Extratropical forcing of equatorial decadal Atlantic variability

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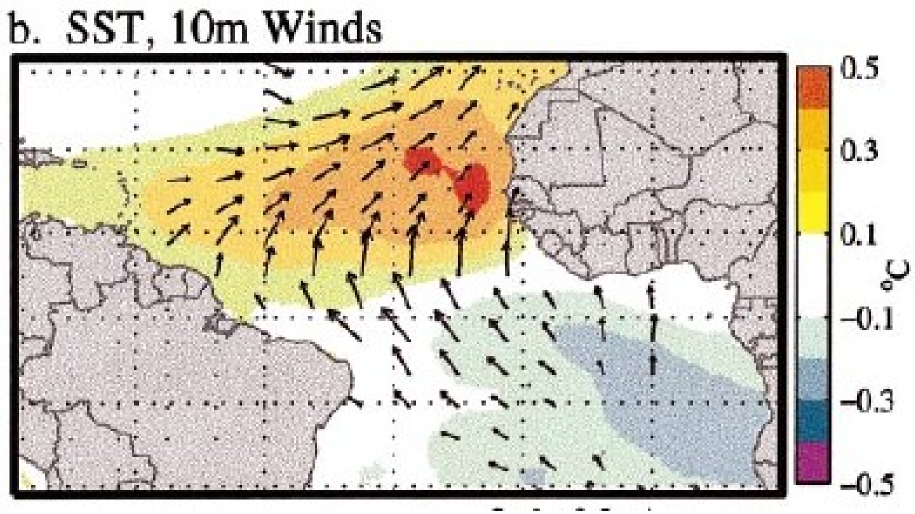
Tropical Atlantic Variability (TAV) in different seasons

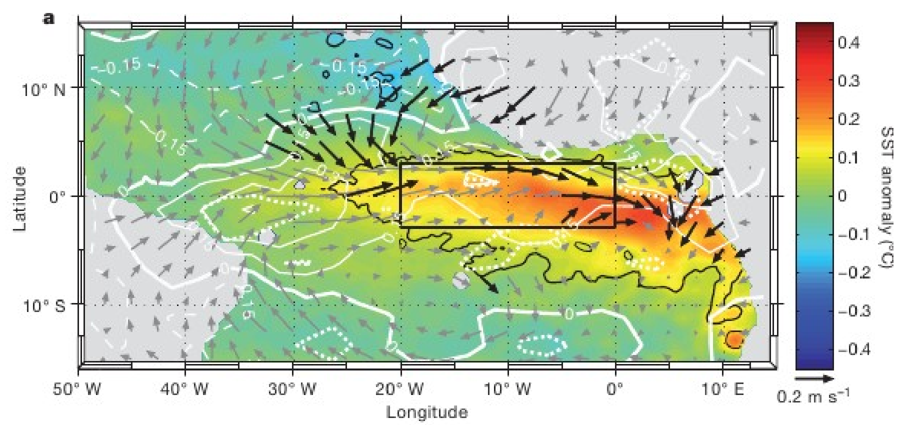


1. Boreal spring (MAM)

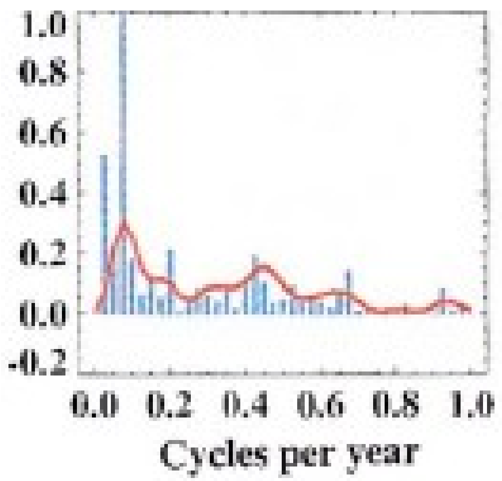
Atlantic meridional mode (AMM)

2. Summer (JJA)

Atlantic Niño, similar *to the Pacific El Niño*

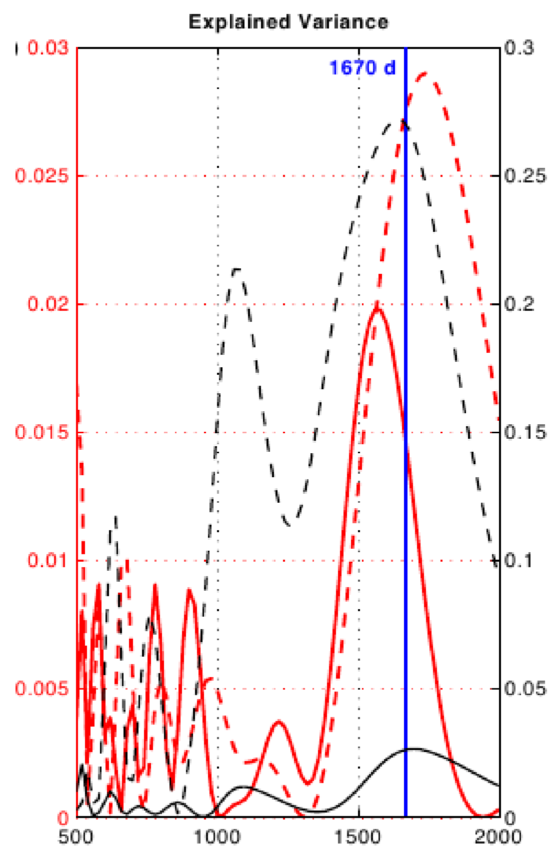


Time scales of TAV in MAM & JJA.



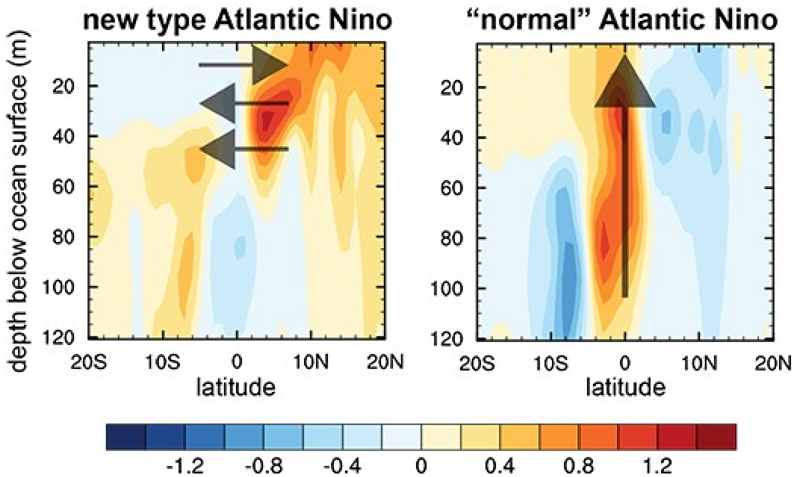
Atlantic meridional mode: sub-decadal; ~8 years.

Atlantic zonal mode: interannual; 1.6-4.5 years.

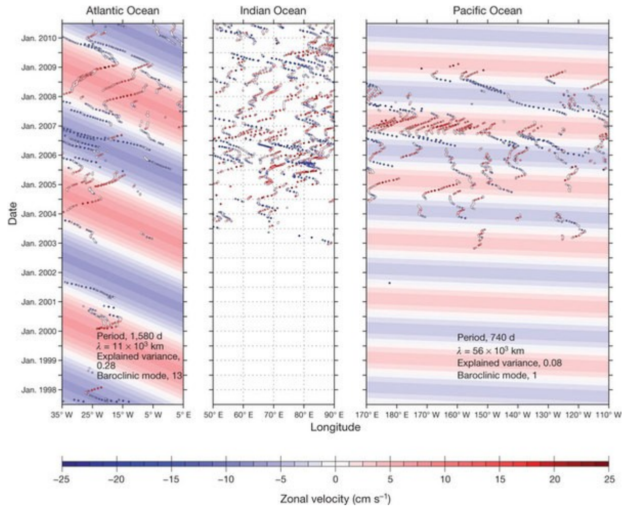


Mechanisms of Atlantic Niño: All based ocean dynamics.

- **Bjerknes feedback:** **wind – SST - thermocline feedback.**



- **New Atlantic Niño: driven by mixed layer temperature advection from north tropical Atlantic Ocean *(Richter et al., 2013, Nature Geosci)*.**



- **Equatorial Atlantic Kelvin waves: deep zonal jets oscillate at 4.5yrs causing Atlantic Nino SST anomalies. Similar jets in Indian and Pacific oceans do not interannual time scales *(Brandt et al., 2011, Nature)*.**

How essential is ocean dynamics for Atlantic Niño?

Nnamchi et al., (2015), Thermodynamic controls of the Atlantic Niño. *Nature Communications*. **6**, doi: 10.1038/ncomms9895.

