

Geophysical Fluid Dynamics Laboratory Review

June 30 - July 2, 2009



Atlantic Meridional Overturning Circulation and Climate

Presented by
Rong Zhang

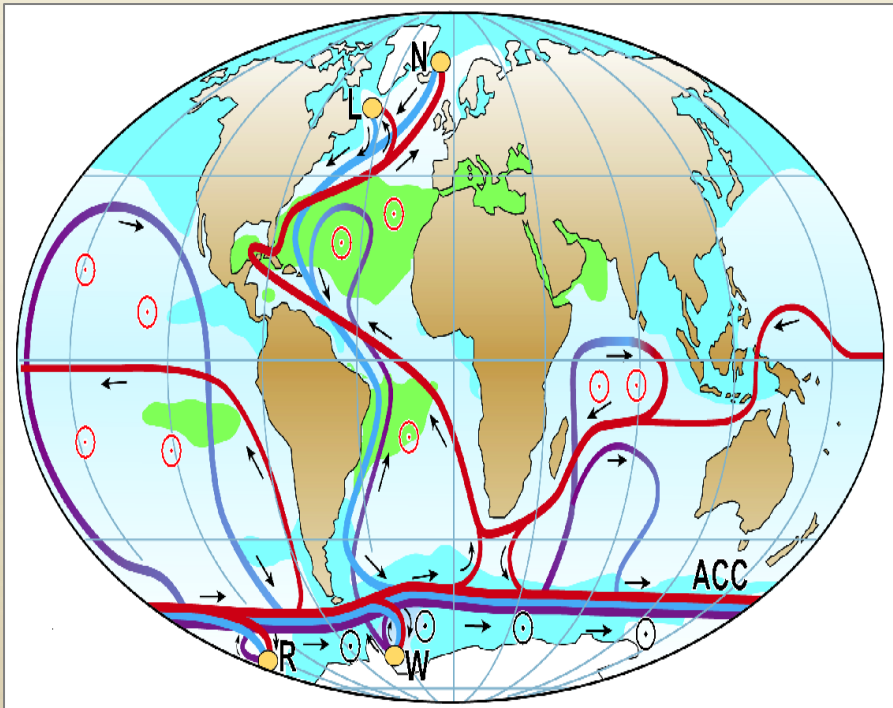
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Introduction

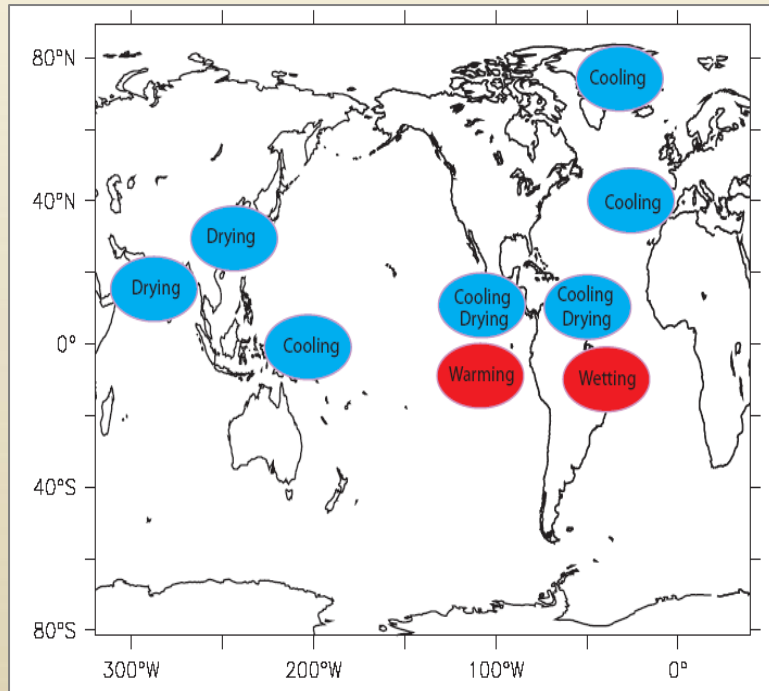
Atlantic Meridional Overturning Circulation (AMOC)



