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17 - 20 November 2008

Low-frequency climate variability in the Atlantic basin during the 20th century

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Low-Frequency Climate Variability in the Atlantic Basin during the 20th Century

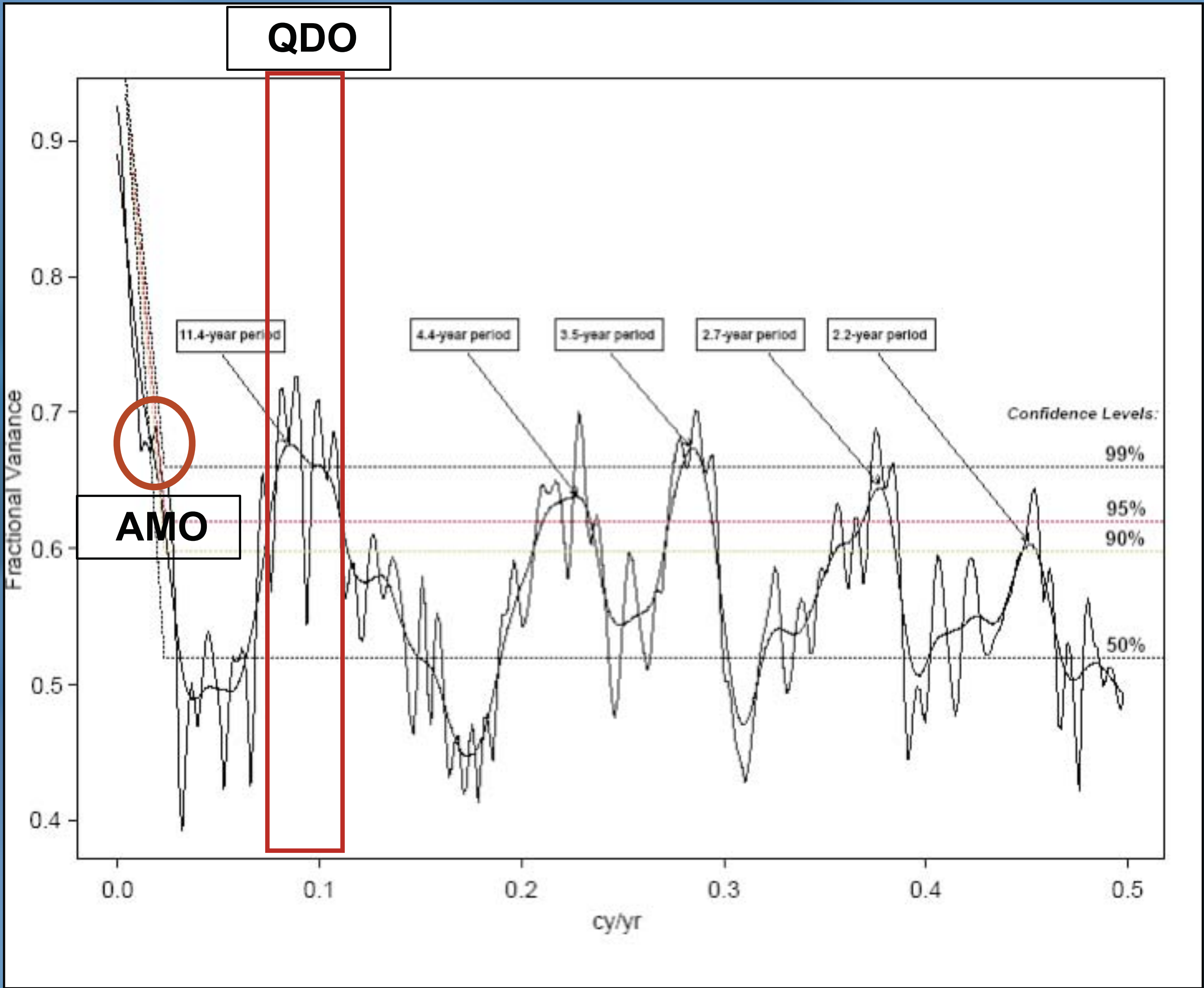
Y. M. Tourre, S. Paz, Y. Kushnir, W. White

MTS/SVD
DATA & METHOD

Monthly SST and SLP gridded datasets (Kaplan *et al 1998, 2000) for the* Atlantic basin north of 30°S and for the 20th century.

