



The role of the oceanic background state on the Atlantic Equatorial Mode impacts

Belén Rodríguez-Fonseca ^(1,2), Teresa Losada ⁽³⁾ and Juergen Bader ⁽⁴⁾

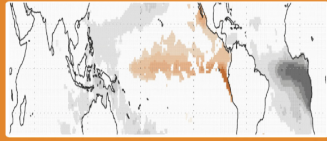
⁽¹⁾ Departamento de Geofísica y Meteorología, UCM, Madrid

⁽²⁾ Instituto de Geociencias (CSIC-UCM)

⁽³⁾ Instituto de Ciencias Ambientales (ICAM), Universidad de Castilla-La Mancha.

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OBSERVATIONAL EVIDENCE

The impact of the tropical Atlantic on the West African rainfall

The Equatorial Mode (EM):

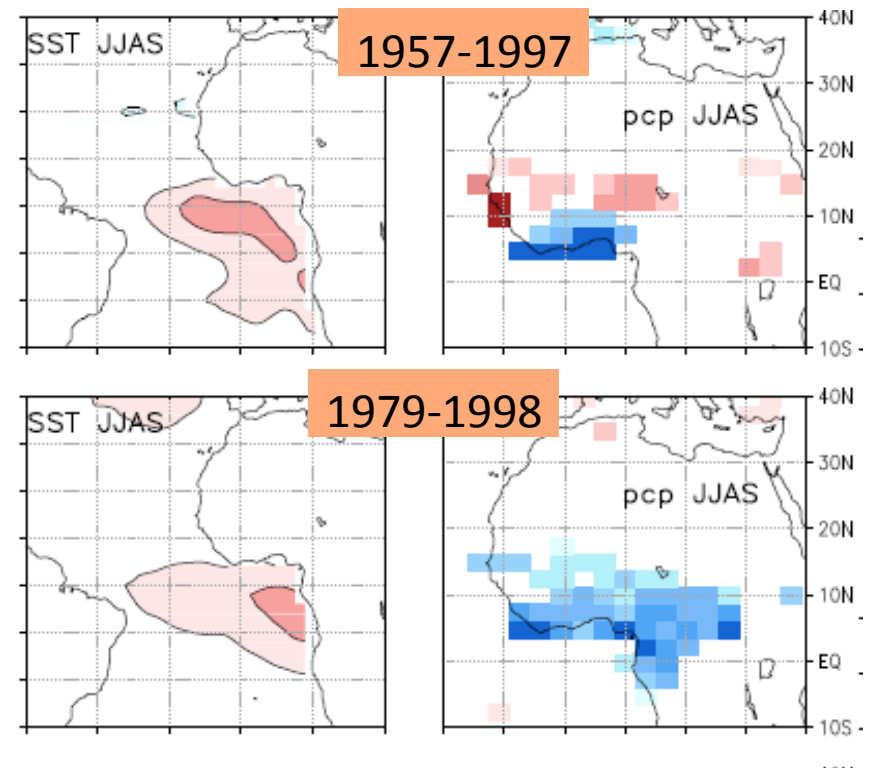
Interannual Tropical Atlantic Variability (TAV) mode

--Anomalous warming or cooling of the SSTs in the equatorial Atlantic.

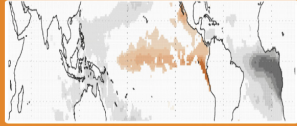
--Maximum in boreal summer

Impact of the EM on WAM:

Anomalous rainfall dipole with positive anomalies over the Guinean Gulf region and negative ones over the Sahel



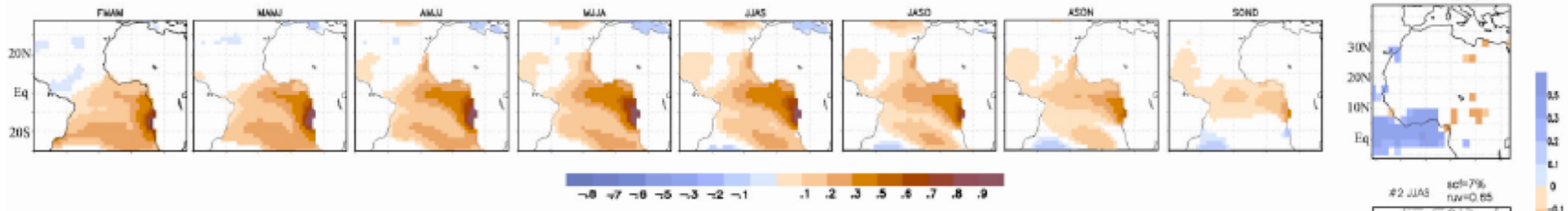
Mohino, E., B. Rodriguez-Fonseca, T. Losada, S. Gervois, S. Janicot, J. Bader, P. Ruti, F. Chauvin, 2011: Changes in the interannual SST-forced signals on West African rainfall. AGCM intercomparison. Climate Dynamics. DOI: [10.1007/s00382-011-1093-2](https://doi.org/10.1007/s00382-011-1093-2)



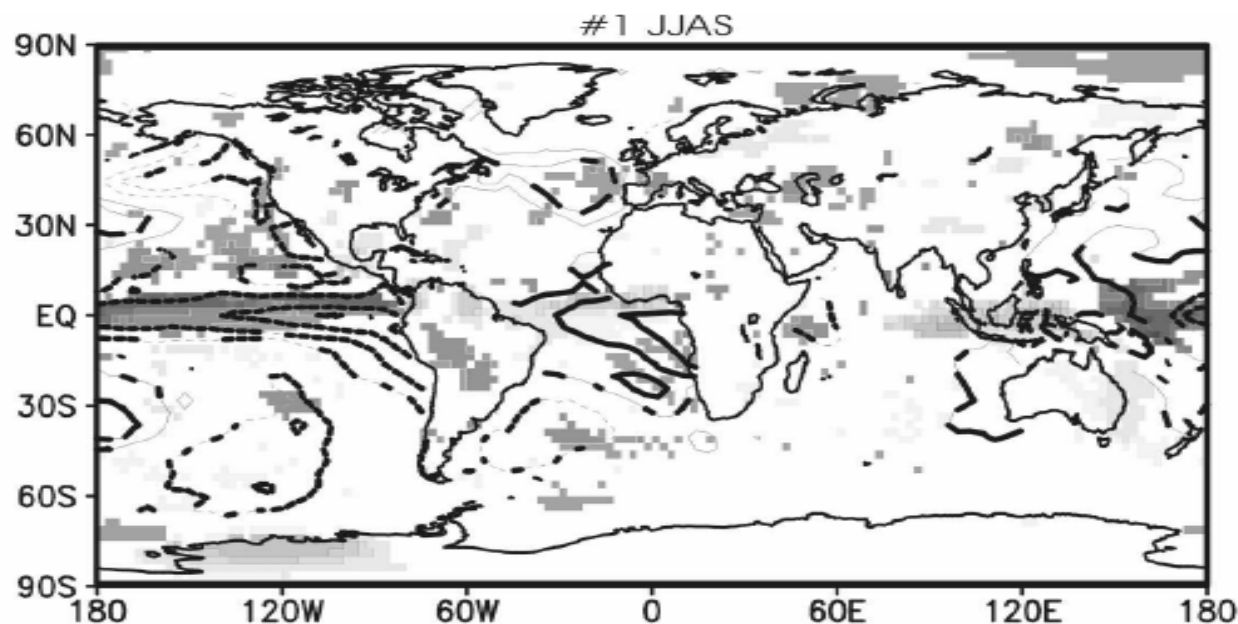
OBSERVATIONAL EVIDENCE

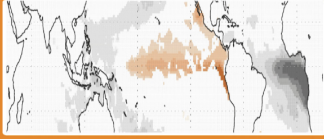
The impact of the tropical Atlantic on the West African rainfall