- Global Scale Impact in Paleo Climate
- Global Scale Impact in Modern Climate
- AMOC Fingerprints

Global Synchronization of Abrupt Climate Change in Response to AMOC Collapse

Schematic diagram of global synchronization of abrupt climate change indicated by paleo records

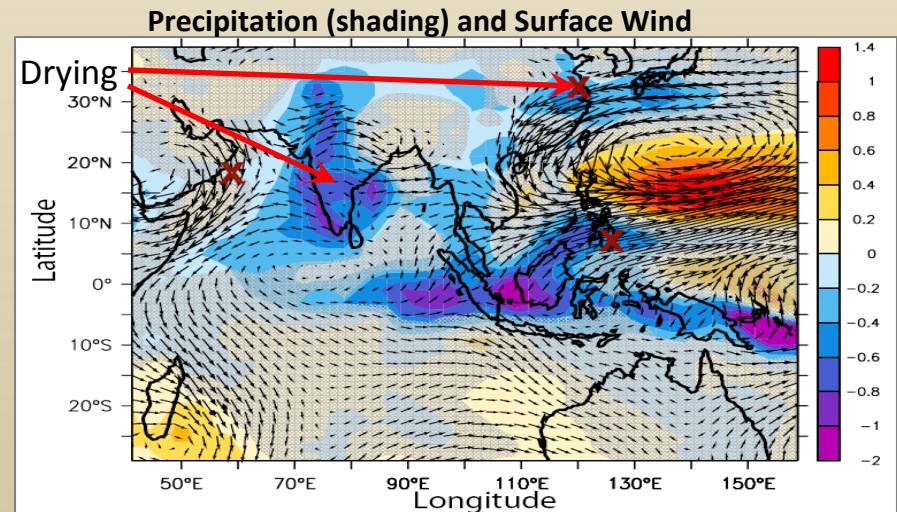
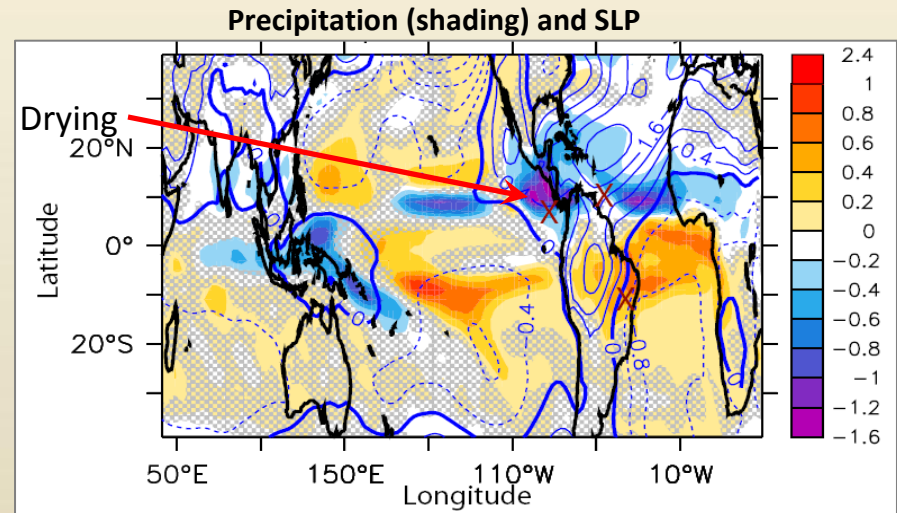


A substantial weakening of the AMOC is linked to:

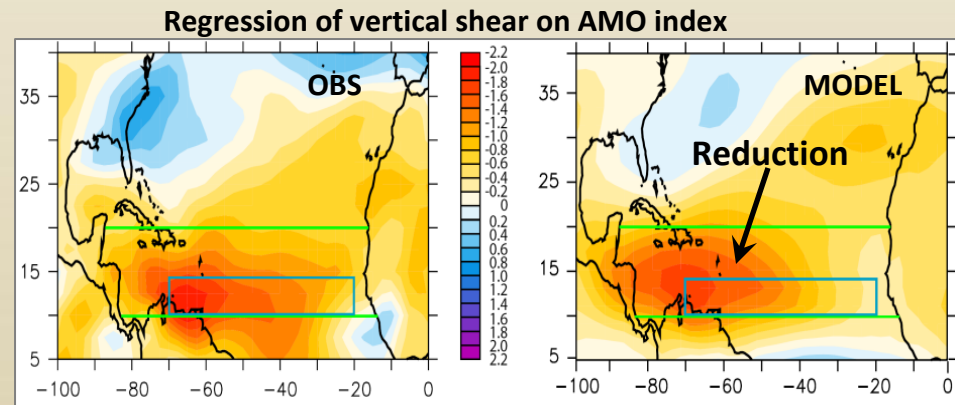
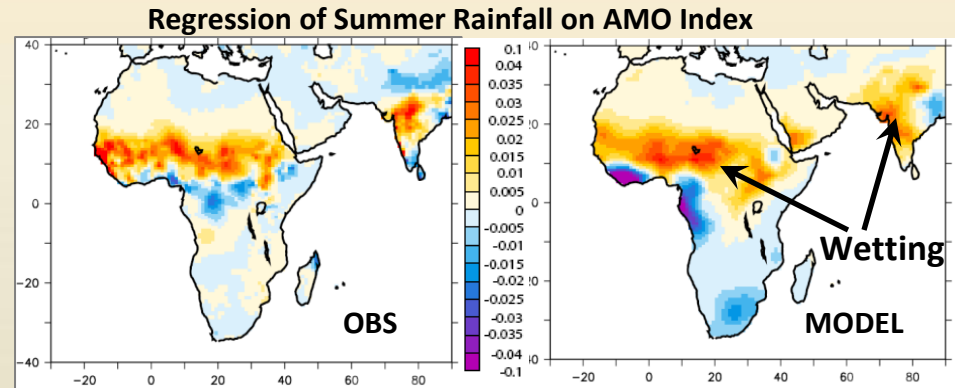
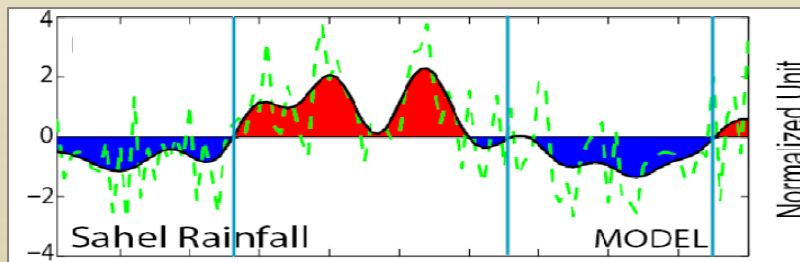
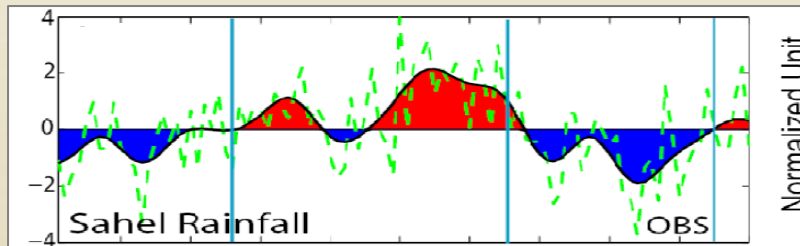
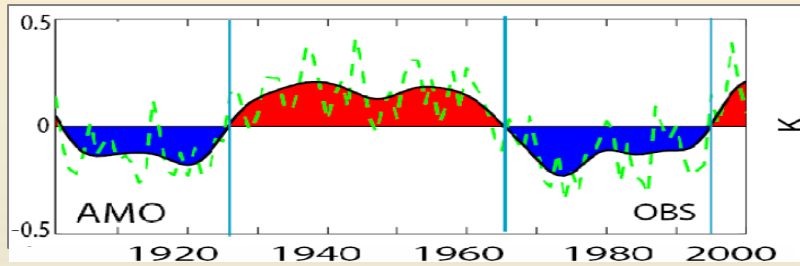
- Southward shift of ITCZ in Atlantic and Pacific
- Weaker East Asia and Indian Summer Monsoons