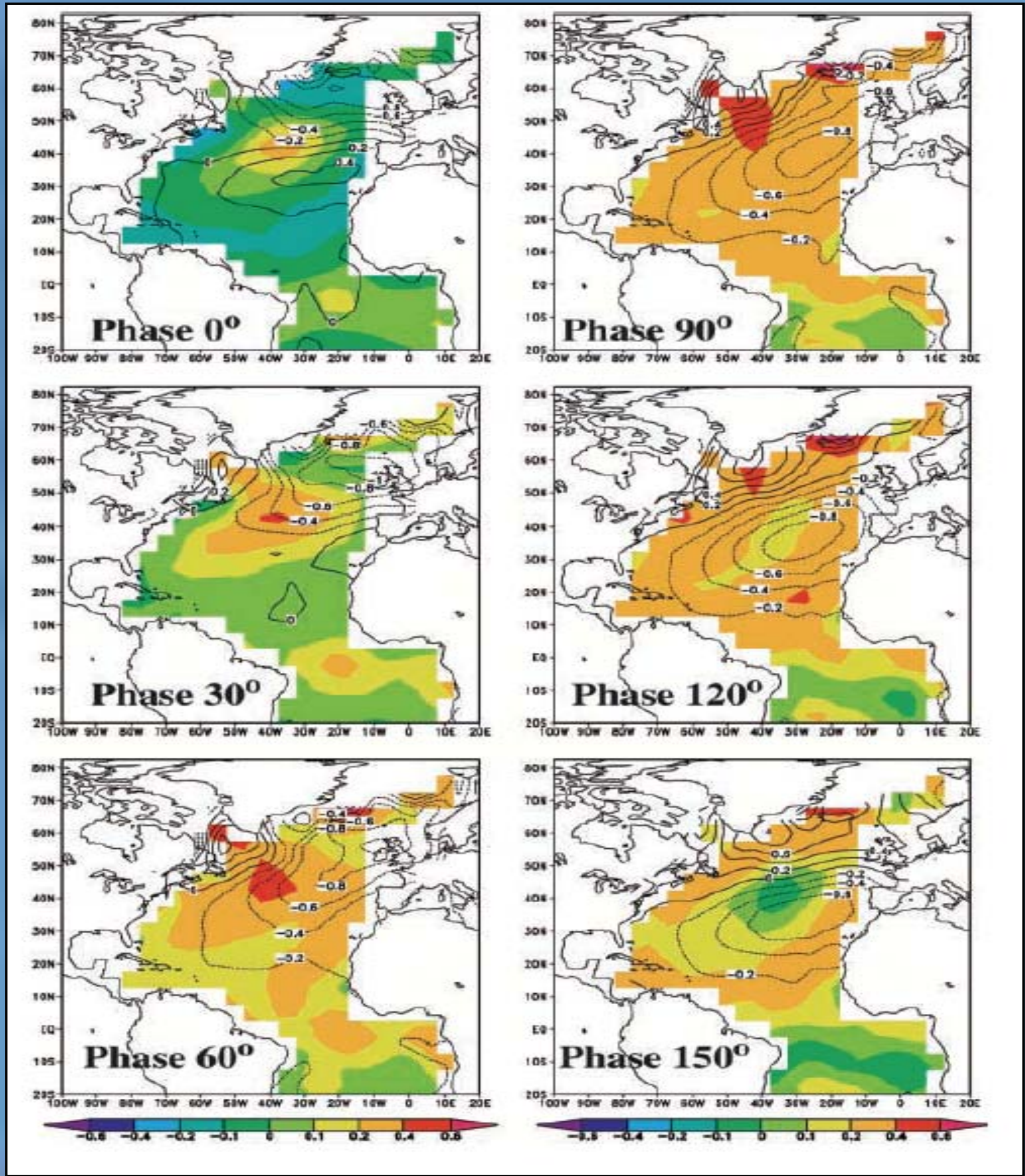
MTM/SVD analysis developed by Mann and Park (1999) which analyses the coherent spatial patterns in the frequency domain, in narrow spectral bands, after the application of an MTM spectral analysis..

Joint SST-SLP MTM/SVD Fractional Variance



Tourre, Y. M., B.Rajagopalan and Y.Kushnir 1999: Dominant Climate Signals in the Atlantic Ocean during the last 136 Years. J. Climate, 8, 2285-2299.

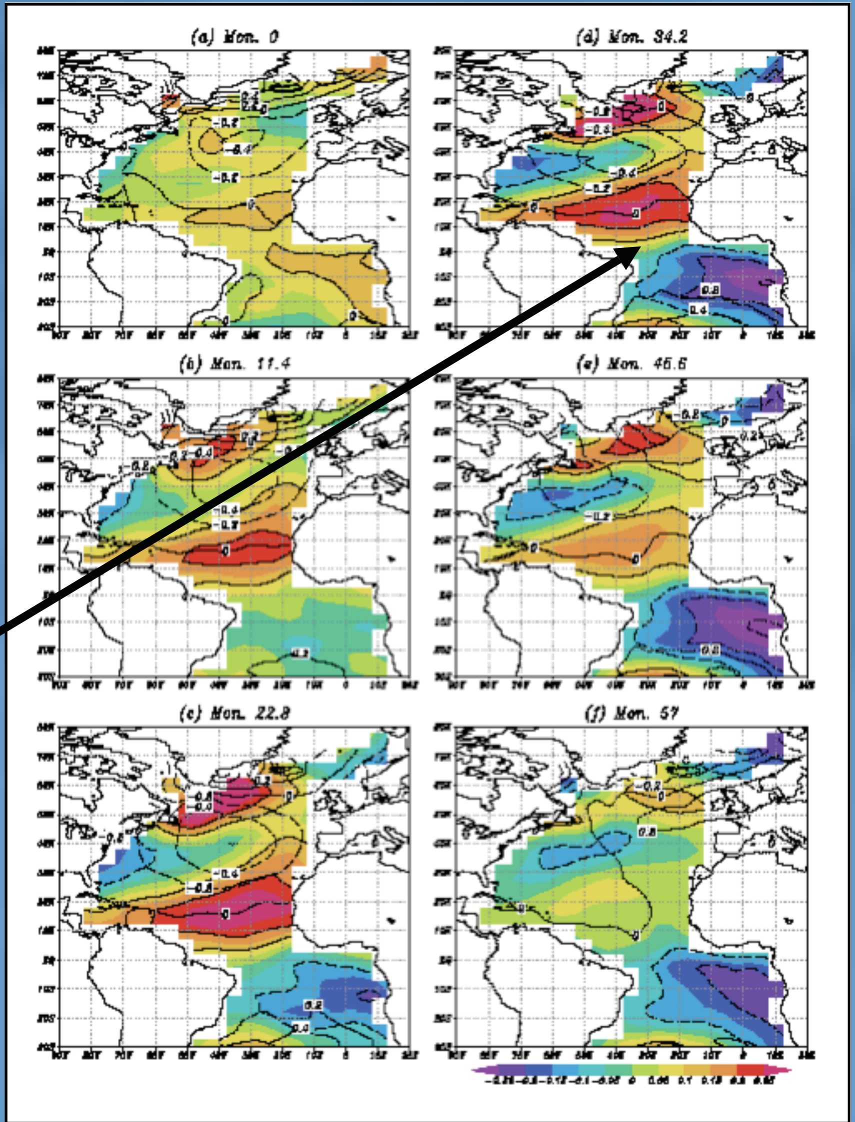
Atlantic Ocean: Multidecadal Variability or AMO



See also: Delworth & Mann (2000)

Atlantic Ocean: Quasi-Decadal Variability or QDO

NAO Modulation
&
SST
North Atlantic
Tripole Structure
&
Equatorial
Dipole Structure



