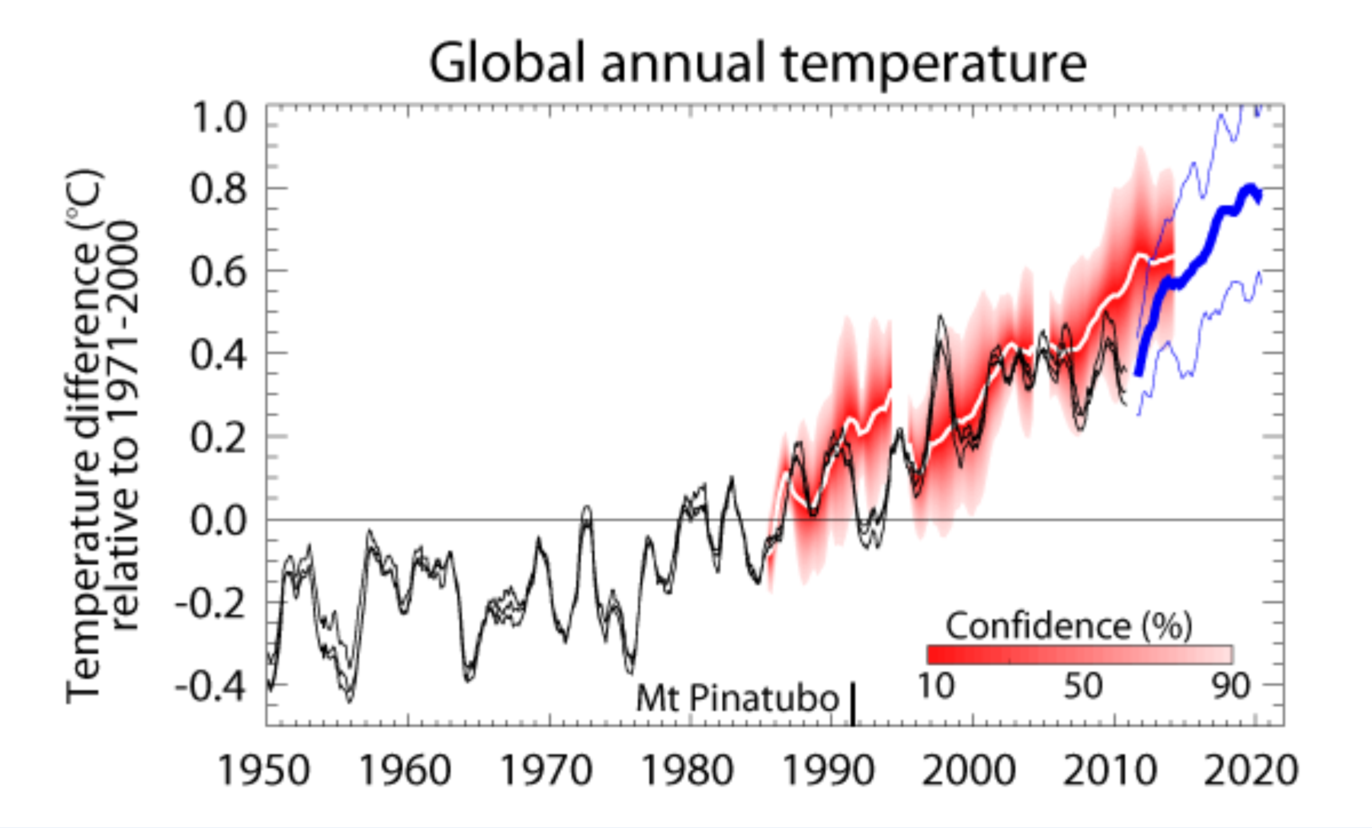
Decadal prediction: where do we stand?

Mojib Latif
Helmholtz Centre for Ocean Research and Kiel University



Hadley Centre

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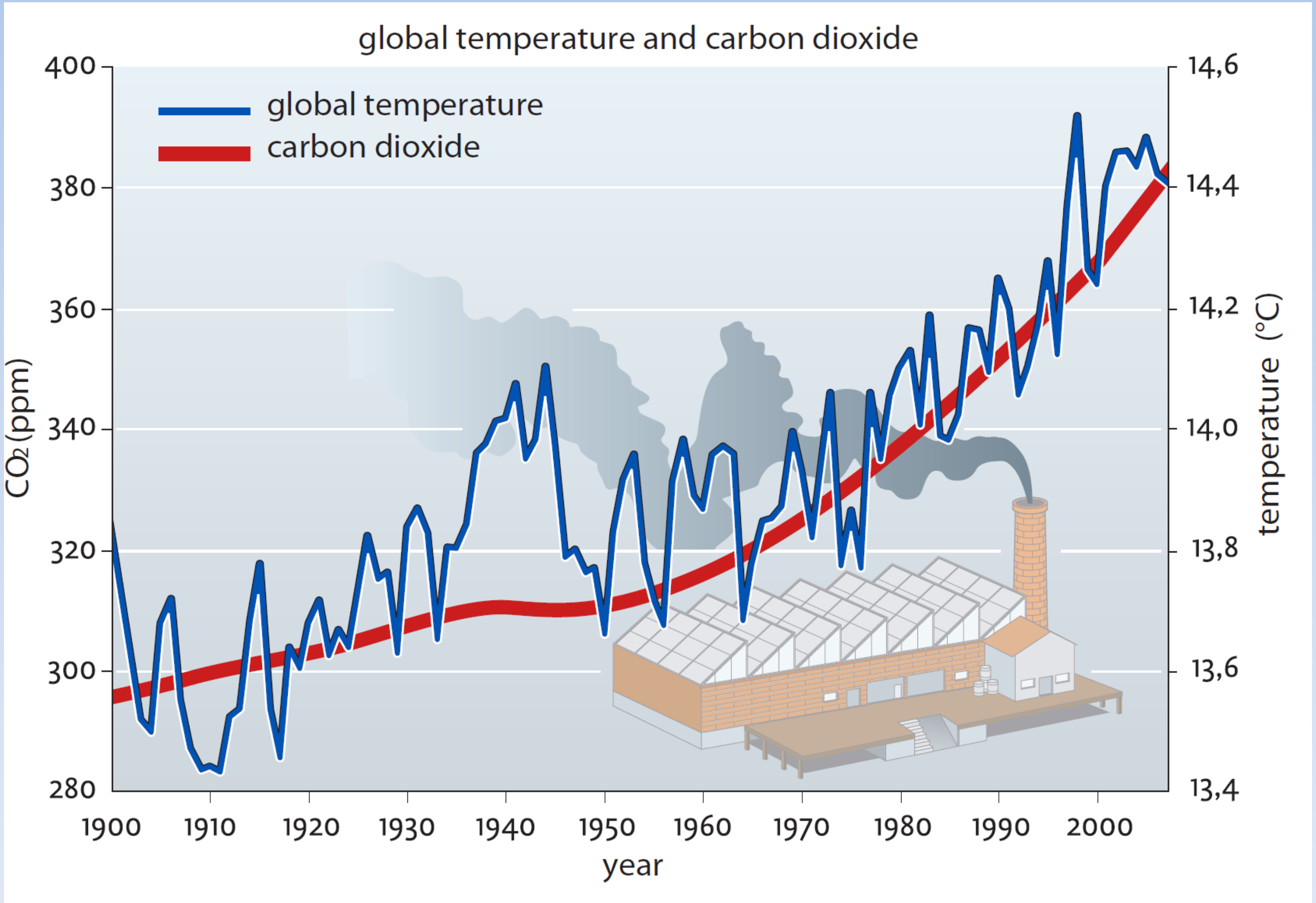
1. Twentieth century climate



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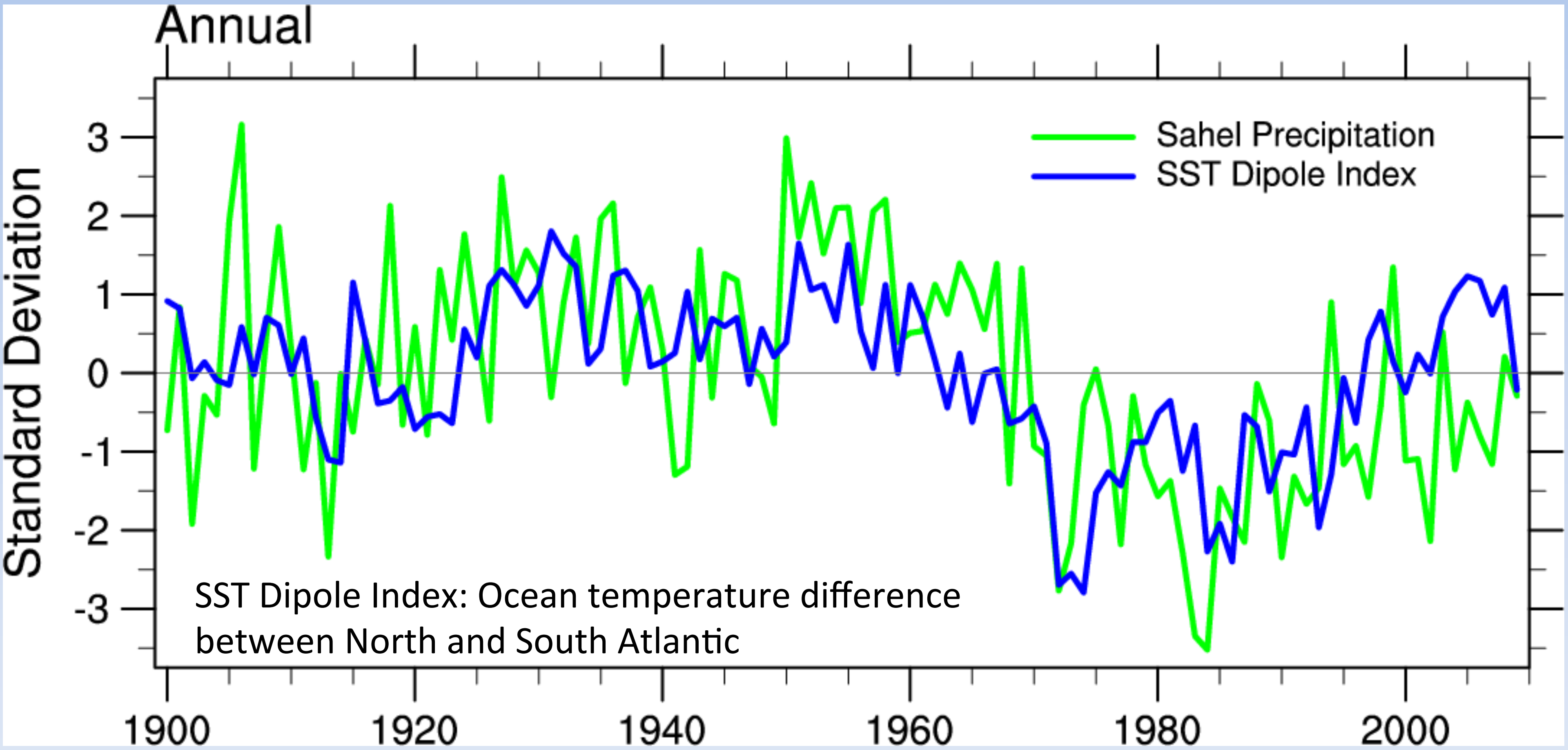
Sahel rain and ocean temperature



Clear link between Atlantic ocean temperature (SST) and Sahel rainfall at decadal timescales

