DECADAL / INTERDECADAL VARIABILITY OF PRECIPITATION OVER SOUTH AMERICA: SEASONALITY AND LINKAGES WITH SST

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MOTIVATION

- Interdecadal oscillations of rainfall have been reported in some regions of South America (SA), but a comprehensive assessment of interdecadal climate variability in the continent has not been carried out so far.

- As there is interdecadal modulation of ENSO, interdecadal climate variability in SA should also be expected from the interdecadal modulation of ENSO impacts.

- The main source of energy in South America is hydroelectric. Besides, Brazilian hydroelectric power distribution networks are interconnected. Thus, more detailed knowledge of the temporal and spatial patterns of interdecadal precipitation variability is useful in medium/long term planning of hydroelectric plants, as well as in water resources management.

OBJECTIVES

- To characterize the interdecadal climate variability in South America in terms of temporal scales and spatial patterns, on the basis of relatively long series of rain gauge data;

- To characterize the seasonality of the interdecadal variability;

- To verify links between the SA interdecadal variability and known modes of large-scale interdecadal climate variability, specially in SST, as well as with well known indices of climate variability (NAO, PDO, AMO).

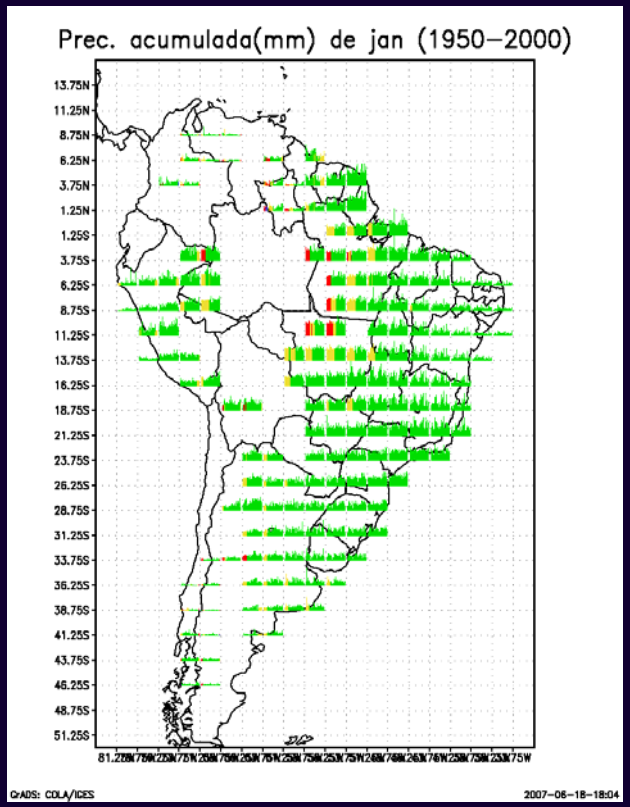
DATA

- **Precipitation:**
  Monthly totals from more than 10,000 stations over most of South America are gridded to 2.5°×2.5° lat-long (1950-2000).
- **Missing data:**
  Filled, when possible, from regression onto data of neighbor stations, to avoid significant inhomogeinities in the gridded data.
- **Sea Surface Temperature:**
  HadISST1.

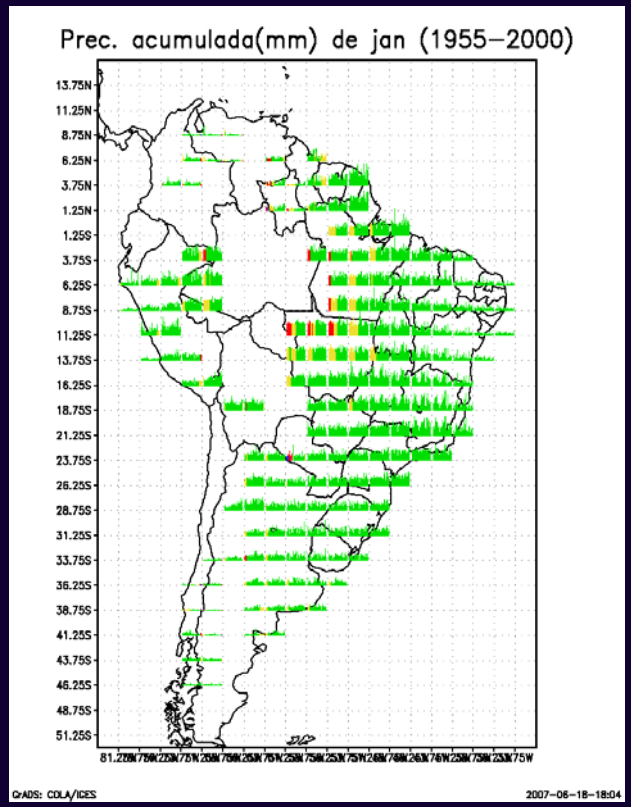
METHODS

- Spectral analysis (Blackman-Tuckey and wavelets)
- Gaussian filter (retains T ≥ 8 years)
- EOF analysis
- Correlation analysis

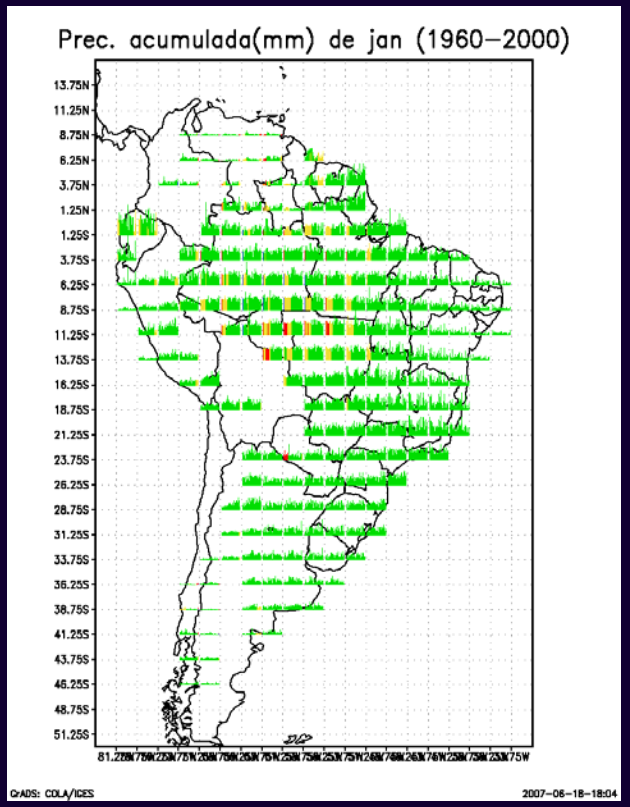
DATA



(1950-2000)

