Decadal Emergence Variations of the Observed Inter-annual Rainfall Patterns over West Africa

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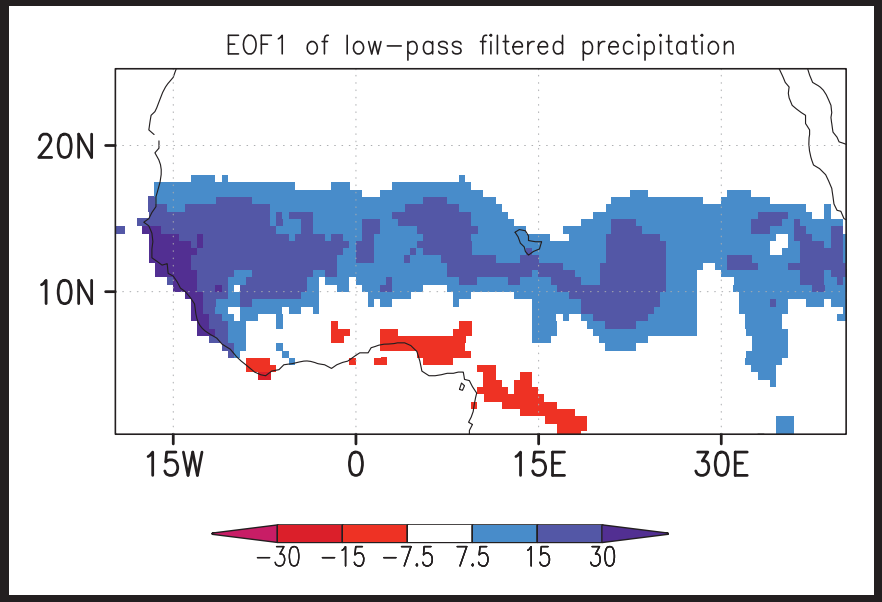
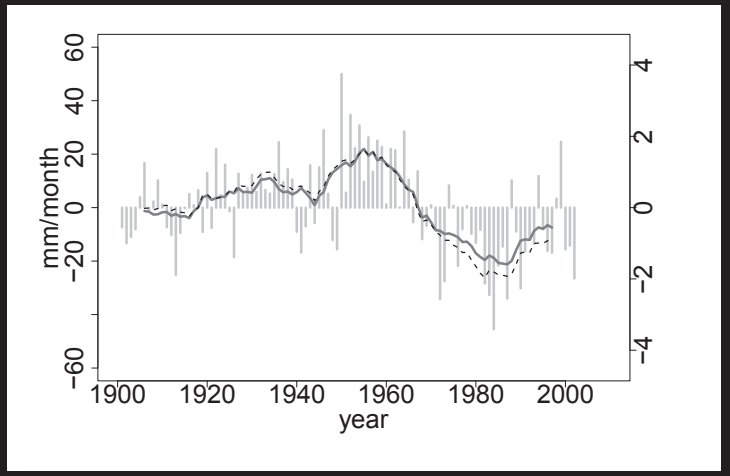
Observed Summer (JAS) rainfall anomaly





- strong drying trend from the fifties
- abundant rainfall in the fifties and early sixties (Wet-Mode)
- drought since approximately 1970s (Dry-Mode)

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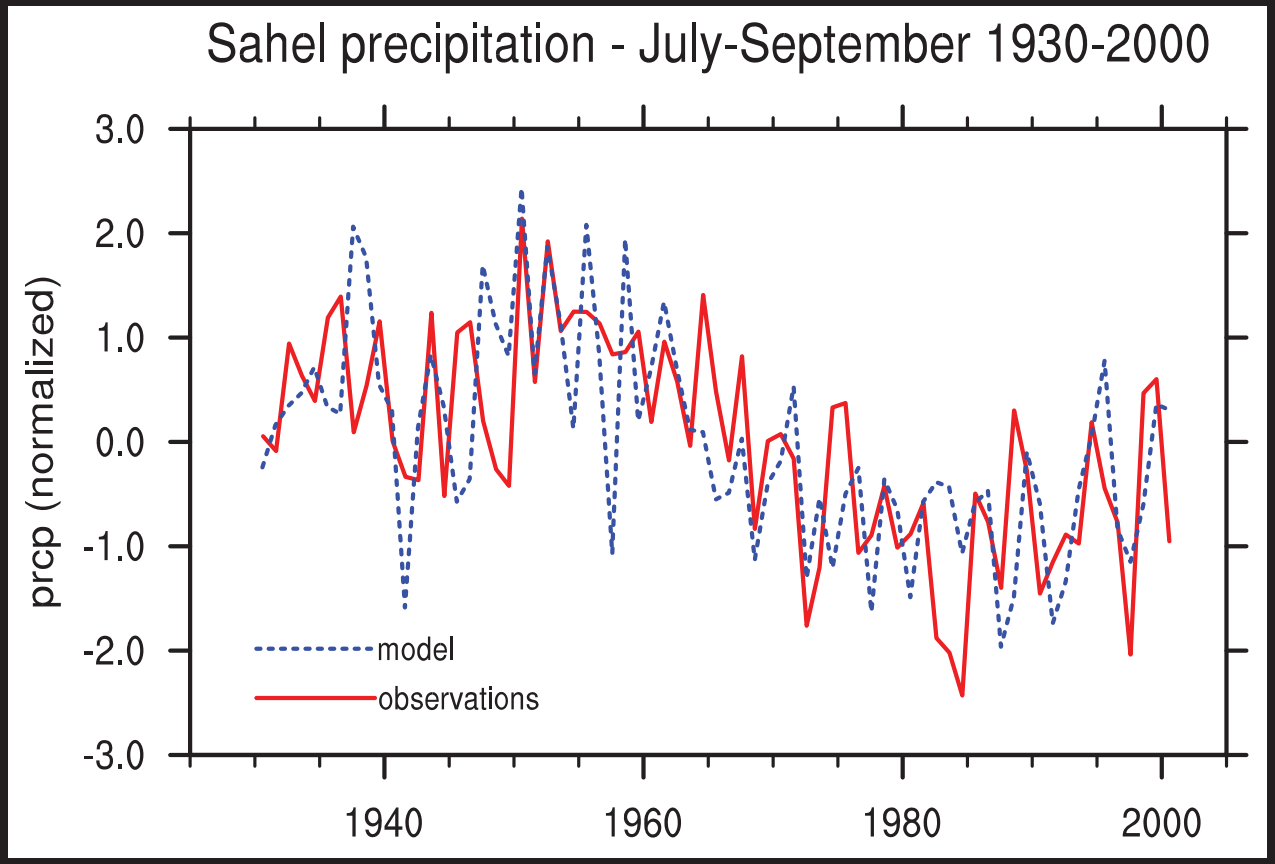
Observed and Simulated Sahelian Rainfall