1979-2002: Evolution of Leading SST mode of covariability with JJAS rainfall

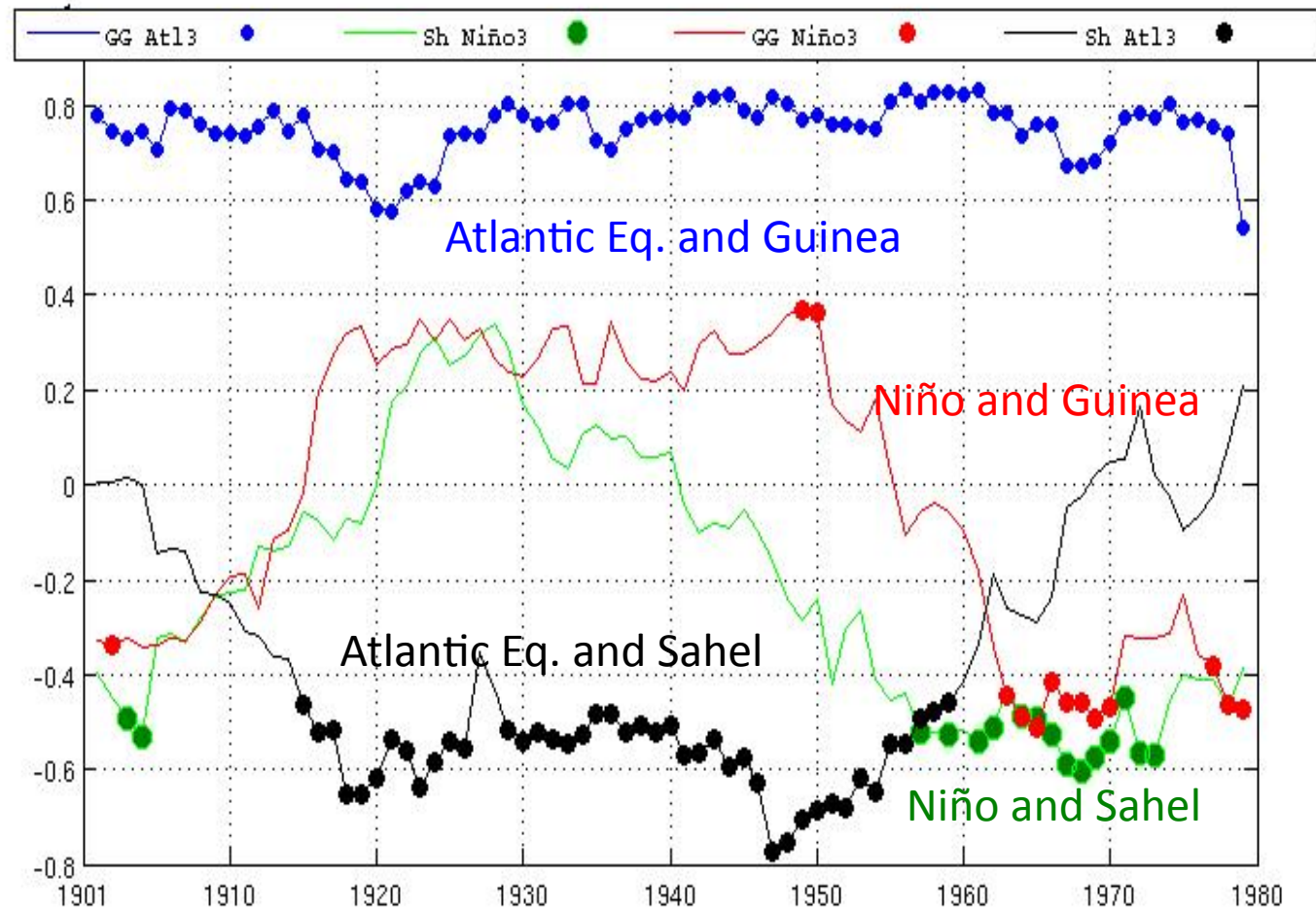


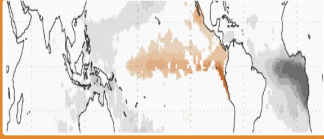
Polo I., B. Rodríguez-Fonseca, T. Losada, J. García-Serrano, **2008**: Tropical Atlantic Variability Modes. Part I: Time-evolving SST patterns related to West African rainfall. Journal of Climate