(Zhang and Delworth 2005)

Modeled responses due to the weakening of AMOC



Atmospheric Impact of Atlantic Multidecadal Oscillation (AMO)

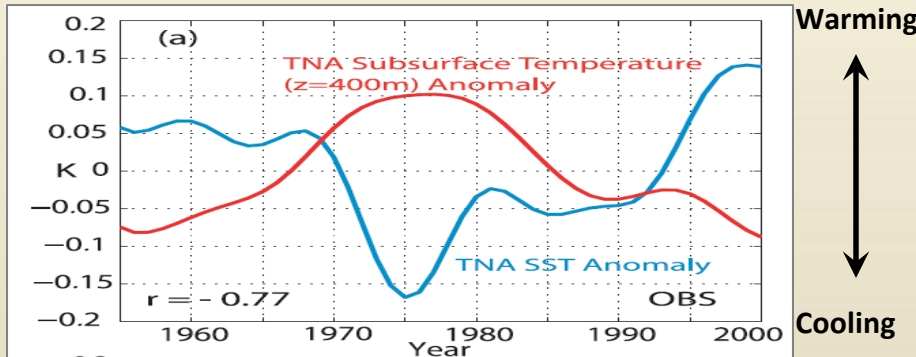


The AMO (area averaged detrended SST anomalies over the North Atlantic) can lead to:

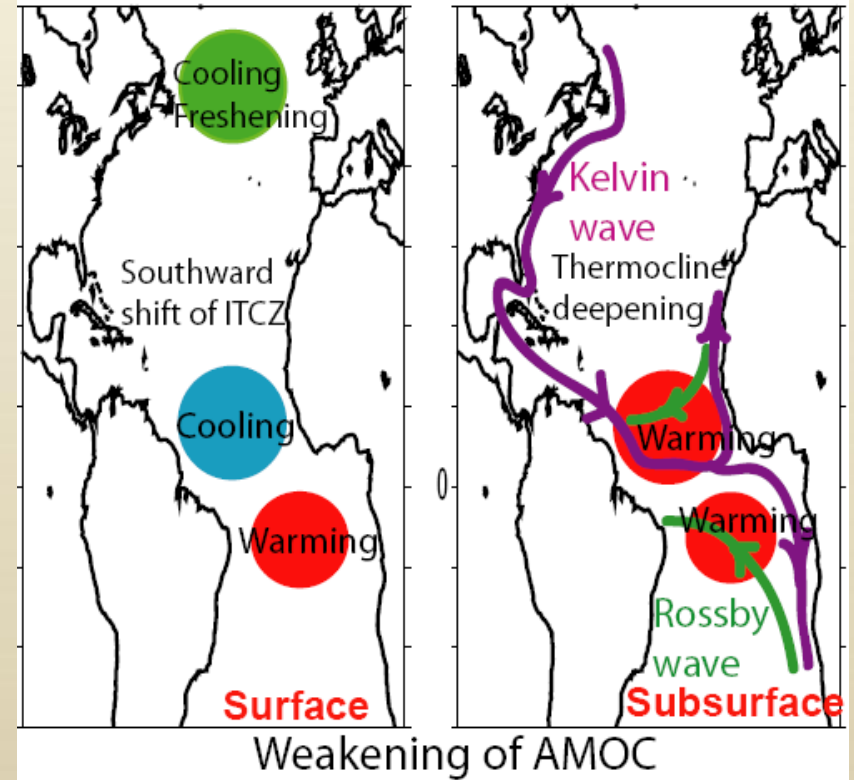
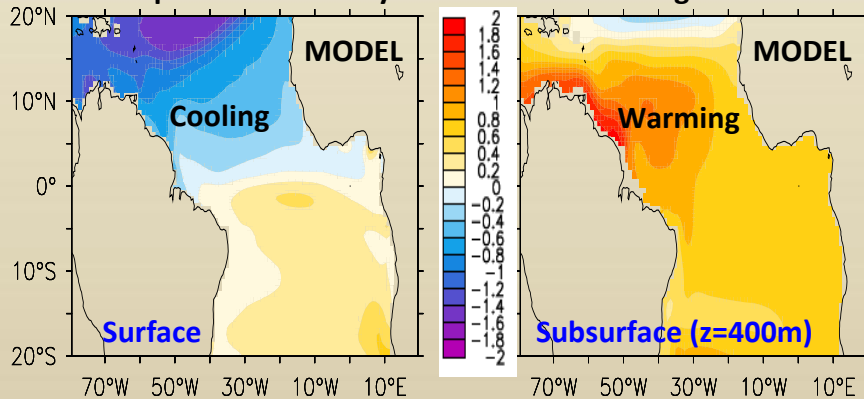
- Multidecadal variations in Sahel and India summer rainfall, and vertical shear over the Atlantic Hurricane MDR (Zhang and Delworth 2006)
- Northern Hemispheric mean surface temperature fluctuations (Zhang et al. 2007)
- Multidecadal variations in the Northern Pacific (Zhang and Delworth 2007)