Giannini et al. 2003 (Science): Correlation 0.6

$\Rightarrow$ AGCM forced by observed SSTs are able to simulate the devolution of low-frequency rainfall

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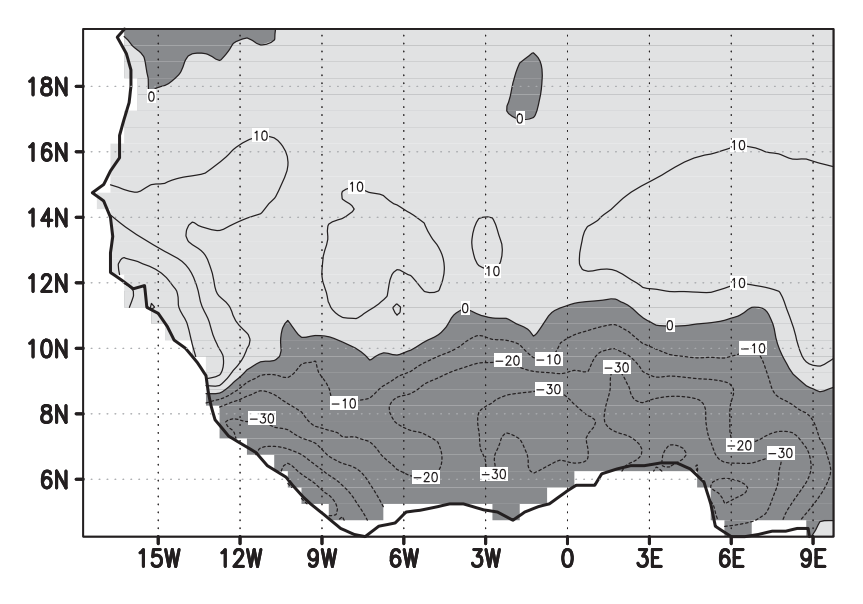
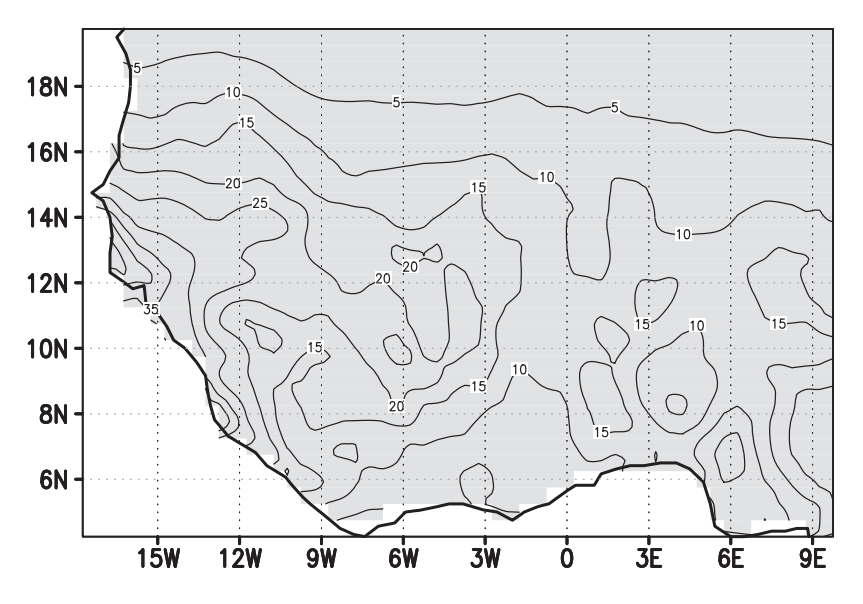
Observed Interannual Summer (JAS) rainfall anomaly patterns

EOF1 (dipole)



EOF2 (monopole)



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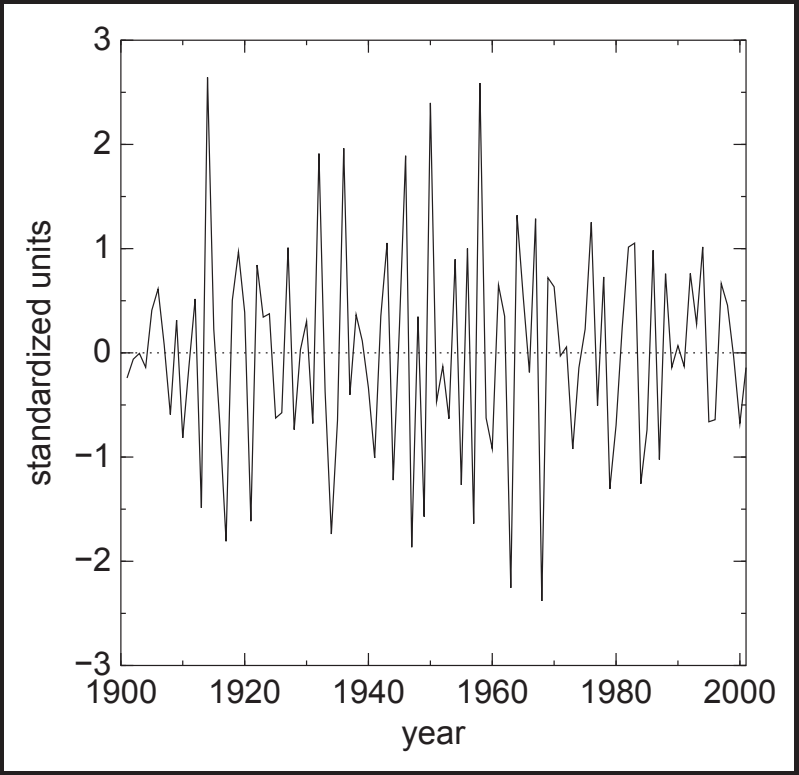
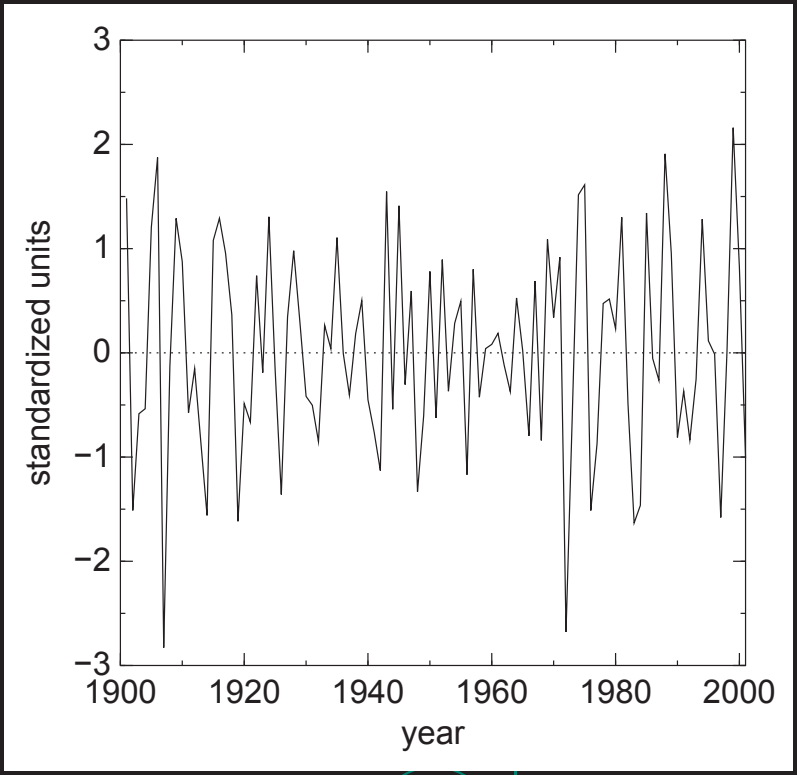
PCs of the observed interannual Summer (JAS) rainfall anomaly patterns