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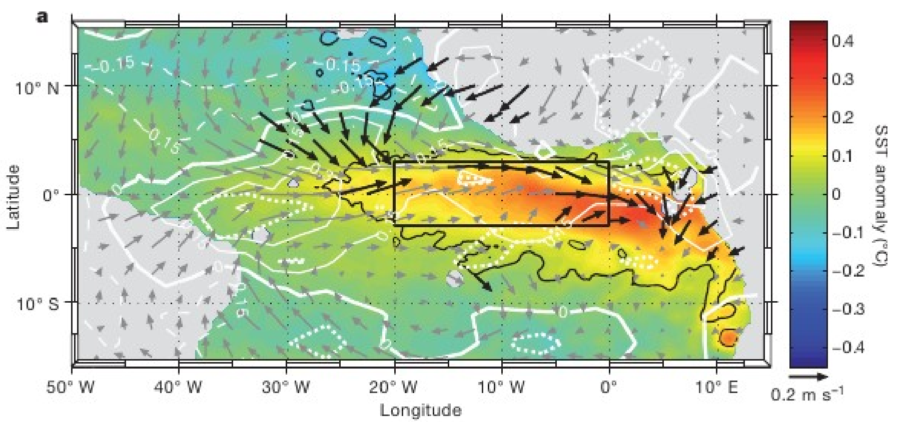
$$\frac{\partial[T]}{\partial t} = -\left[u\frac{\partial T}{\partial x}\right] - \left[v\frac{\partial T}{\partial y}\right] - \left[w\frac{\partial T}{\partial z}\right] + \frac{Q_{SW} - Q_{LW} - Q_{LH} - Q_{SH}}{\rho C_w h} + R$$

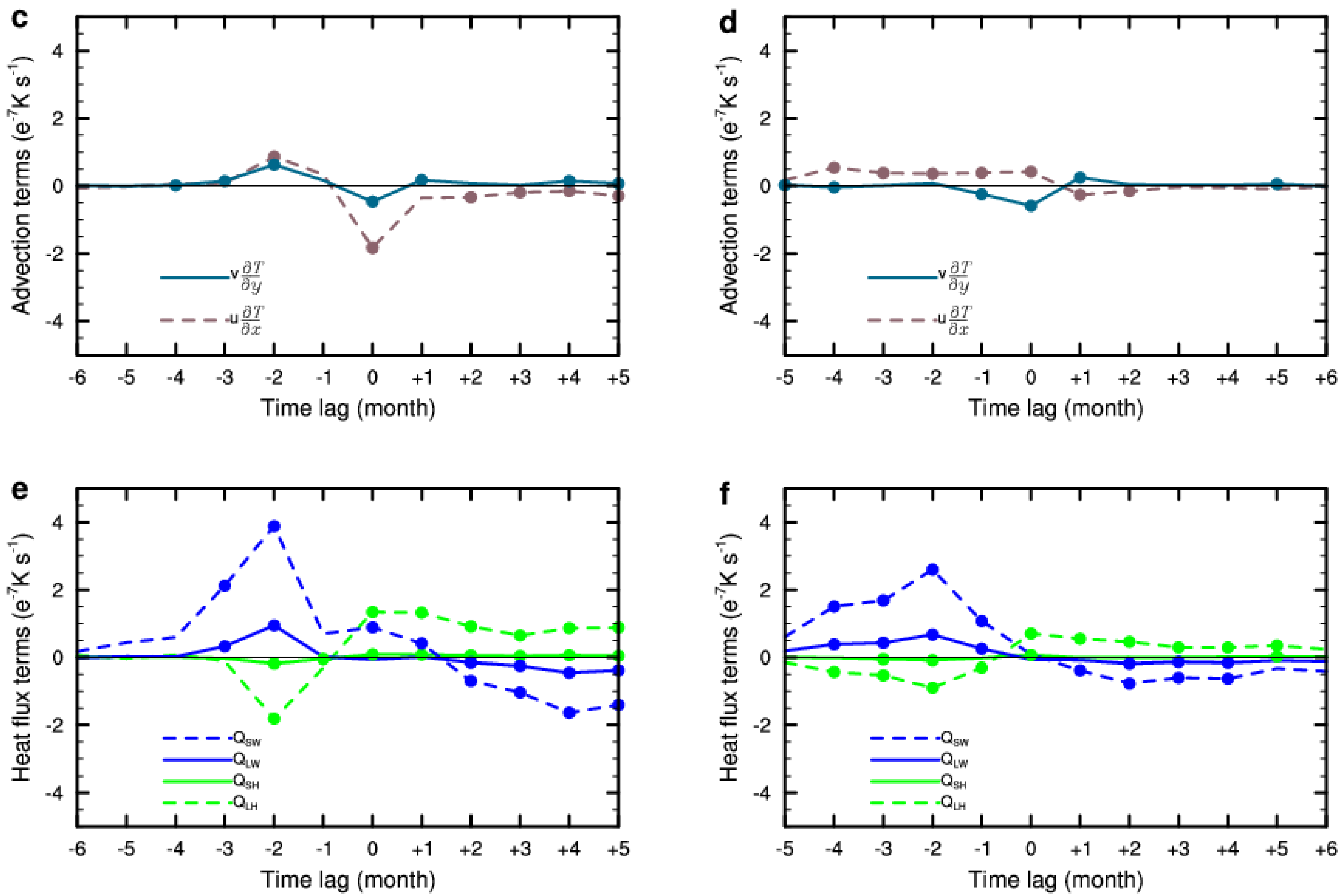
ρ, **sea water density;** ***Cp,*** **specific heat constant pressure;** ***h,*** **ocean mixed layer depth;** ***Qnet,*** **net radiation; R, unresolved physical processes.**

Slab model equation: $$\frac{\partial T}{\partial t} = \frac{Q_{net}}{\rho h C_w} + Q_{flux}$$

Qflux, **climatological-mean ocean heat flux.** ***h*** **= 50 m.**



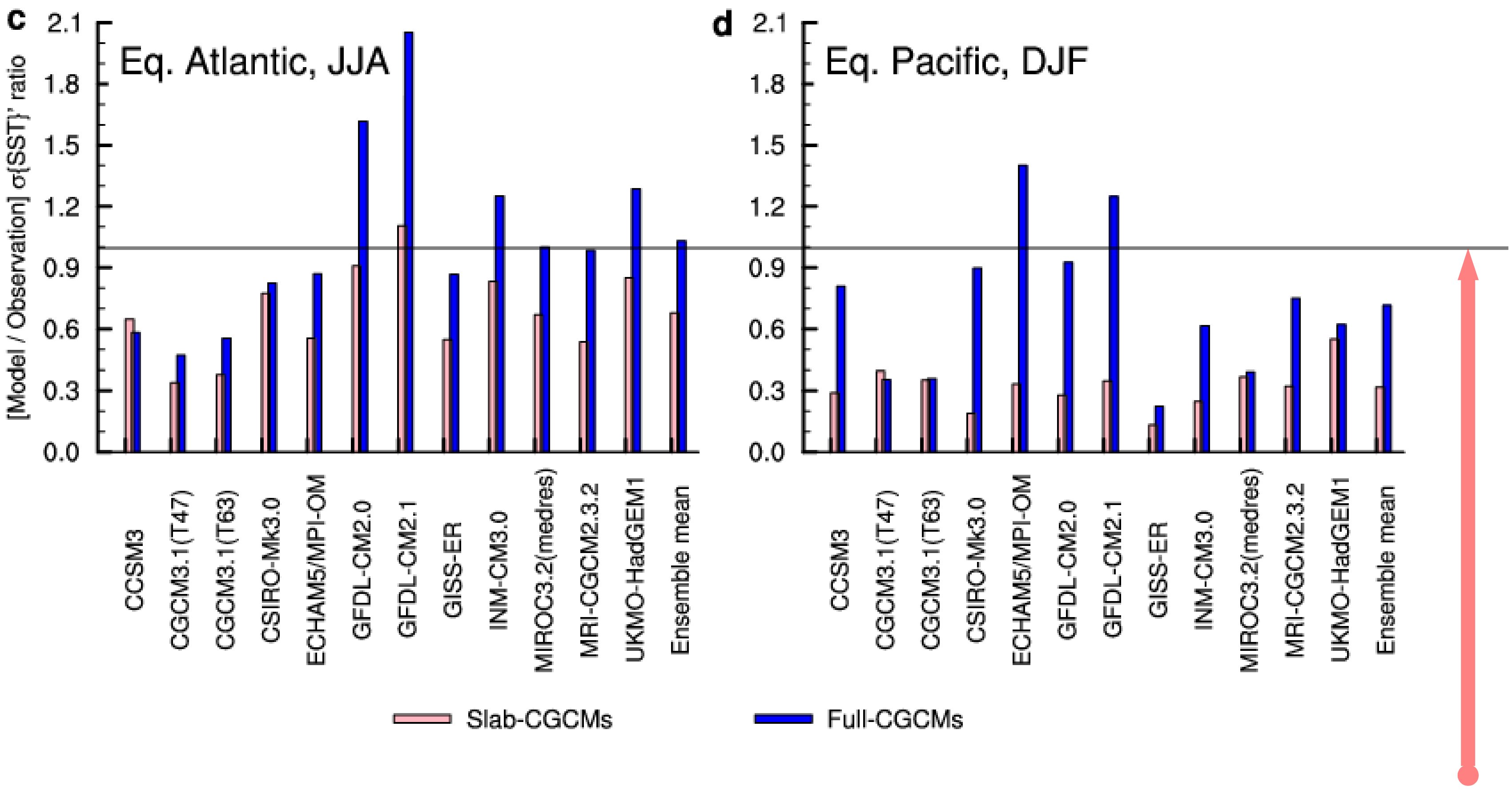
GFDL-CM2.0 | MIROC3.2 (medres)