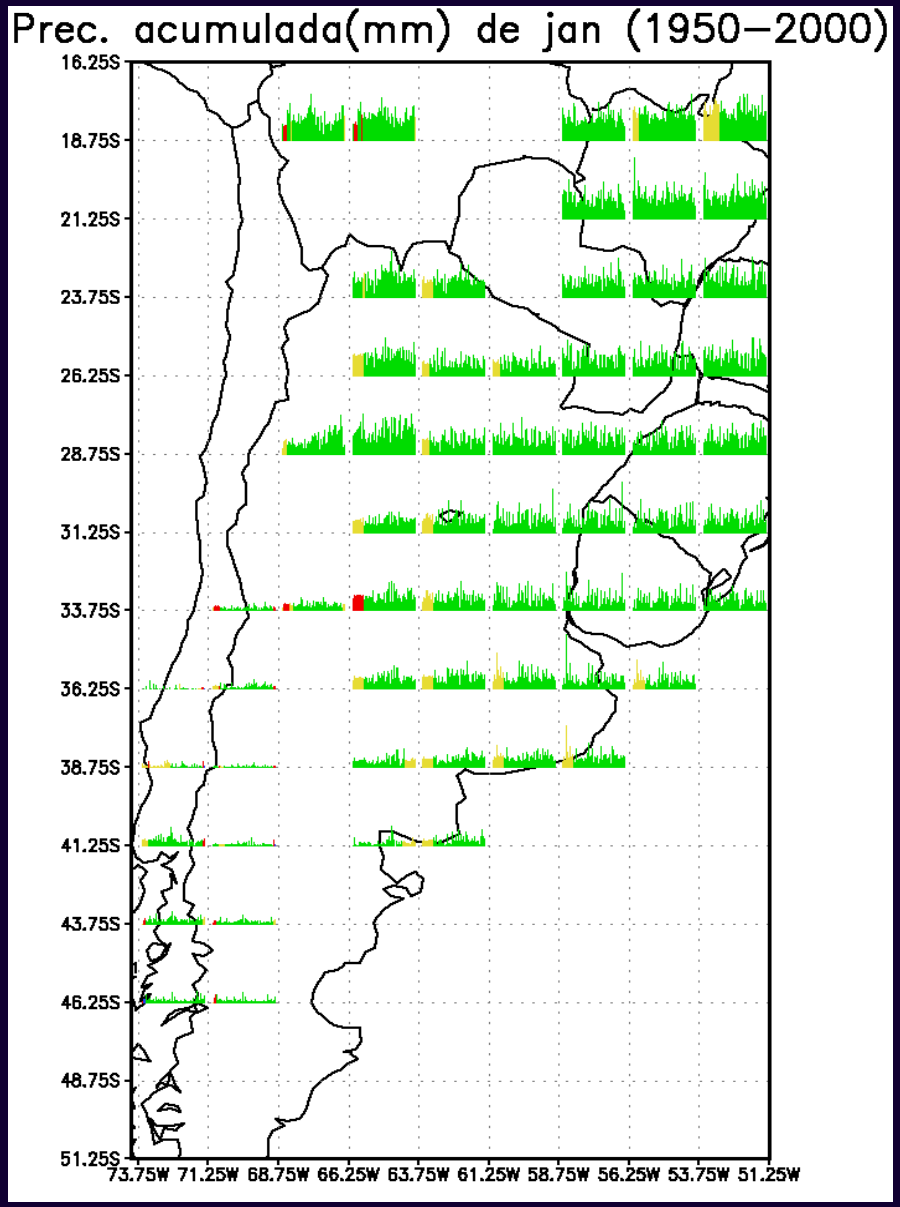


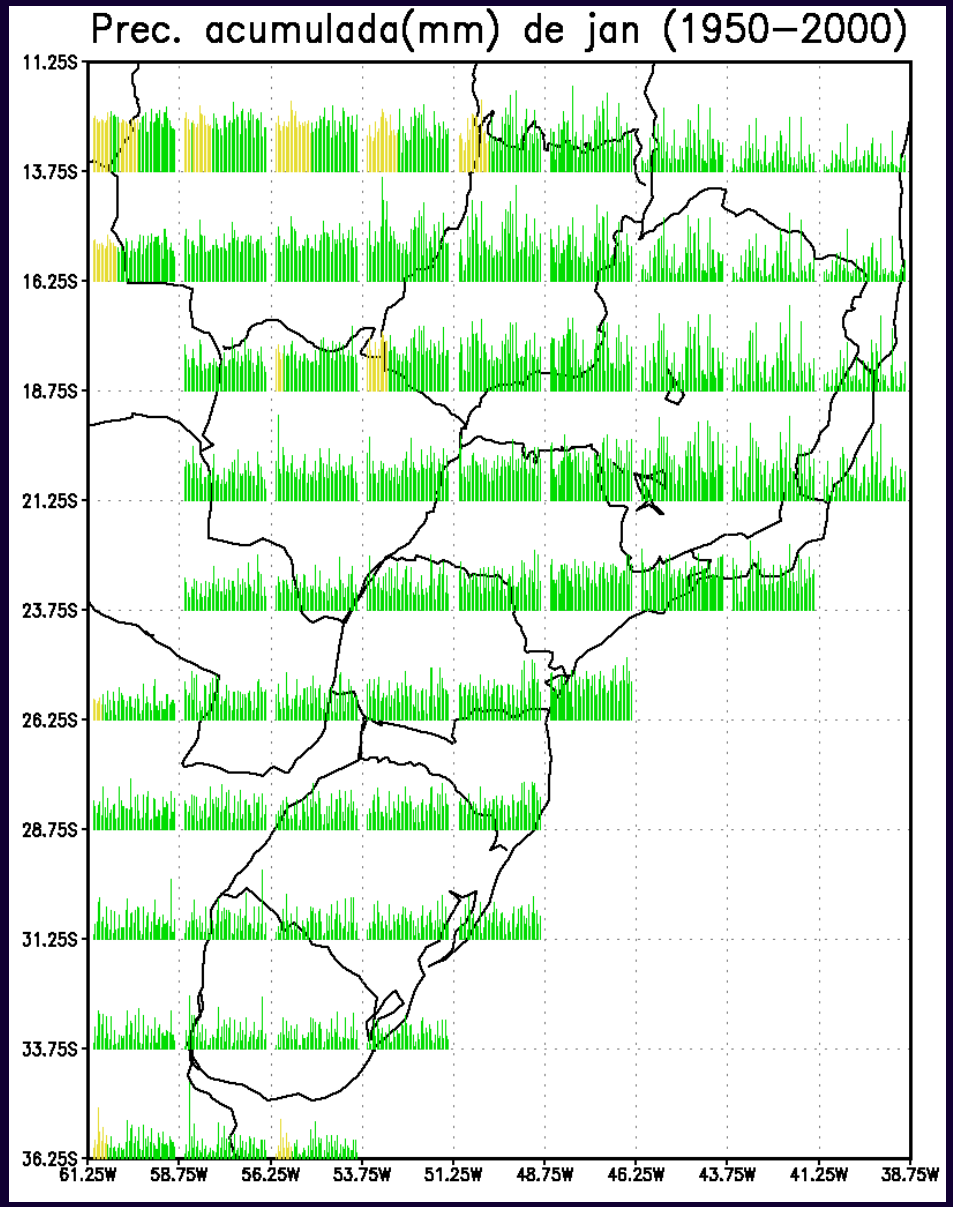
(1955-2000)



(1960-2000)