PC1 (Dipole)



PC2 (Monopole)



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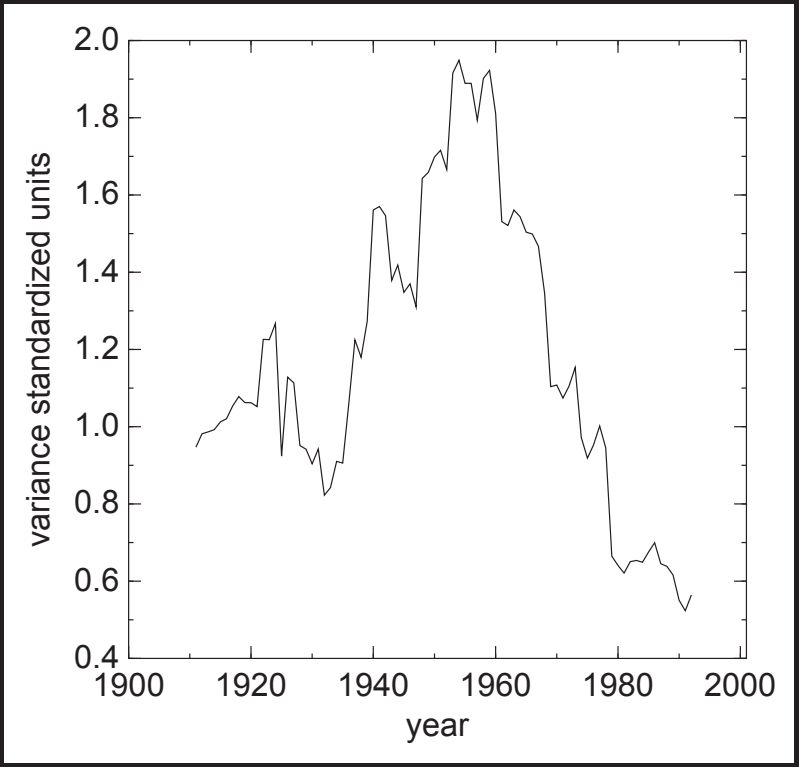
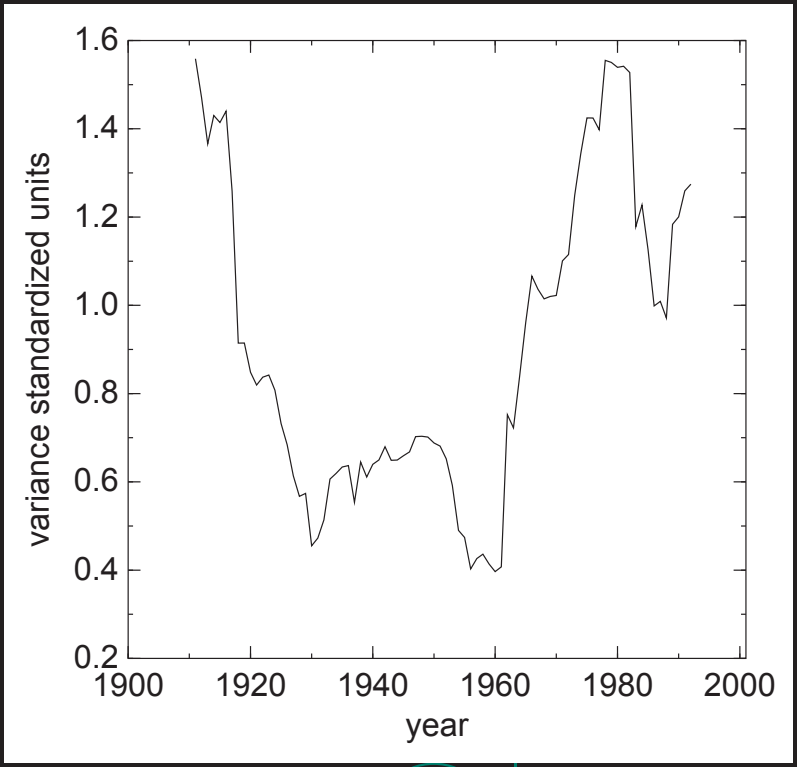
Running variance of the PCs of the observed interannual Summer (JAS) rainfall anomaly patterns

PC1 (dipole)



PC2 (monopole)