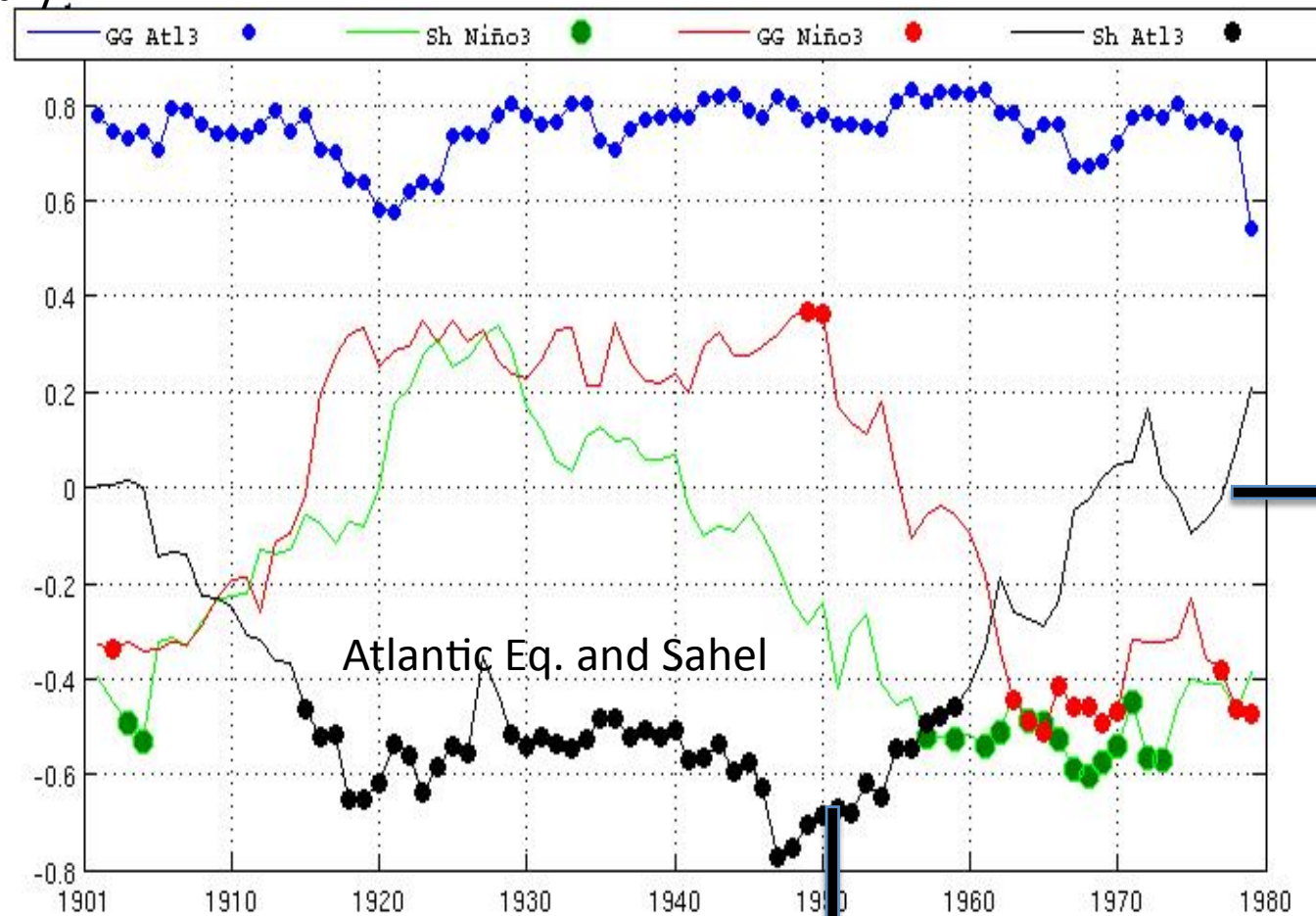


OBSERVATIONAL EVIDENCE



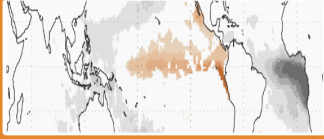


Recent studies have determined how the atmospheric response to the Atlantic Equatorial Mode is non-stationary.

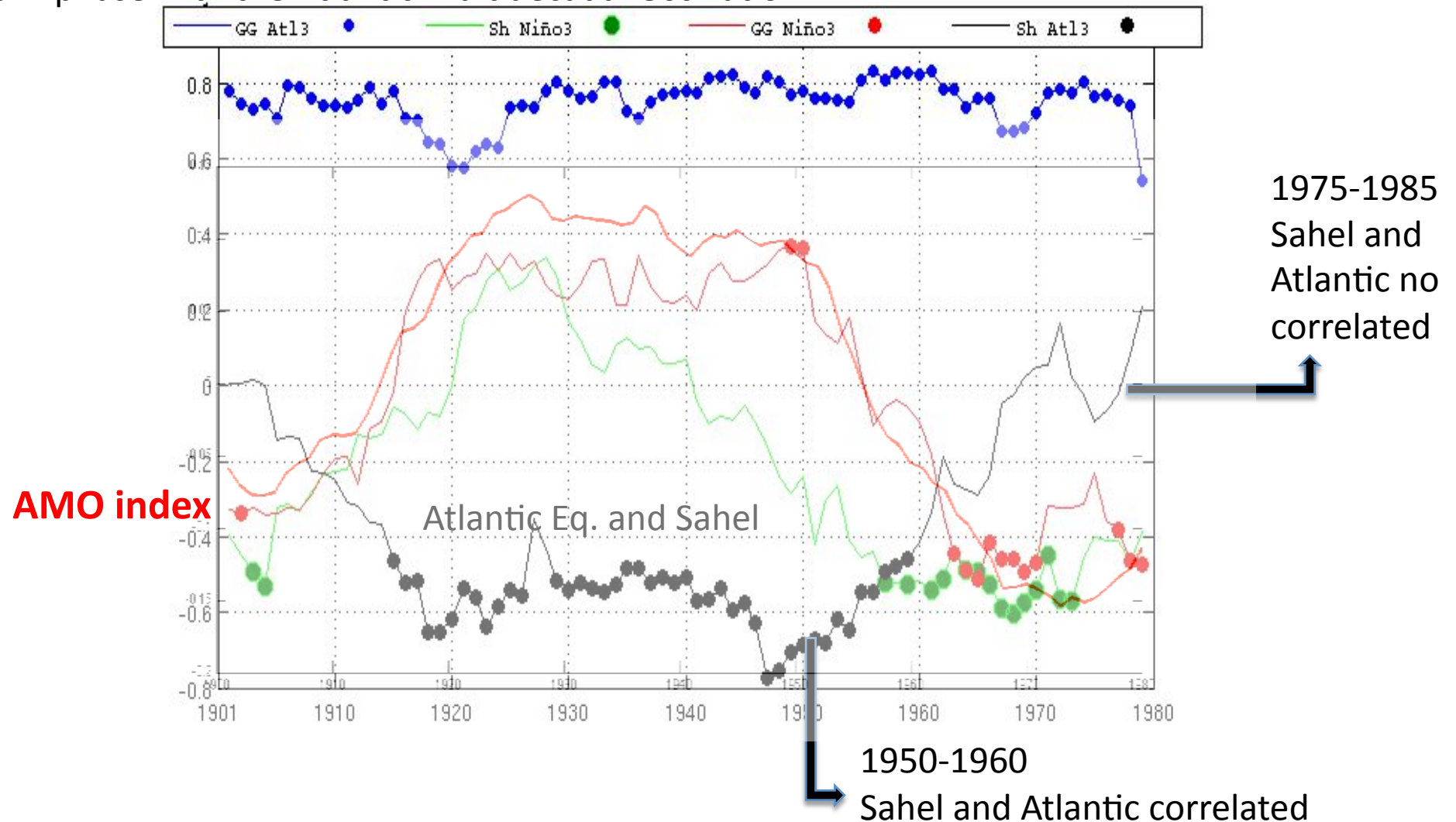


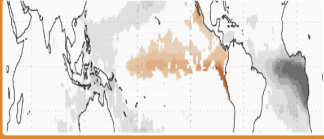
1975-1985
Sahel and
Atlantic no
correlated

1950-1960
Sahel and Atlantic correlated



The modulation of the Pacific impact on WAM and of the Equatorial Atlantic impact on Sahel goes in phase with the Atlantic Multidecadal Oscillation

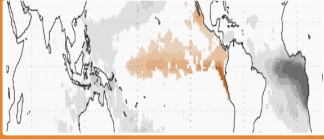




Question to address

What is the role of the background state of the global SST modulating the Equatorial Mode
Impact on WAM?

Do different background states produce different impacts of the same Equatorial mode?



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What is the role of the background state of the global SST modulating the Equatorial Mode Impact on WAM?

Do different background states produce different impacts of the same Equatorial mode?

