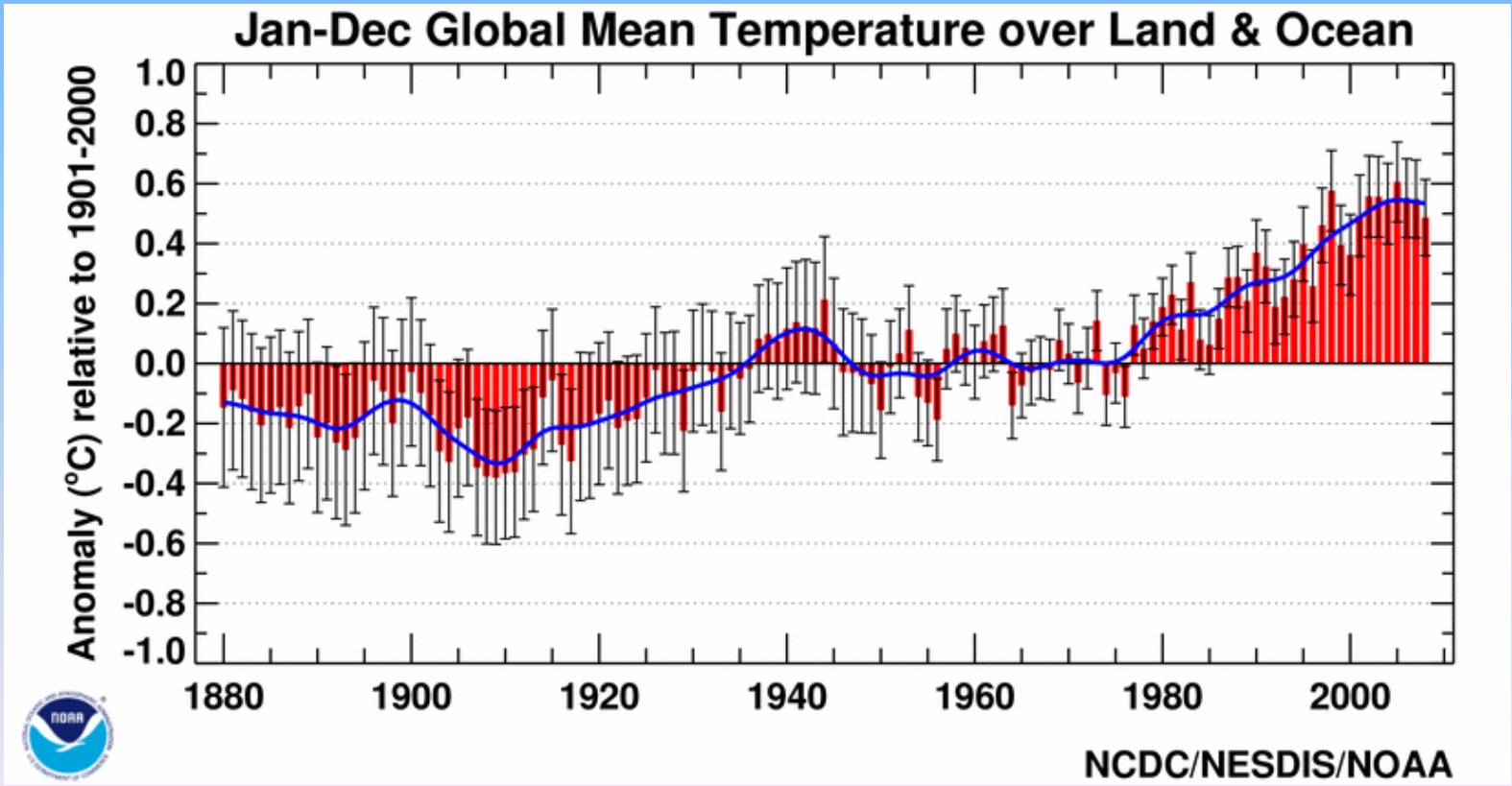

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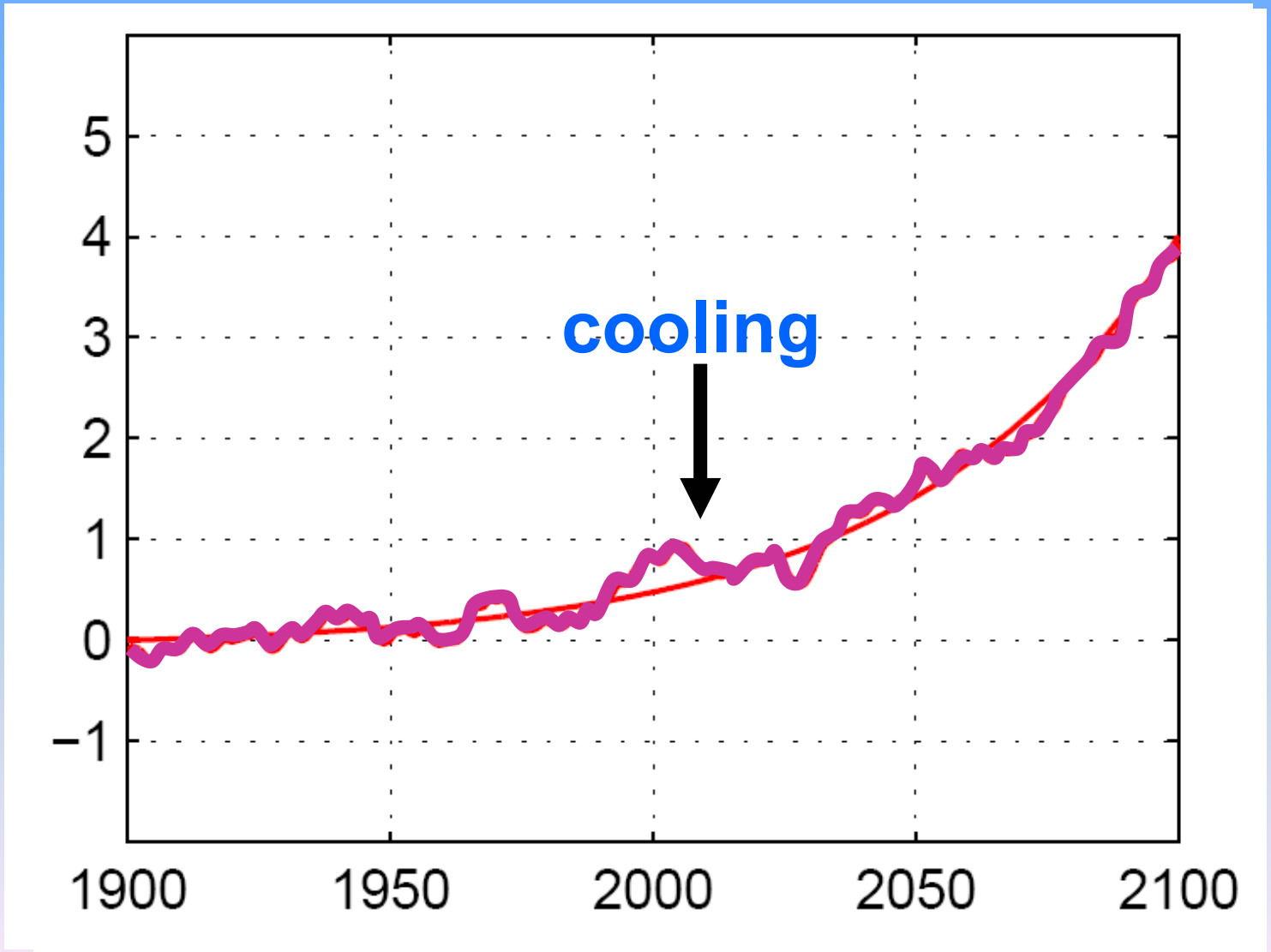
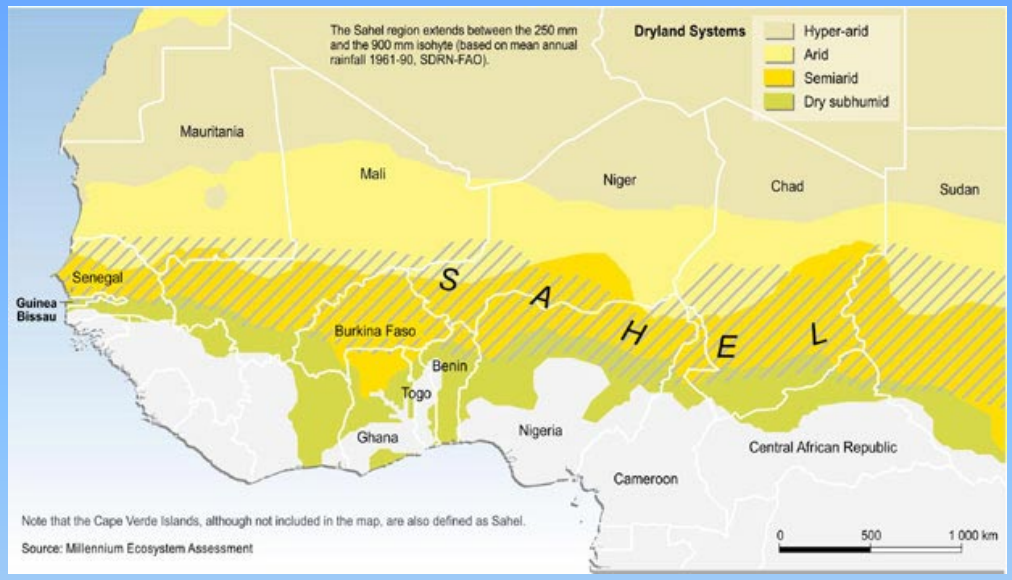
Outline