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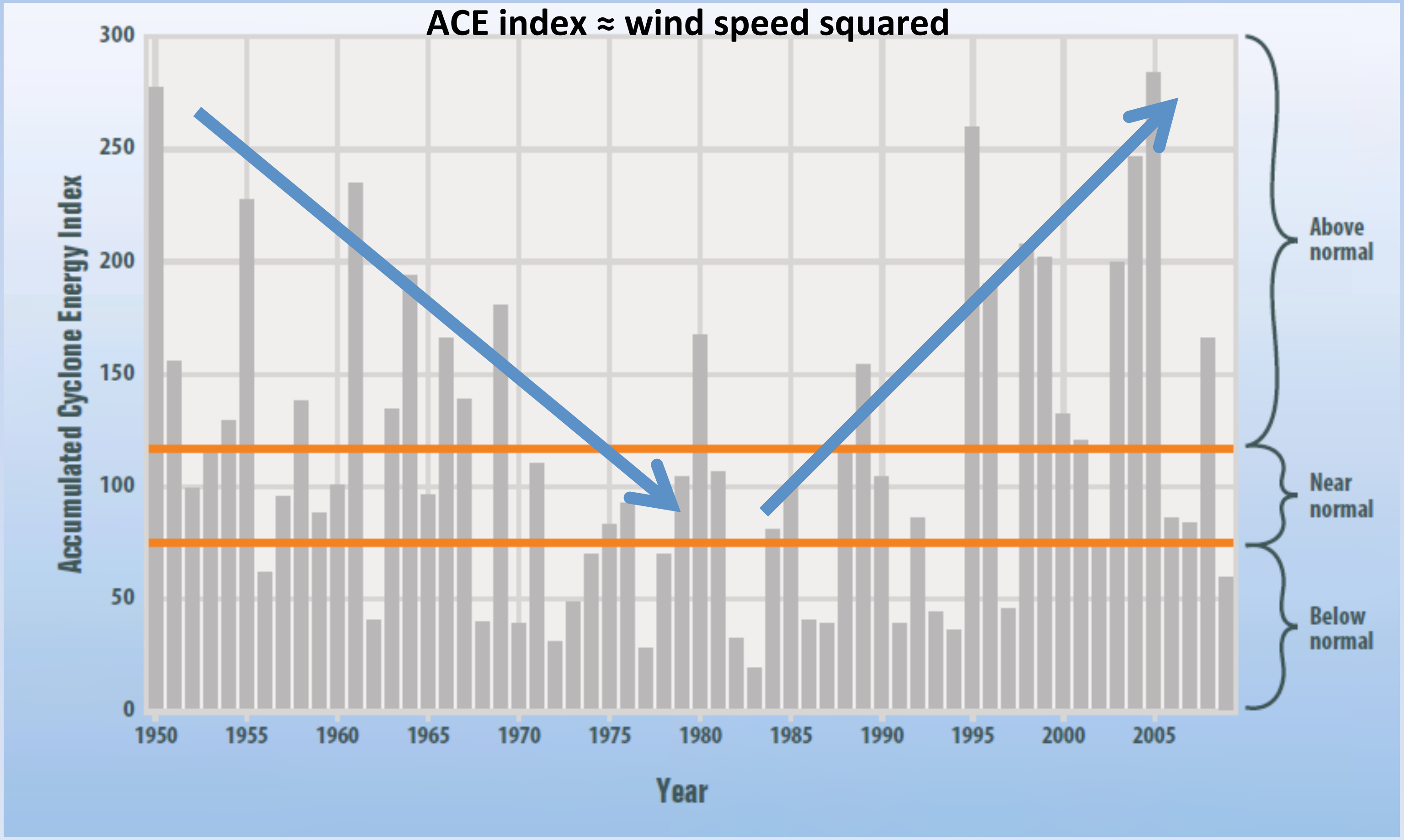
Atlantic hurricane activity 1950-2009



Decadal timescale variations of hurricane activity are obvious and also related to changes in sea surface temperature

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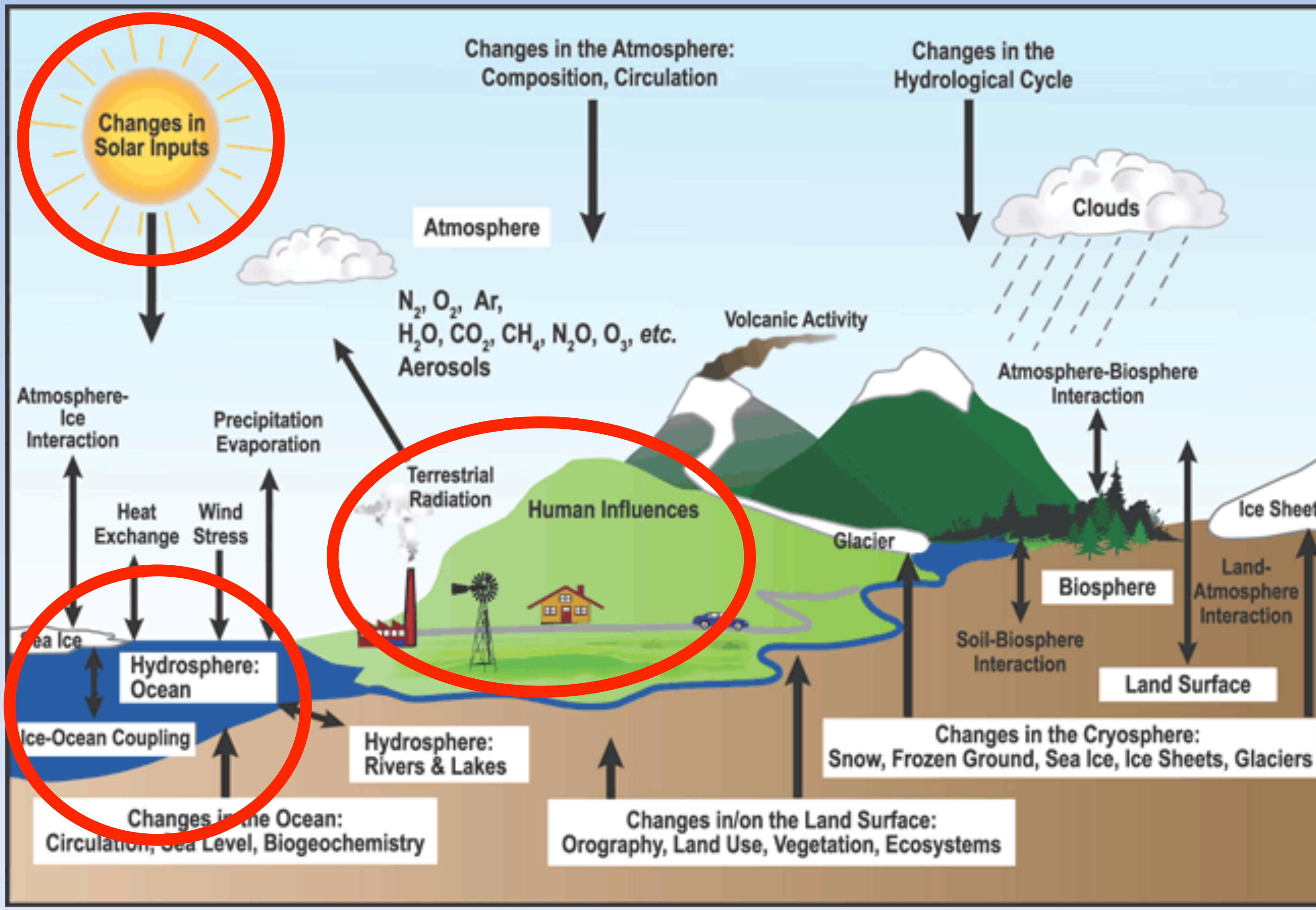
2. Climate predictability

Stop Global Warming

The Earth system



Drivers of climate change can be both natural or anthropogenic

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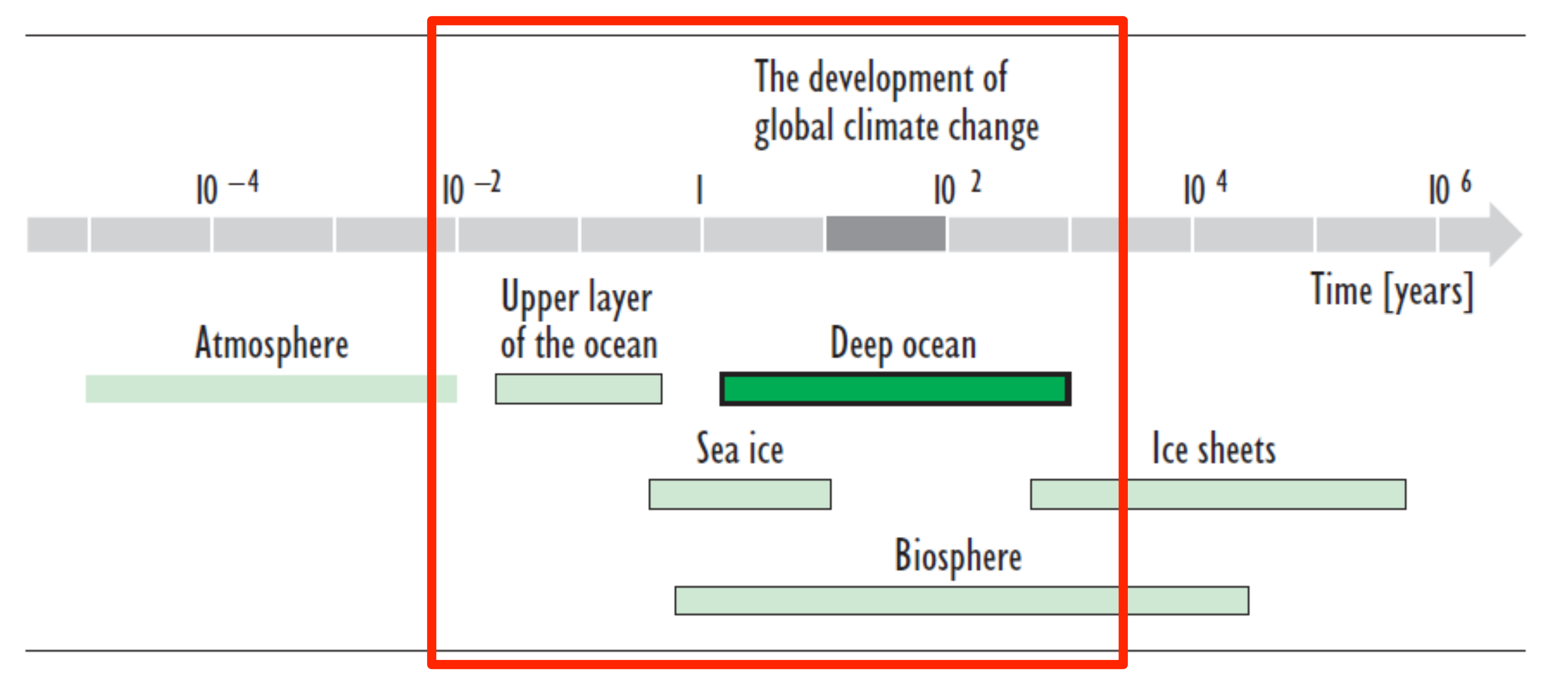
Timescales in the Earth system



The oceans have intrinsic timescales similar to those on which also global warming evolves. Changes in the ocean currents can mask the regional effects of global warming