Tropical Fingerprint of AMOC Variability

The link between AMO and AMOC is highly debated. Developing AMOC fingerprints is crucial for understanding the origin and the attribution of observed SST variations.

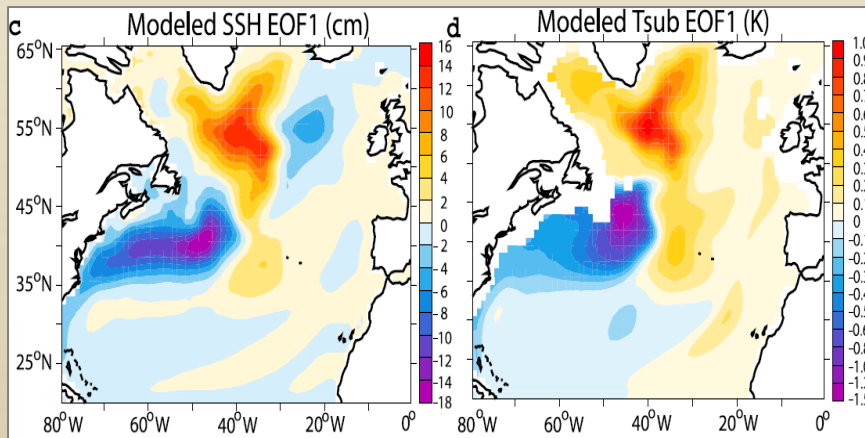
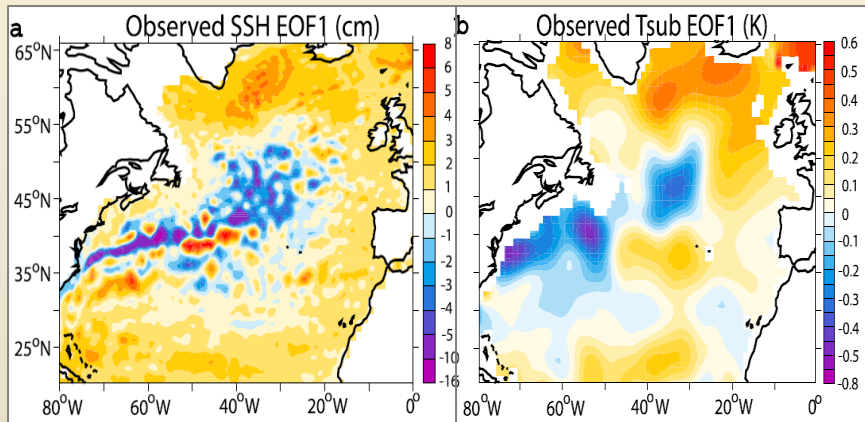