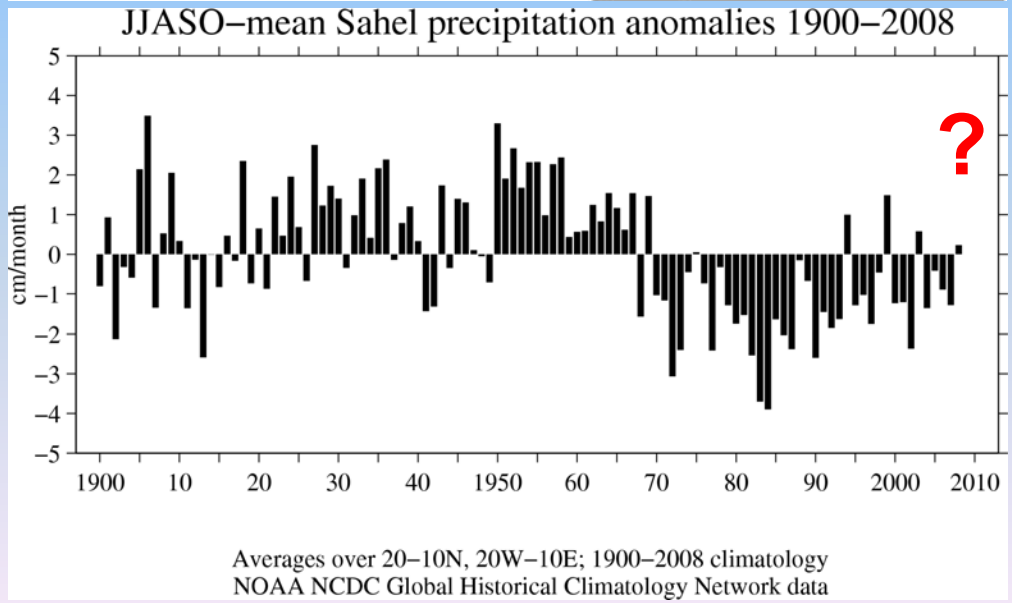
- Why decadal prediction
- Mechanisms of decadal variability
- What is the decadal predictability potential
- Challenges

“Climate surprises”



Decadal variations in Sahel rainfall





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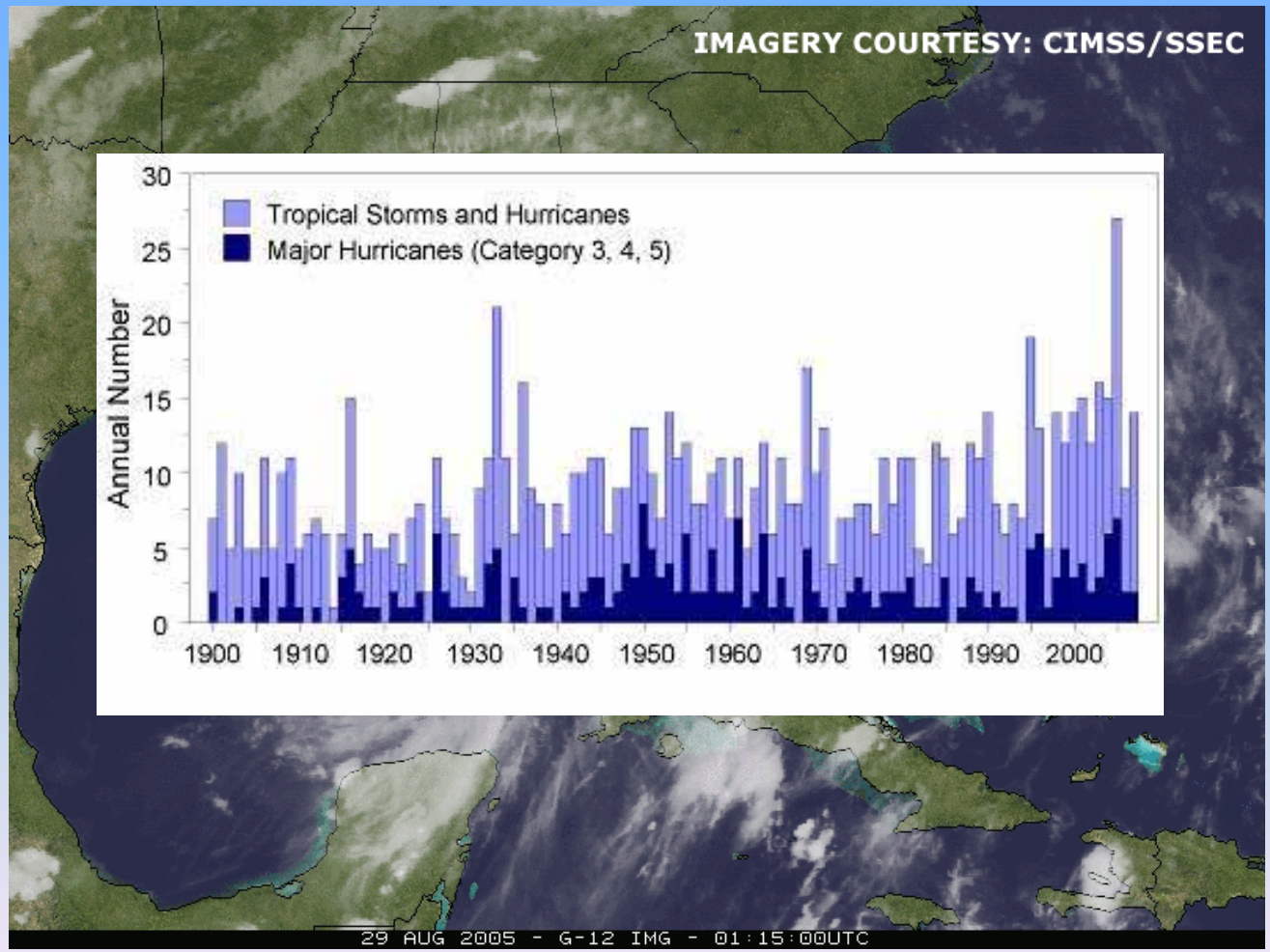
Decadal variations in Atlantic hurricane activity



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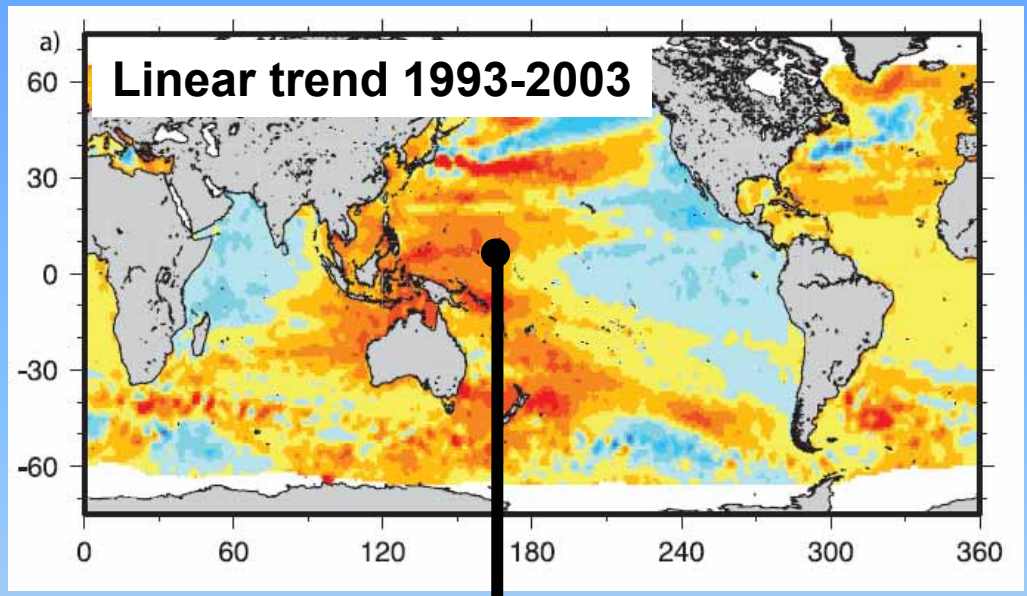
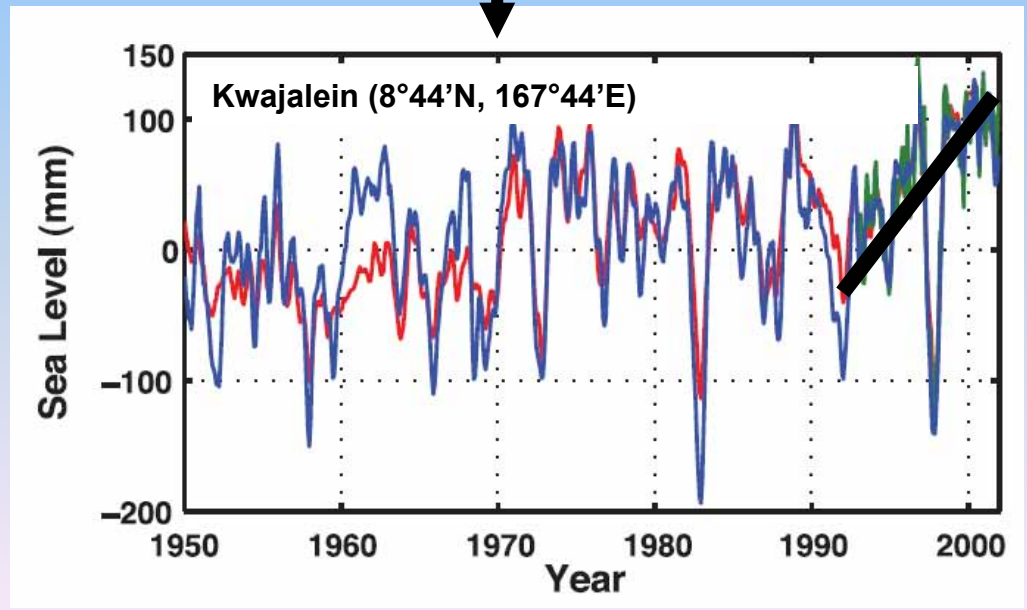
Decadal variability in sea level