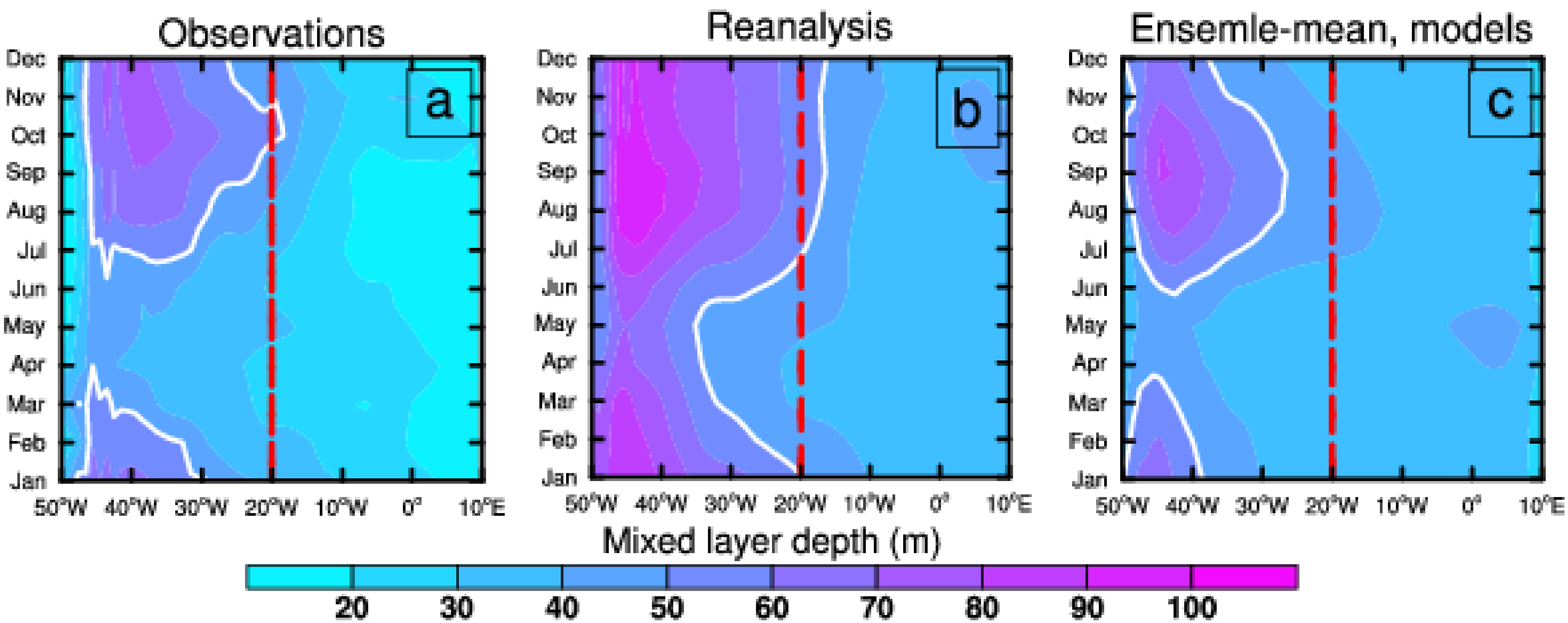
Nnamchi et al., (2015), *Nature Commun*.

Proportions of observed variability explained by "slab" processes.

Nnamchi et al., (2015), *Nature Commun*.