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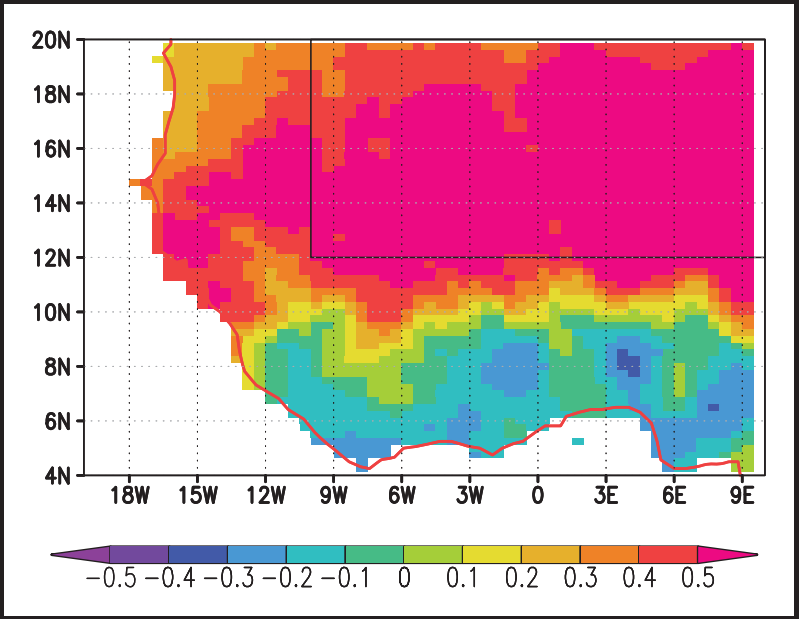
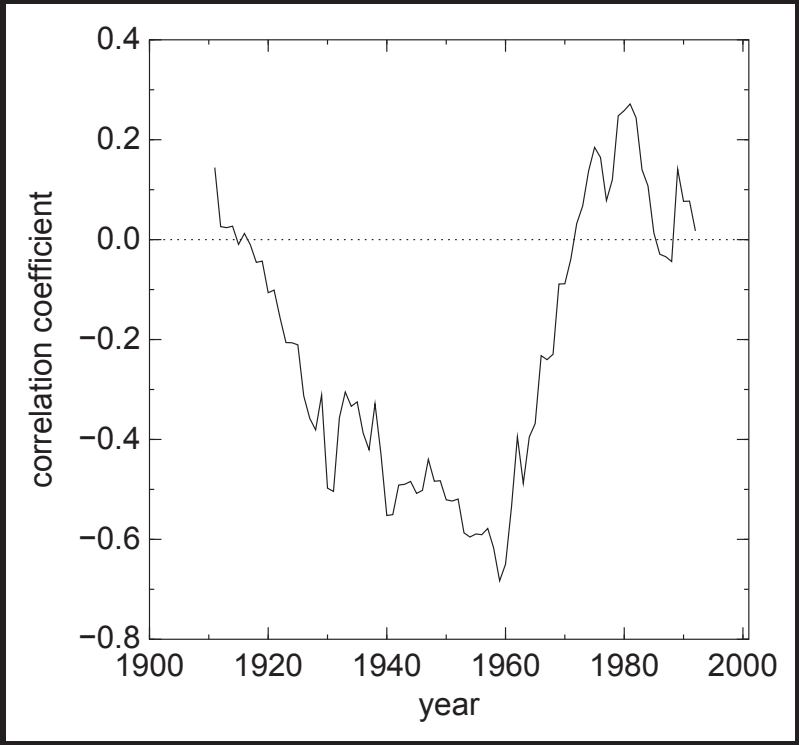
Correlation analysis of the observed interannual Summer (JAS) rainfall

correlation coefficient



Sahel–Guinea Coast



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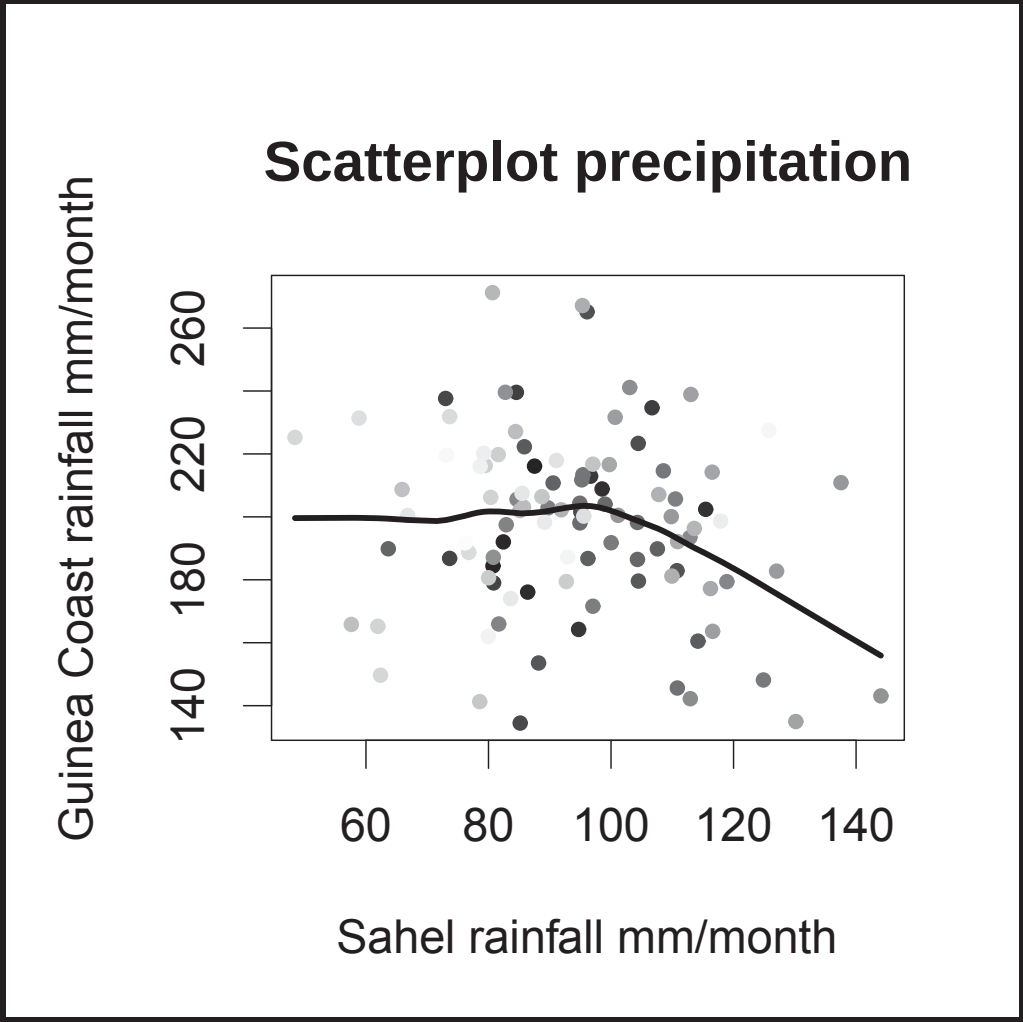
Scatterplot Sahel-Guinea Coast rainfall

non-filtered data used!