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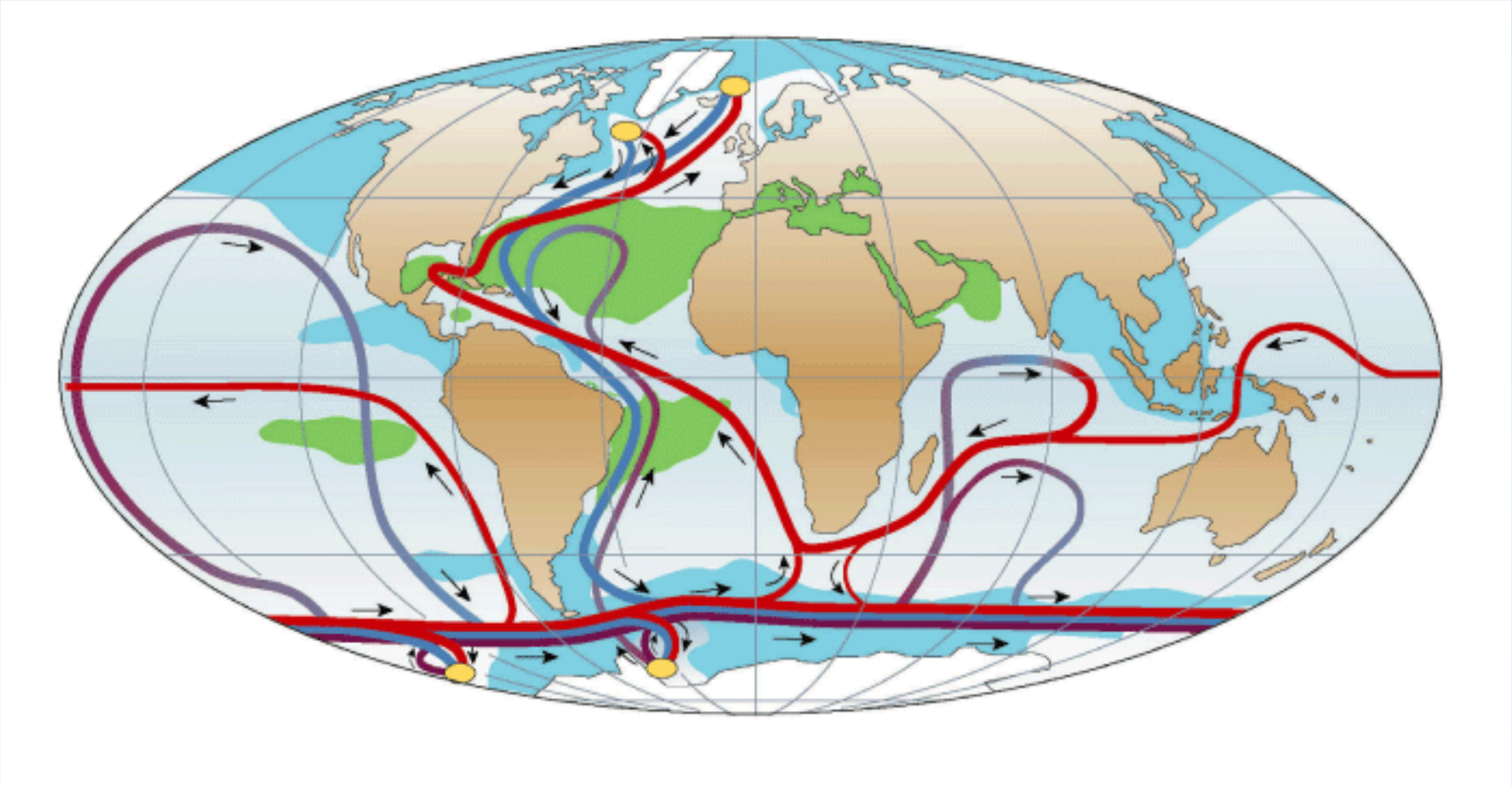
The global overturning circulation



Slow changes in the 3-d ocean circulation cause slow changes in the climate of the adjacent continents

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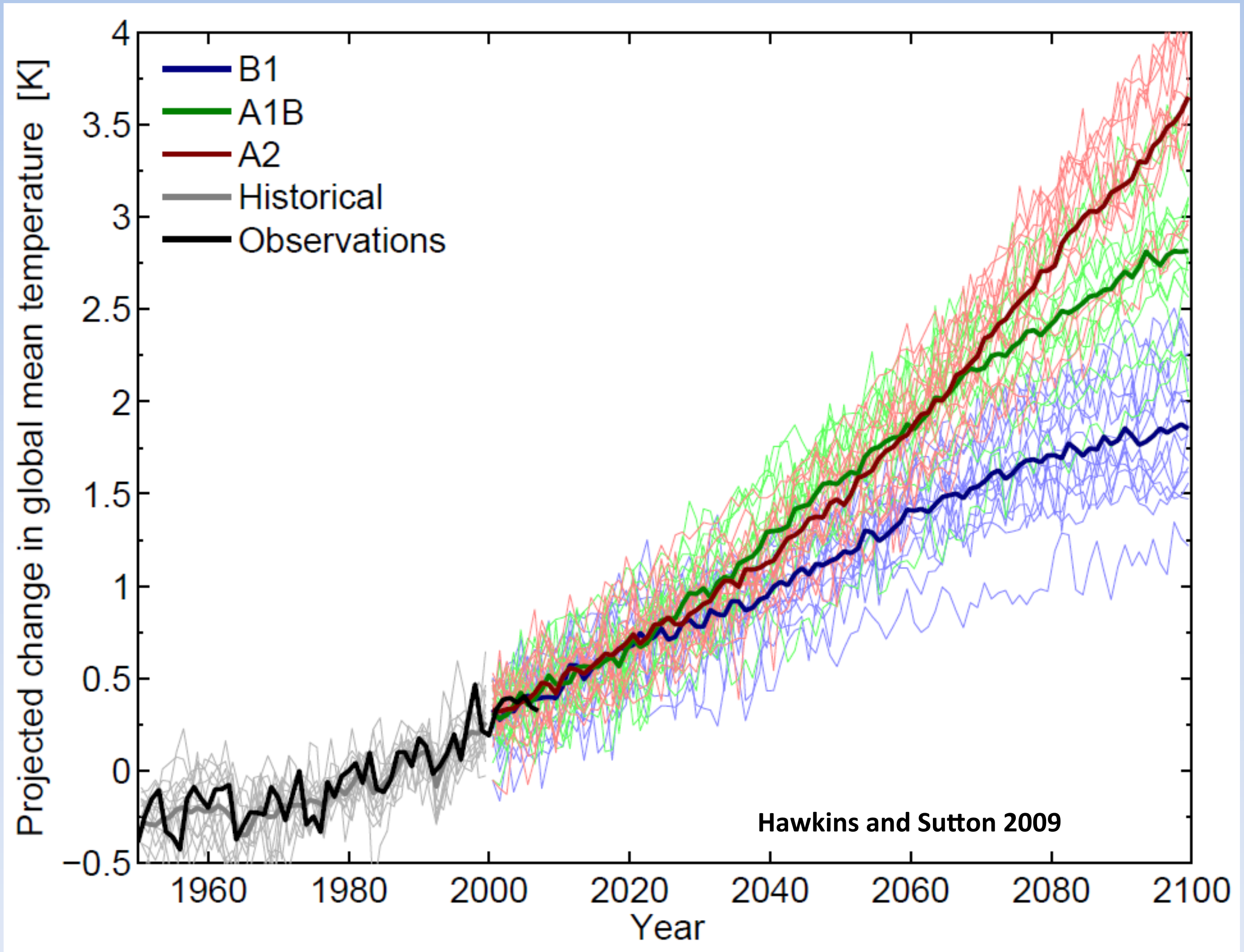
Two types of predictability (after Lorenz)

- **Predictab** ... **m the initial conditior** ...
- **Predictab** ... **from the boundary** ... **lobal change p** ... **istics of weather,** ... **e weather itself**
- **Global ch** ... **oth**

Uncertainties in the climate projections



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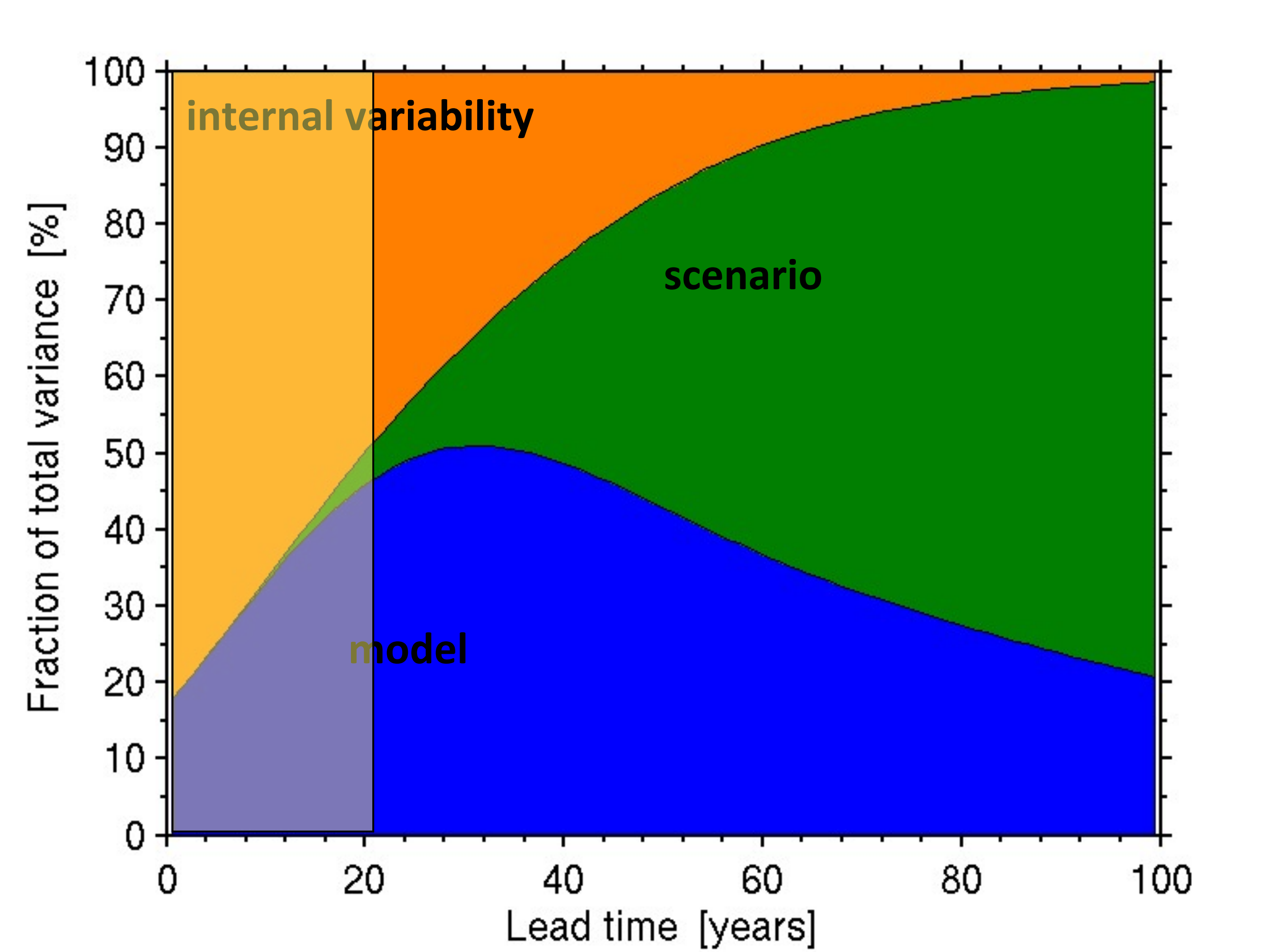
Uncertainties in global change projections