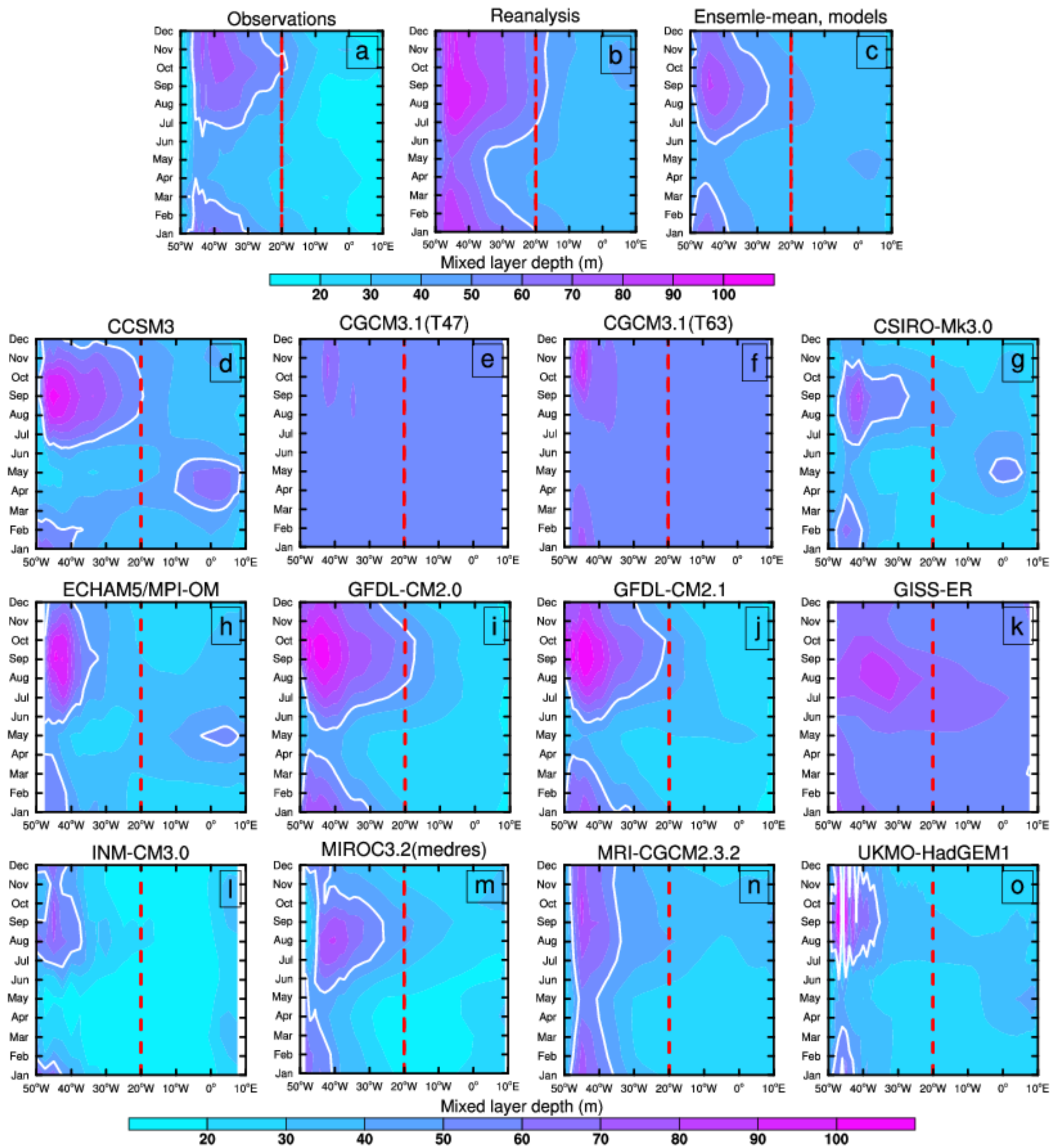


Equatorial Atlantic ocean mixed layer depth

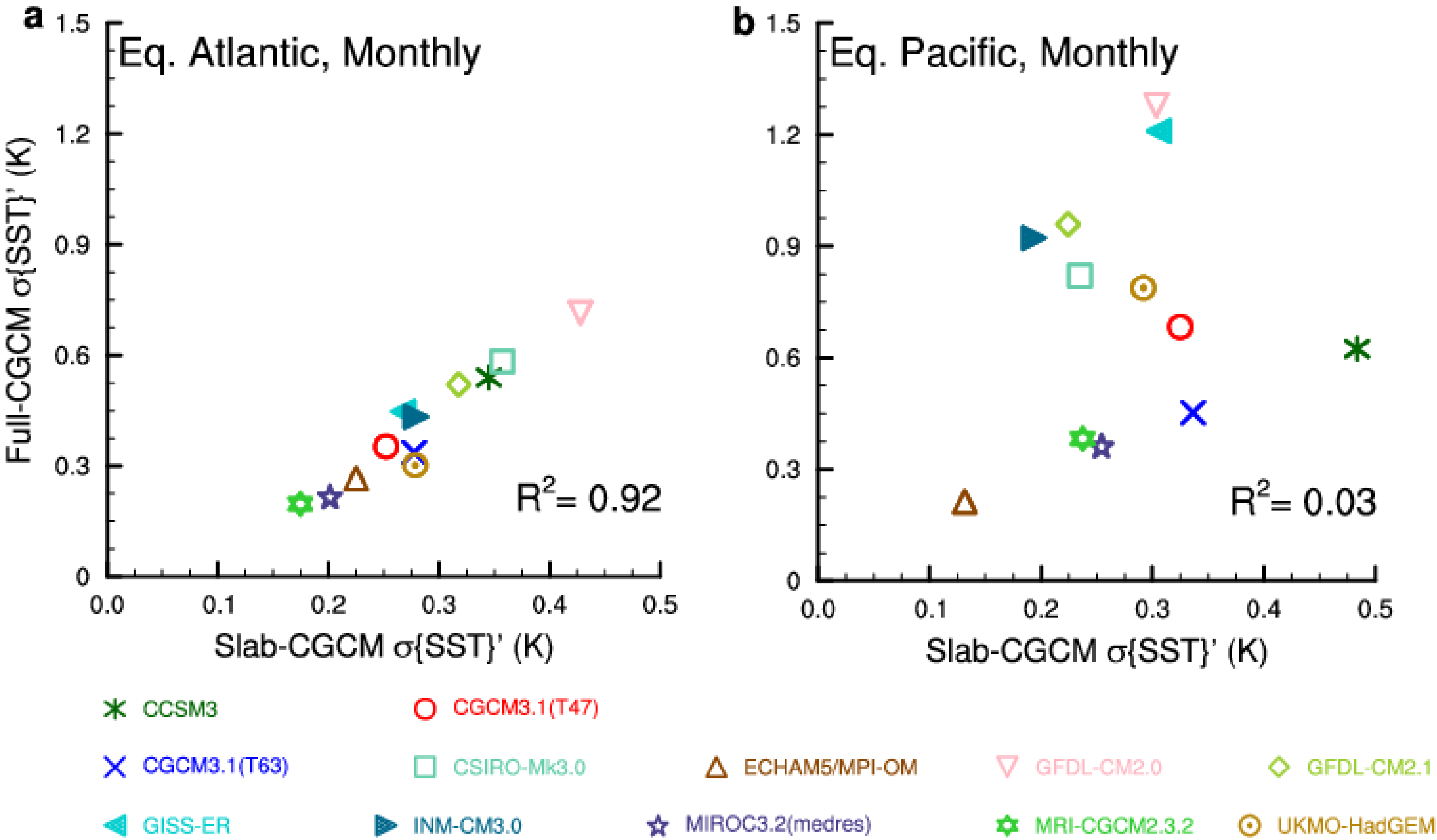


Mixed layer of models not shallower than the observed

Equatorial Atlantic ocean mixed layer depth



"Slab" as a predictor of total variability



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Atmosphere's role in equatorial Atlantic variability?

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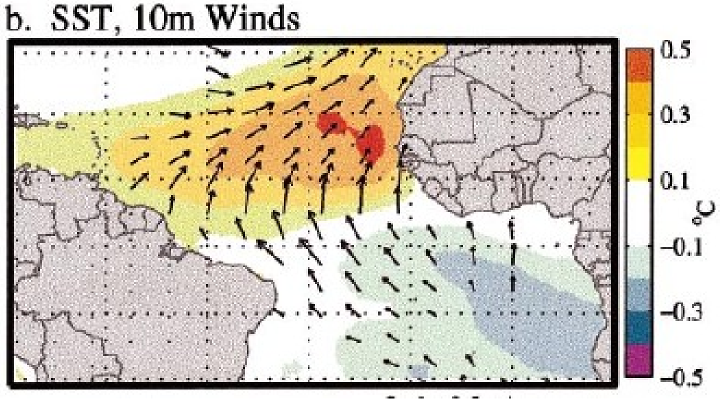
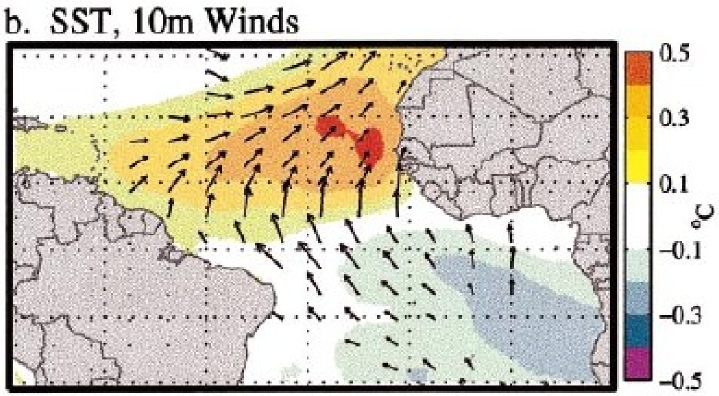
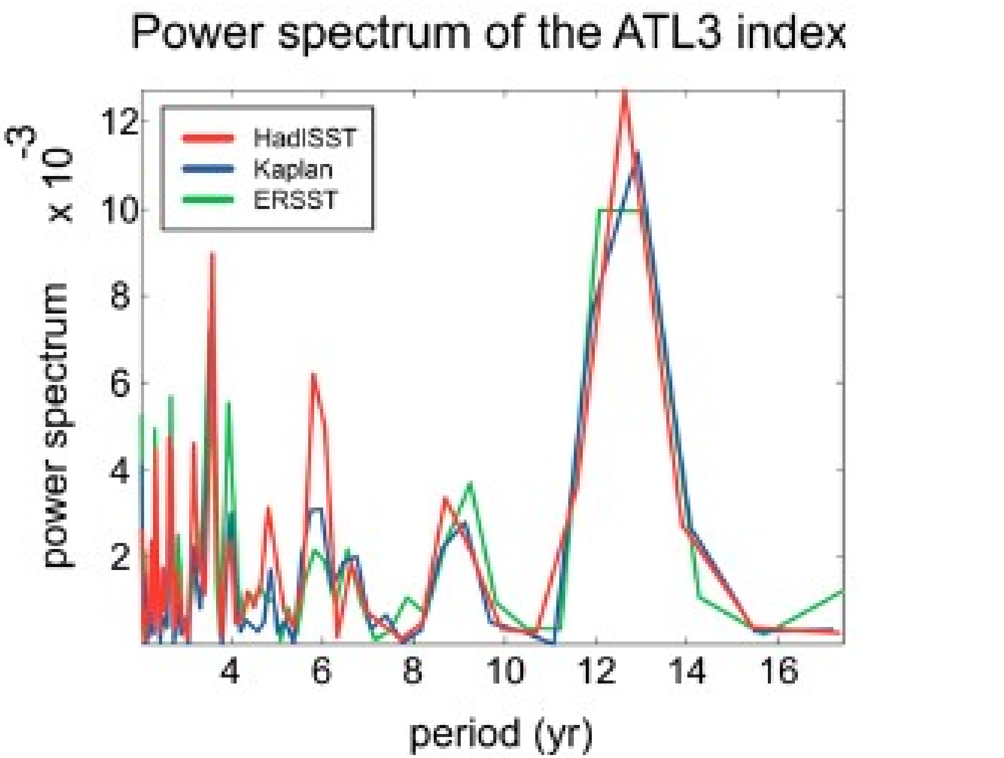


~8 years

Atmosphere's role in equatorial Atlantic variability?