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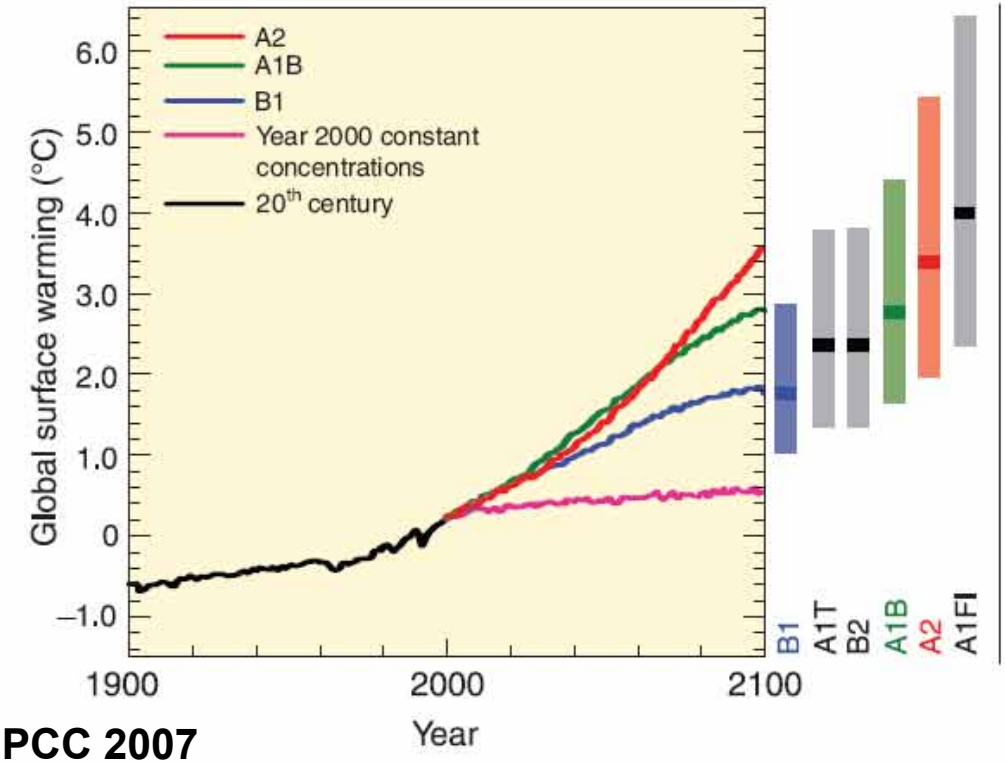
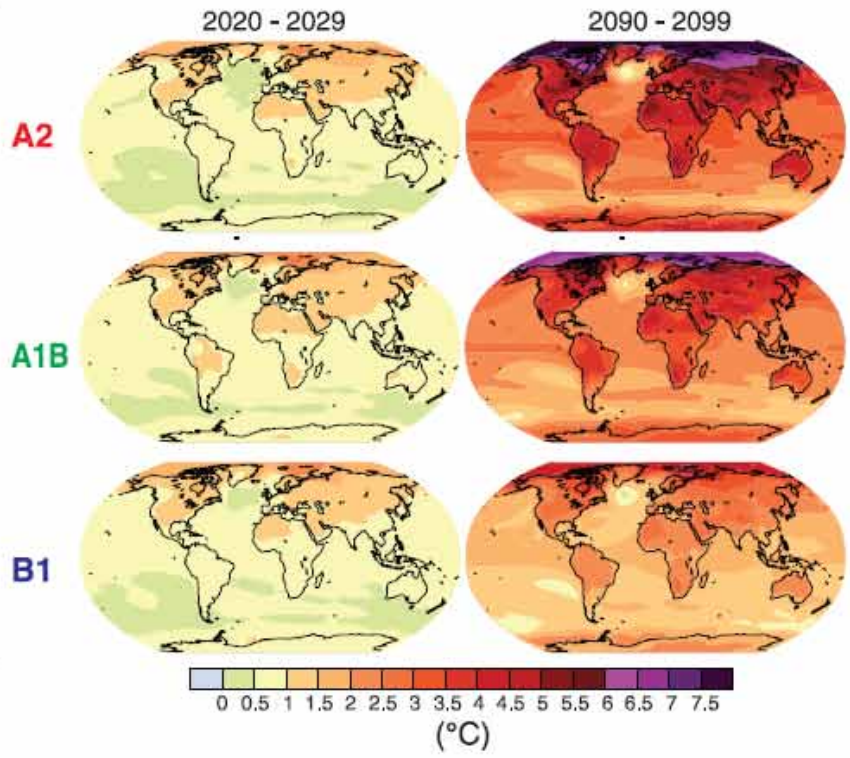
Global change prediction is a joint initial/boundary value problem





IPCC 2007

Projections were not initialized in IPCC-AR4

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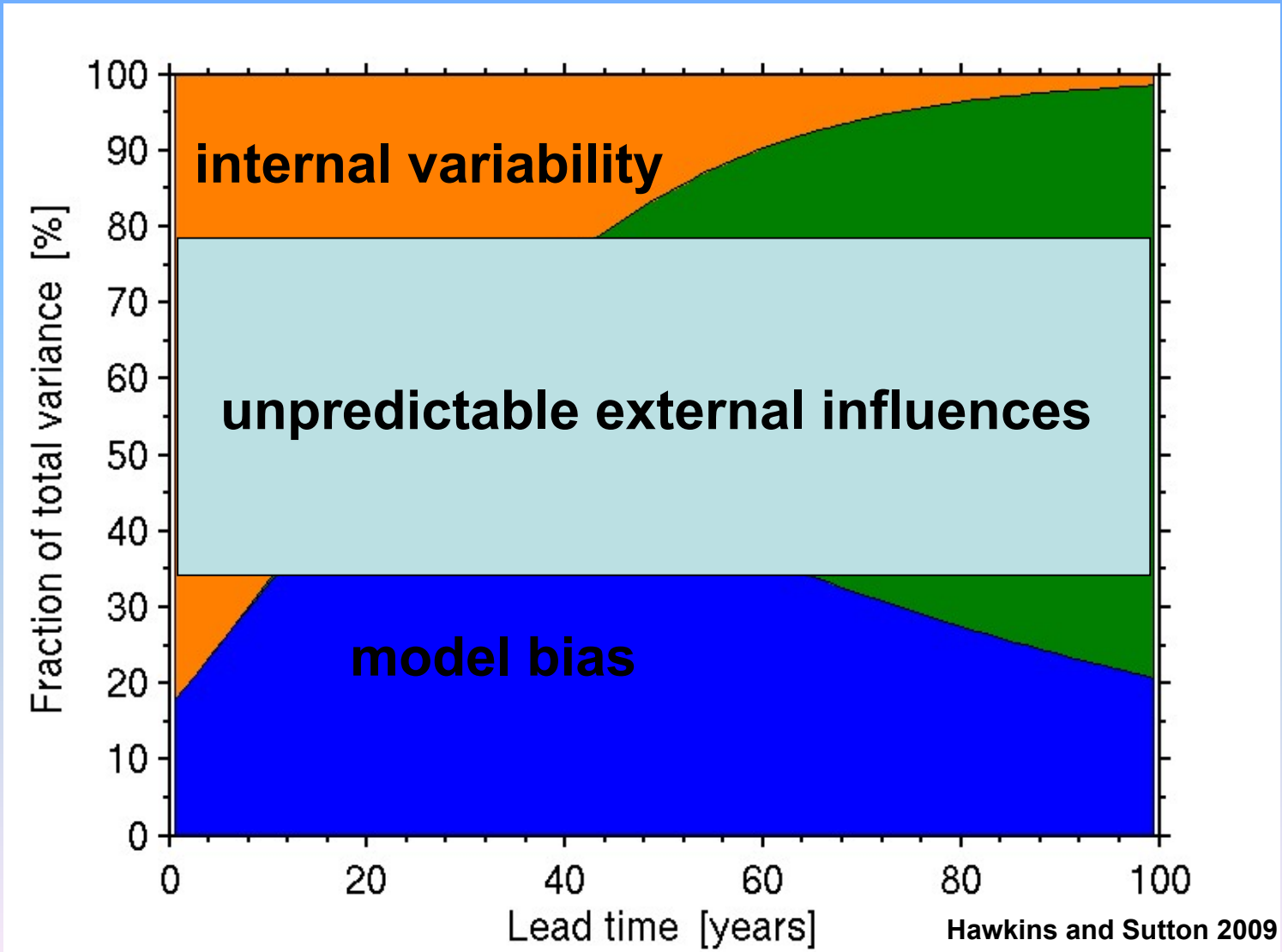
The uncertainty in climate projections for the 21st century