Hawkins and Sutton 2009

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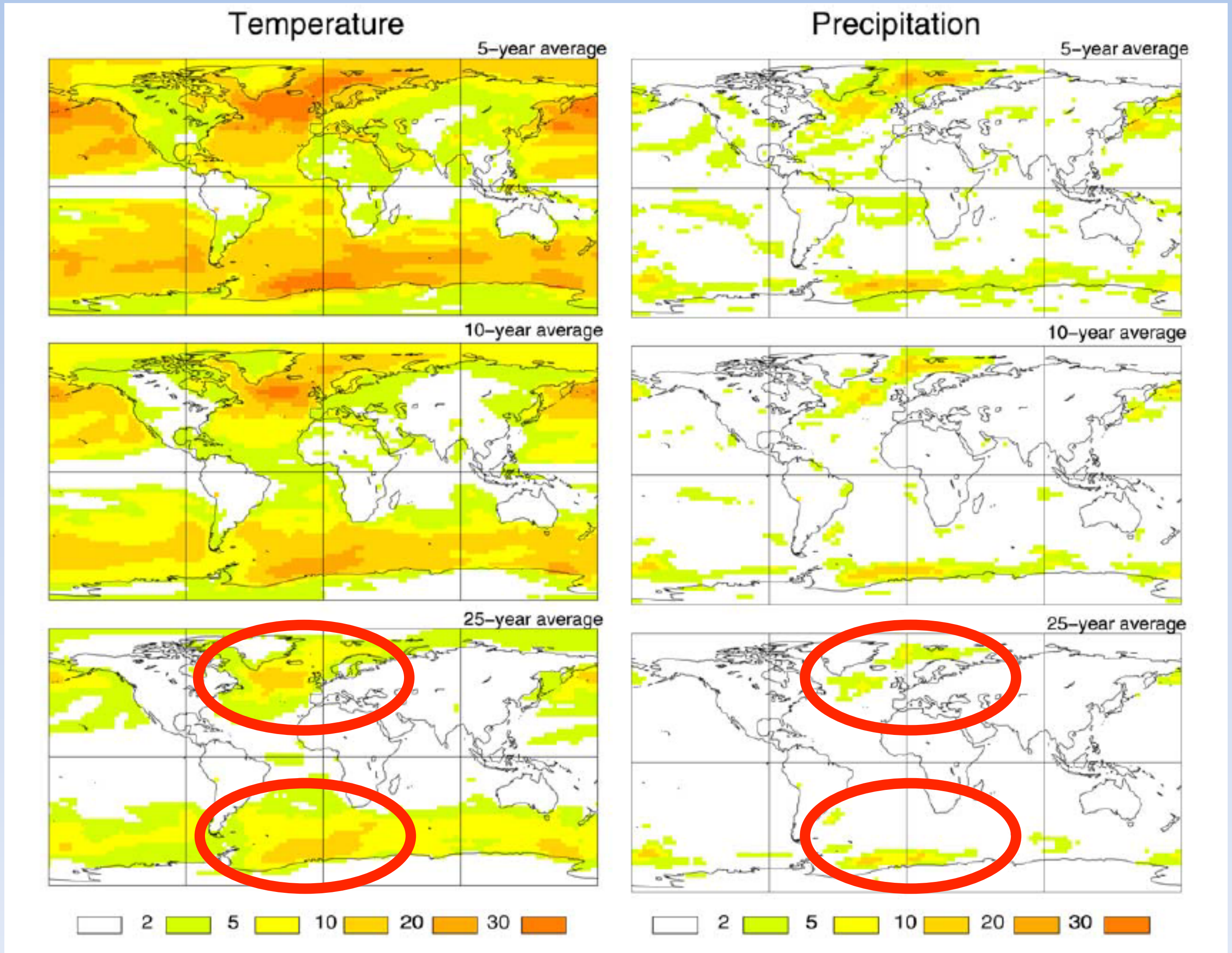
3. Diagnostic decadal predictability



potential predictability variance fraction (σ_v^2/σ^2) **Boer and Lambert (2008)**

high extra-tropical decadal predictability

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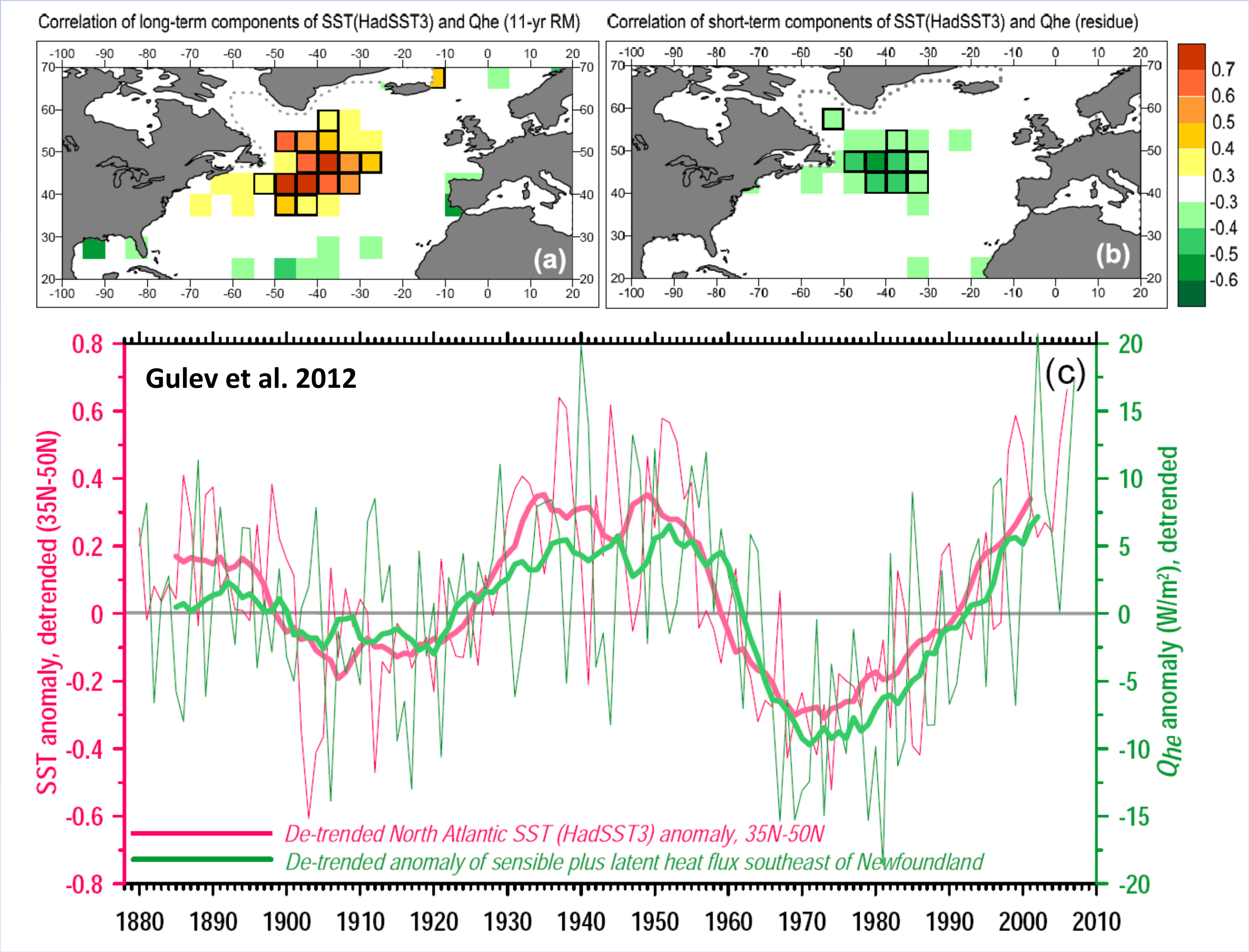
The atmosphere feels the ocean at decadal timescales



implies a strong control of ocean dynamics in driving SST at multidecadal timescales, heat flux damps

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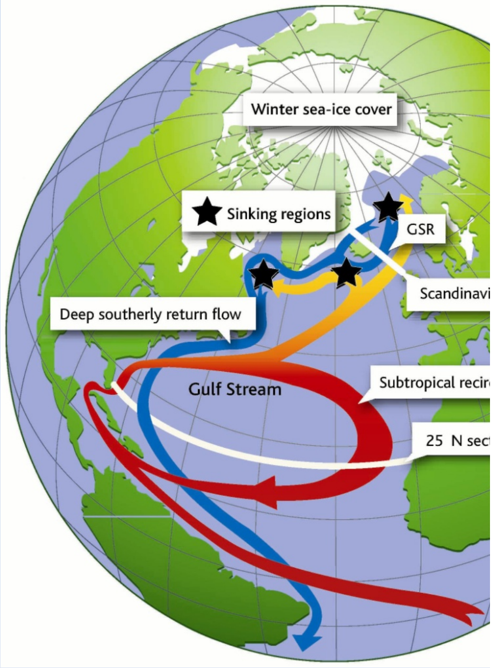
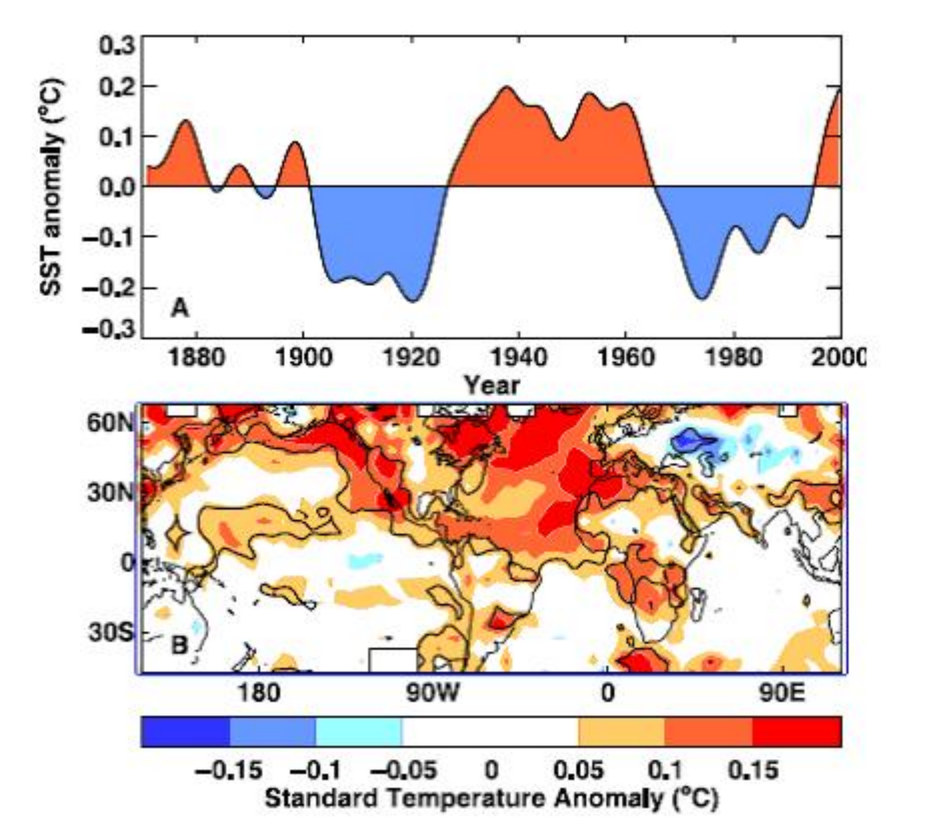
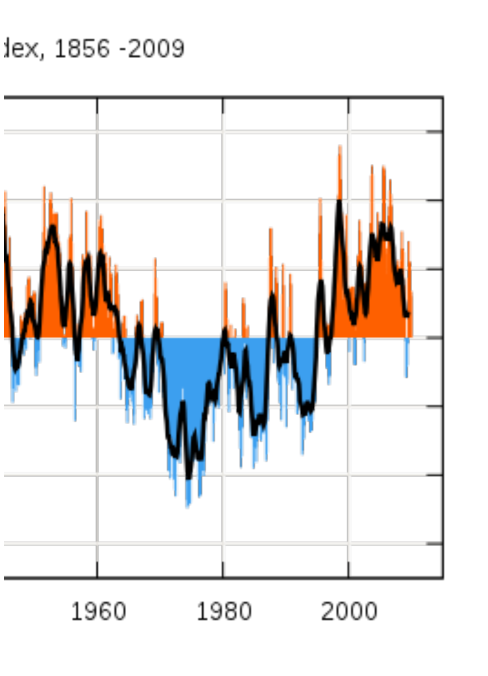
The Atlantic Multidecadal Oscillation (AMO), the leading mode of Atlantic SST