Warm Equatorial
Mode

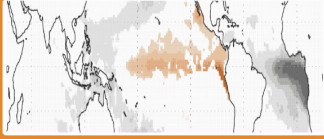
+

Warm
Background
state

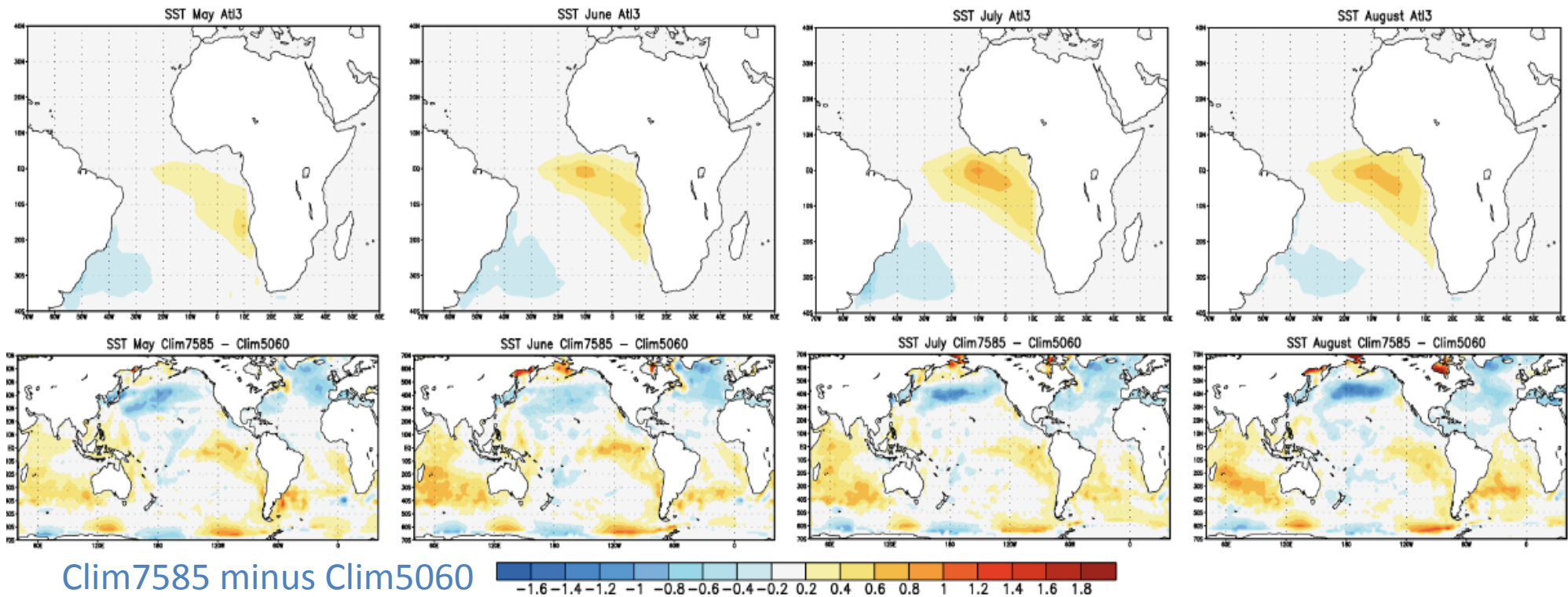
Warm Equatorial
Mode

+

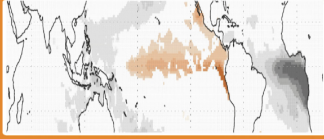
Cold
Background
state



Design of the Experiments



- Atl+Clim5060: 10 runs ,same interannual anomaly over the Atlantic ,plus 1950-1960 climatology
- Atl+Clim7585: 10 runs ,same interannual anomaly over the Atlantic , plus 1975-85 climatology
- Clim7585: 10 runs with global climatology of 1950-1960
- Clima5060: 10 runs with global climatology of 1975-1985

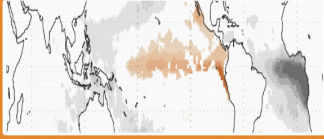


Interpretation of the results

Results

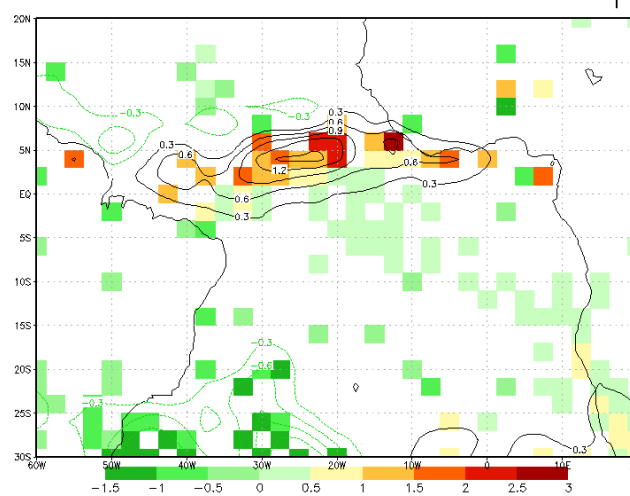
$$(\text{Atl} + \text{Clim7585}) - (\text{Atl} + \text{Clim5060}) = \text{Clim7585} - \text{Clim5060} + \text{Residual}$$

Residual: non linear part due to different responses of the Atlantic Equatorial mode when adding a cooler or warmer background state.