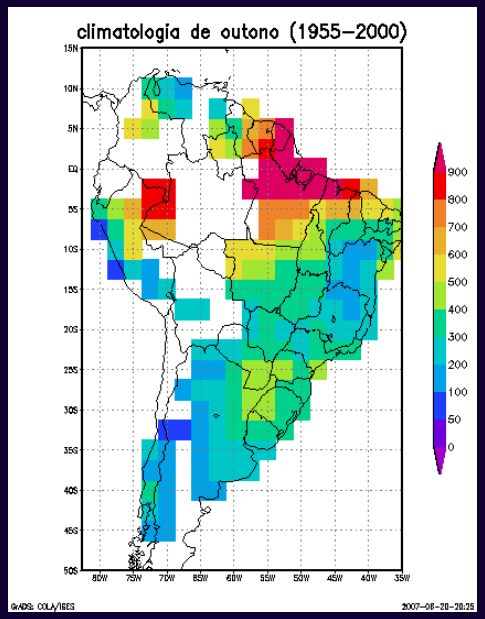
DATA

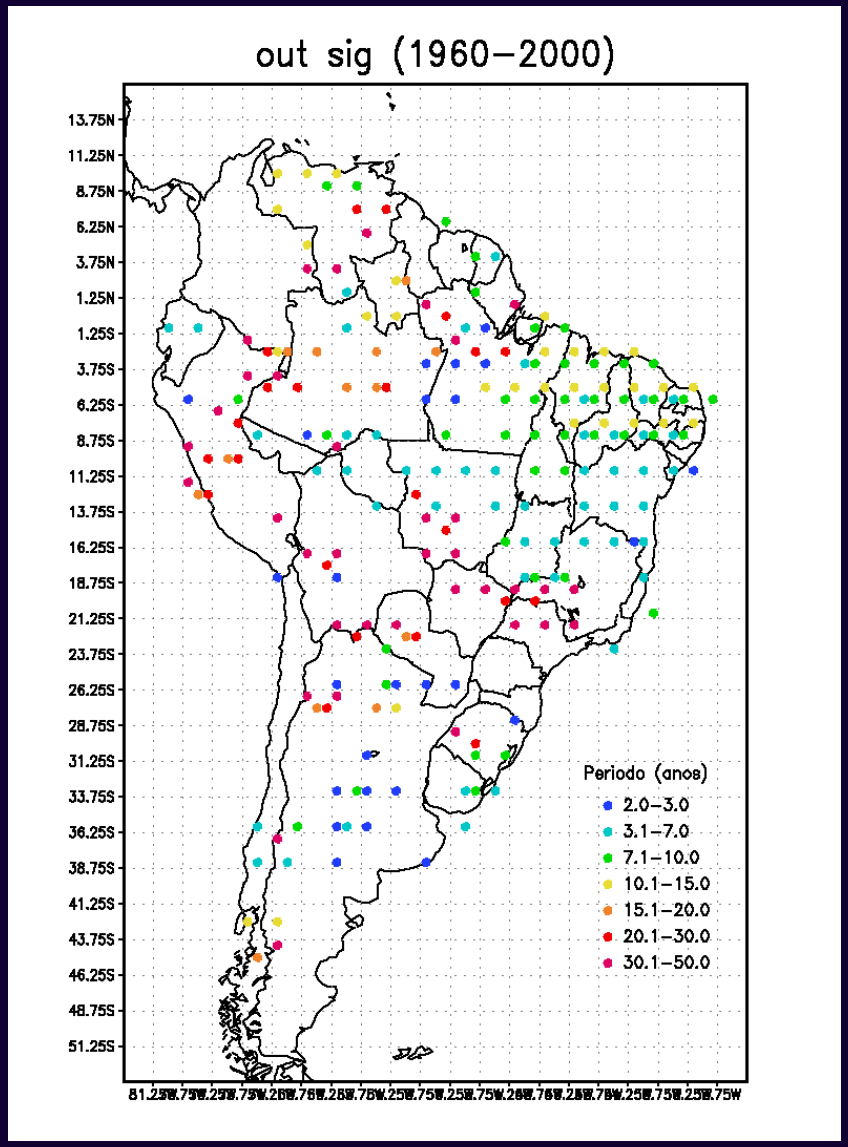

Prec. acumulada(mm) de jan (1950–2000)
16.25S
18.75S
21.25S
23.75S
26.25S
28.75S
31.25S
33.75S
36.25S
38.75S
41.25S
43.75S
46.25S
48.75S
51.25S
73.75W 71.25W 68.75W 66.25W 63.75W 61.25W 58.75W 56.25W 53.75W 51.25W


Prec. acumulada(mm) de jan (1950–2000)
11.25S
13.75S
16.25S
18.75S
21.25S
23.75S
26.25S
28.75S
31.25S
33.75S
36.25S
61.25W 58.75W 56.25W 53.75W 51.25W 48.75W 46.25W 43.75W 41.25W 38.75W