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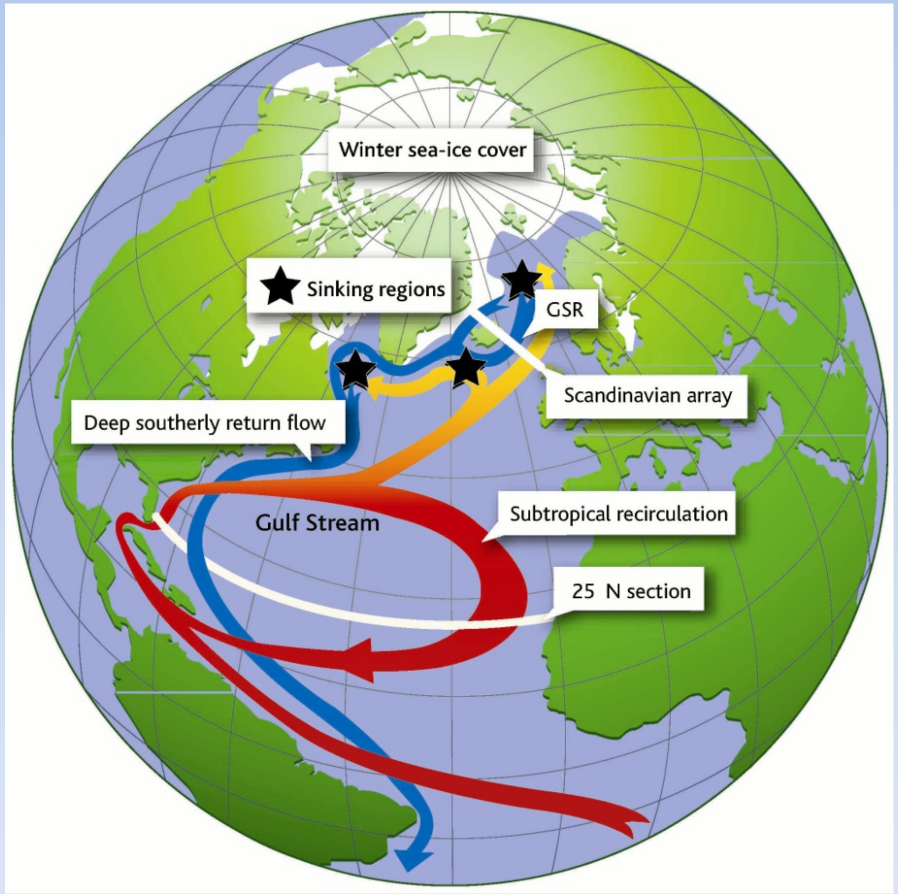
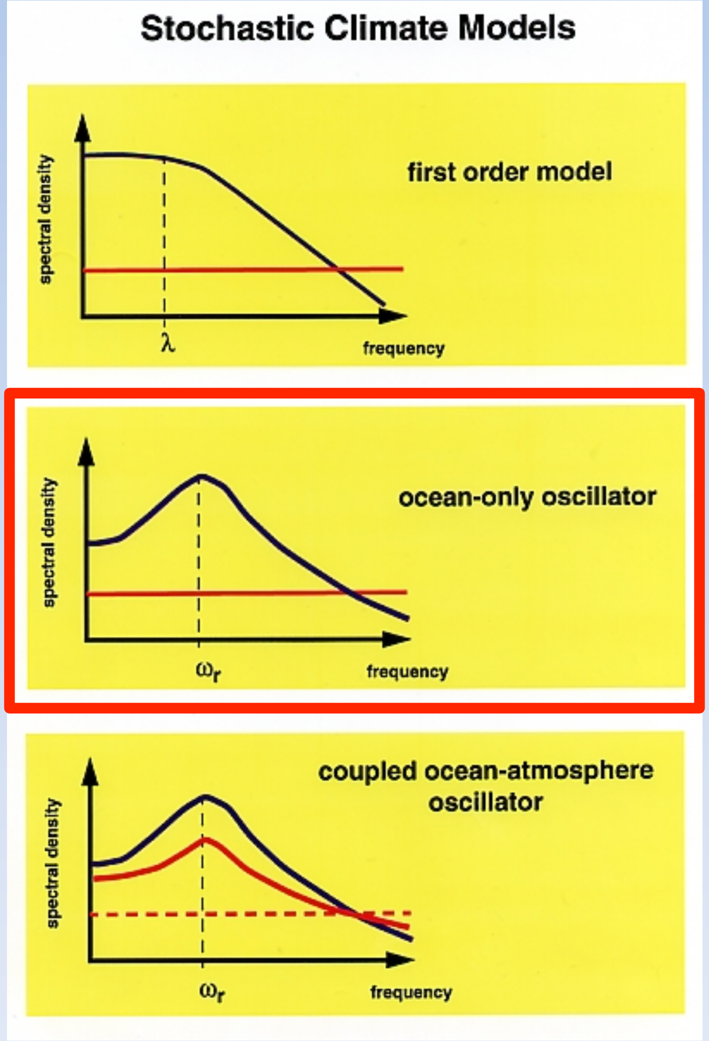
4. The simplest AMO mechanism





Most evidence points towards the "ocean-only" oscillator

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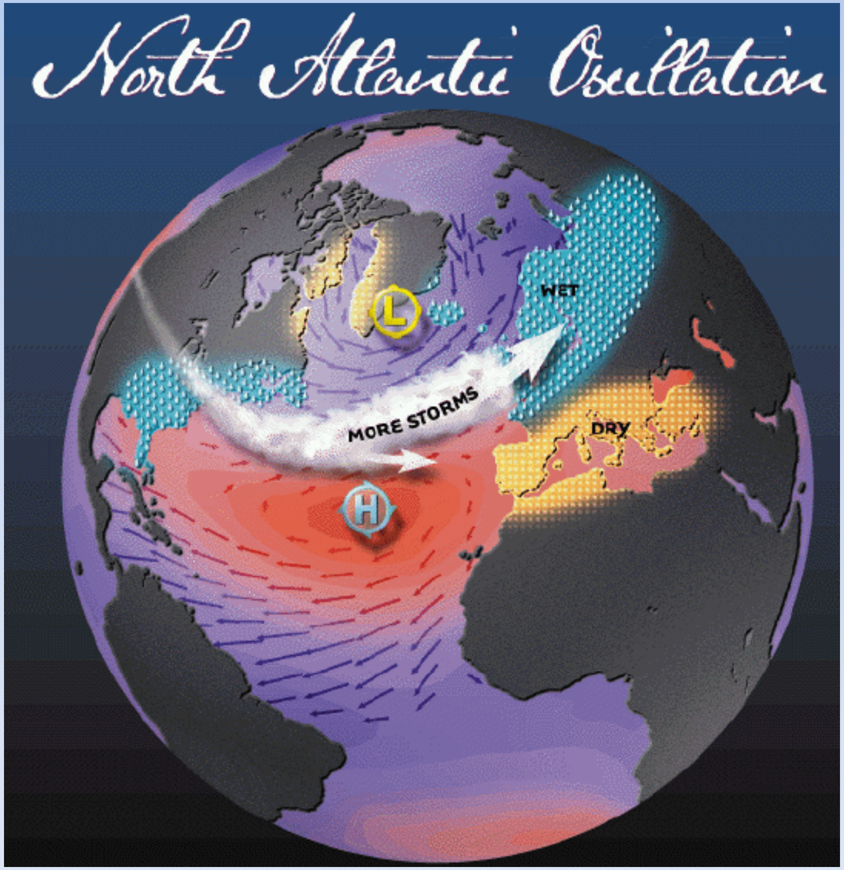
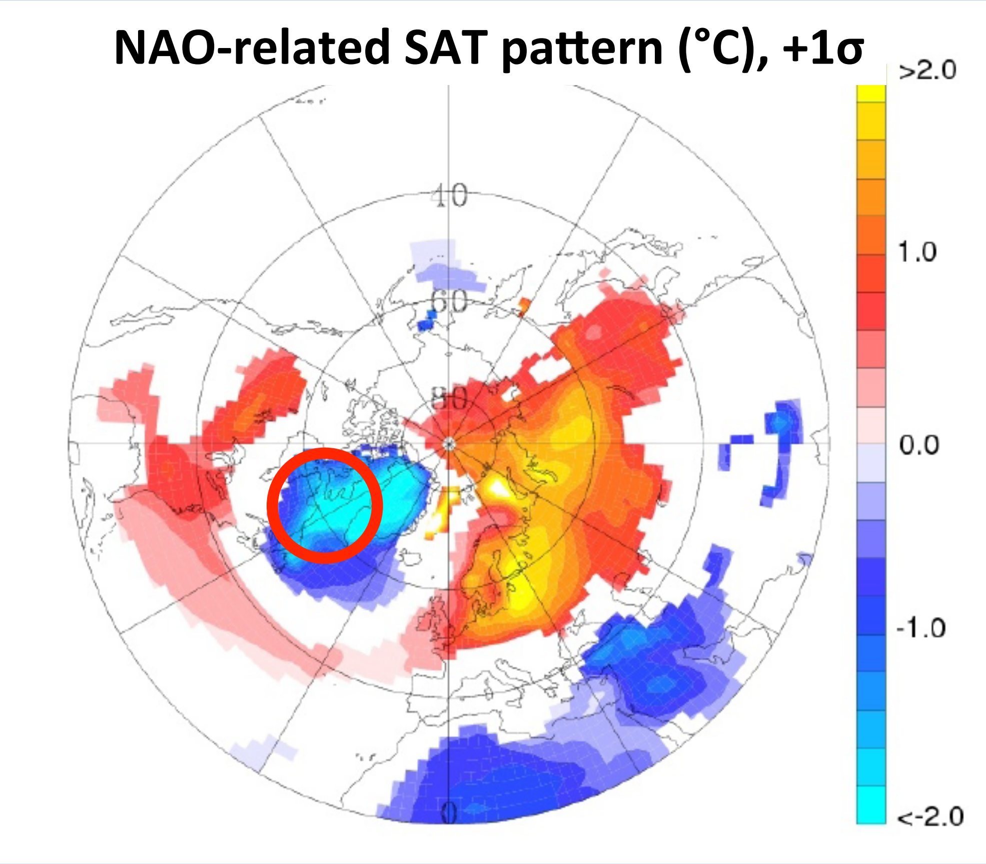
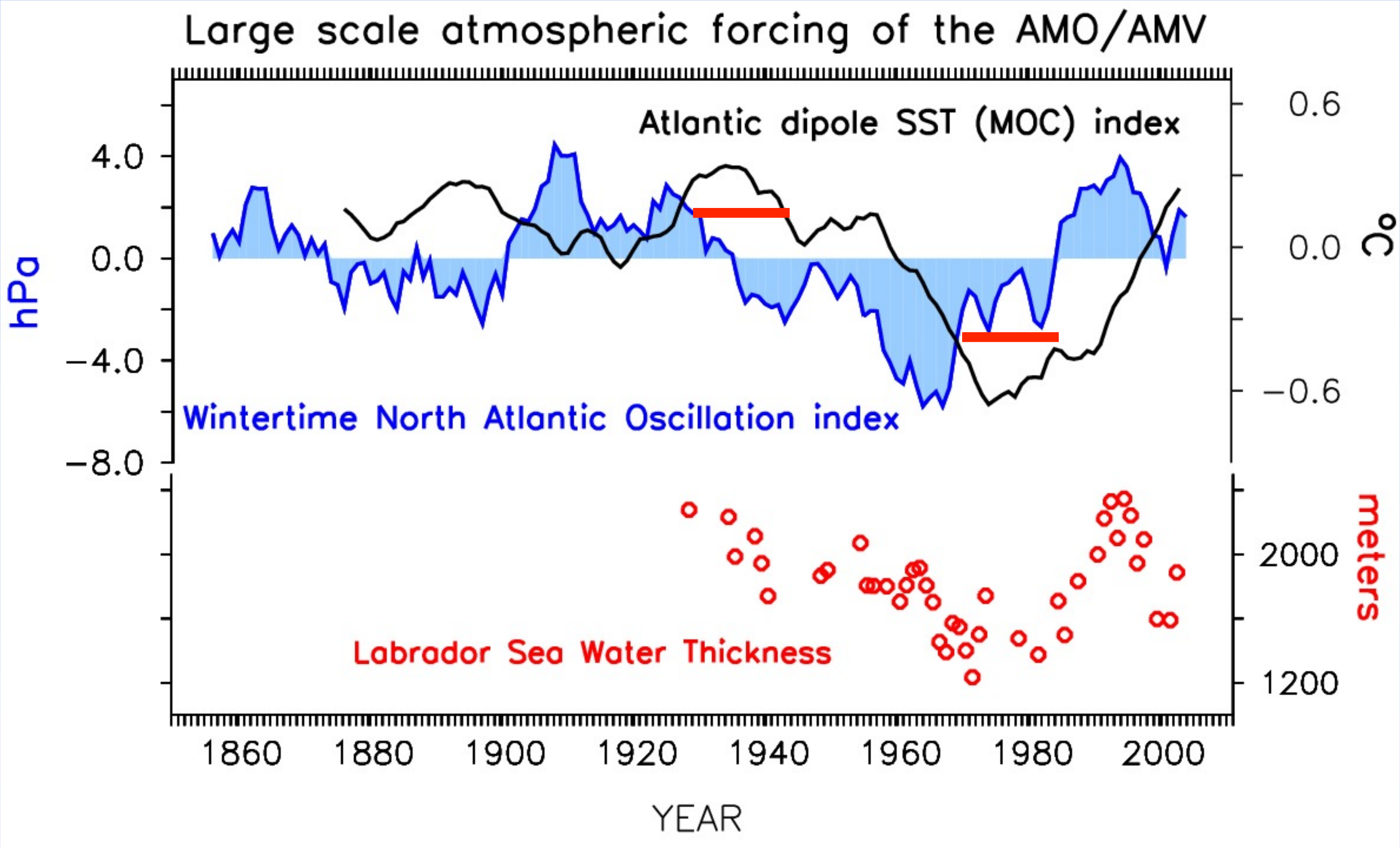
The null hypothesis for multi-decadal AMOC variability