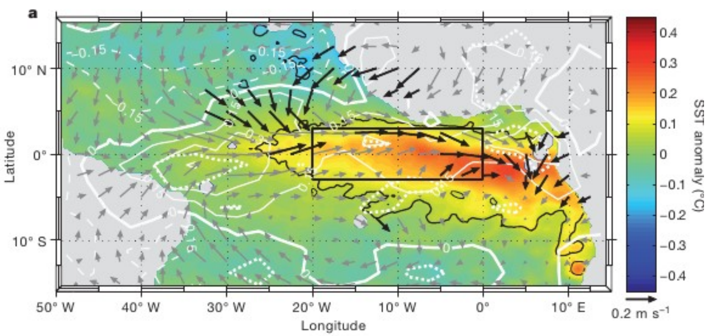


~8 years

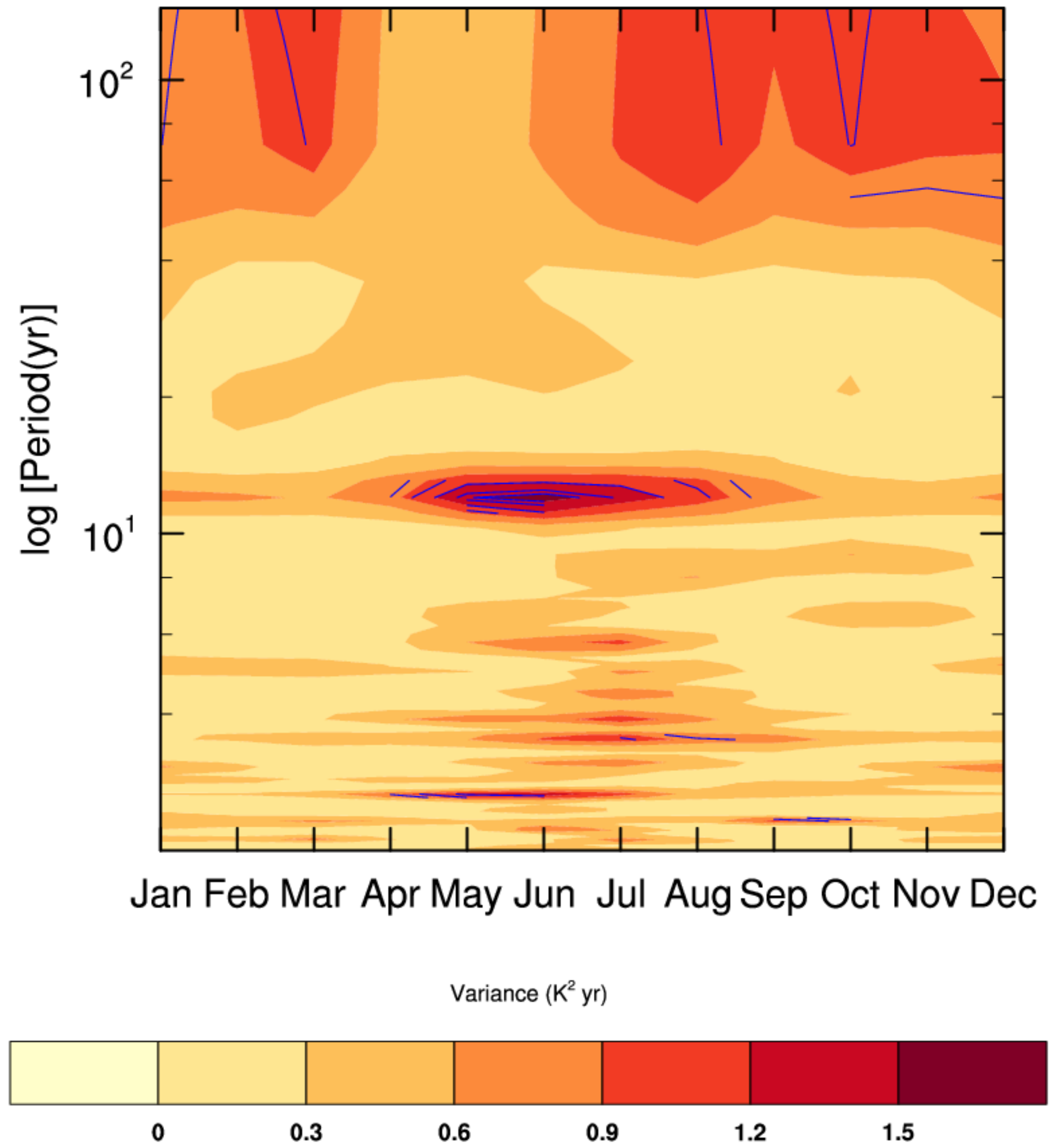


Garcia-Serrano et al., 2013.

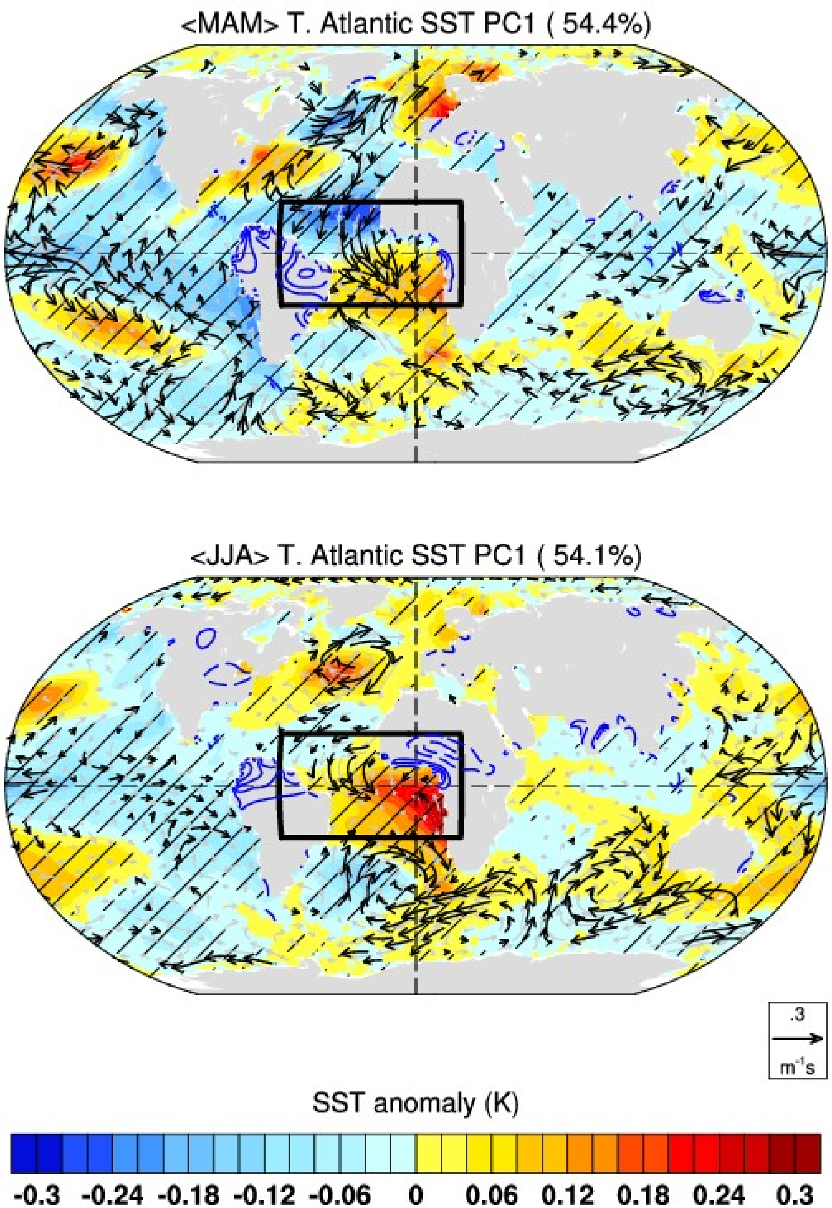
Observations



Contours show significant decadal variability in spring to summer months.