Spectral Analysis: Significant peaks

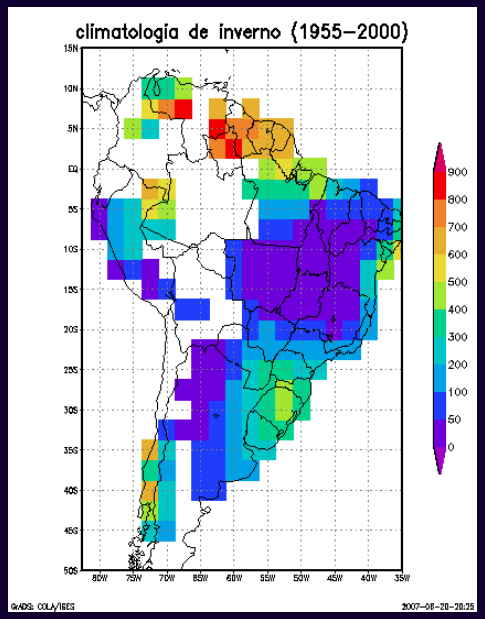
Rainfall Climatology **Autumn**

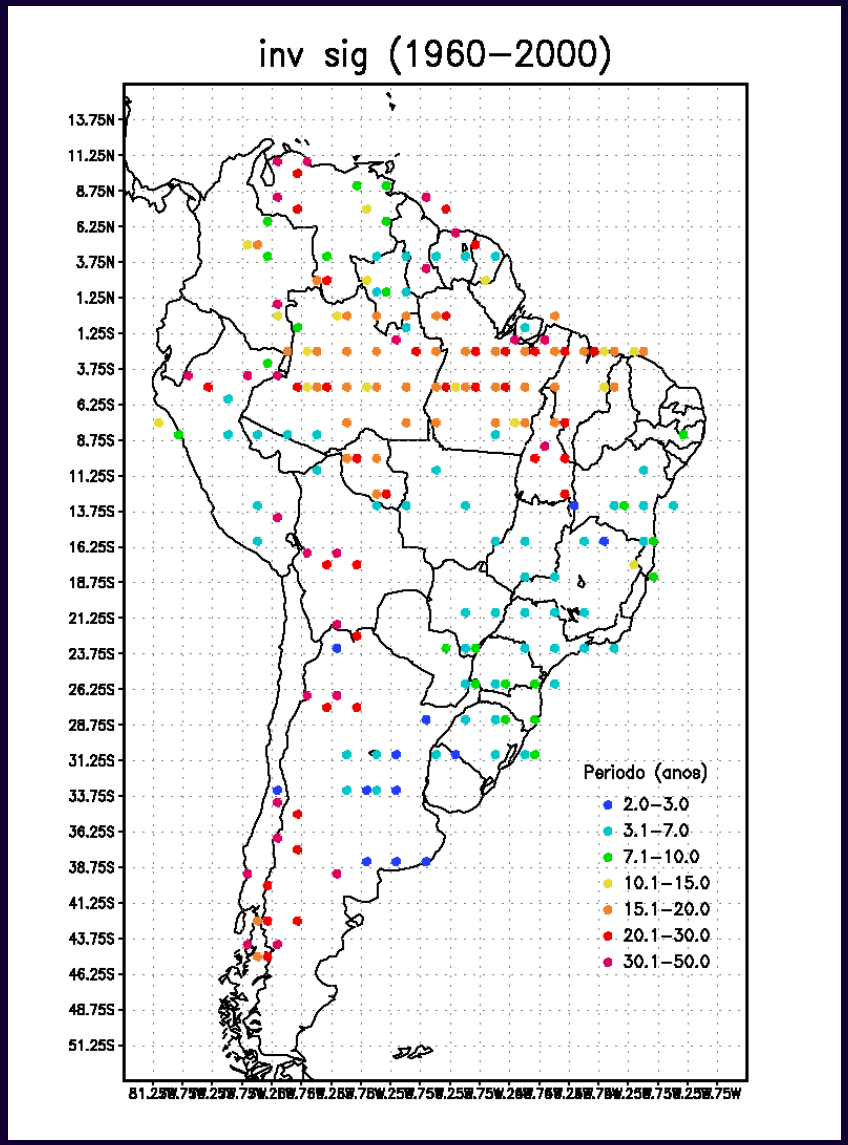




Spectral Analysis: Significant peaks

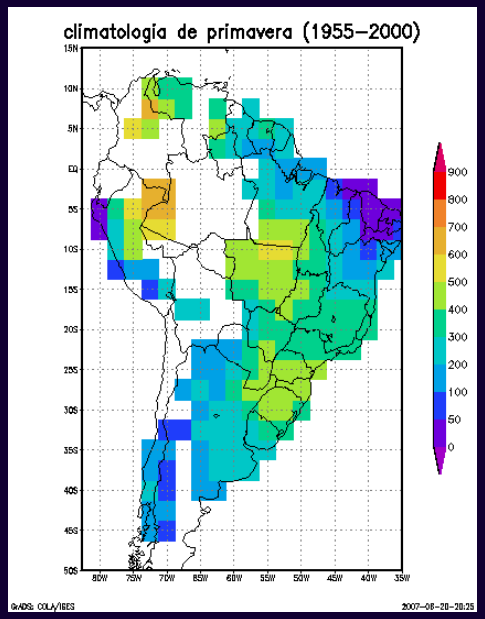
Rainfall Climatology **Winter**