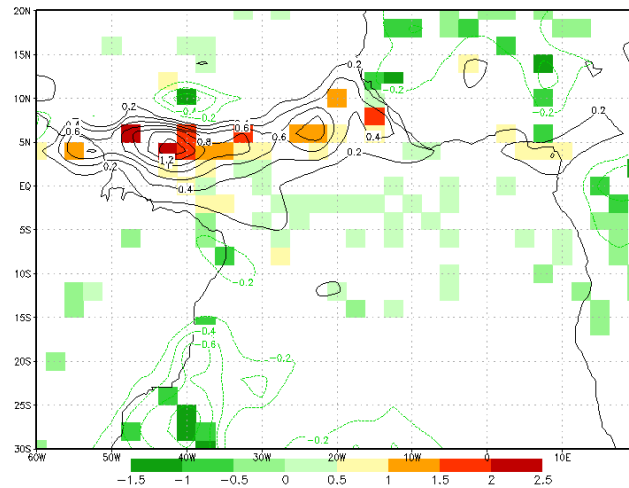


Interpretation of the results

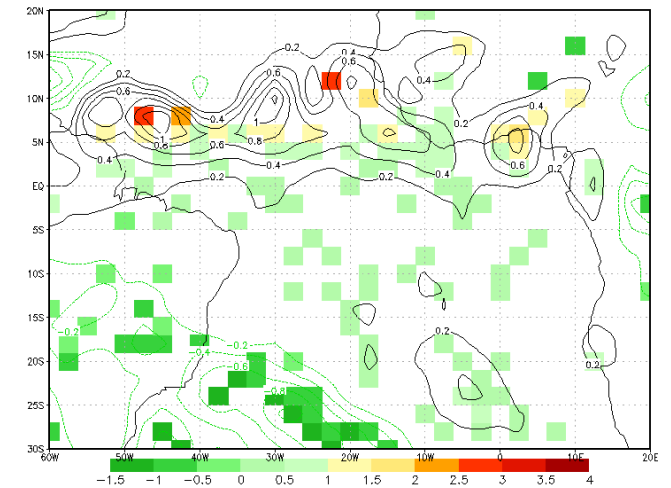
Atl3Cli7585 min Cli7585 June



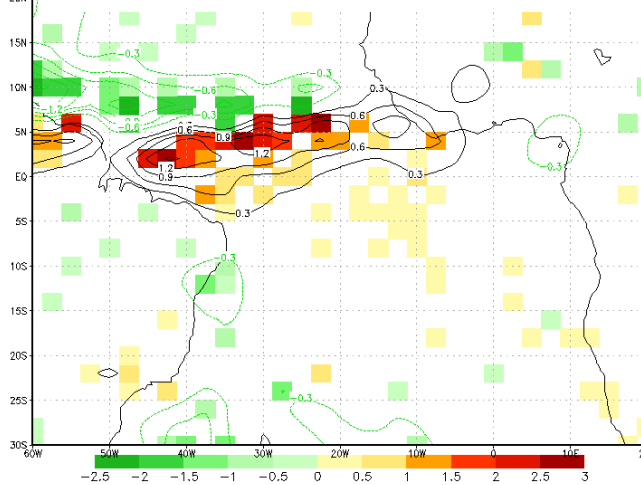
Atl3Cli7585 min Cli7585 July



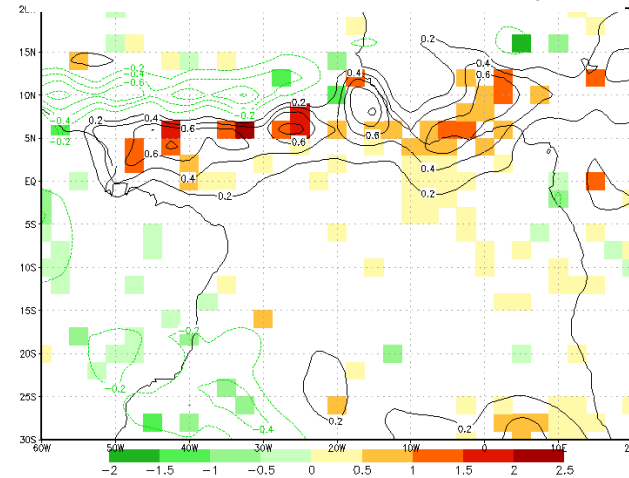
Atl3Cli7585 min Cli7585 August



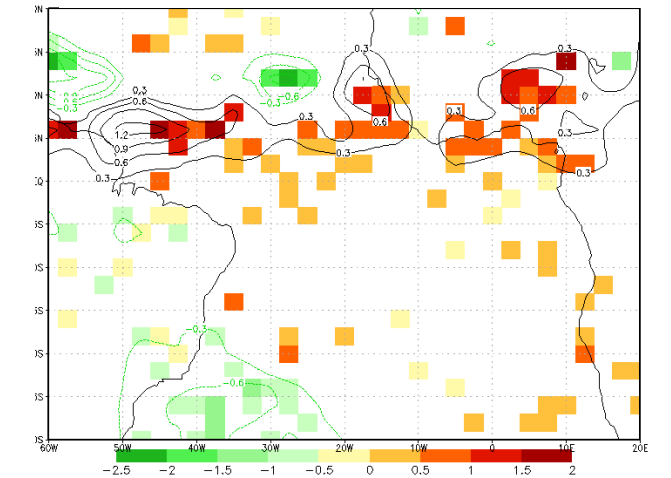
Atl3Cli5060 min Cli5060 June

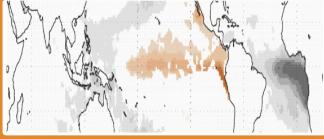


Atl3Cli5060 min Cli5060 July



Atl3Cli5060 min Cli5060 August



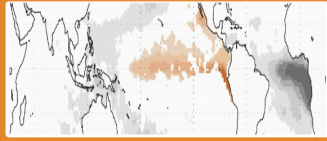


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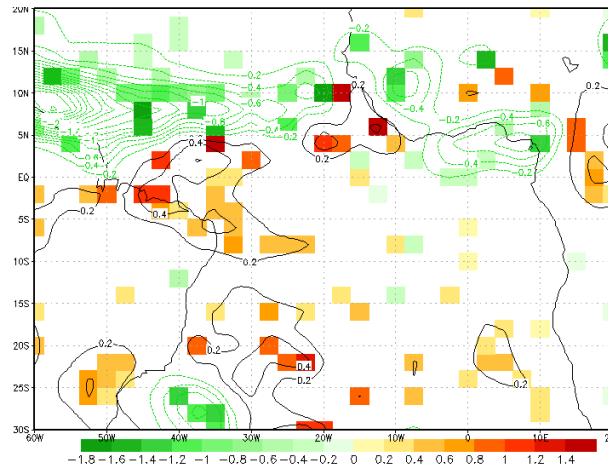
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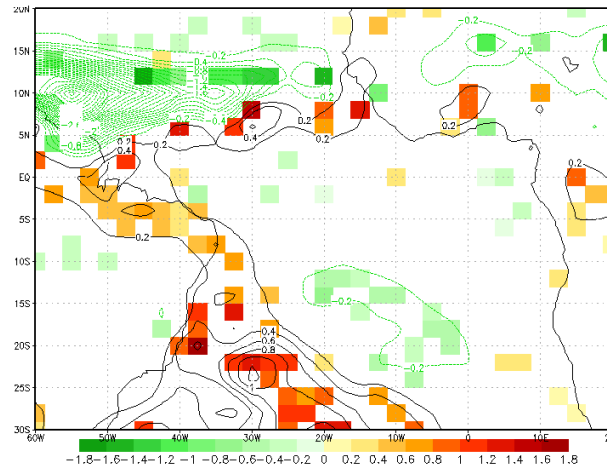


Clim1975_1985 minus Clim1950_1960:
significant decrease of rainfall over Sahel
(agreement with Mohino et al 2011b)