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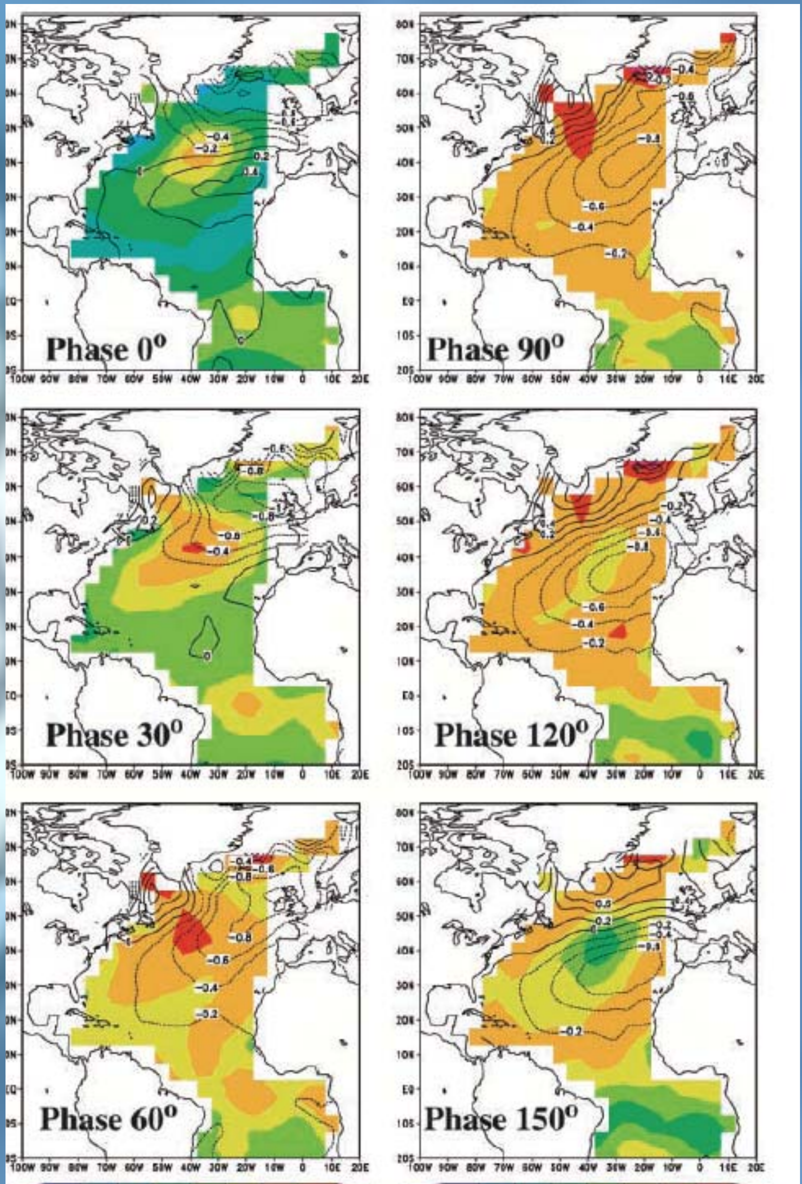
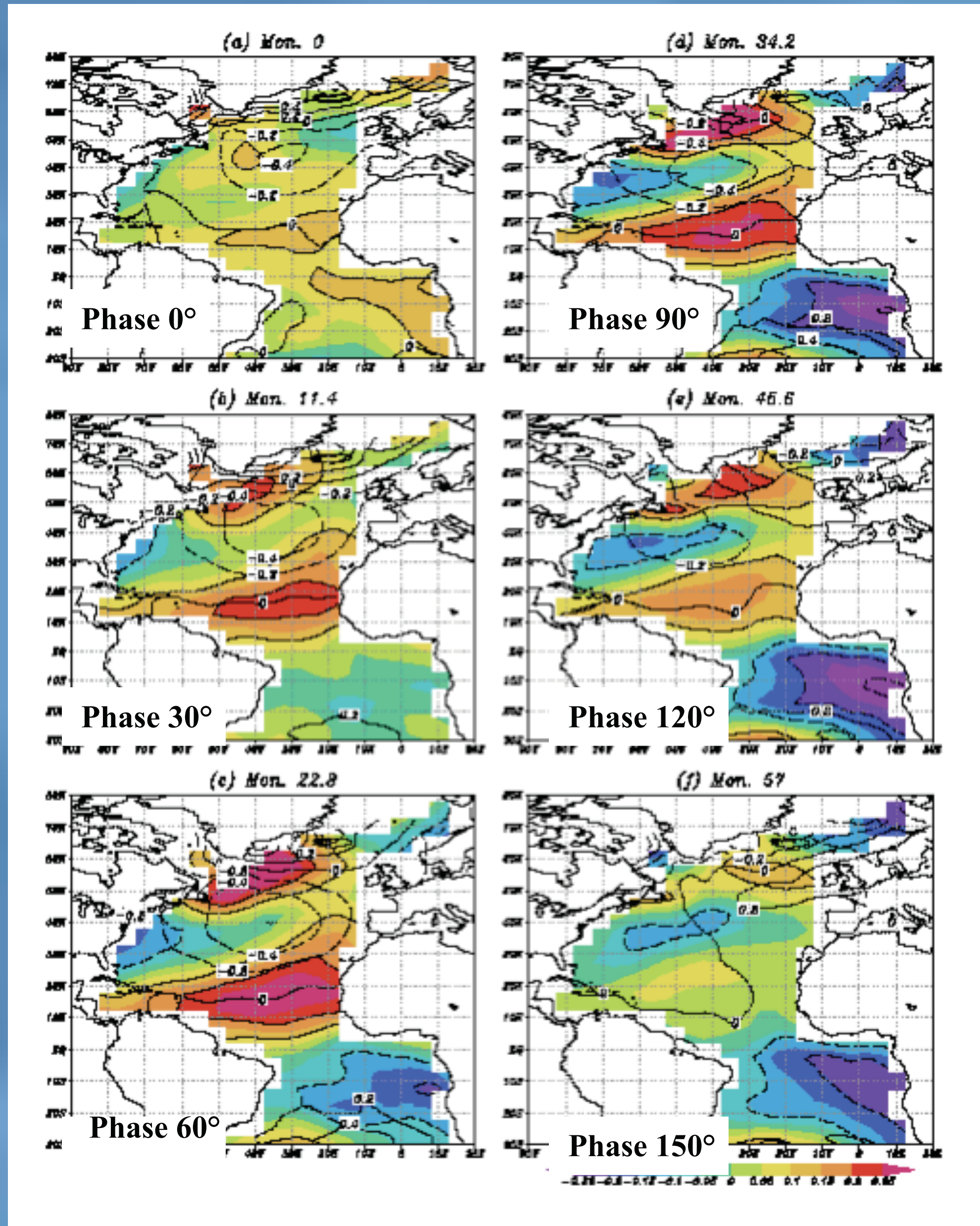
Spatio-Temporal Evolutions of AMO & QDO