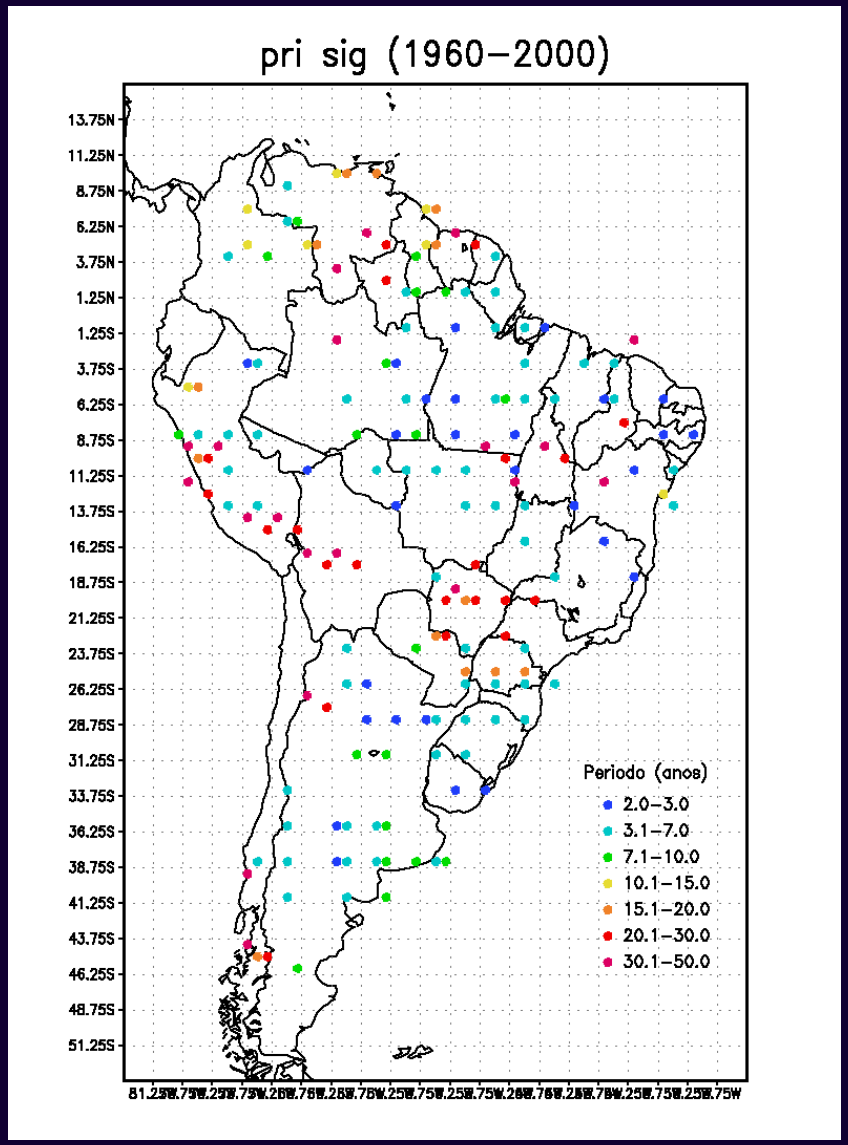




Spectral Analysis: Significant peaks

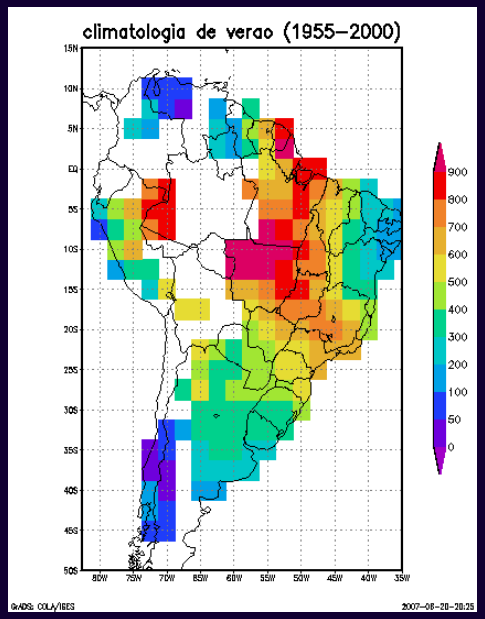
Rainfall Climatology **Spring**

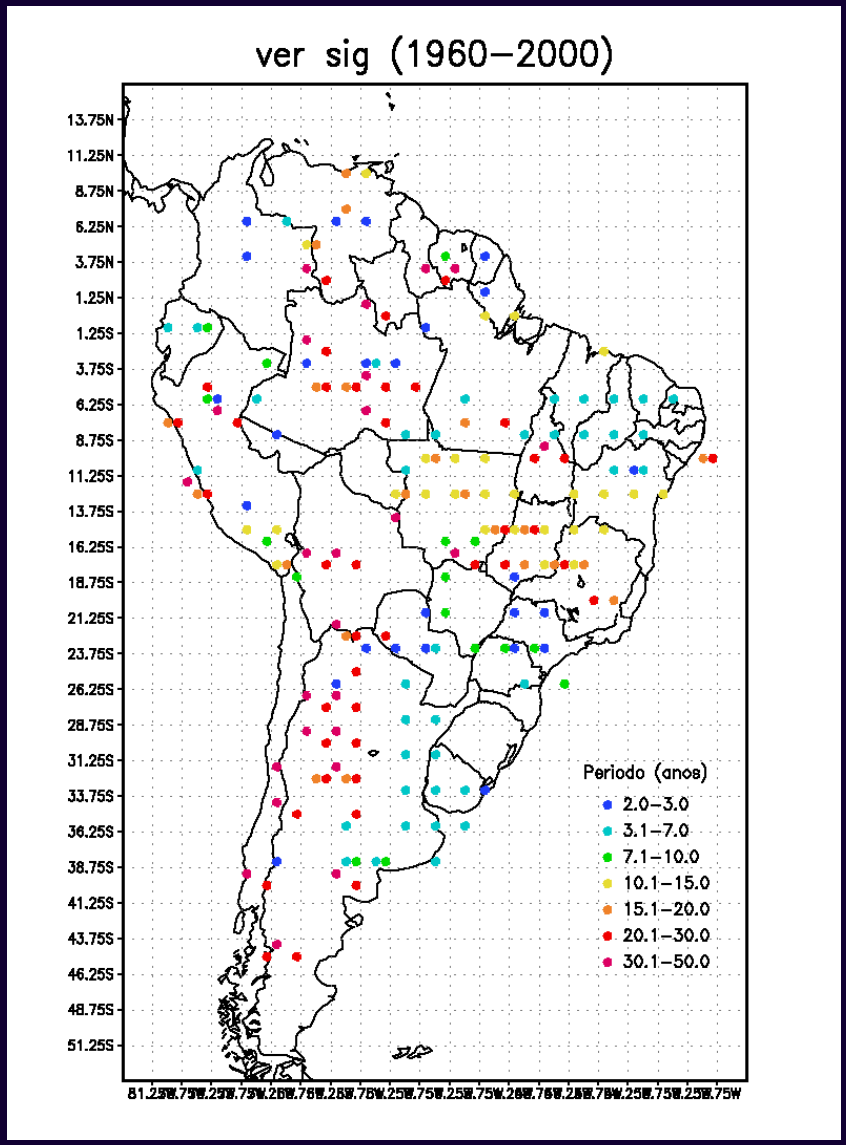




Spectral Analysis: Significant peaks

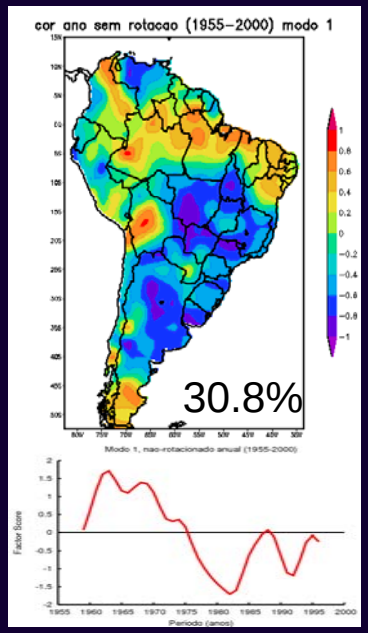