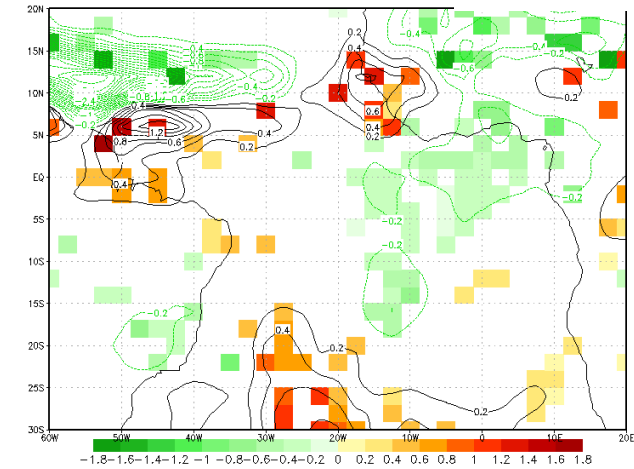
Clim 1975_85 – Clim 1950_60 June



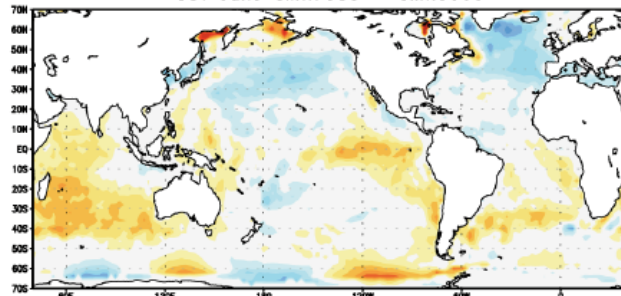
Clim 1975_85 – Clim 1950_60 July



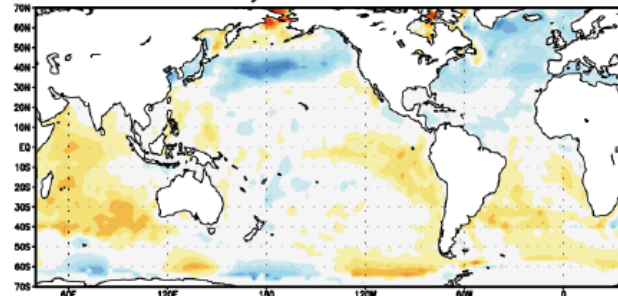
Clim 1975_85 – Clim 1950_60 August



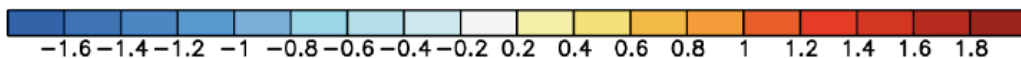
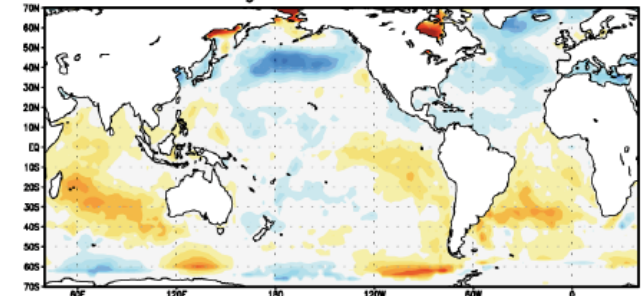
SST June Clim7585 – Clim5060

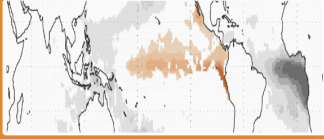


SST July Clim7585 – Clim5060



SST August Clim7585 – Clim5060



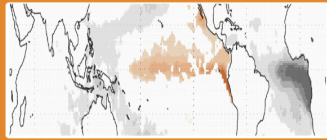


Interpretation of the results

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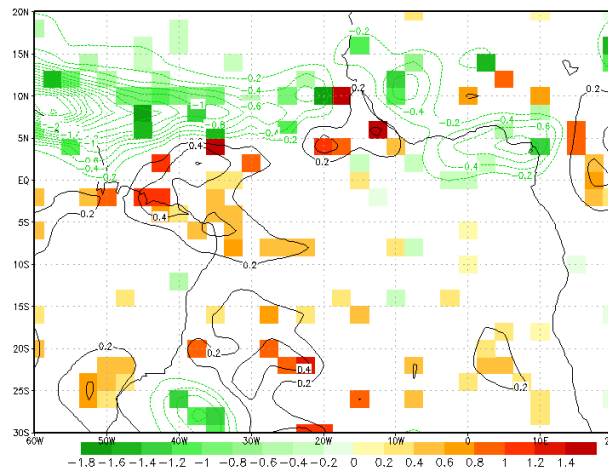
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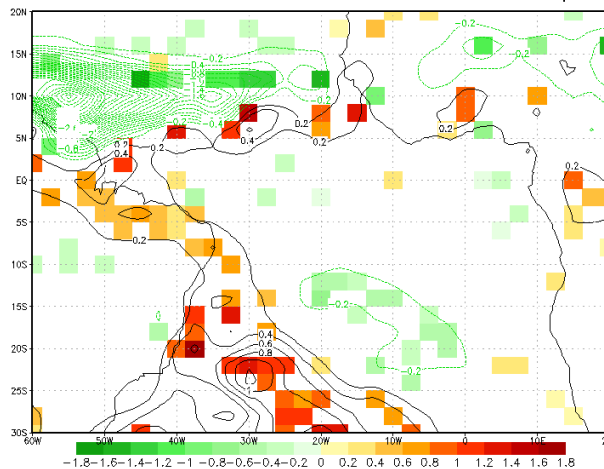


(Atl3+clim1975_85)_minus_(Atl3+ Clim1950_1960):
more significant regions with a decrease of rainfall over
the Sahel