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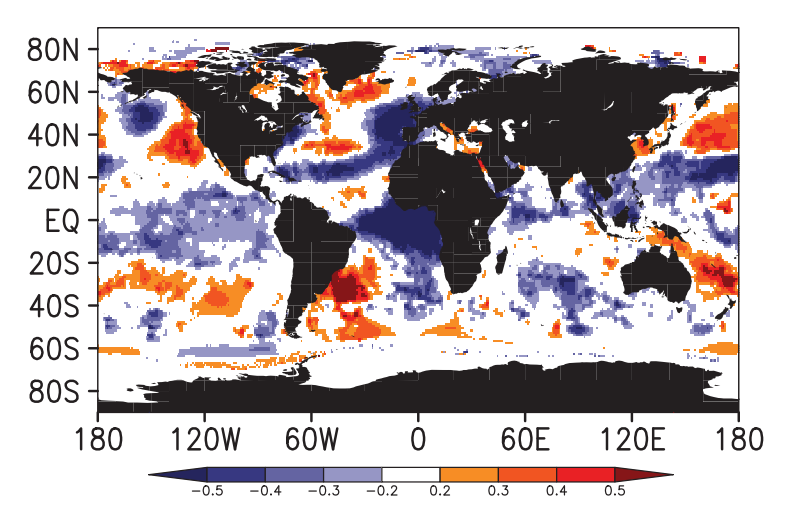
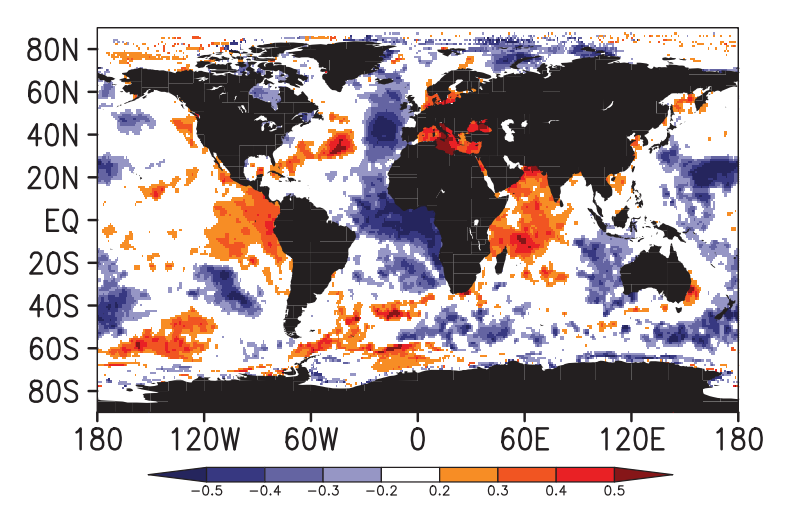
Correlation between JAS SSTs and the rainfall dipole pattern (PC1)

wet-mode (1950s)



dry-mode (1990s)



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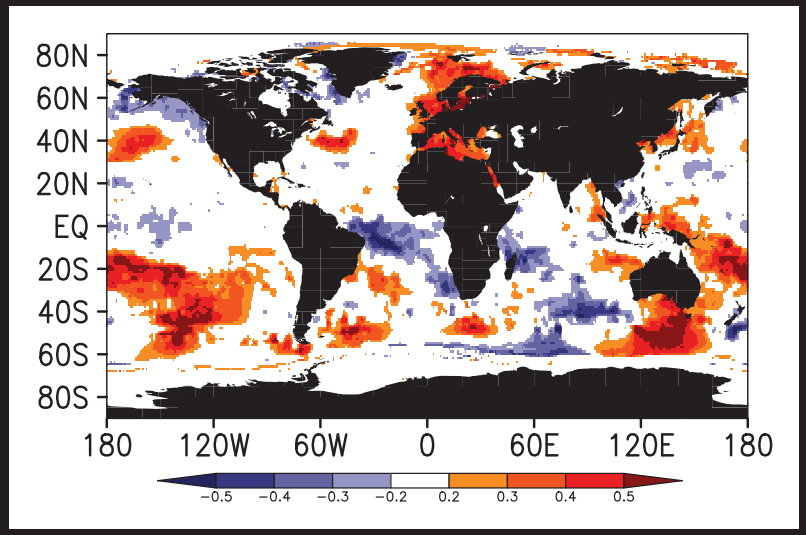
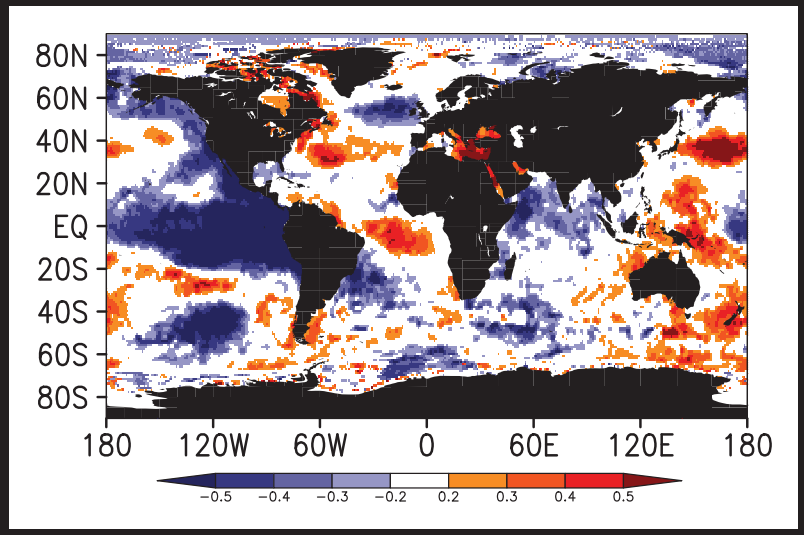
Correlation between JAS SSTs and the rainfall monopole pattern (PC2)

wet-mode (1950s)



dry-mode (1990s)