Multi-decadal Signal (40-60 Years)

Quasi-Decadal Signal (8-12 Years)

POTENTIAL PHYSICAL MECHANISMS

AMO

- Oceanic signal memory: Heat content
- ‘Doming effect’ in the anticyclonic gyre
- THC & Subpolar wind stress & Oceanic convective activity
- Meridional heat flux & Meridional Overturning Circulation
- Negative feedback onto the atmosphere & modulated NAO

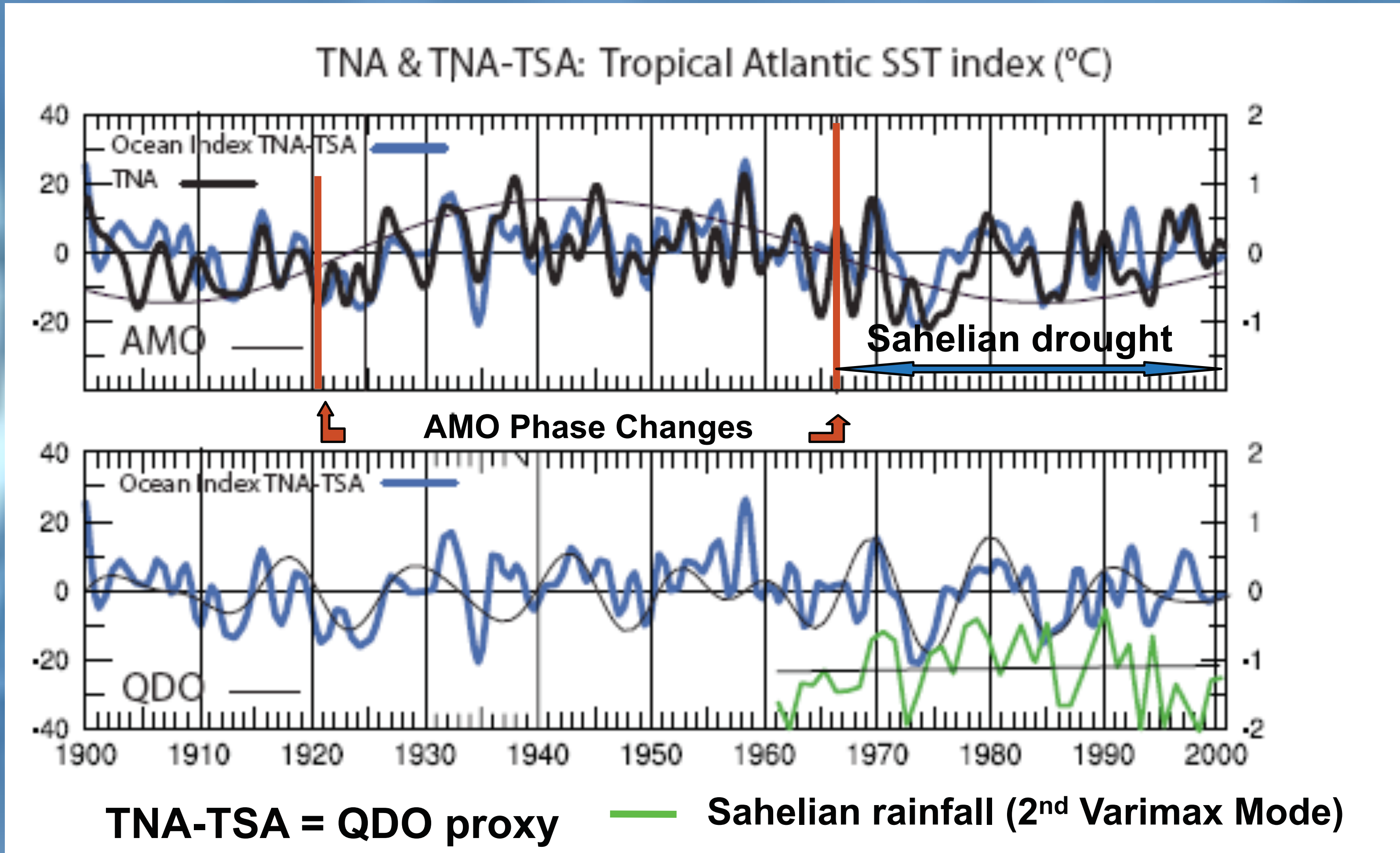
QDO

- Air-sea interaction fluxes & north Atlantic SST tripole pattern
- Slow oceanic advection & non-stationary tropical SST dipole
- Anomalous SLP gradients & westerlies/north easterlies & modulated NAO