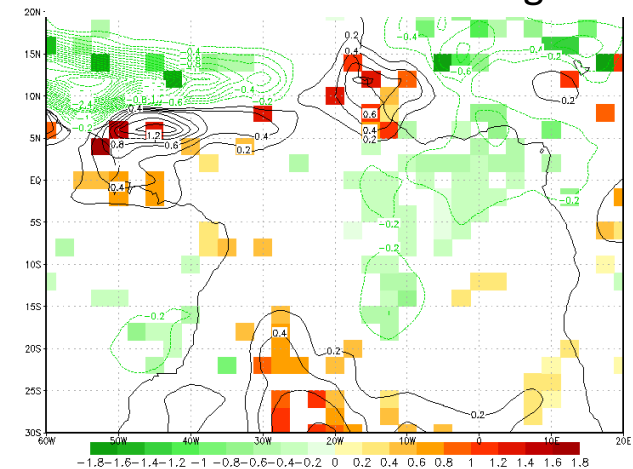
Clim 1975_85 – Clim 5060 June



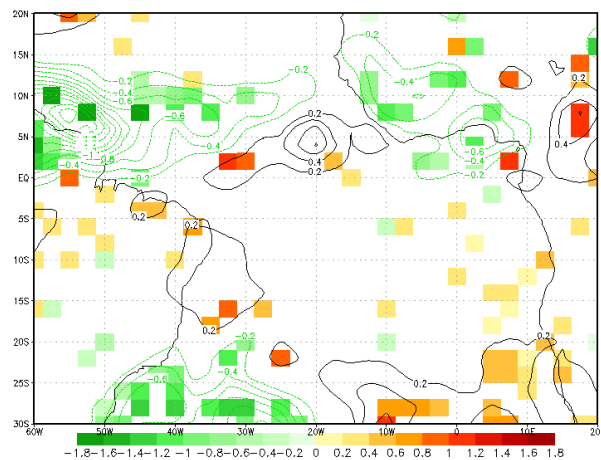
Clim 7585 – Clim 5060 July



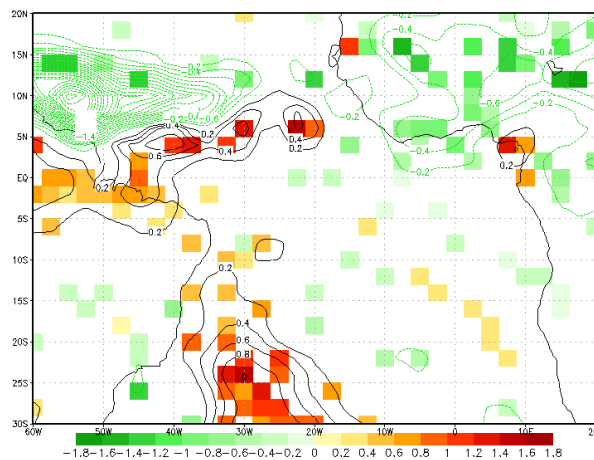
Clim 7585 – Clim 5060 August



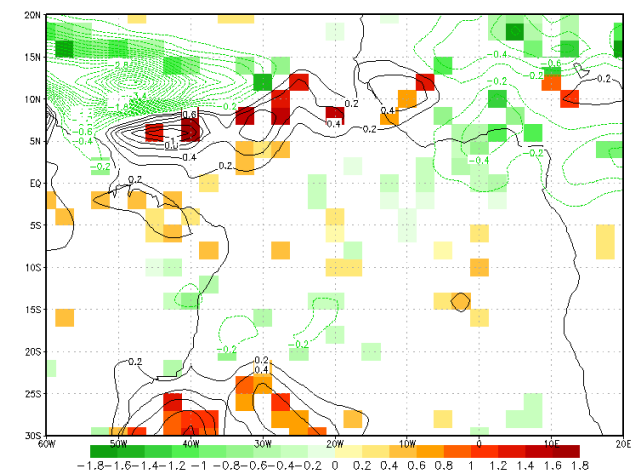
Atl3Cli 7585 – Atl3Cli 5060 June

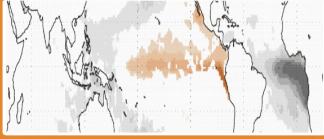


Atl3Cli 7585 – Atl3Cli 5060 July



Atl3Cli 7585 – Atl3Cli 5060 August



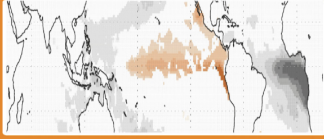


Interpretation of the results

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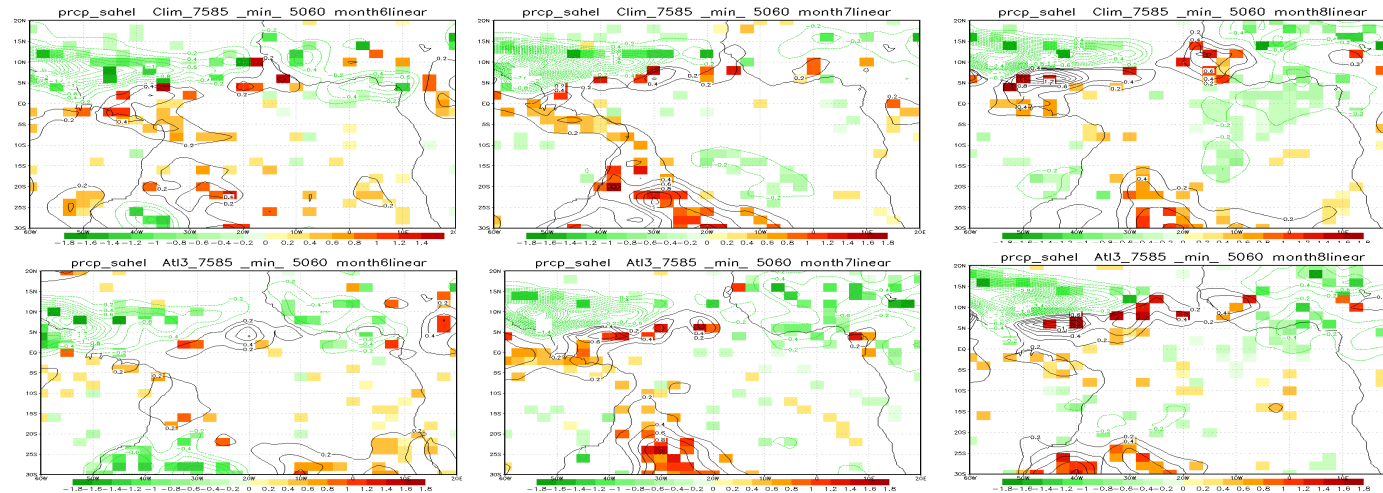
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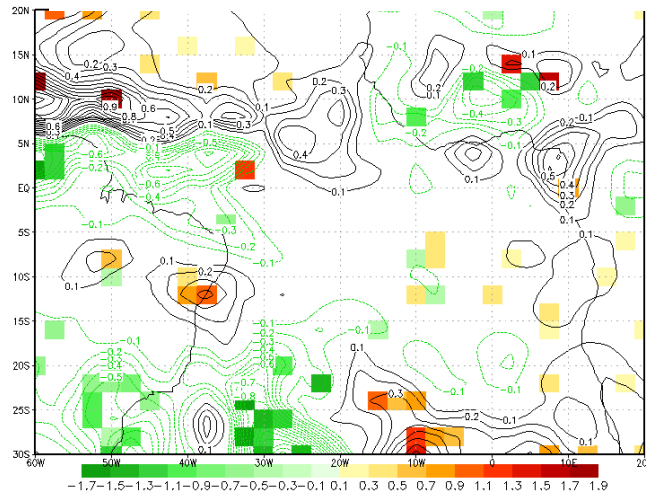
Residuals:
significant decrease of rainfall over the whole WA