Rainfall Climatology **Summer**

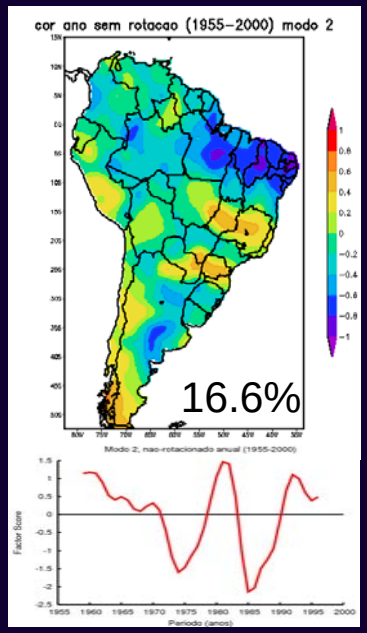


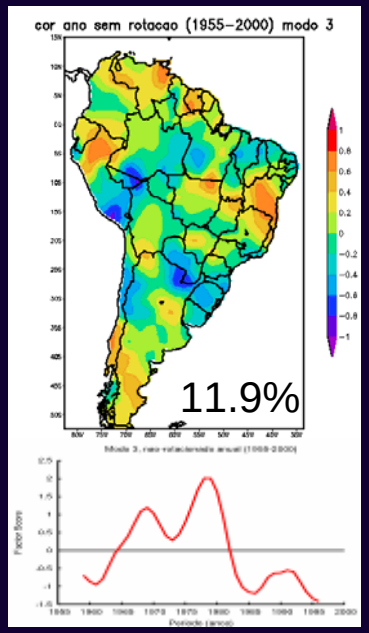


EOFs: filtered annual total precipitation

Non-rotated modes

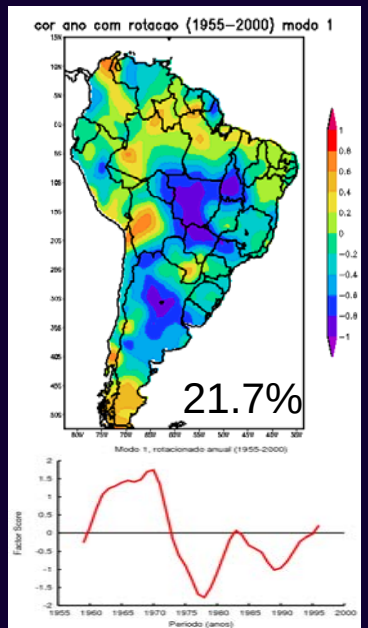


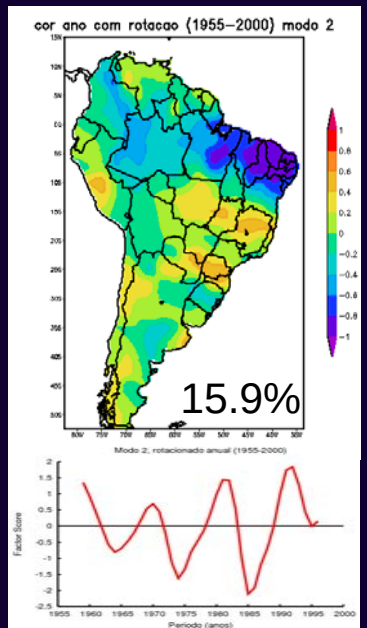