Hawkins and Sutton 2009

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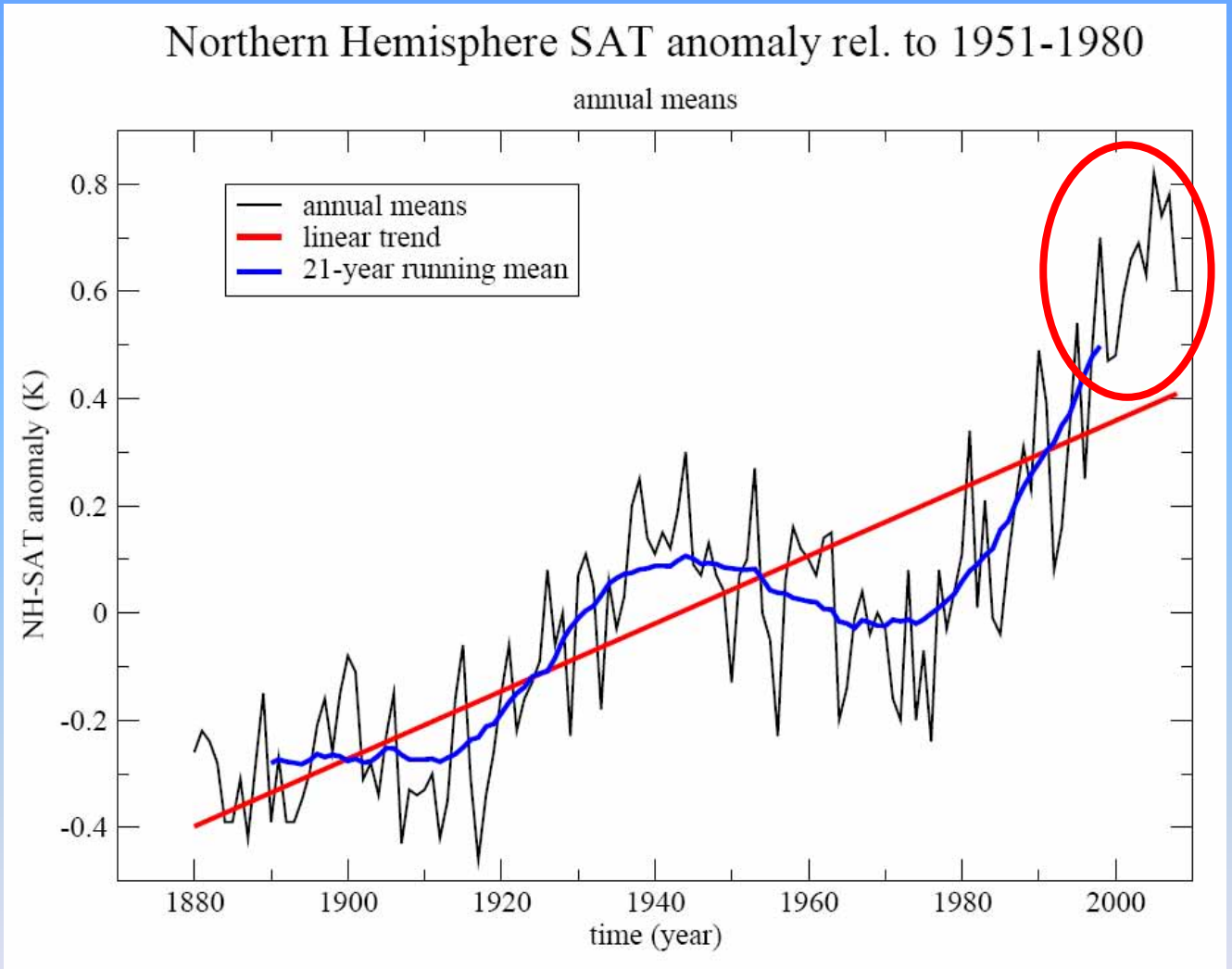
Outline

- Why decadal prediction
- **Mechanisms of decadal variability**
- What is the decadal predictability potential
- Challenges

Internal vs. external influences



How much did internal decadal variability contribute to the warming during the recent decades?

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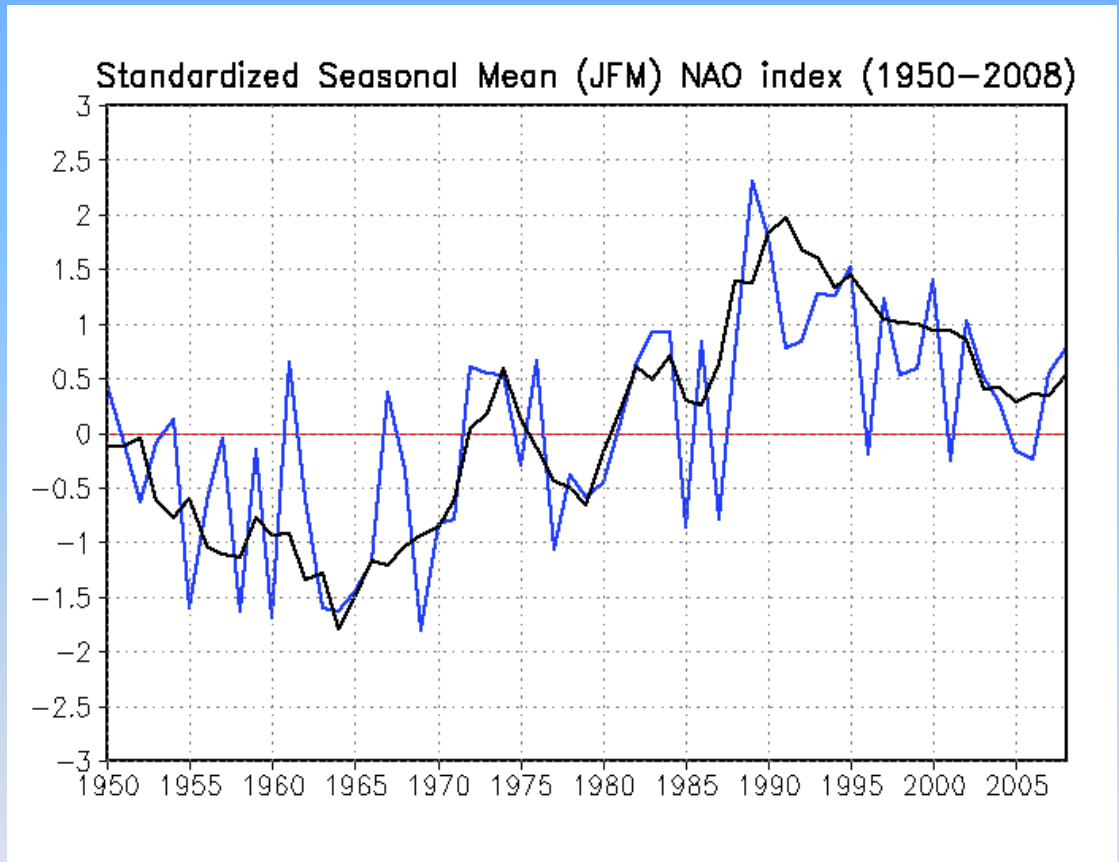
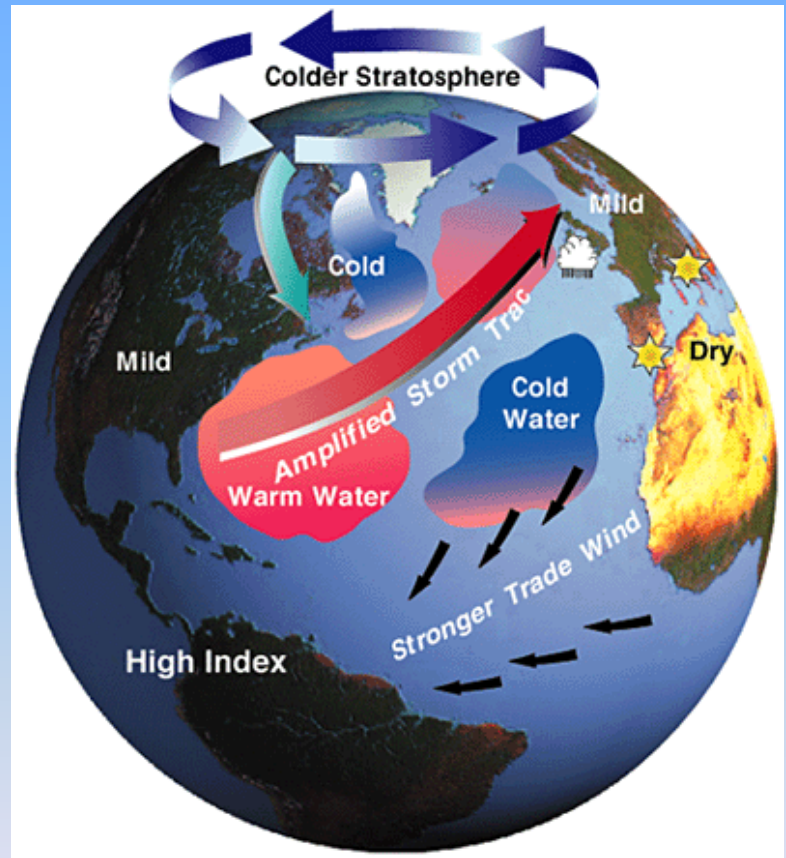
Decadal variations in the North Atlantic Oscillation





How much of the decadal NAO variability is forced by changes in the boundary conditions?