A Clim

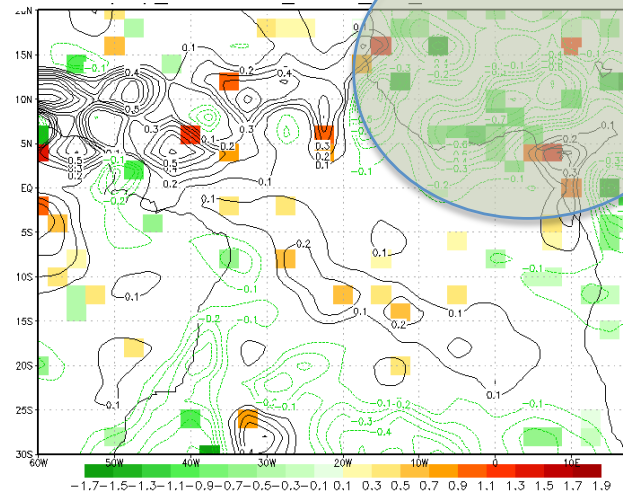


B AtI3clim

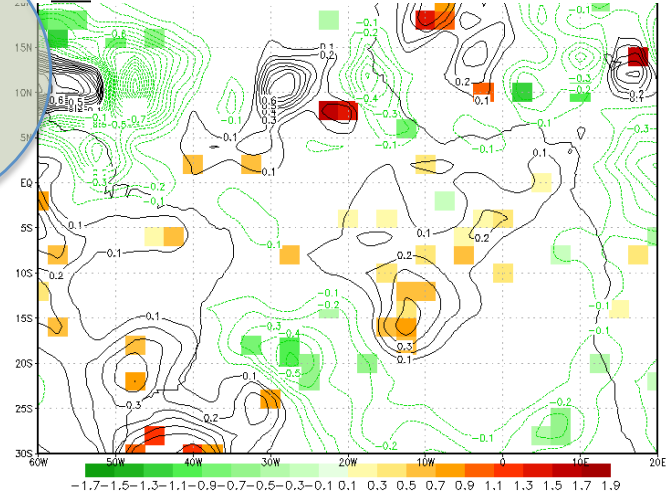
A-B June

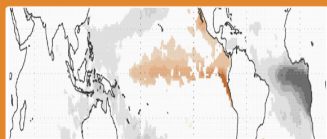


A-B July

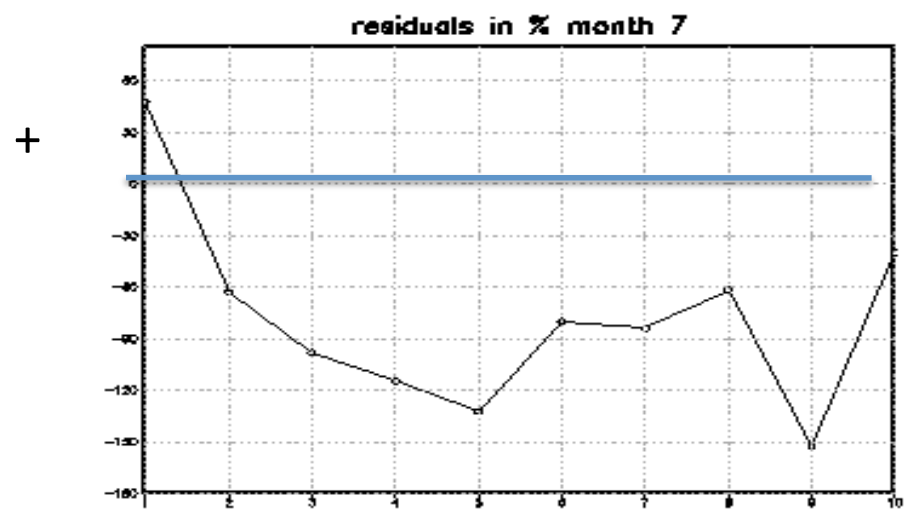
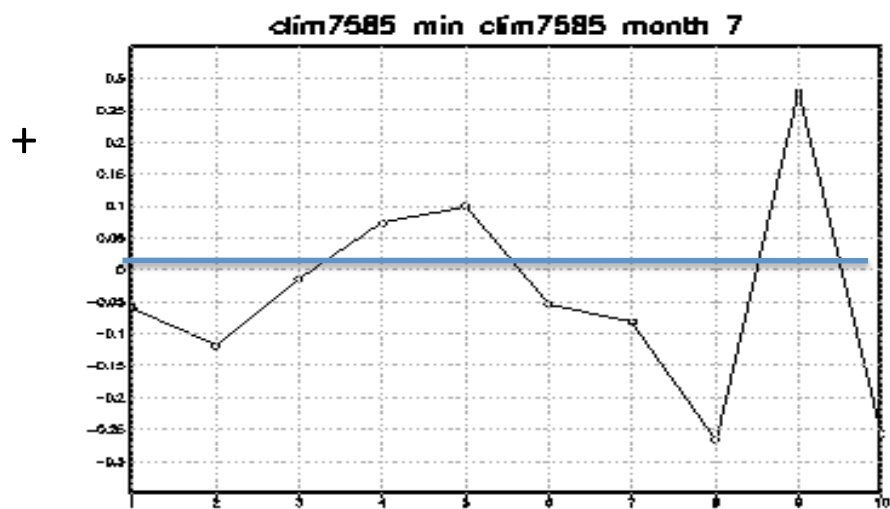
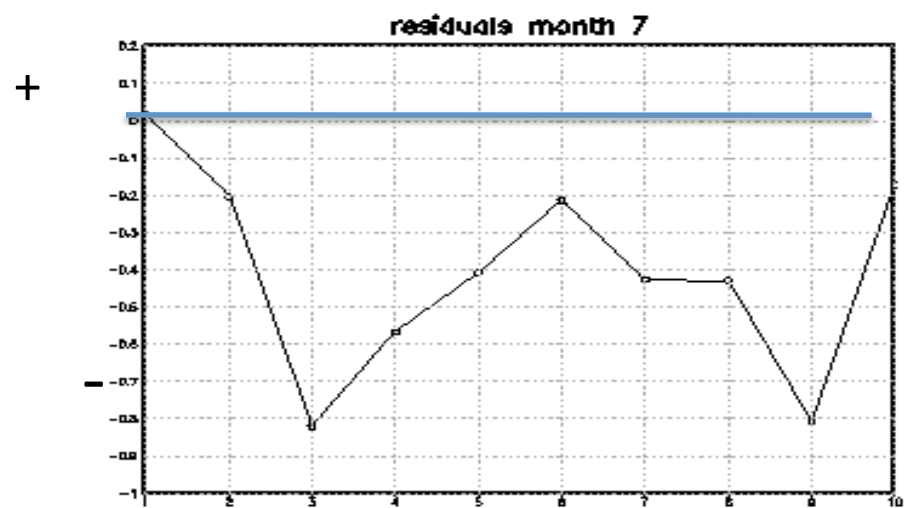
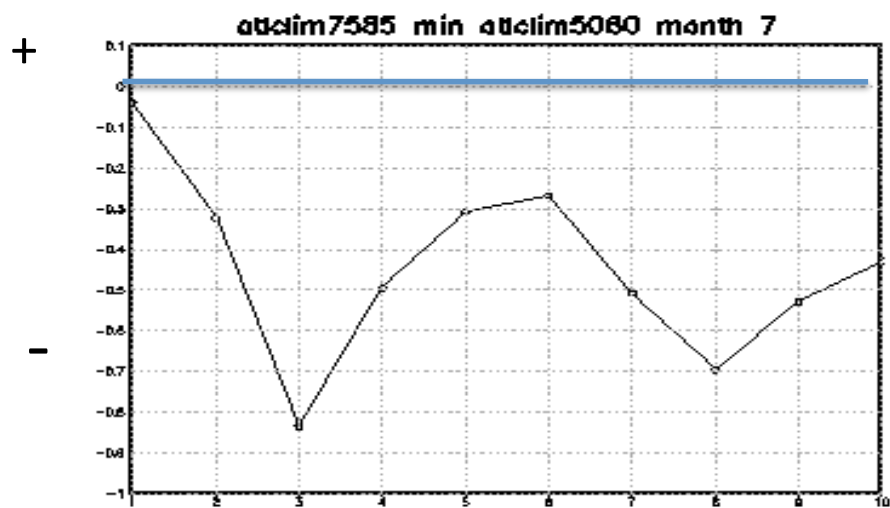


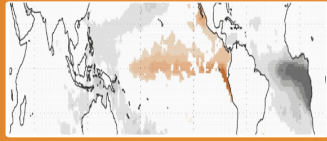
A-B August





Robustness of the results Analysis of each of the members





Discussions and Conclusions

The Atlantic Equatorial mode exerts a different influence on the Sahelian rainfall depending on the decades considered

During positive phases of the AMO, the Atlantic EM is significantly correlated with the variability of rainfall over the Sahel

During the negative phases of the AMO, the Atlantic EM and Sahelian rainfall presents no correlation, due to the counteracting effect of the Pacific.

Nevertheless, in the present study we demonstrate, using an ensemble of simulations with the same EM and different climatologies, that the same EM superimposed to different (positive and negative phases of the AMO) background state produces a different response over the whole WA region