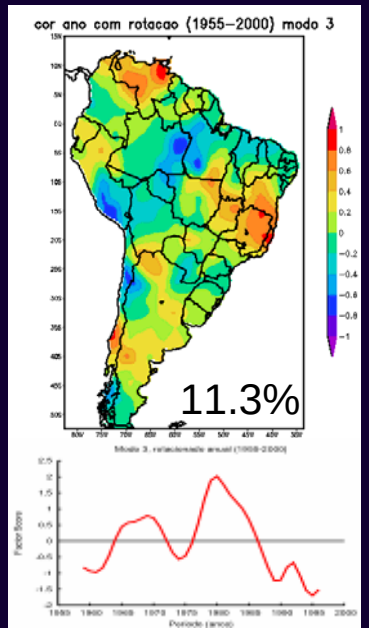


11.9%

Rotated modes

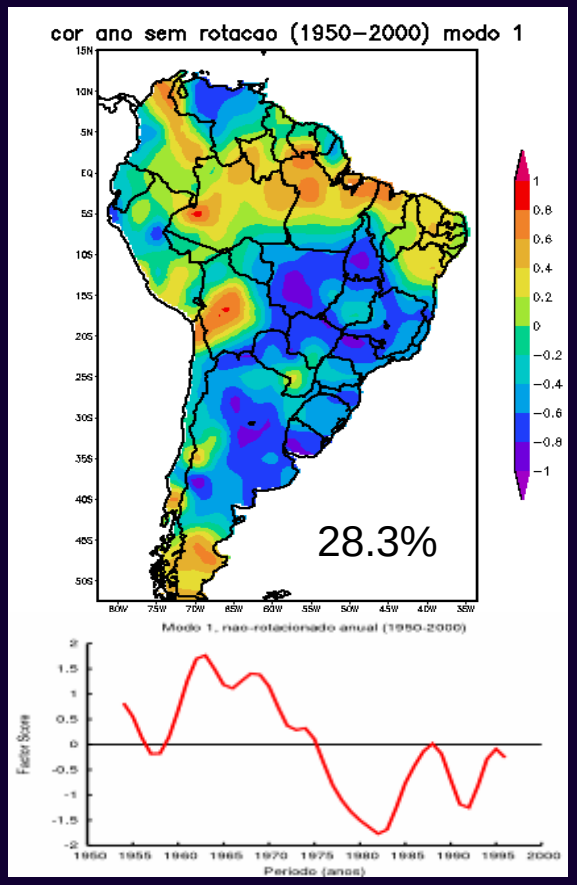




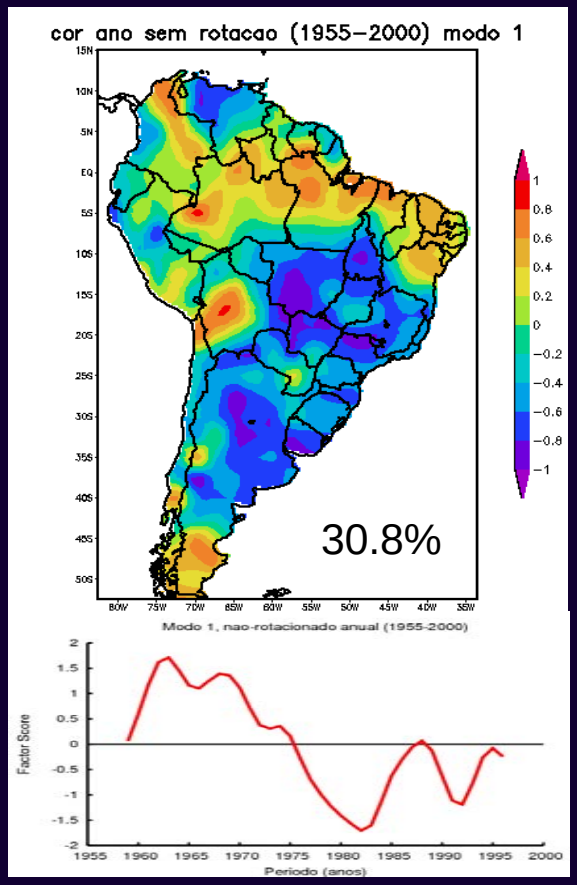


EOF1 for different periods

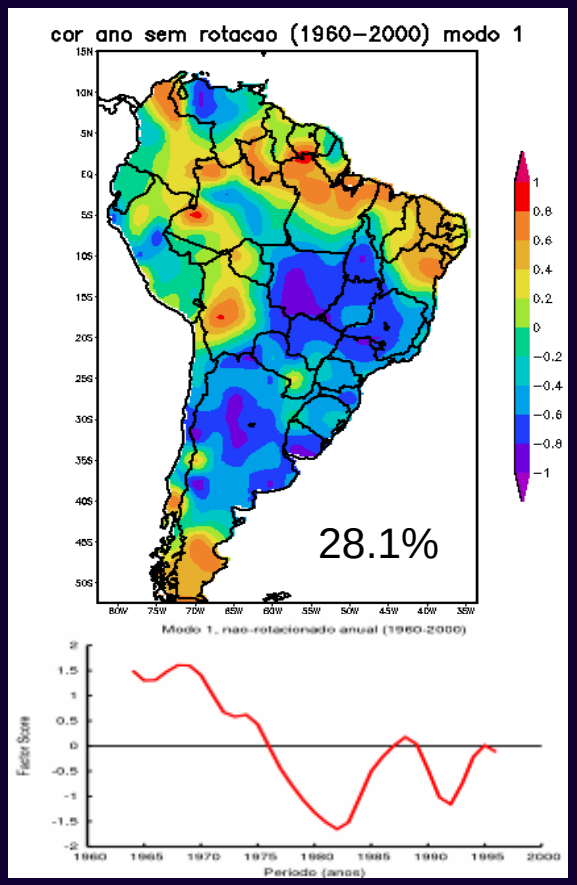
EOF1 annual (1950-2000)



EOF1 annual (1955-2000)