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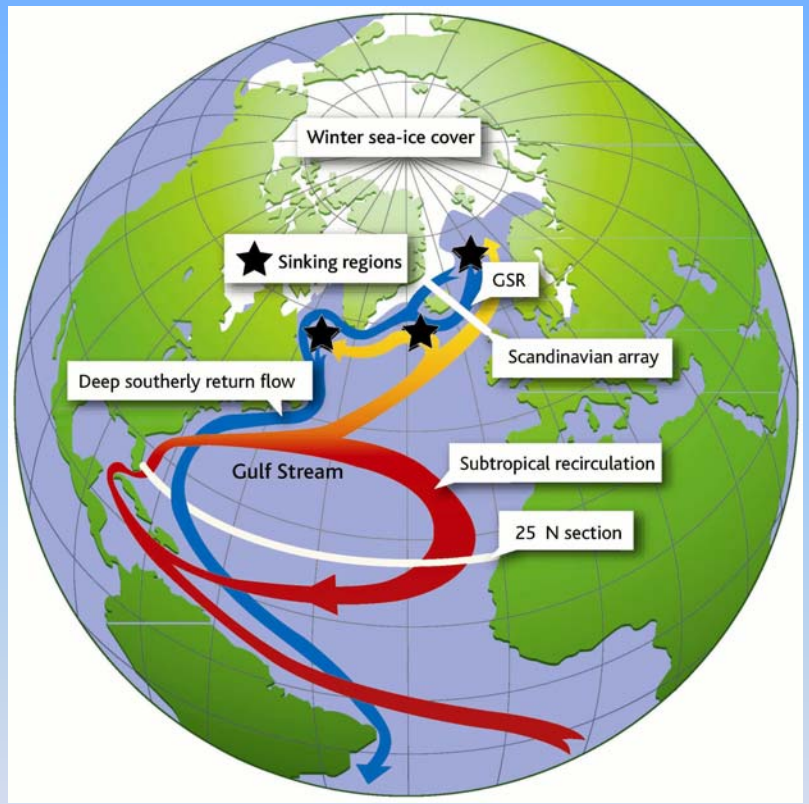
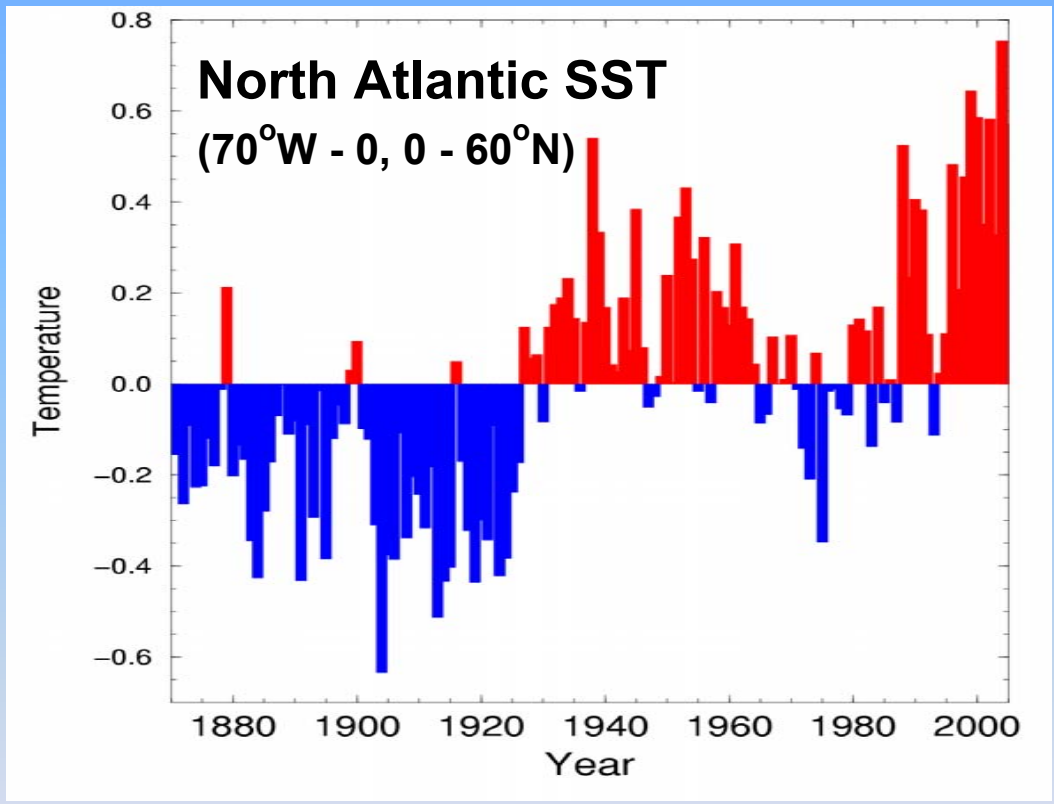
Decadal North Atlantic sea surface temperature variations





Changes in hurricane activity and Sahel rain, for instance, can be traced back to variations in Atlantic sea surface temperature (SST)

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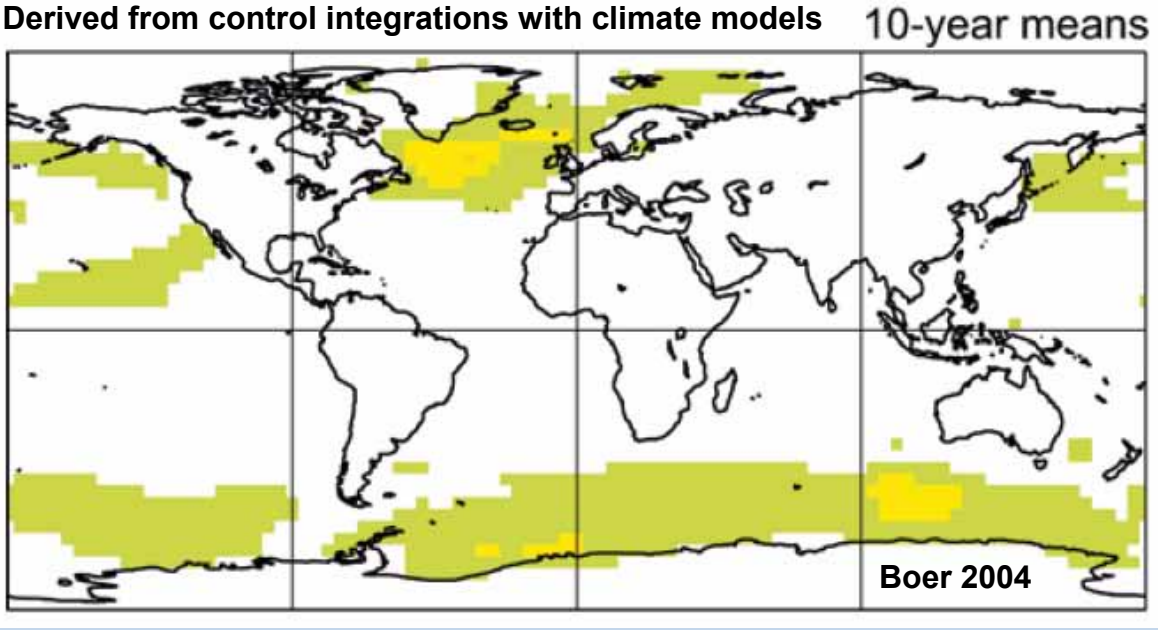
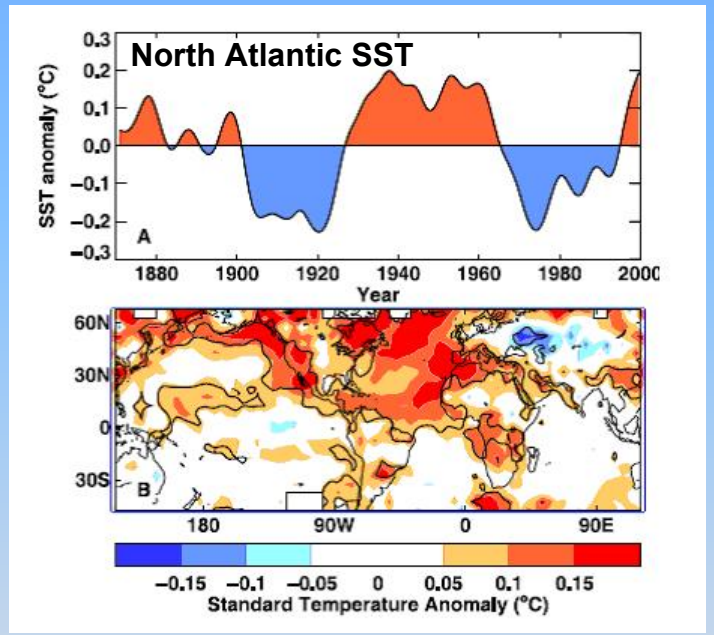
Potential predictability of surface air temperature (SAT)

Derived from control integrations with climate models





Knight et al. 2005

The North Atlantic Sector appears to be one of the promising regions

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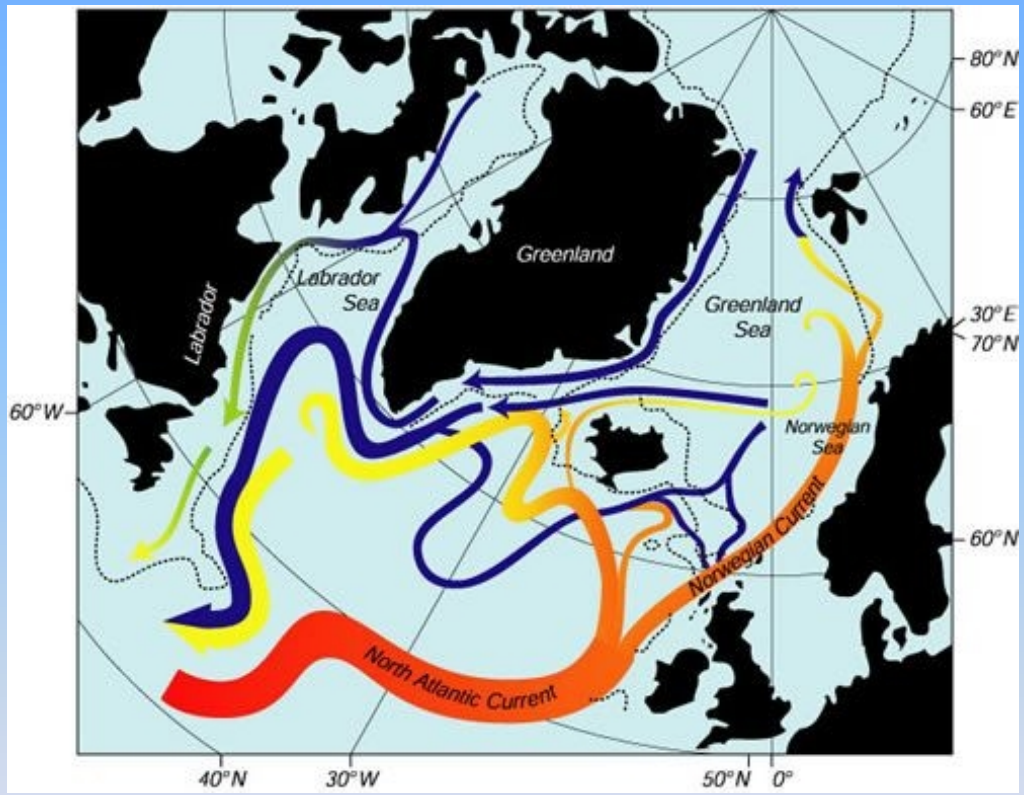
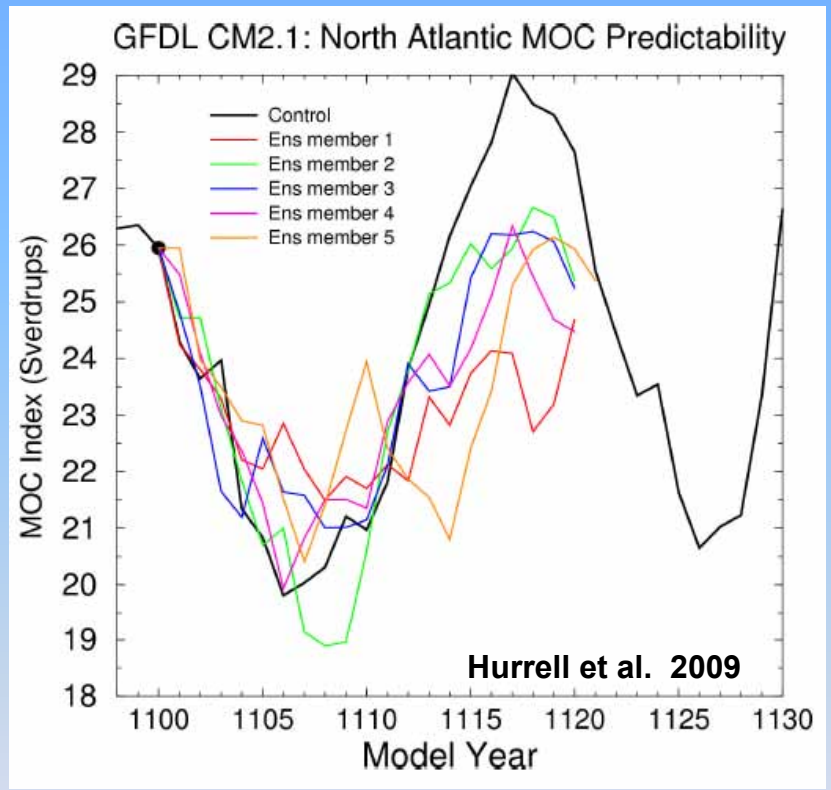
Predictability of the Meridional Overturning Circulation (MOC)