INDICES DEFINITION

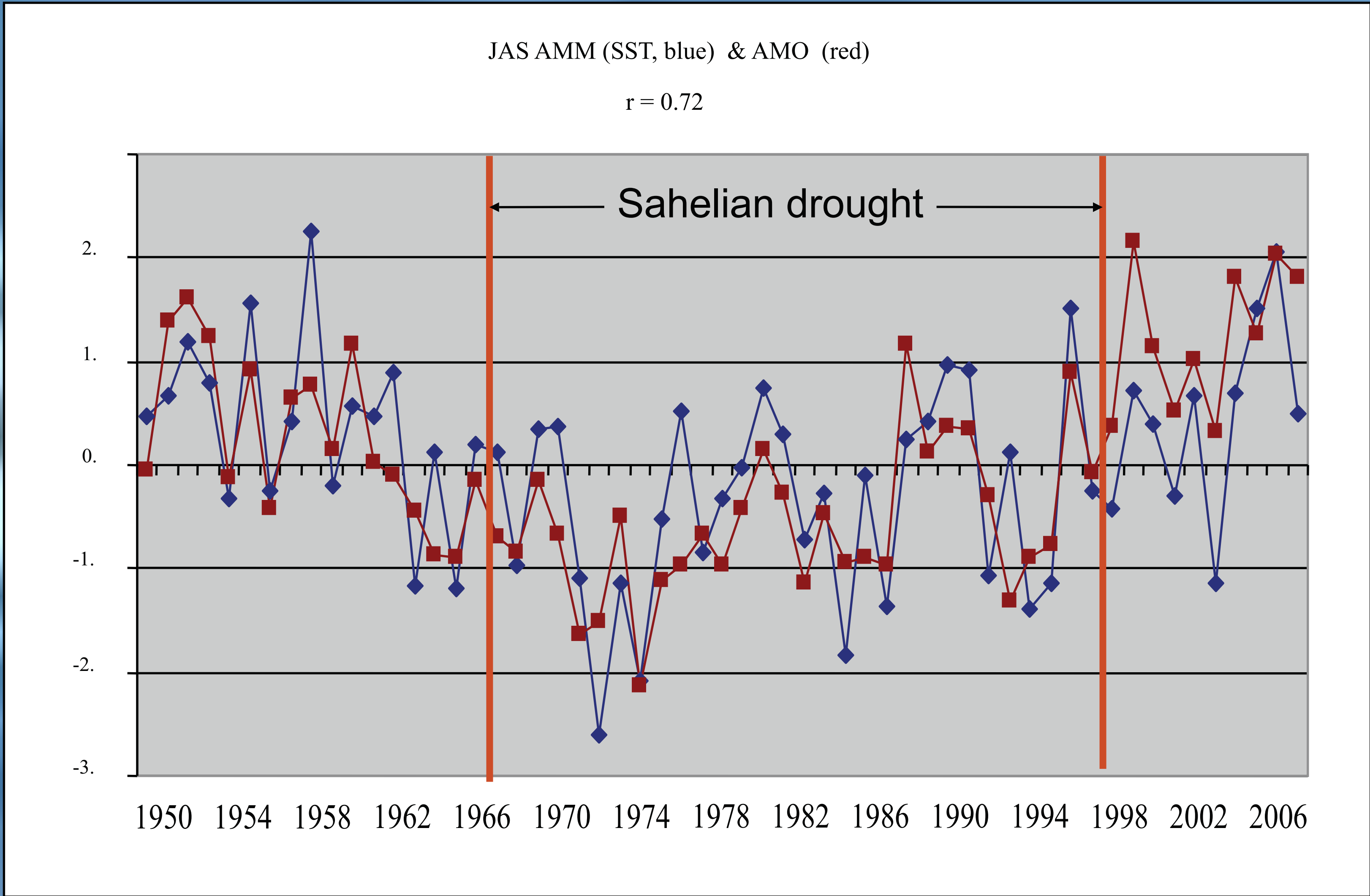
Indices	Acronyms spelled-out	Selected references
AMM	Atlantic Meridional Mode	Chiang and Vimont 2004
AMO	Atlantic Multi-decadal Oscillation	Kerr 2000; Enfield *et al* 2001; Knight *et al* 2005
ATC	Atlantic Tropical Cyclones	Jarvinen, *et al* 1984 with details at: http://www.aoml.noaa.gov:80/hrd/data_sub/hurdat.html
MDO	Multi-Decadal Oscillation	Schlesinger and Ramankutty 1994; Mann and Park 1999
MOC	Meridional Overturning Circulation	Delworth and Greatbatch 2000; Zhou 2003
NAWA	North Africa-West Asia Index	Paz et al 2003; Tourre *et al* 2006
PDI	Power Dissipation Index	Emanuel 2005
QDO	Quasi-Decadal Oscillation	Enfield *et al* 2001, Sutton and Hudson 2005
THC	Atlantic Thermohaline Circulation	Delworth and Mann 2000; Dijkstra *et al* 2005
TNA	Tropical Northern Atlantic Index	Rajagopalan *et al* 1998; Tourre *et al* 1999; Enfield *et al* 2001
TSA	Tropical Southern Atlantic Index	
TNA-TSA	SST difference between the tropical North and South Atlantic	