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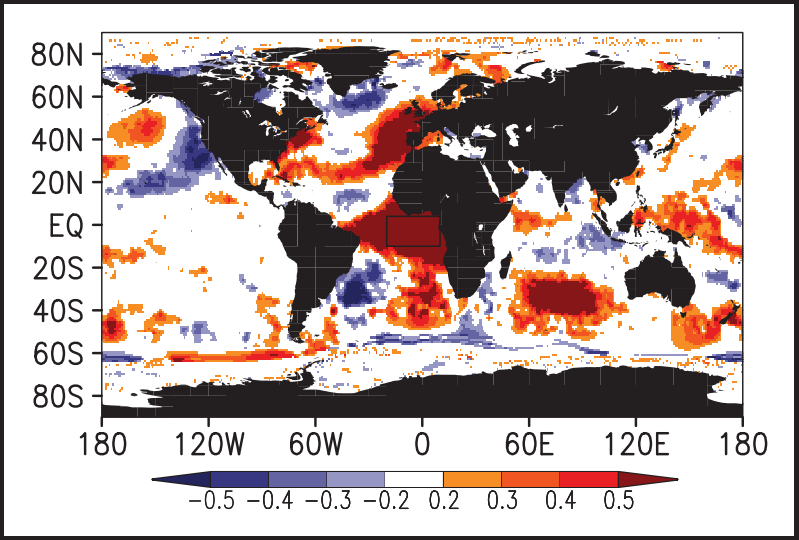
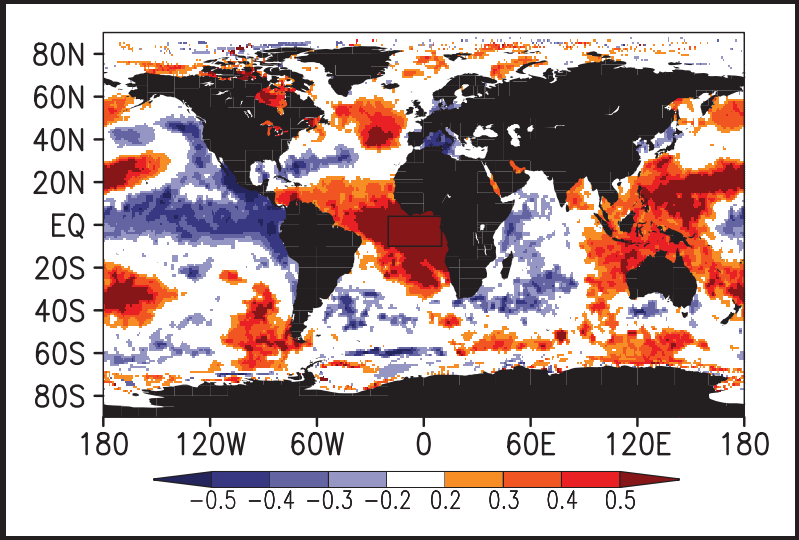
The covariability of interannual SSTs has changed

correlation between ETA SSTs and global SSTs (wet)



correlation between ETA SSTs and global SSTs (dry)



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hypothesis/scientific questions

- What role does the decadal change of the interannual covariability between SSTs play?
- Is the out-of-phase relationship between tropical South Atlantic SSTs and eastern Pacific SSTs in recent years the cause for the weakend dipole occurence?

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SST-sensitivity experiments

strategy: pick a year with a observed strong monopole or dipole pattern and try to simulate them by prescribing only SST anomalies:

1958 (dipole year), and 1997 (monopole year)

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SST sensitivity experiments with the AGCM ECHAM5

- ECHAM5 run in T42 horizontal resolution and 19 vertical level
- forced by different SST seasonal cycles (12 monthly values)
- other external forcing kept constant e. g GHGs
- integration length 21 years, first year is cut off.
- only the summer (JAS) response is shown

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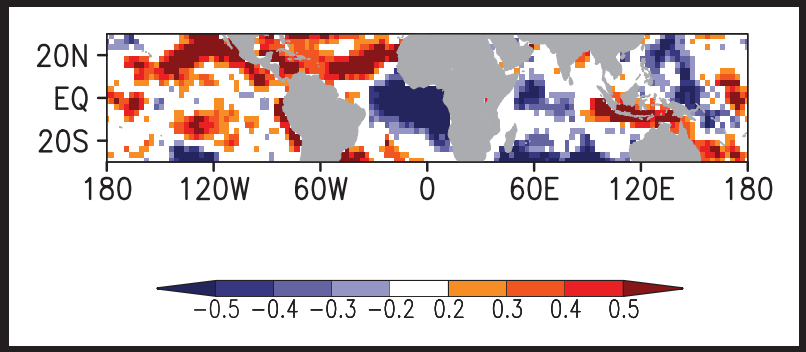
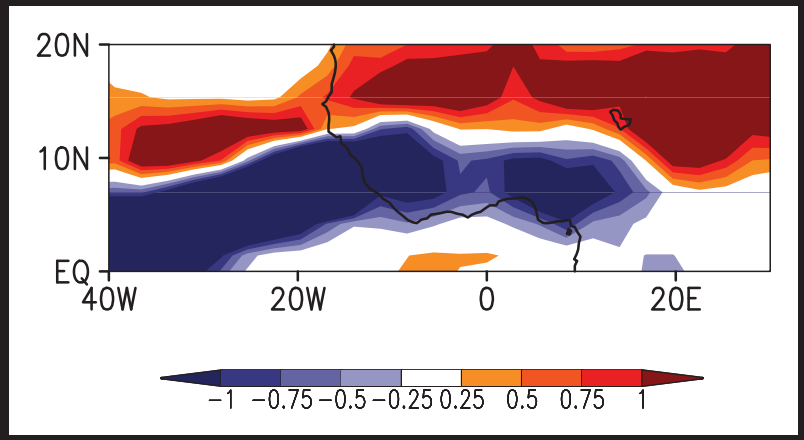
Simulation of the dipole rainfall anomaly in 1958