The MOC is predicable at a lead of one to two decades in perfect model studies

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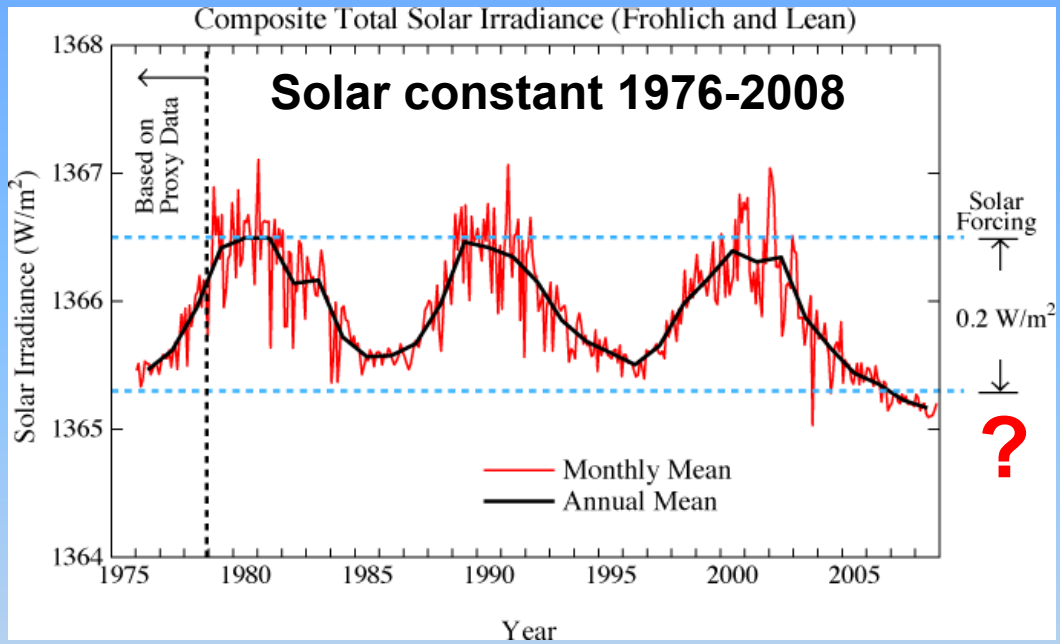
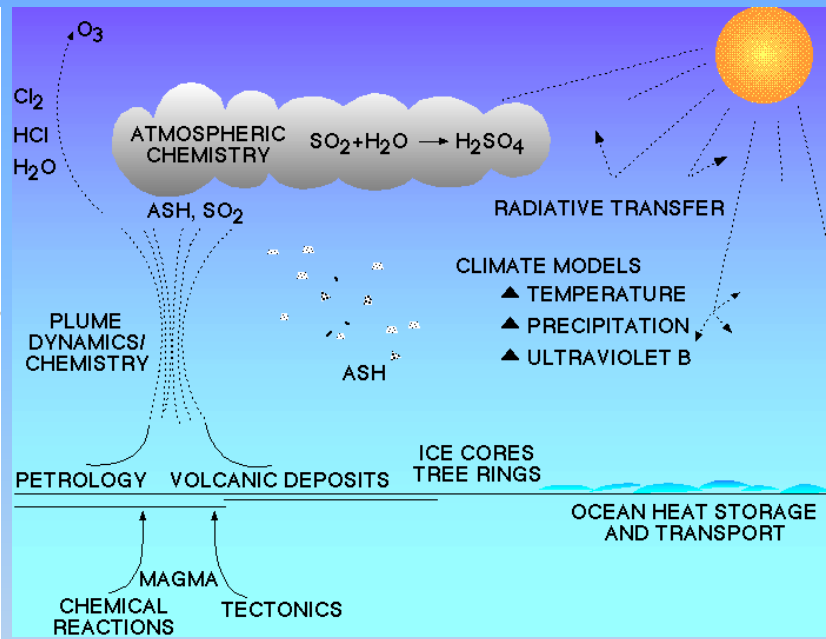
Unpredictable external influences





Strong volcanic eruptions, for instance, can cause global cooling of about 0,2°C for a few years and persist even longer in the ocean heat content. If they happen, we can exploit their long-lasting climatic effects.

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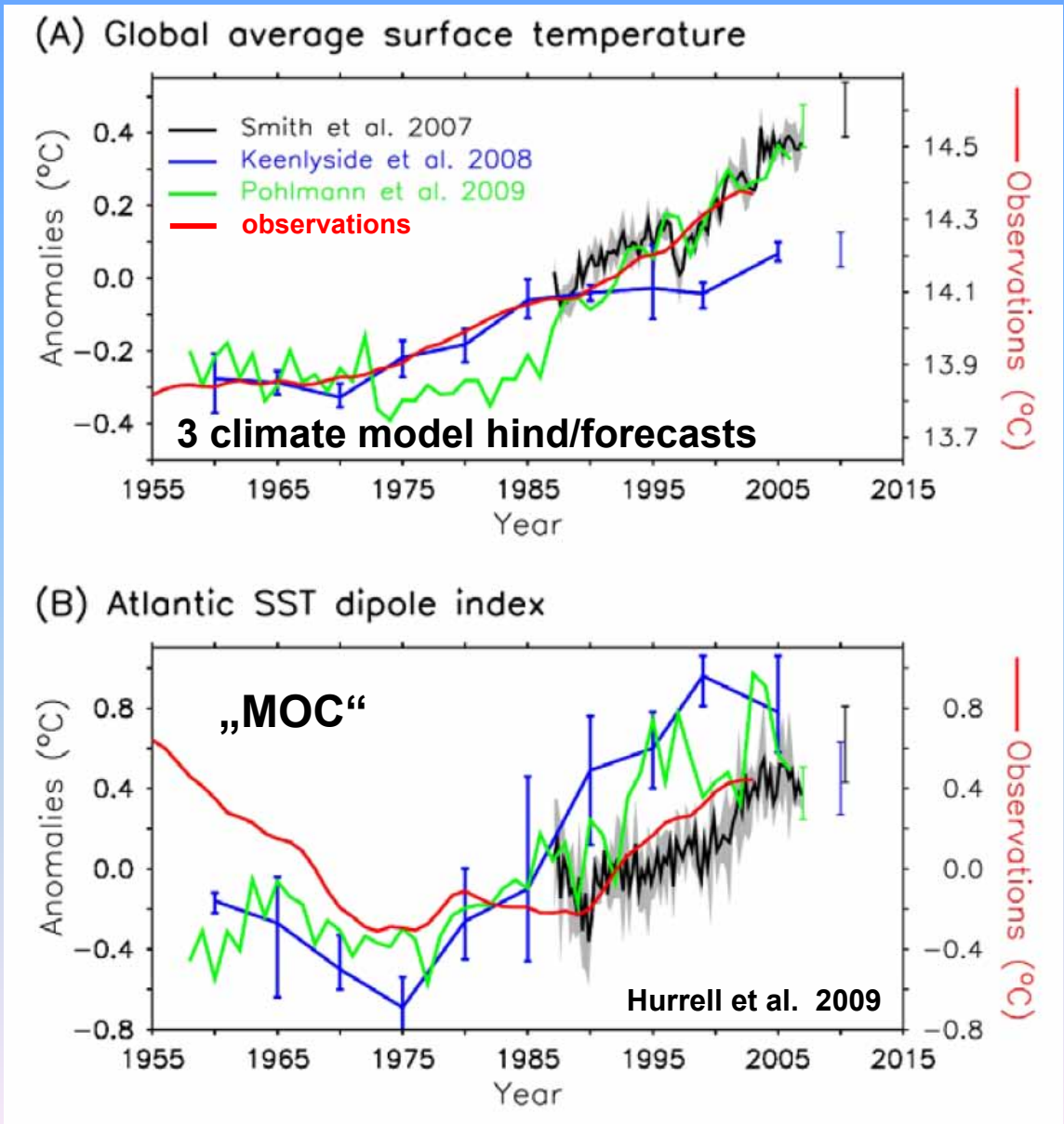
Large spread for the next decade