AMO and QDO during the 20th Century

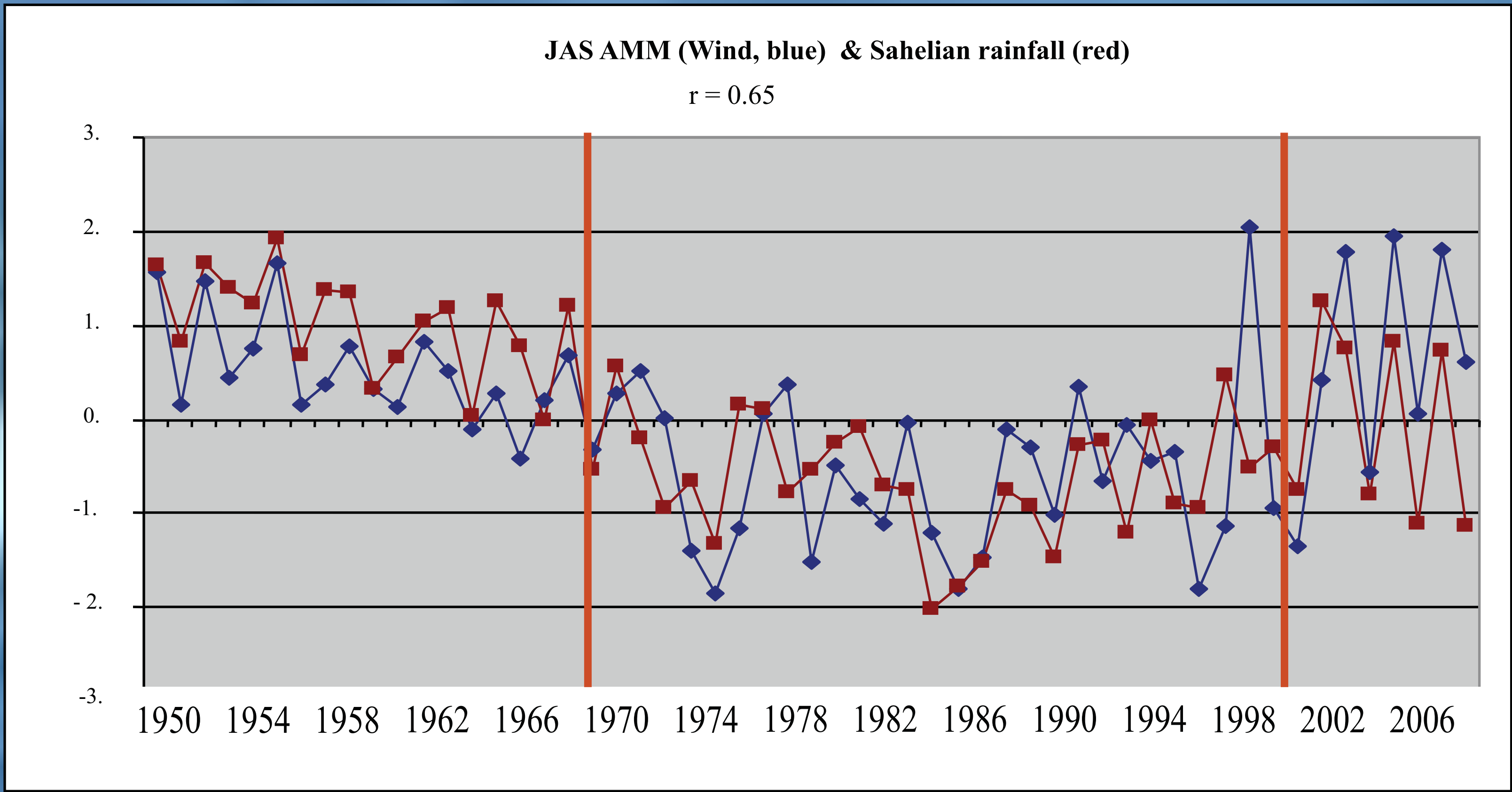


Similarity between AMO & TNA Low-Frequency Variability
Induced Similarity between TNA-TSA (QDO proxy) & ITCZ Latitudinal Variability

SST Atlantic Meridional Mode (AMM) as THC proxy & AMO

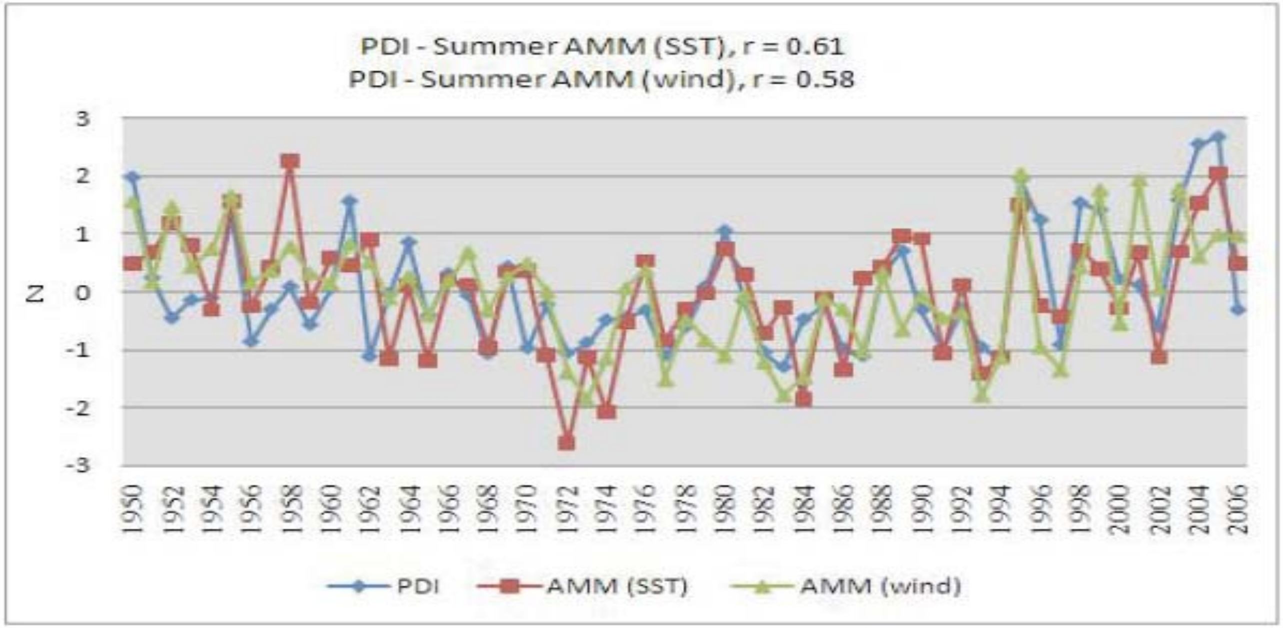


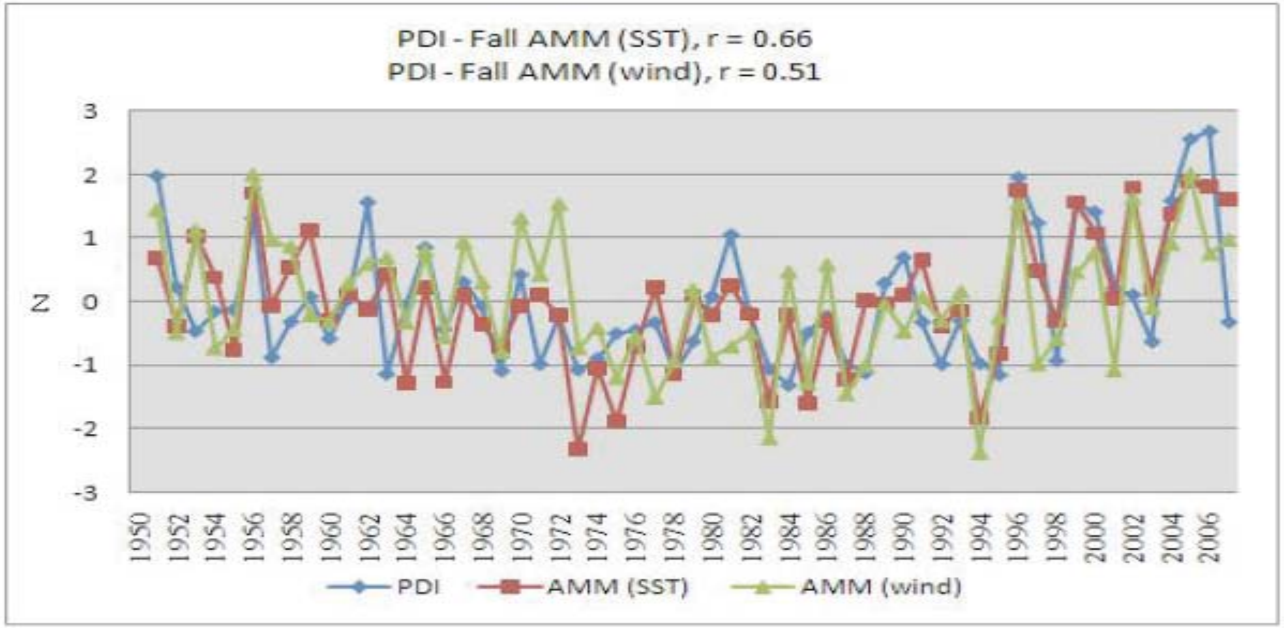
Wind Atlantic Meridional Mode (AMM) and Sahelian Rainfall