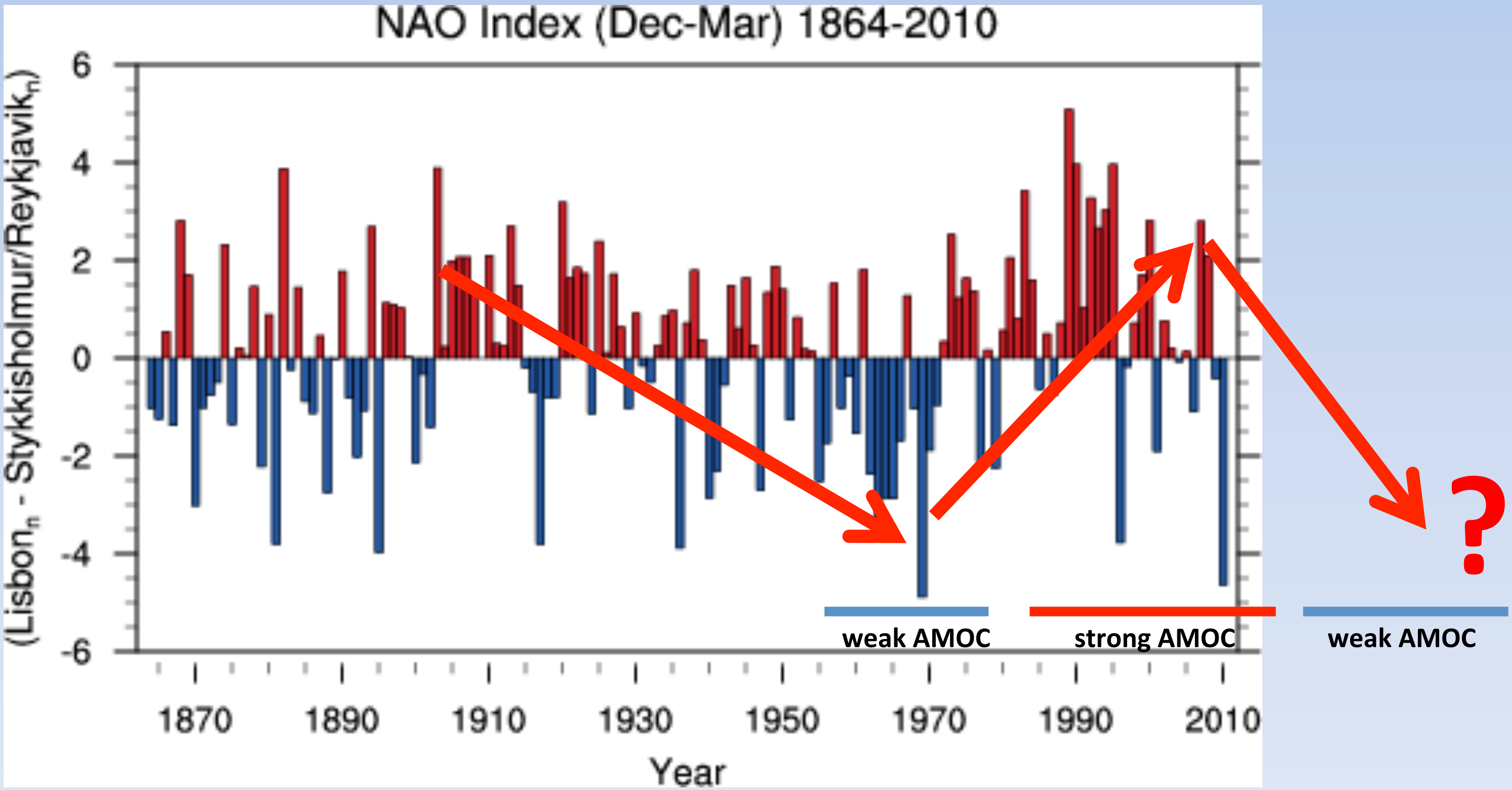
The NAO affects Labrador Sea convection which in turn drives AMOC (Delworth and Greatbatch, 2000; Eden and Jung, 2001)

The NAO: a key for decadal MOC variability in recent decades?



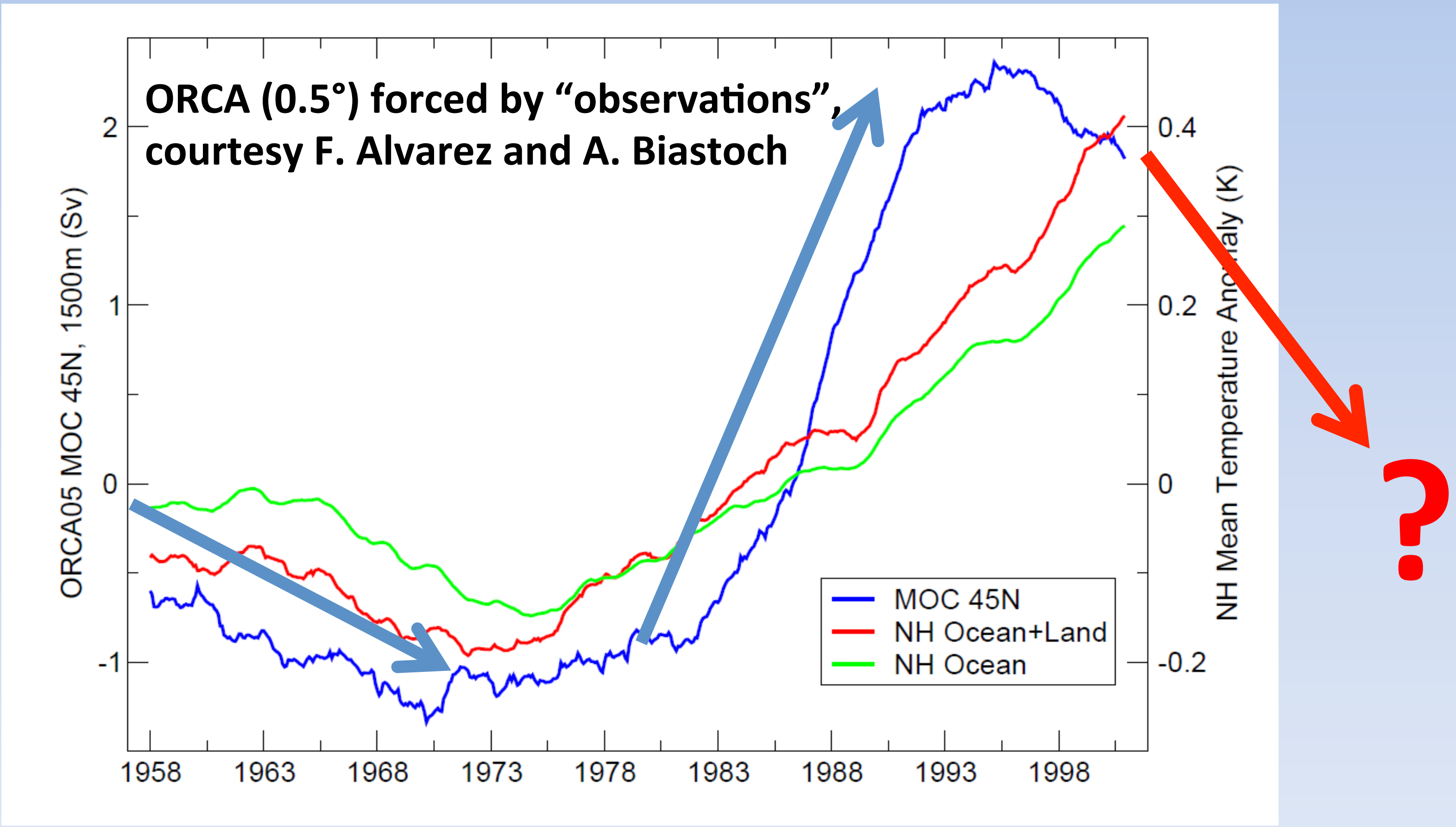
Time lag is of the order of a decade

The NAO-I spectrum is white, but there is decadal variability by definition



AMOC may respond to the multi-decadal NAO changes. Are we facing a slow down of AMOC?