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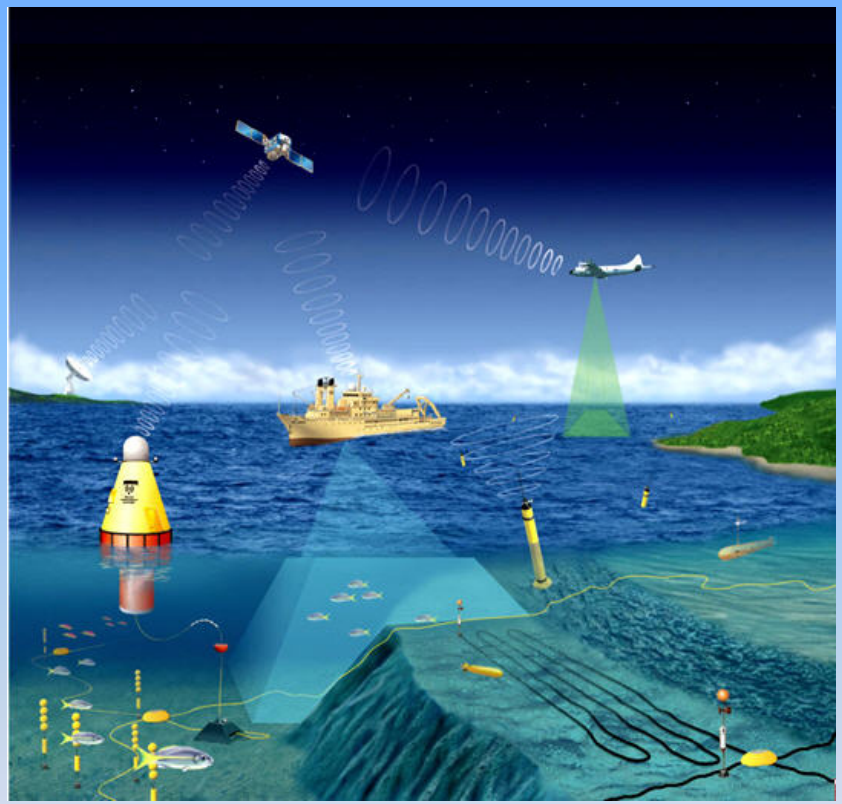
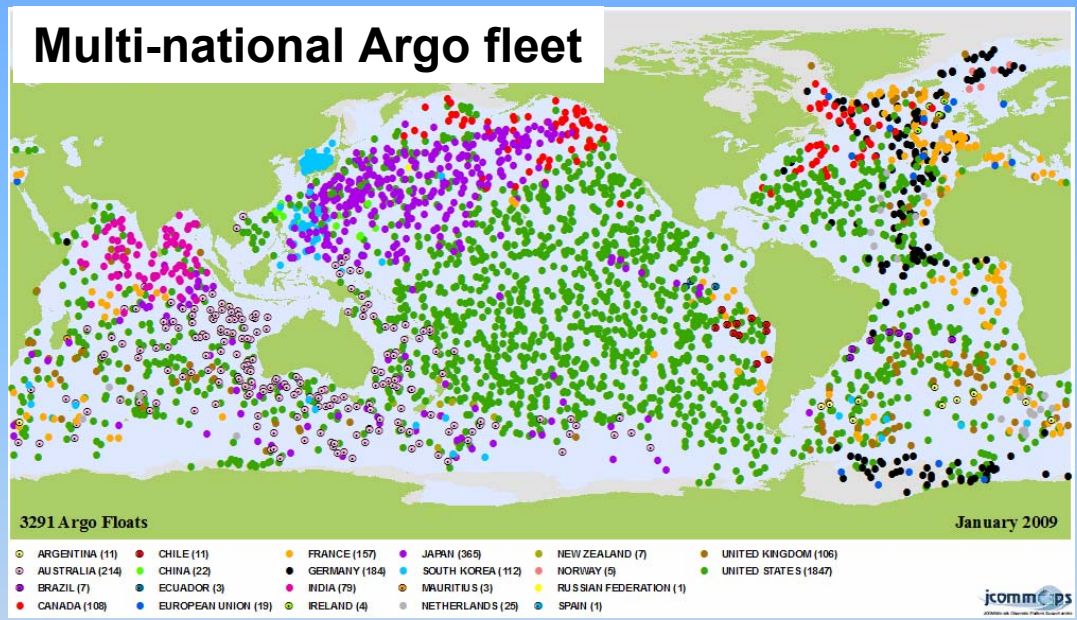
Climate observing system

Example: ocean observing system





We need climate observations to initialize the models to forecast variations up to decadal time scales

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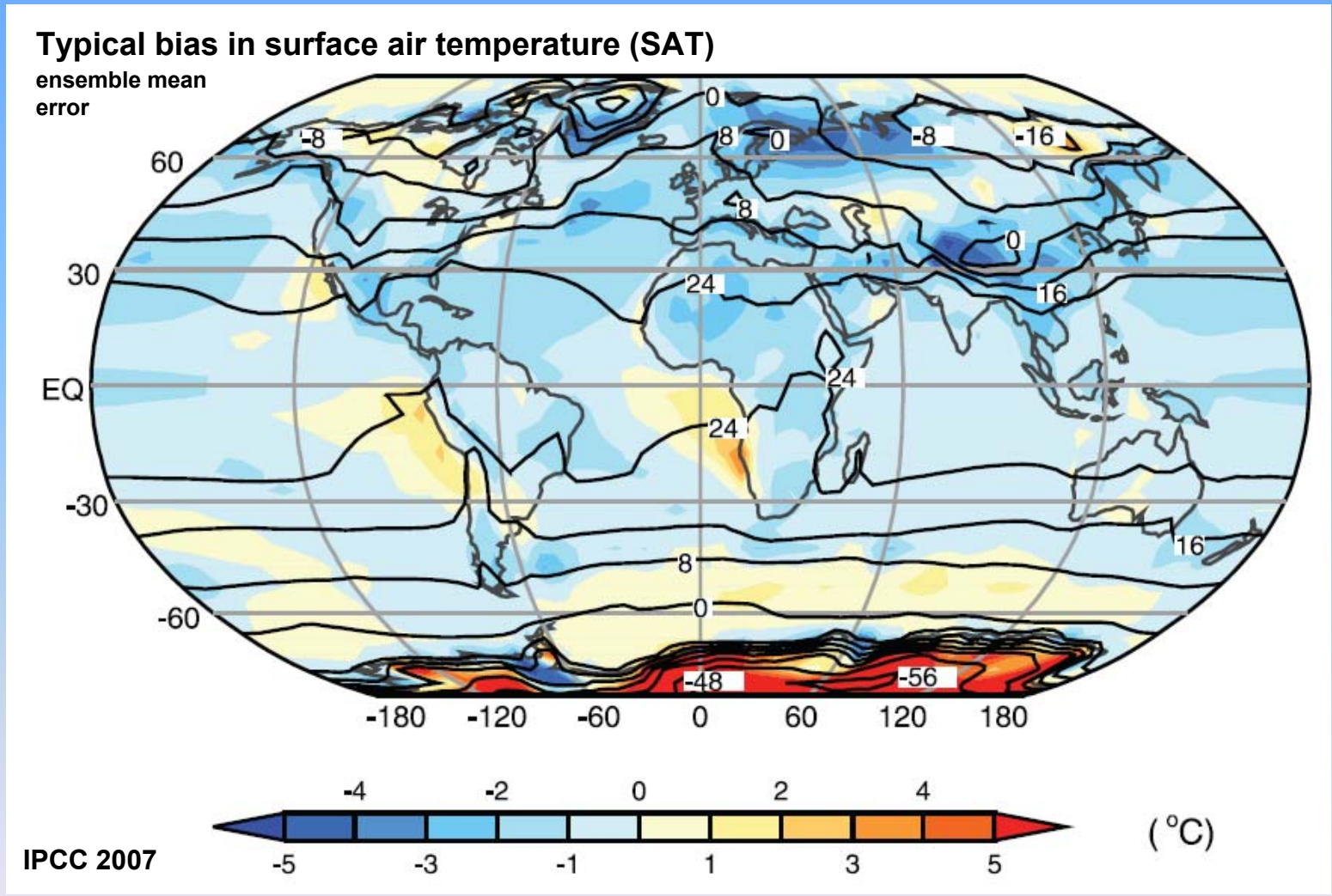
Model biases are large