Spatial patterns of TAV in spring and summer

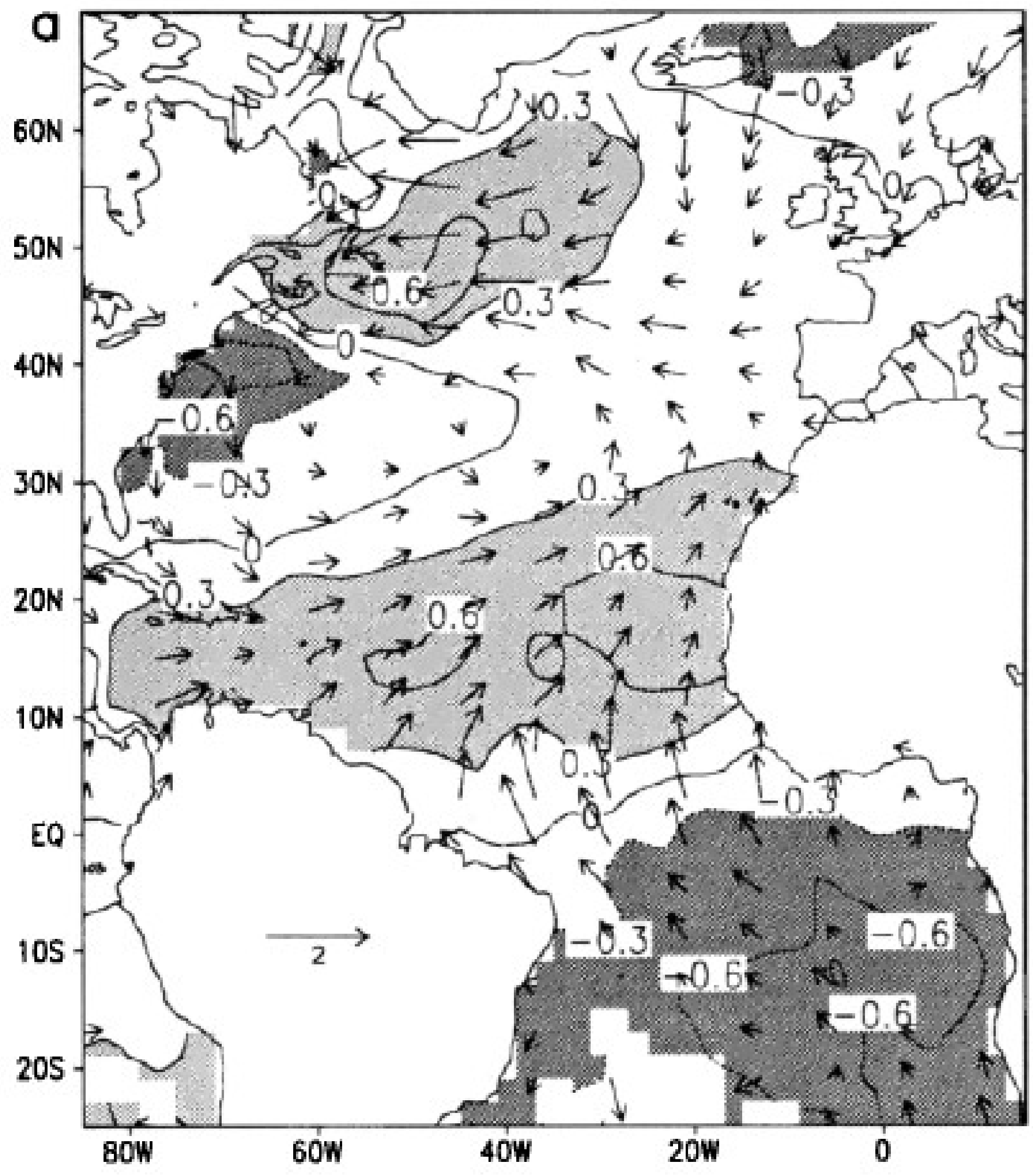


Correlations with regional precipitation anomalies.

	G. Coast	Sahel	NS America
20CR	0.60*	-0.36	0.56*
Obs	0.45*	-0.11	0.50*

"Pan-Atlantic mode"

Xie and Tanimoto (1998)

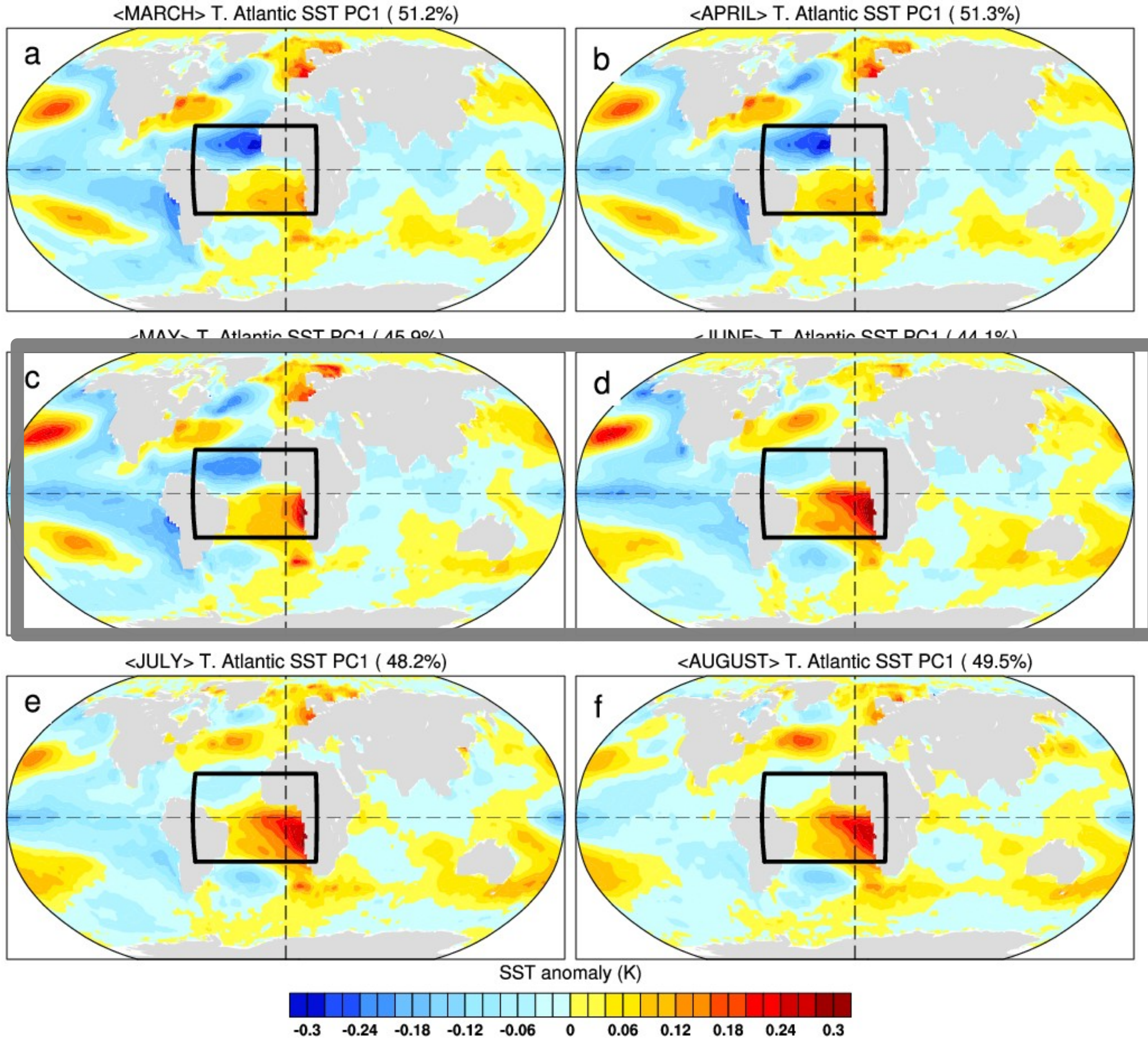


Evolution of tropical Atlantic decadal variability

March-April: meridional mode.

May June: Transition.

July-August: zonal mode.