Potential Linkages between AMM/Wind and ITCZ Low-Frequency Variability

Hurricane Power Dissipation Index & AMM (SST + Wind)

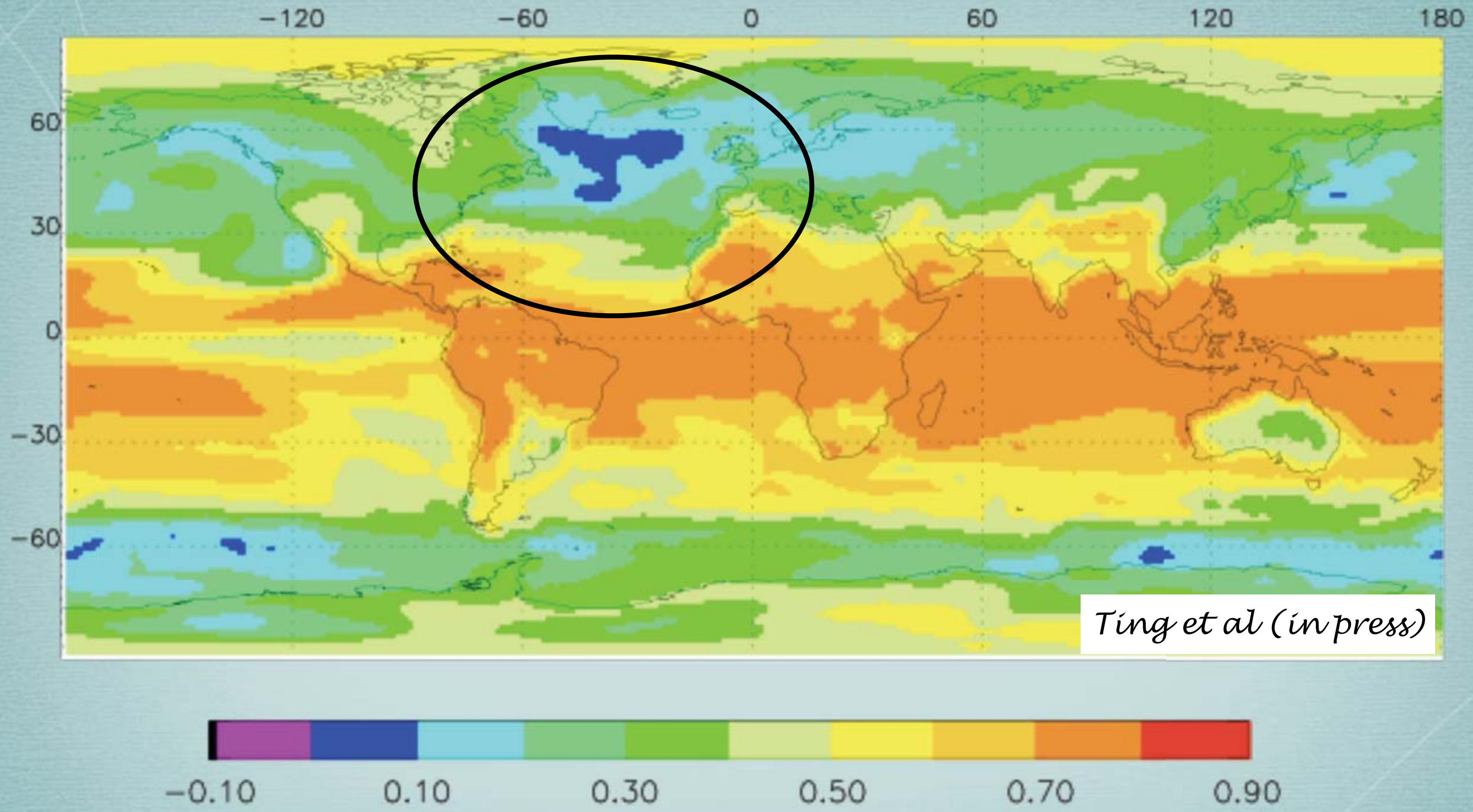




Conclusions

- Combining our results with that from other scientists & from proxy and modelling studies, AMO and QDO are two robust low-frequency ‘natural’ climate signals in the Atlantic Basin
- Both signals associated with the NAO
- Both signals associated with changes in Sahel rainfall
- Both signals are associated with long-term changes in Atlantic Hurricane intensity