interannual SST anomaly in 1958



simulated rainfall anomaly



ECHAM is able to simulate the observed dipole pattern over WA

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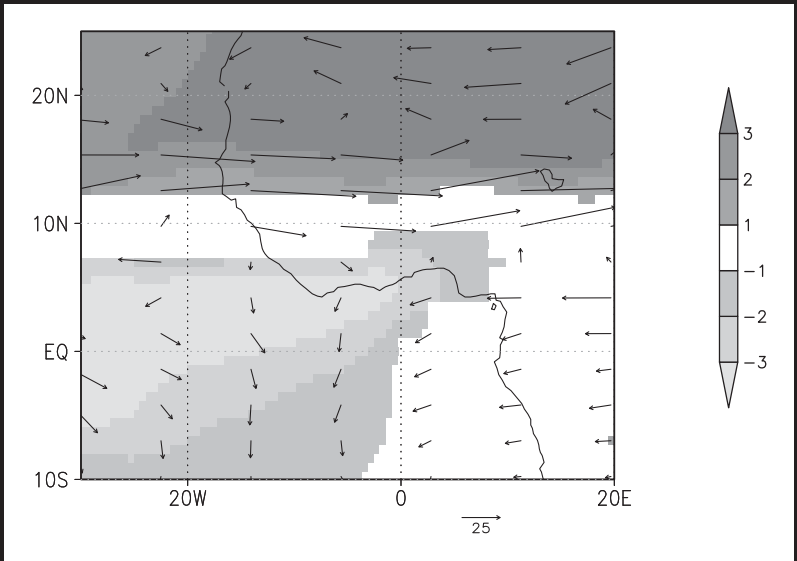
Simulated JAS humidity flux and precipitable water response

units $\frac{kg}{kg}\frac{m}{s}$ and kg/m^2



- reduced humidity flux to the Guinea Coast
- enhanced humidity flux to the west Sahel

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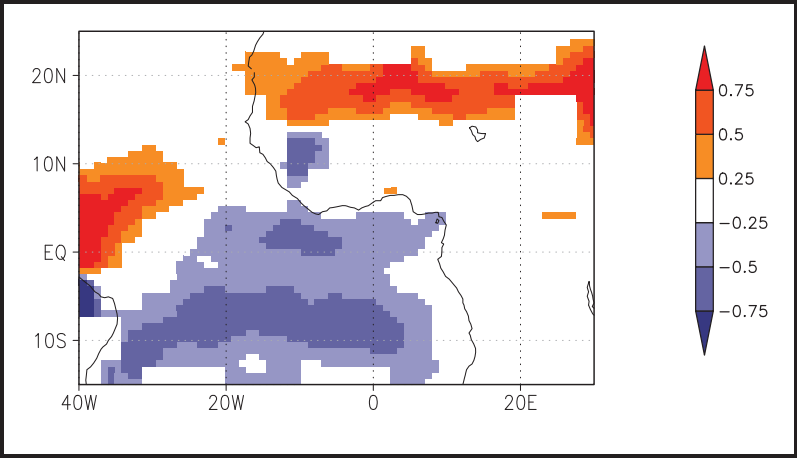
Simulated JAS evaporation response

units *mm/day*



- reduced evaporation over the tropical South Atlantic ocean

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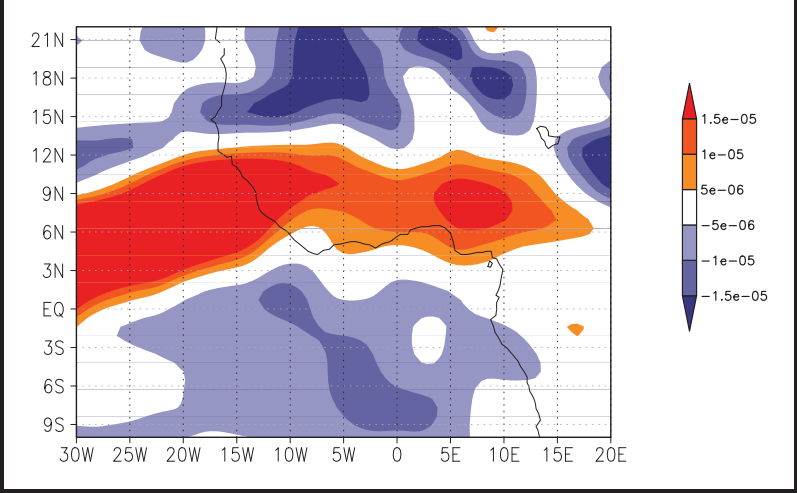
Simulated JAS vertically integrated horizontal moisture divergence response

units m/s^2



- reduced moisture convergence along the Guinea Coast
- enhanced moisture convergence over the west Sahel

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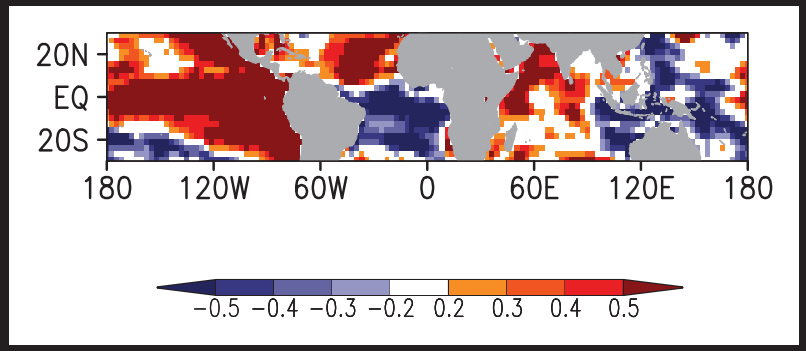
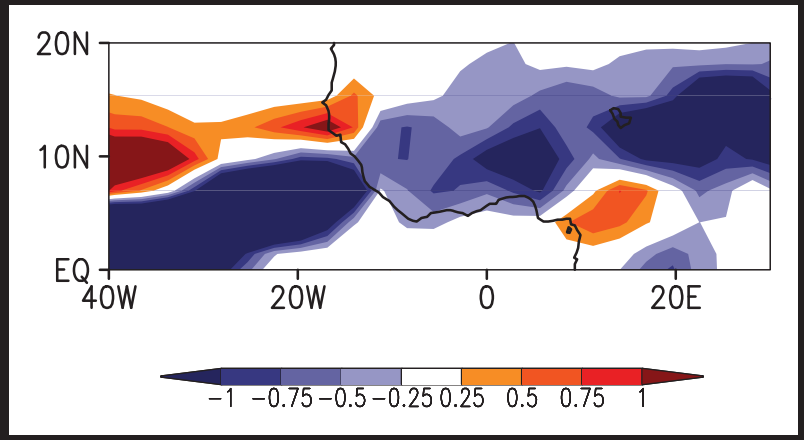
Simulation of the monopole rainfall anomaly in 1997