Errors of several degrees C in some regions

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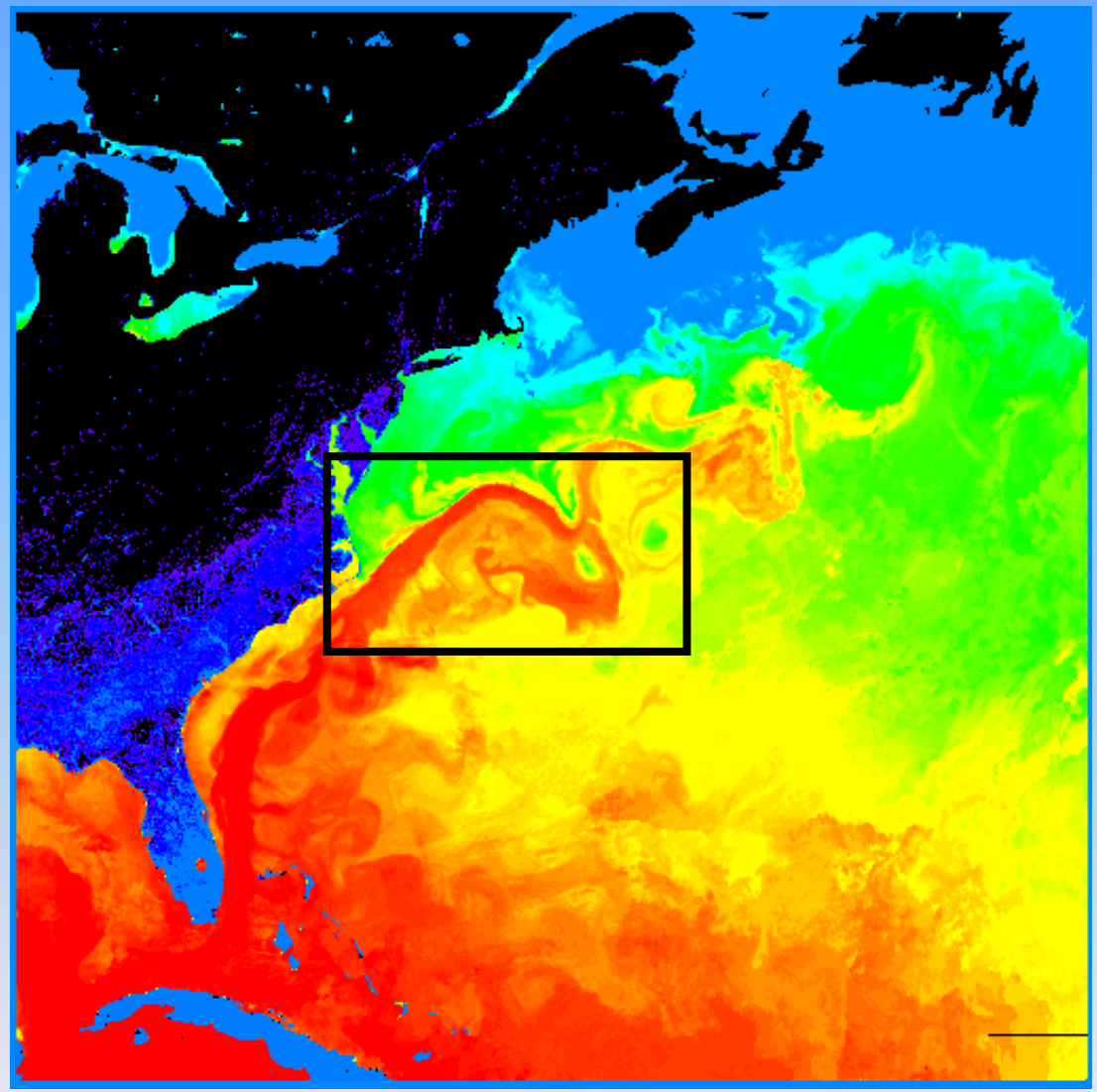
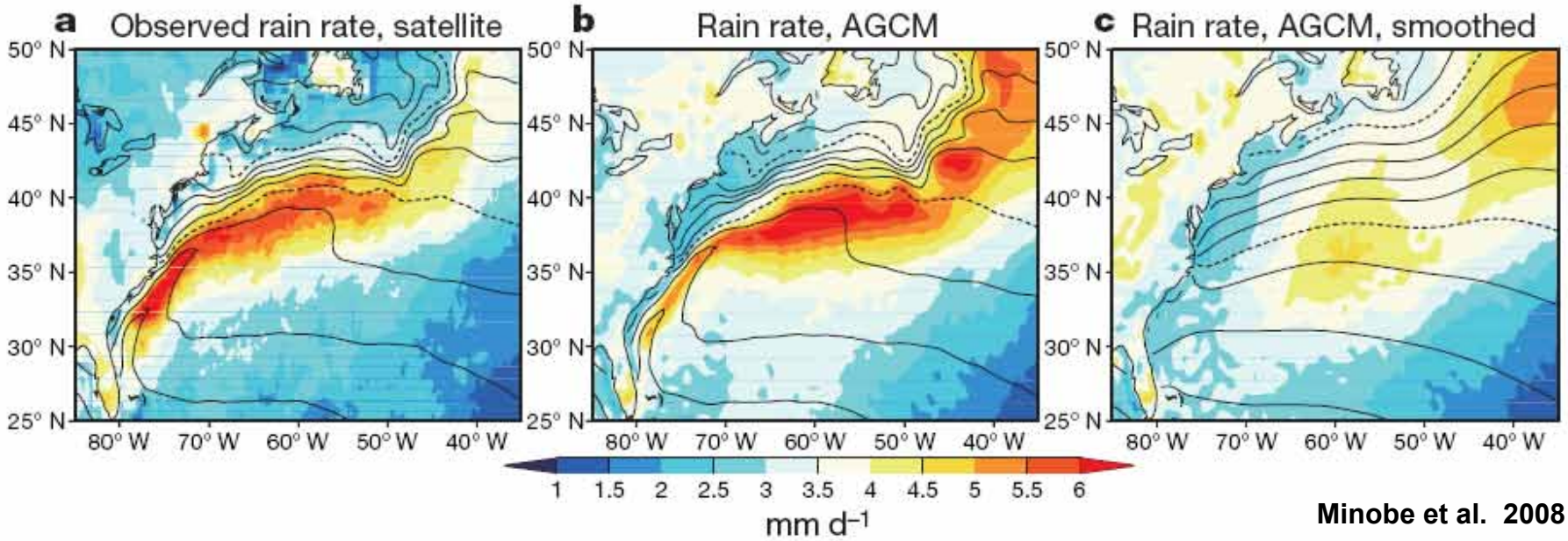
Gulfstream SST front



Represention of small-scale processes

Resolution matters



Minobe et al. 2008

The AGCM has T239 horizontal resolution (~50 km) and 48 levels

Compared to the smoothed SST run, rain-bearing low pressure systems tend to develop along the Gulf Stream front in the control simulation

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Where are we today?

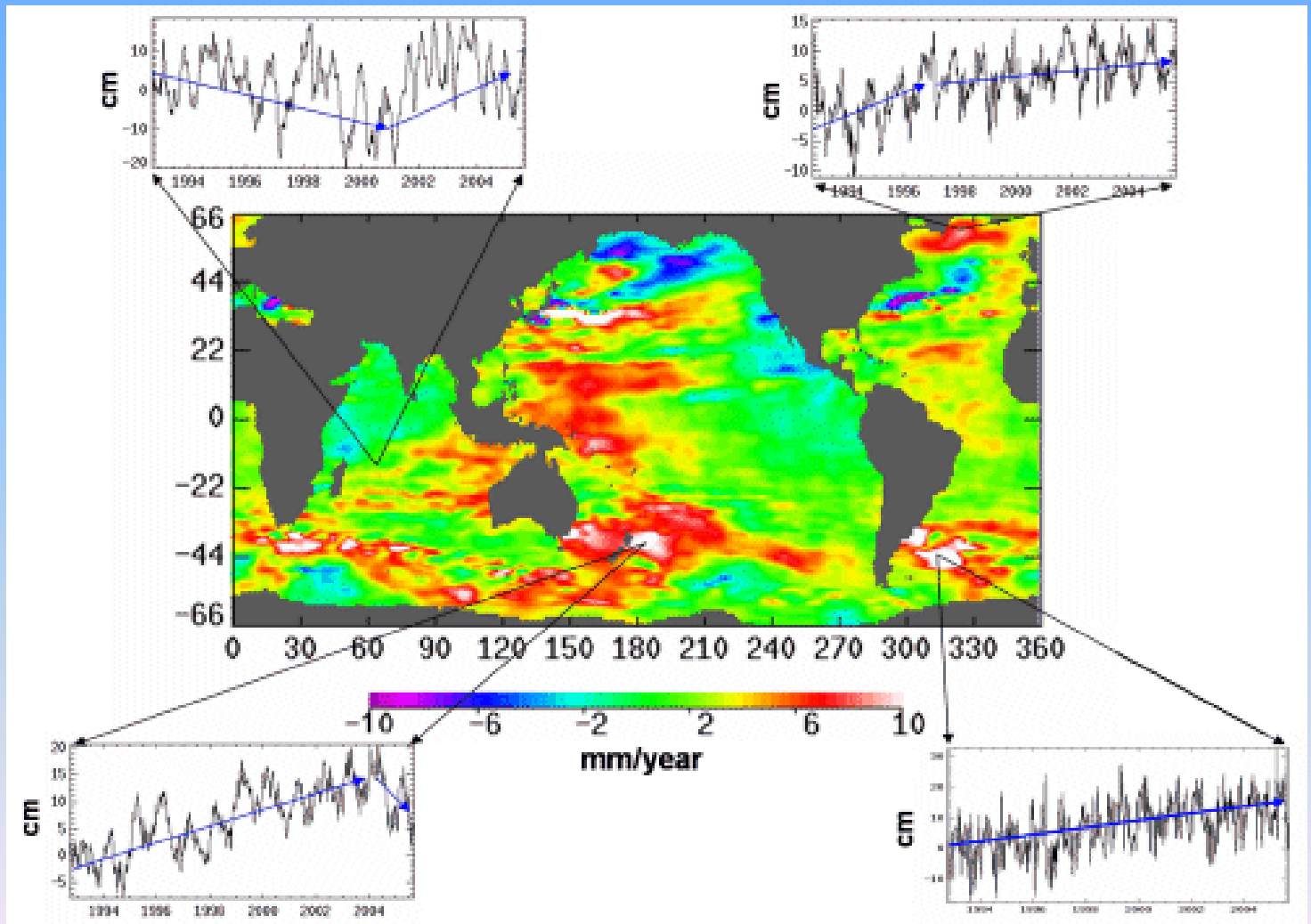
- A decadal predictability potential for a number of societal relevant quantities is well established.
- We need a better understanding of the mechanisms of decadal variability
- We need a suitable climate observing system (ocean, land surface, sea ice...)
- We need „good“ models! We know from NWP that reduction of systematic bias helps. Biases in climate models are still large

To realize the full decadal predictability potential we need a coordinated scientific programme under the auspices of the World Climate Research Programme (WCRP)

Thank you for your attention

Decadal variability in sea level

Topex/Poseidon 1993-2005



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