Ratio of Variance

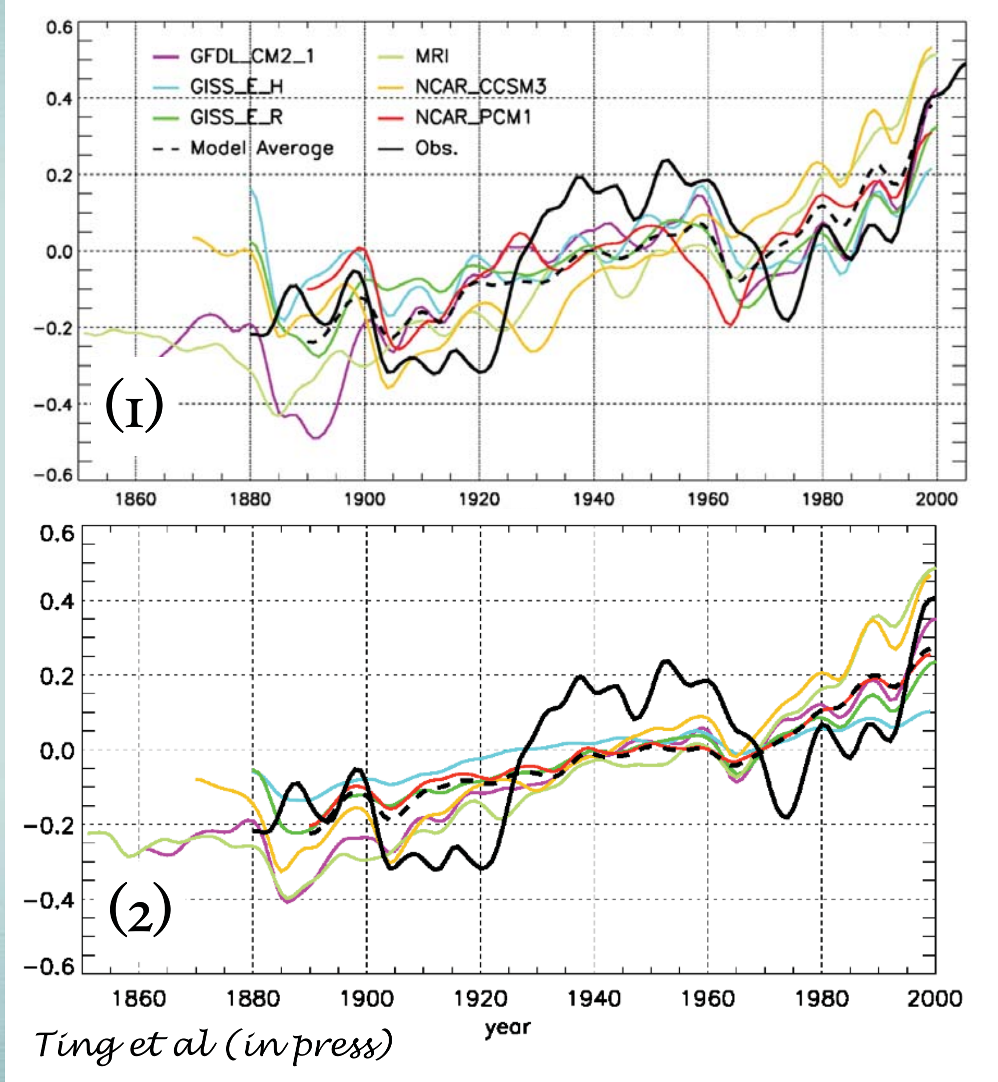


Forced/Total variability in IPCC AR4 models (CMIP5 runs). Results are based on 6 model ensemble with # members ≥ 4.

AMV and Global Warming

1. Annual SST anom. averaged over the N. Atl. in observations (solid black) and 6 CGCMs ensembles. Dashed line is the multi-model average.

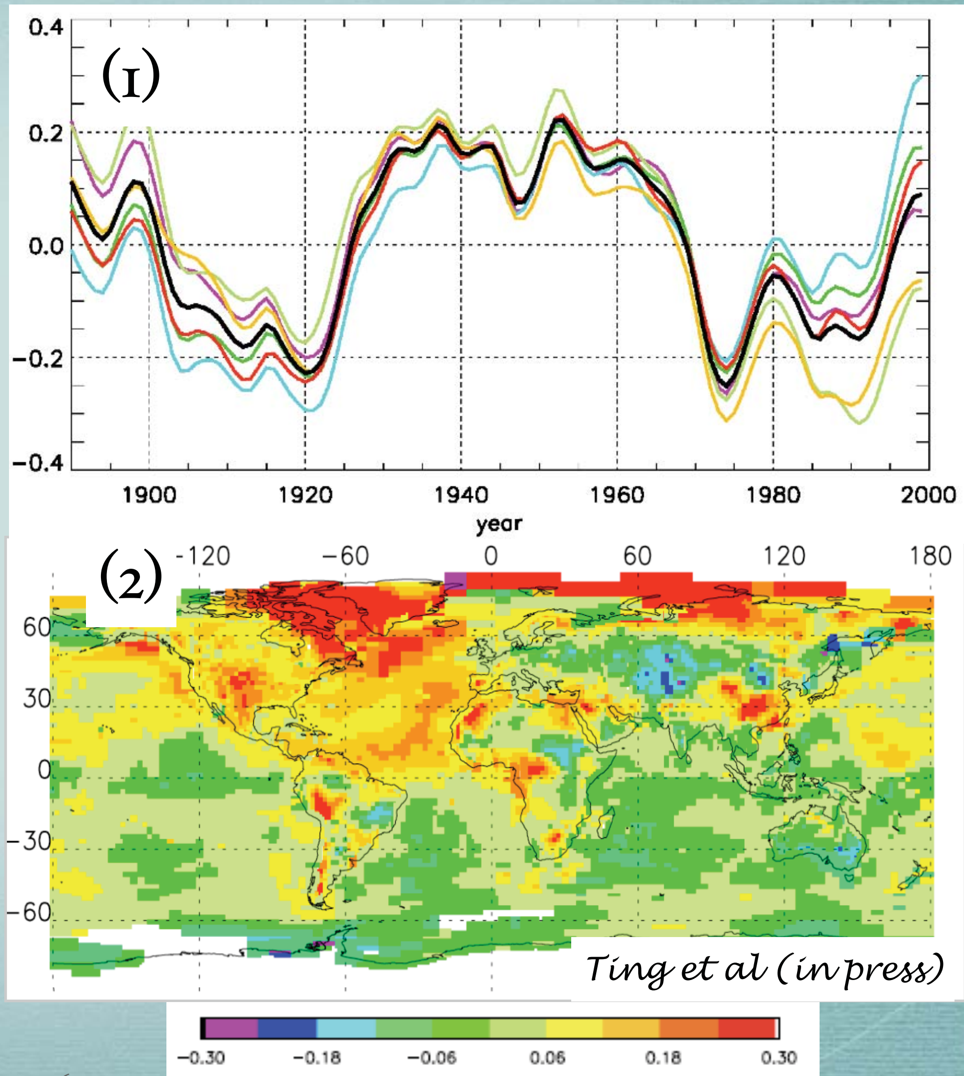
2. Solid line is the same as above. Colored lines are the projections of N. Atl. SST on each model's S/N maximizing PCs of global surface air temperatures (the <u>externally forced signal</u>).



Pattern of AMV

1. Time series of annual mean SST averaged over the N. Atl. minus the externally forced signal estimated using S/N maximizing PC analysis (each color represents a different model estimate of the forced signal).

2. The projection of annual mean surface air temperature on the time series in (1).



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