Ocean temperature anomaly due to the weakening of AMOC

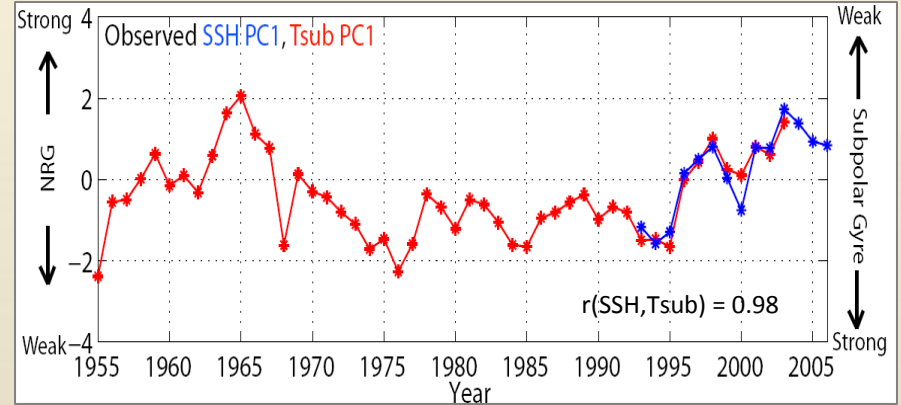


Observed Tropical North Atlantic (TNA) SST is anticorrelated with TNA subsurface ocean temperature. The anticorrelation is a fingerprint of AMOC variations in coupled model simulations, indicating observed TNA SST fluctuations may be AMOC-related (Zhang 2007).

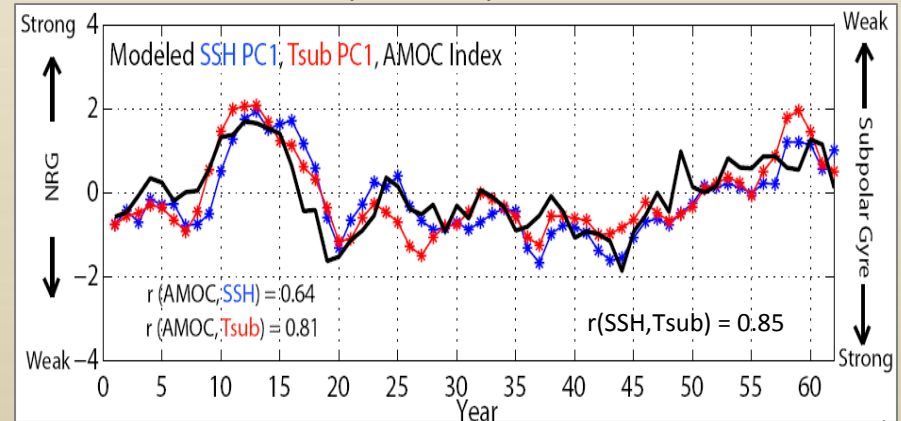
Extra-tropical Fingerprint of AMOC Variability



Observed SSH PC1 and subsurface temperature (Tsub) PC1



Modeled SSH PC1, Tsub PC1, AMOC Index



The leading modes of SSH and subsurface temperature constitute a fingerprint of AMOC variations, and might be used as AMOC proxies. It indicates that during the 60's and the recent decade, the AMOC was stronger, and the recent slowdown of the subpolar gyre is a multidecadal variation (Zhang 2008).

- **Simulated global synchronization of abrupt climate change due to the AMOC collapse is consistent with that indicated by paleo records.**
- **The AMO can lead to multidecadal variations in Sahel and India summer rainfall, Atlantic Hurricane activity, northern hemispheric surface temperature, and Northern Pacific SST.**
- **AMOC fingerprints are developed and could be used for AMOC reconstruction in the past. They suggest that the observed AMO is linked to AMOC variations.**
- **Observations of SSH and subsurface temperature could be used to monitor AMOC variations.**

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