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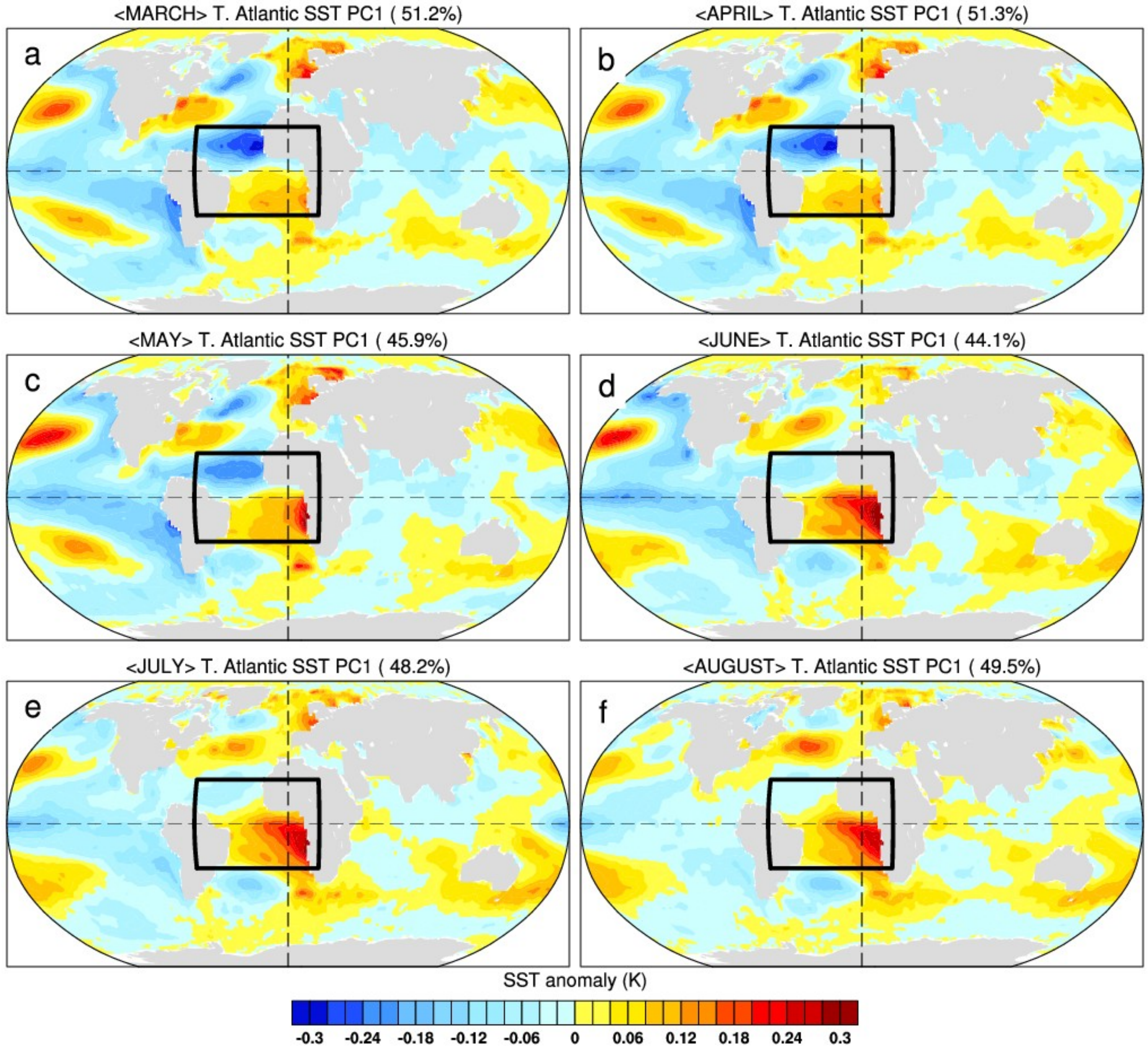
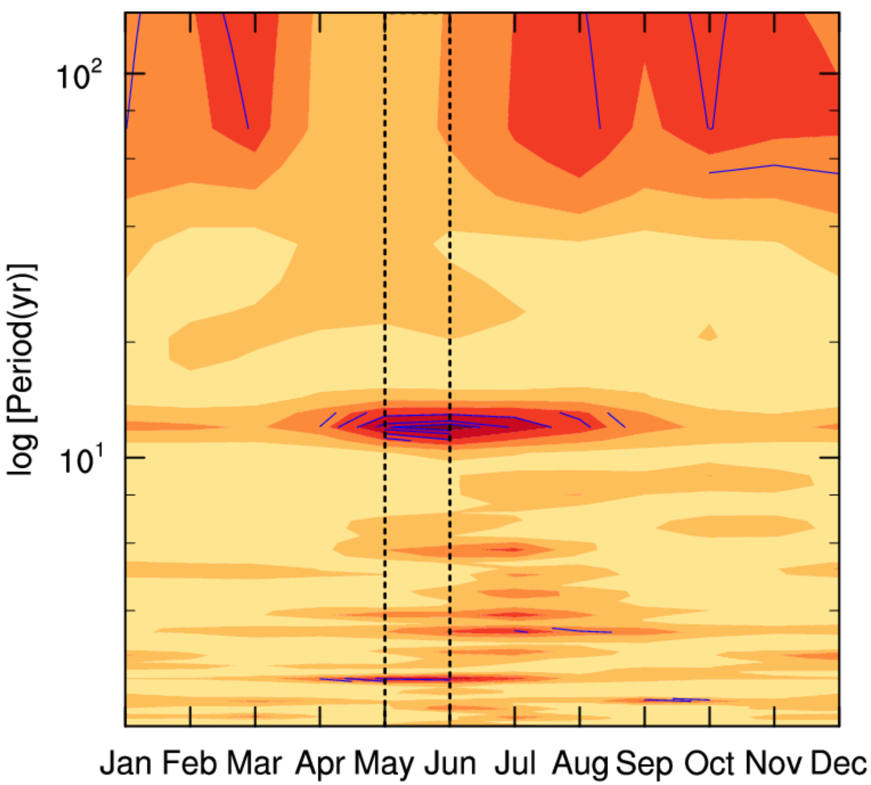
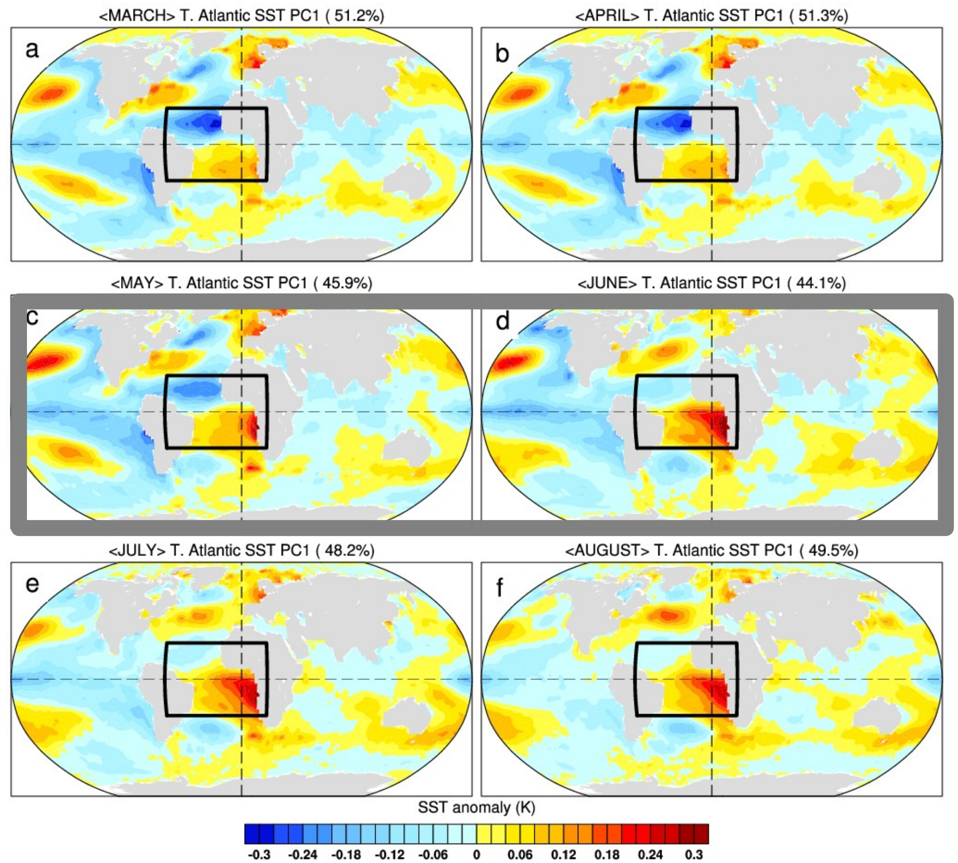


May-June transition

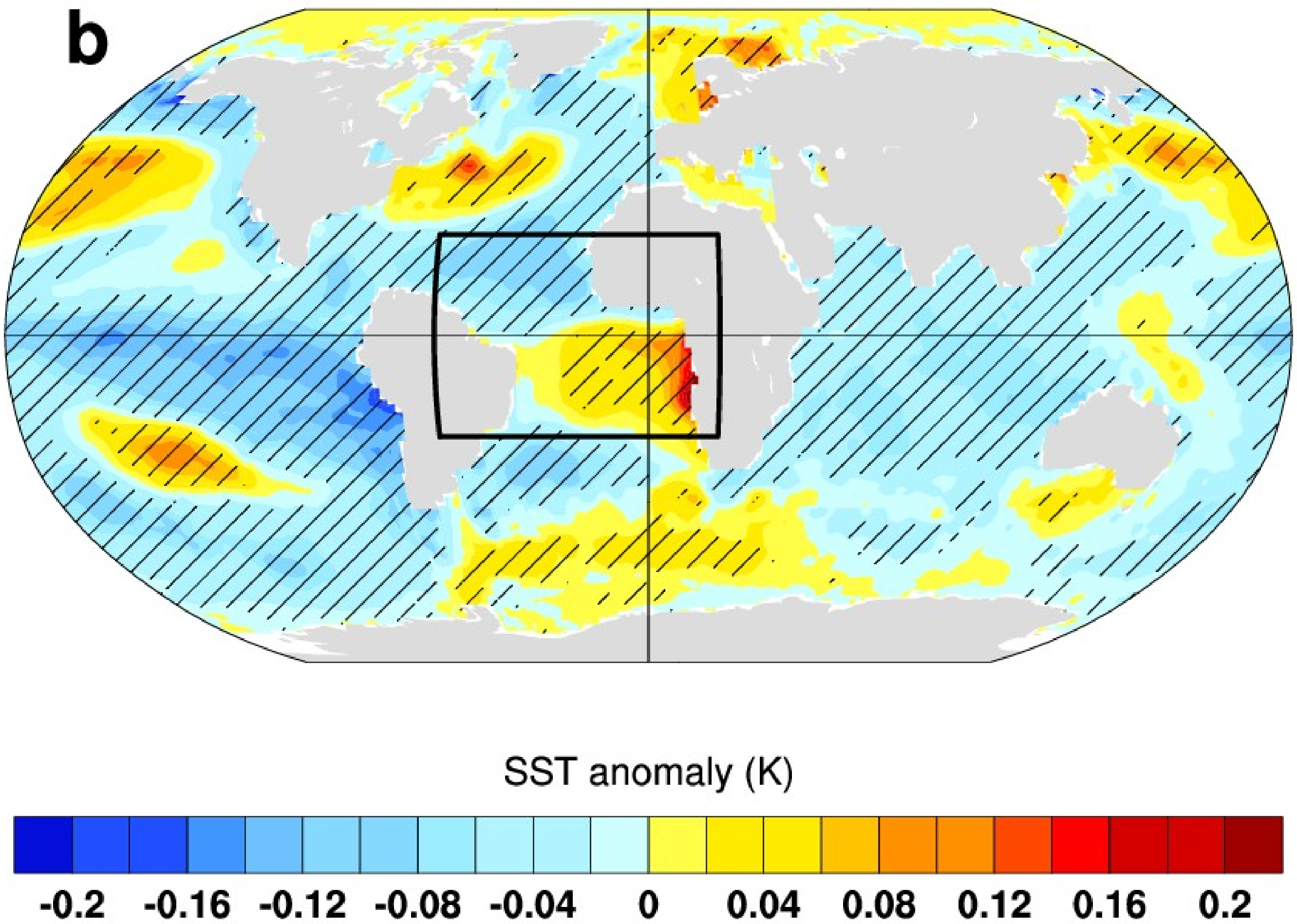
Strongest variability, but also transition occur in May June.