interannual SST anomaly in 1997



simulated rainfall anomaly



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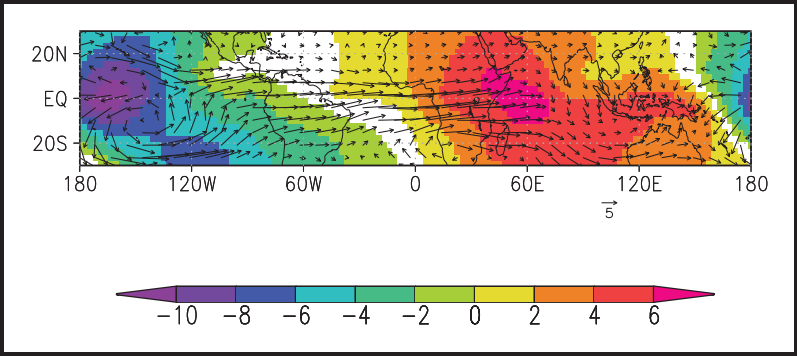
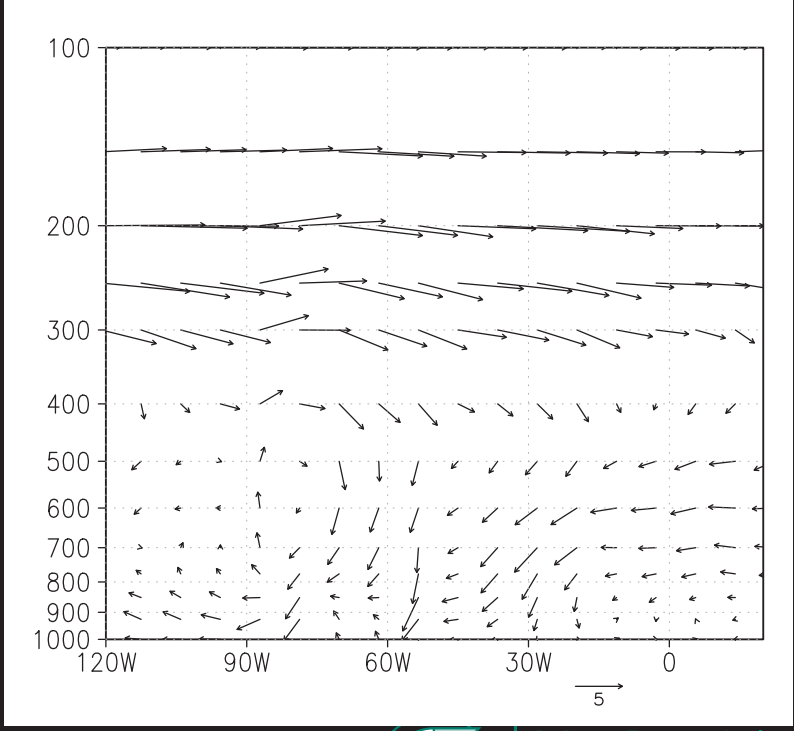
Velocity potential and circulation response for 1997 (monopole pattern)

JAS velocity potential response 200hpa (scaled)



JAS wind x-p cross-section response



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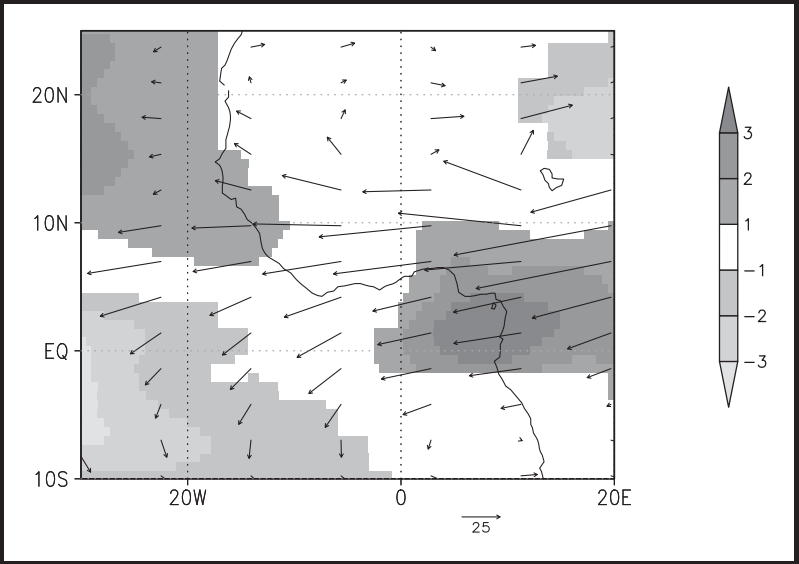
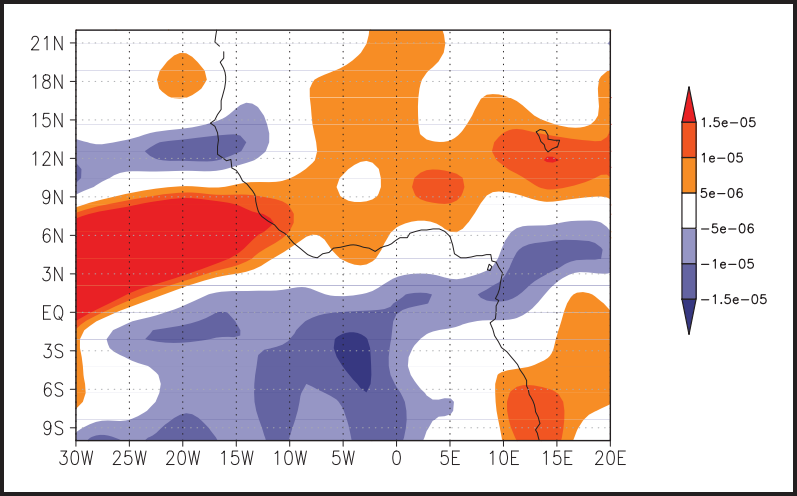
Humidity Flux and Moisture divergence for 1997

Simulated JAS Moisture flux response



Simulated JAS moisture divergence



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Conclusions

- changes in the decadal emergence of interannual rainfall anomaly patterns over west Africa
- simulations show significant impact of SSTs on the interannual rainfall patterns
- covariability changes of the interannual SSTs seems to be an important cause of the decadal emergence changes of the interannual rainfall patterns

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Thank you very much for your attention!

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