Forced ocean model AMOC



Past (model-derived) changes in AMOC are consistent with this picture

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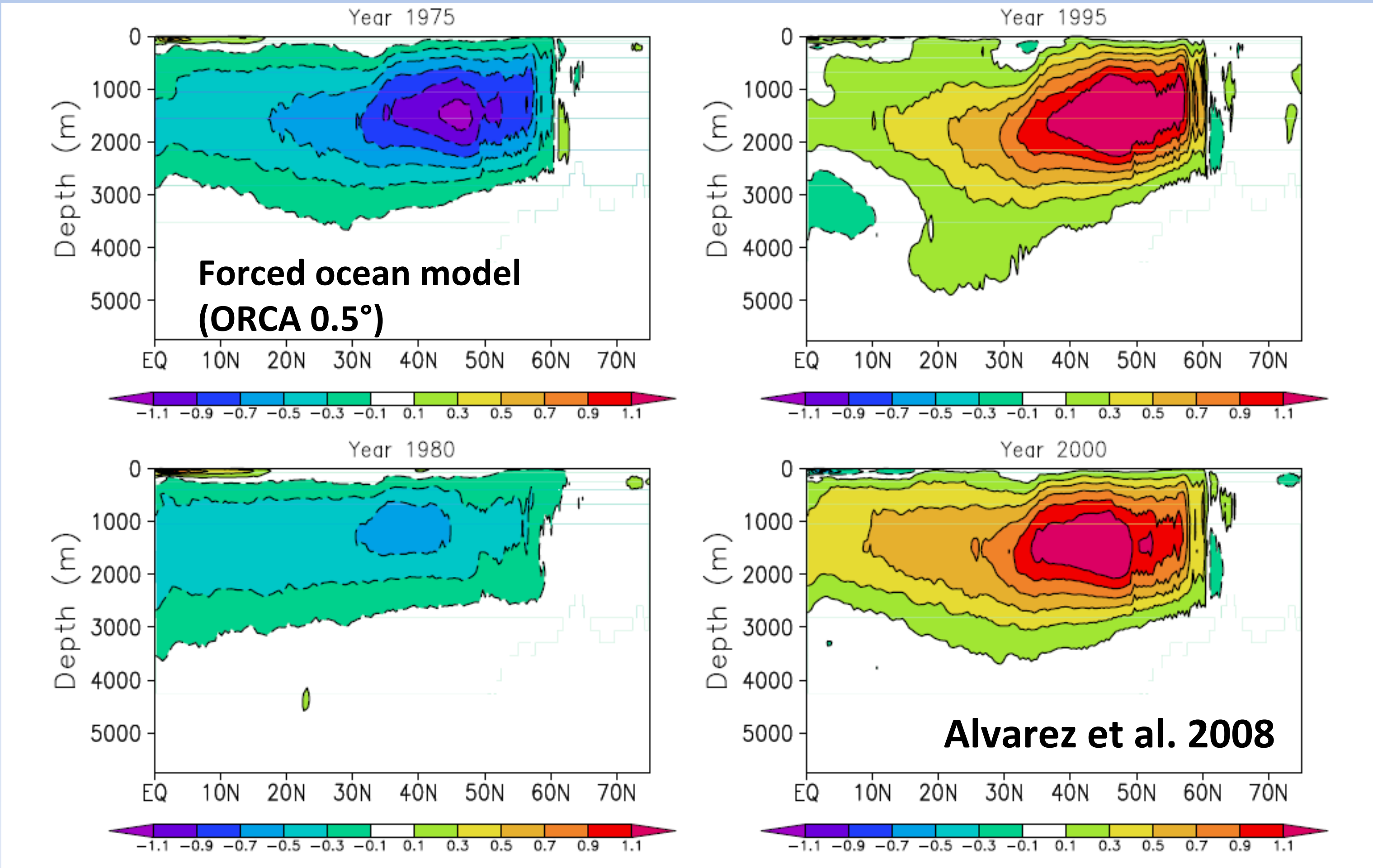
Overturning anomalies from OGCM

Cold phase of multidecadal mode **Warm phase of multidecadal mode**



AMOC changes follow low-frequency NAO changes, as suggested by the simple stochastic picture

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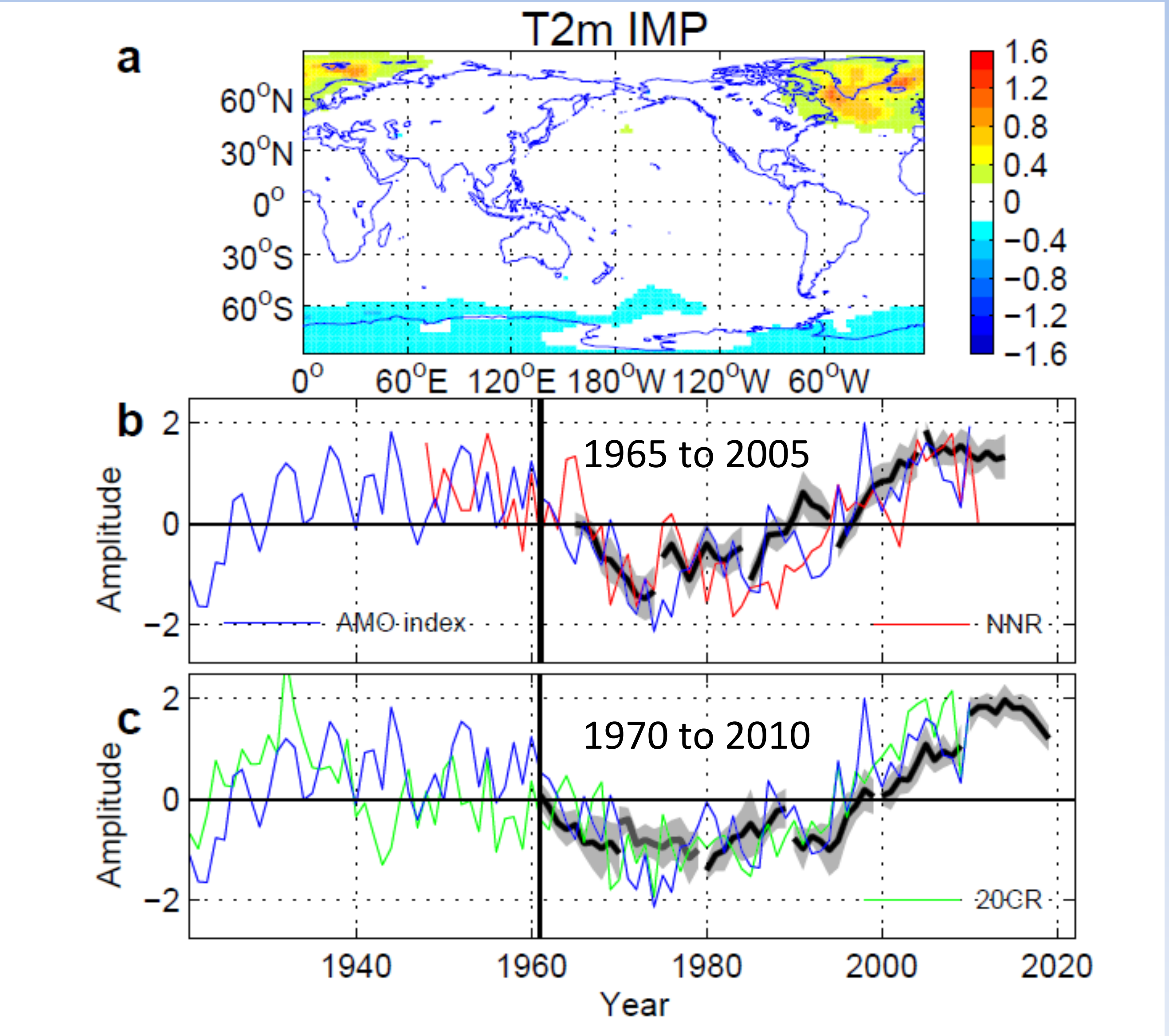
AMO hindcasts with the GFDL model



Yang et al. (2012)

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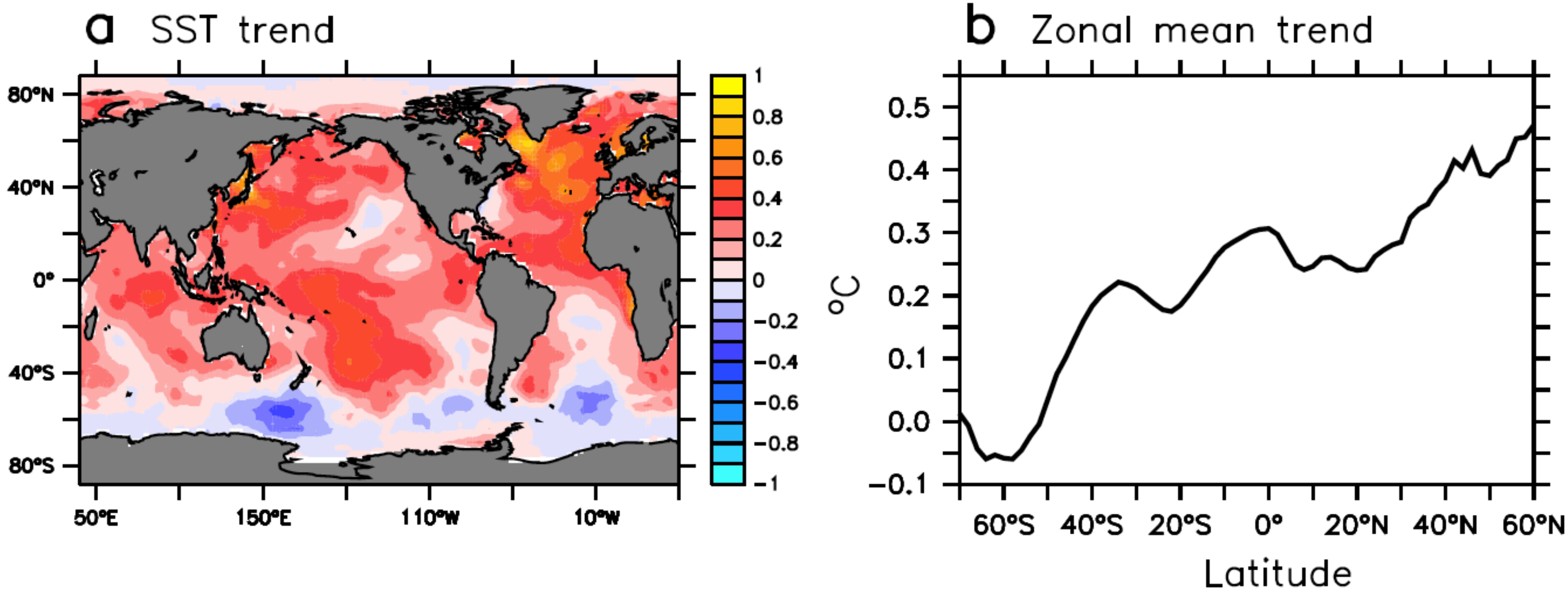
5. Centennial variability



linear trend in SST 1971-2010

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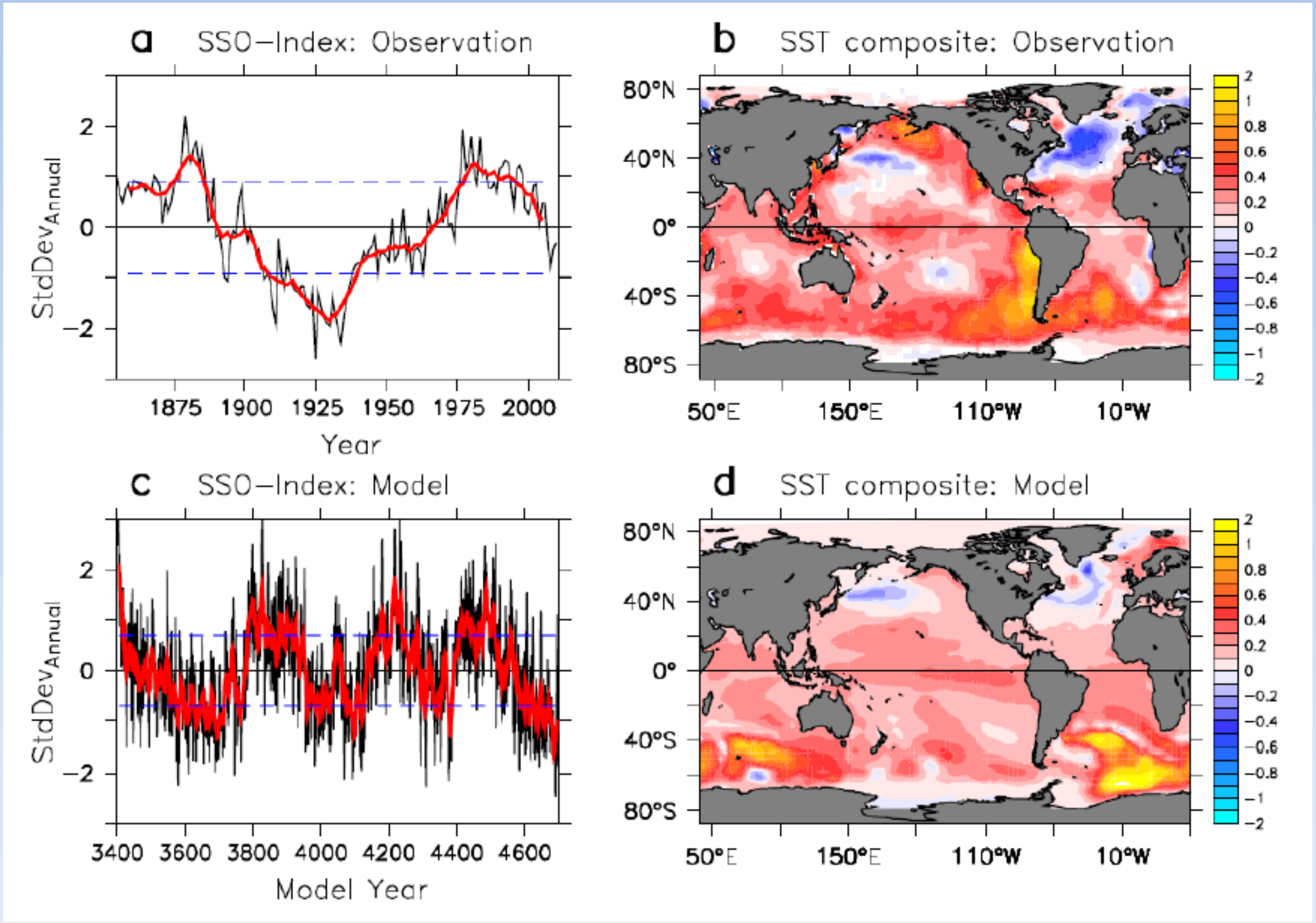
20^{th} Century centennial variability