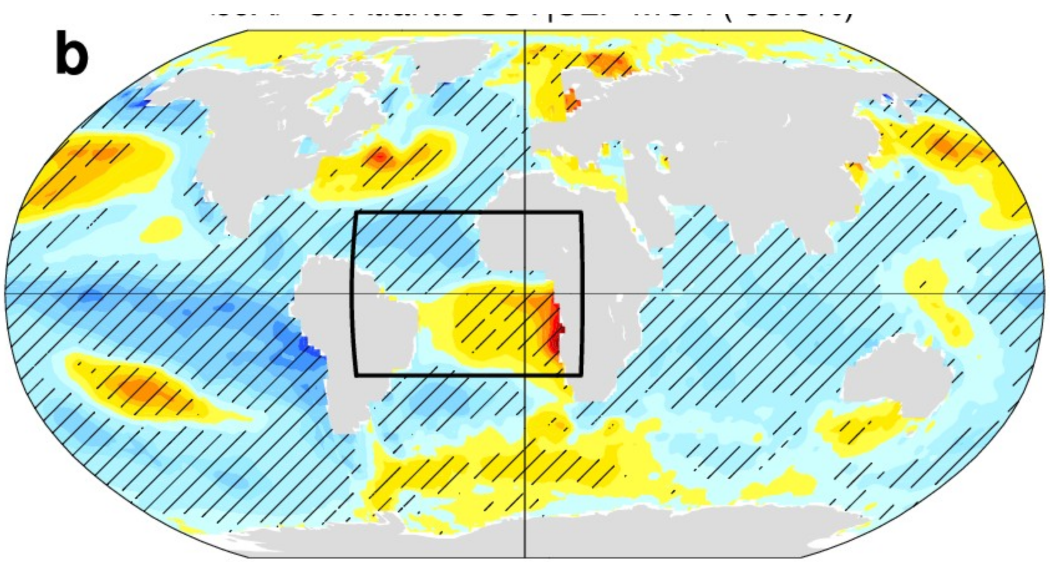


Coupled variability, "Pan-Atlantic mode"

Maximum Covariance Analysis (MCA): SST and SLP

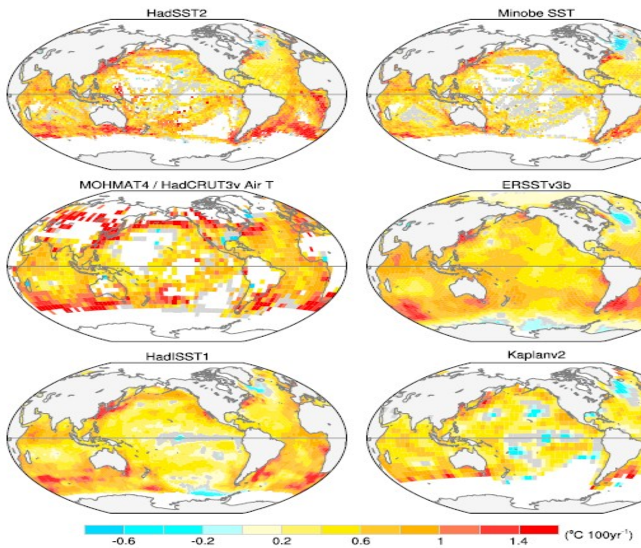


Concluding remarks

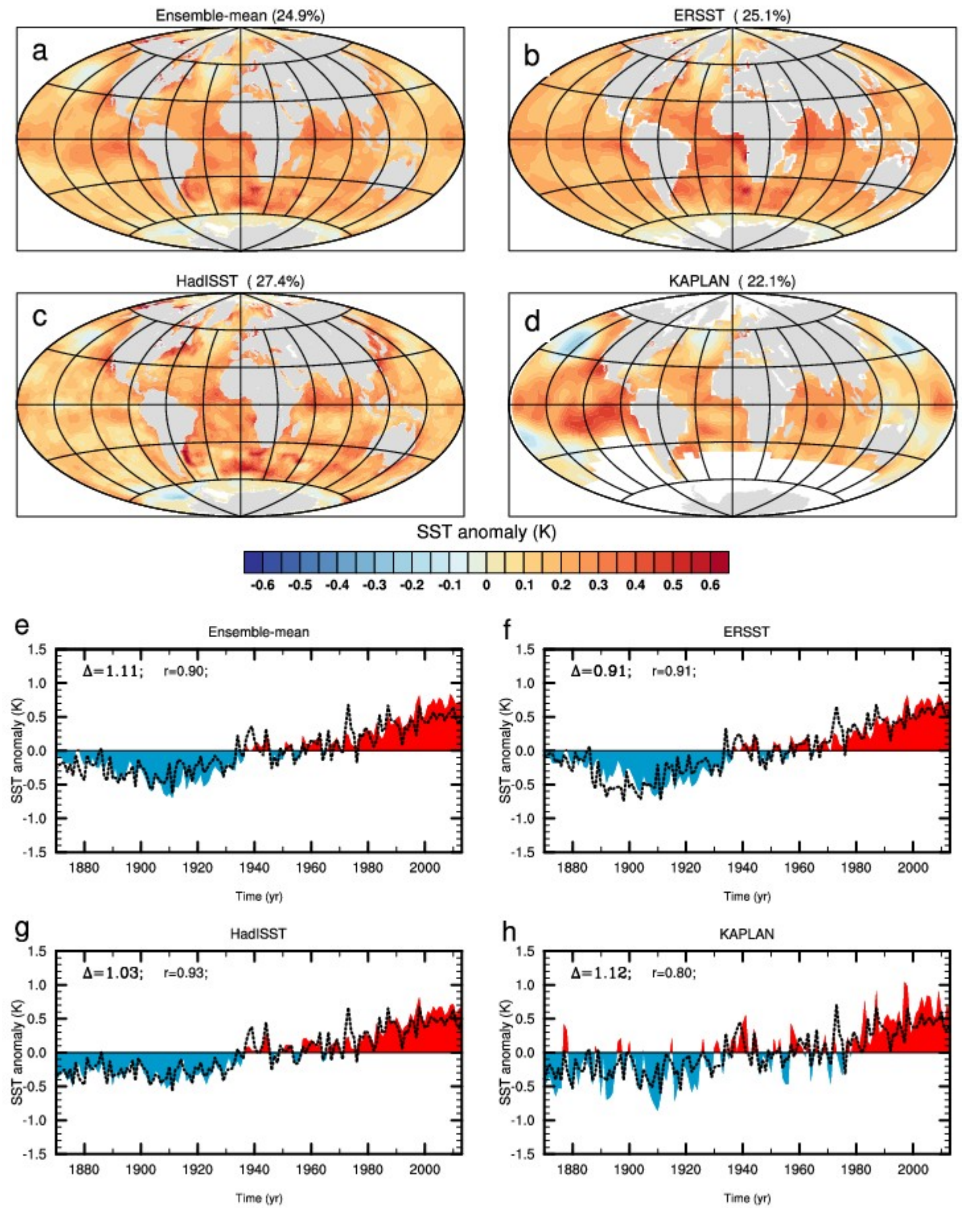


***Robust decadal variability occur in equatorial Atlantic in JJA.**
***Related to precipitation over the nearby continents.**
***May be seen as a part of "Pan Atlantic mode", with extratropical to tropical connections.**

Deser et al., 2010, GRL



1st EOF of global JJA SST



Blue line: SA Ocean [5N-45S, 60W-20E] Mean SST anomaly.

Δ is the regression between *x*(global) and *y*(BW) anomaly
r is the correlation

$$SST'_{filtered} = SST'_{raw} - BWA_{low.freq}$$