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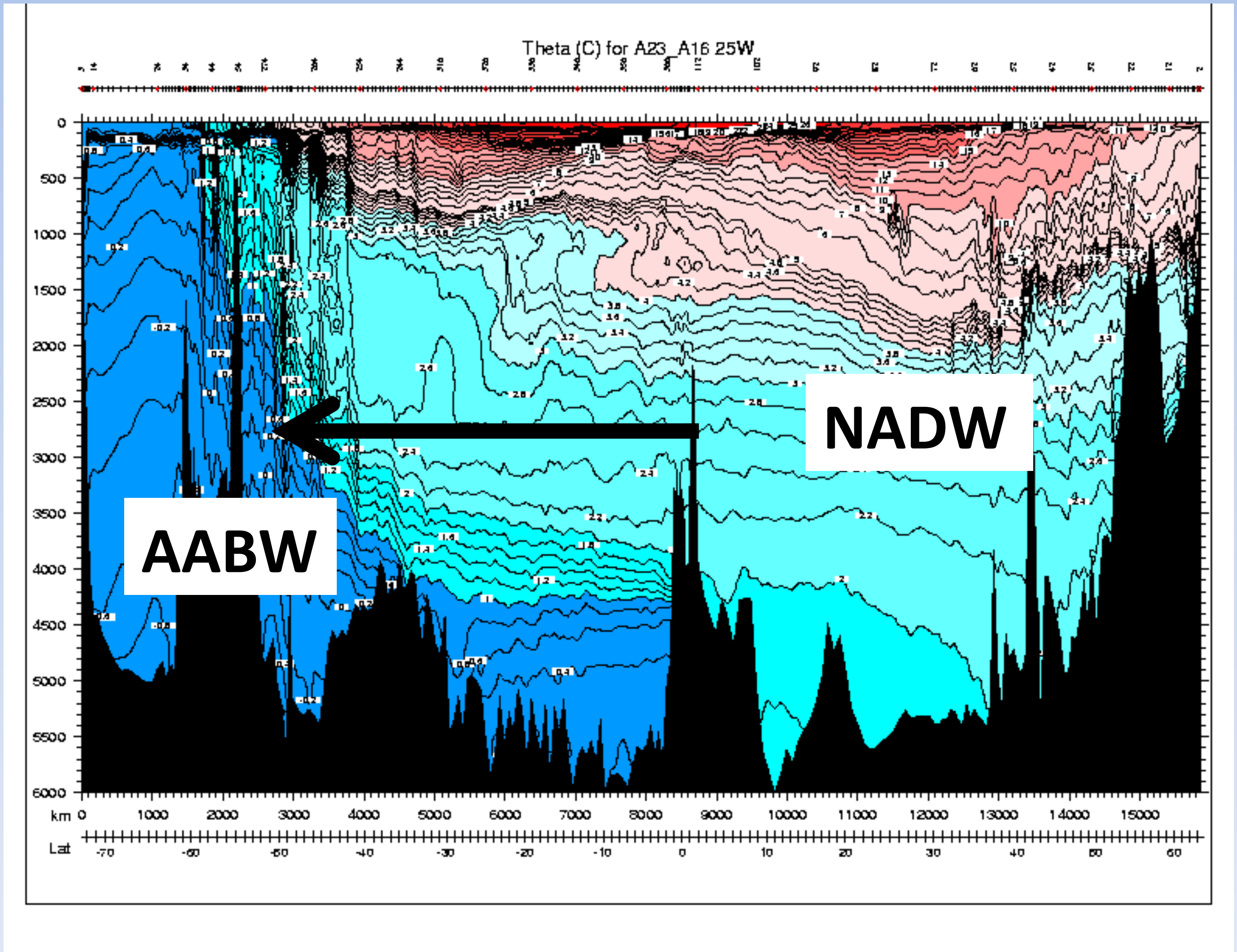
Potential temperature in the Atlantic (WOCE)



NADW (warm water) accumulation in the Southern Ocean by the lower limb of the AMOC

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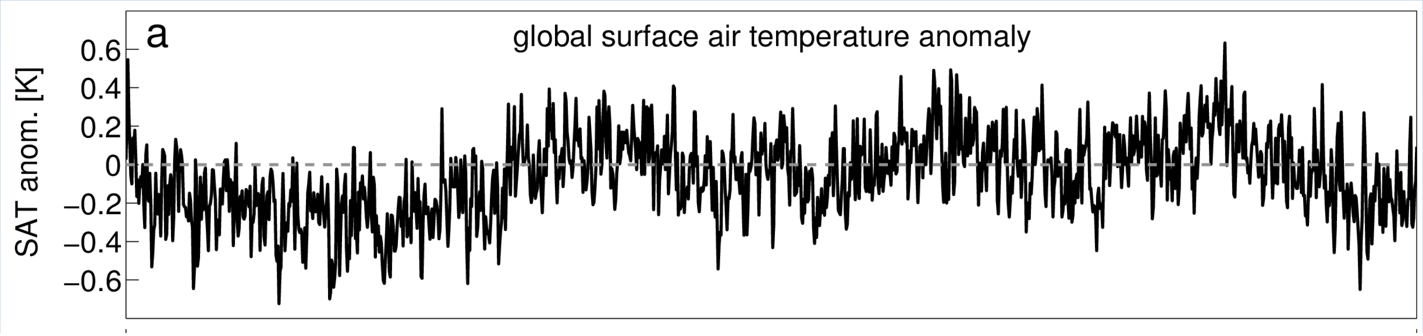
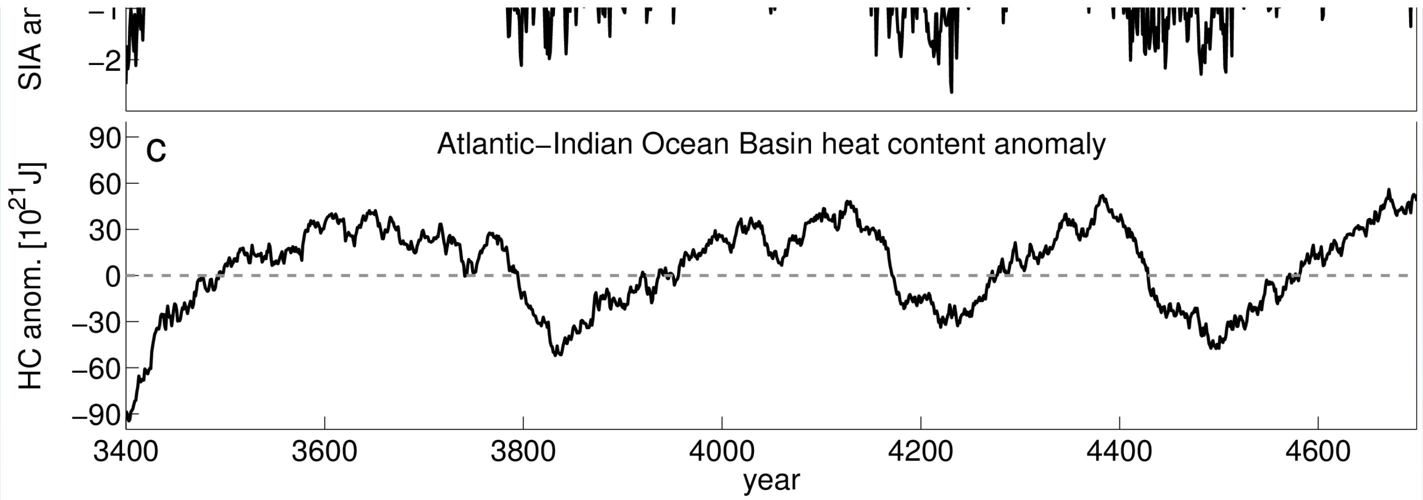
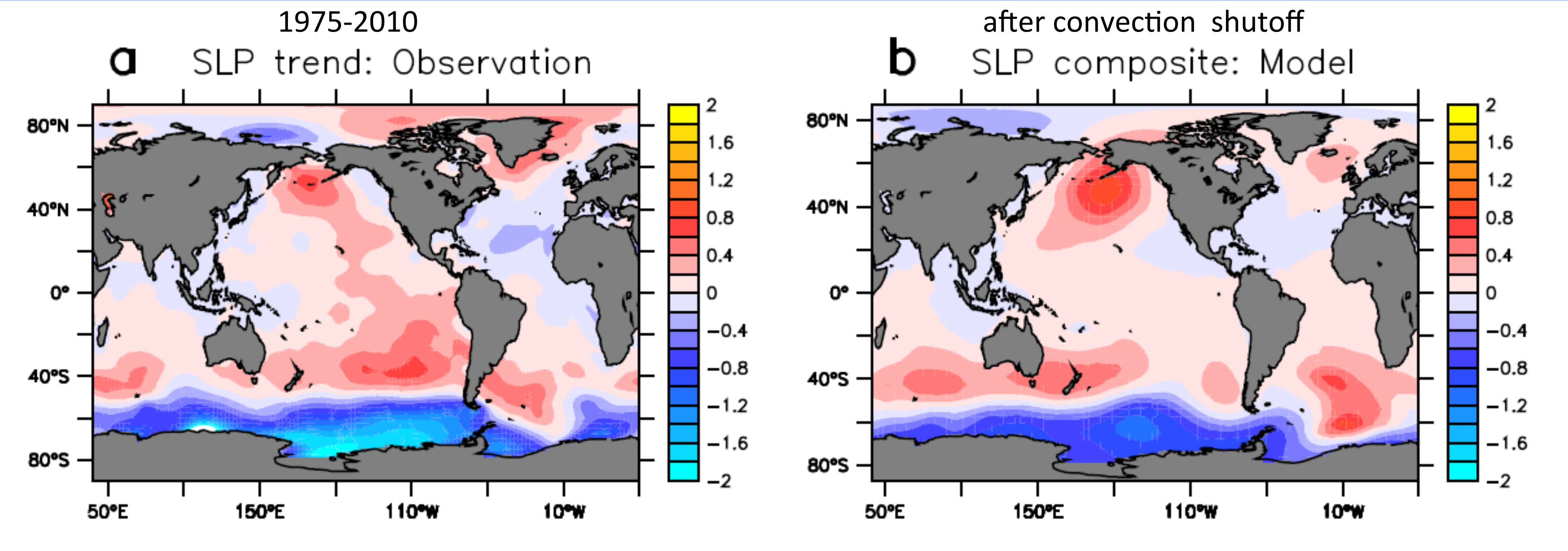
Heat accumulation at mid-depth



Convection sets in after "enough" heat is accumulated, destabilizing the water column from below



Global teleconnections forced through changes in Weddell Sea convection



The pattern correlation amounts to about 0.7.

Can some of the recent decadal trends (e.g., increasing Antrarctic sea ice) understood in terms of longer-term centennial variability?

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Thank you for your attention!

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