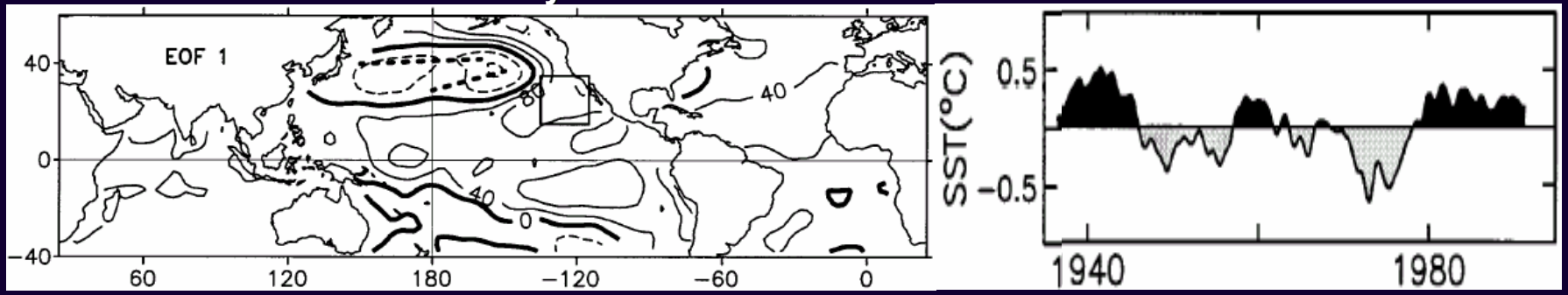
EOF1 annual (1960-2000)



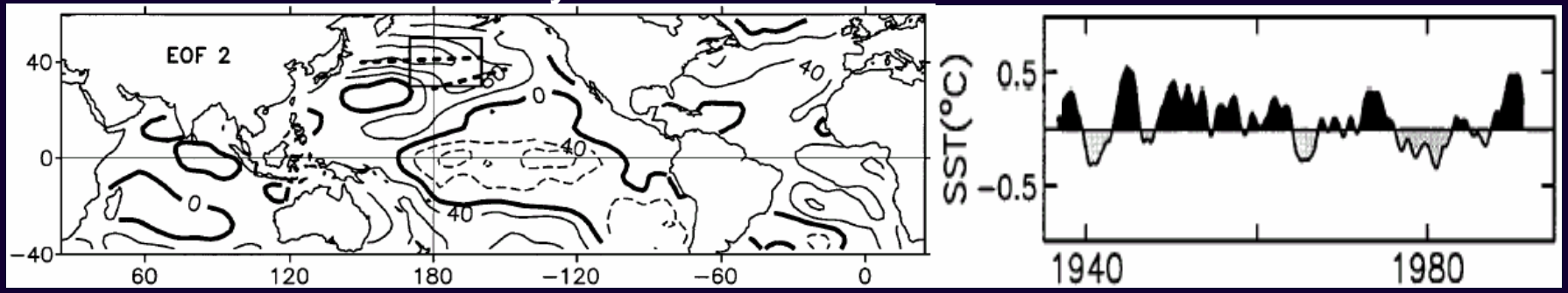
Non-ENSO modes of SST variability

(Enfield and Mestas-Nuñez 1999)

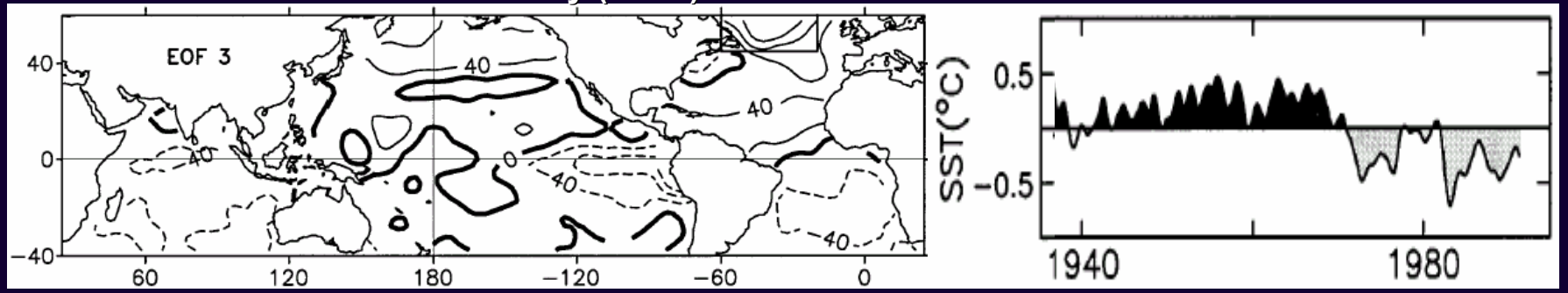
Pacific Interdecadal Variability



Pacific Multidecadal Variability

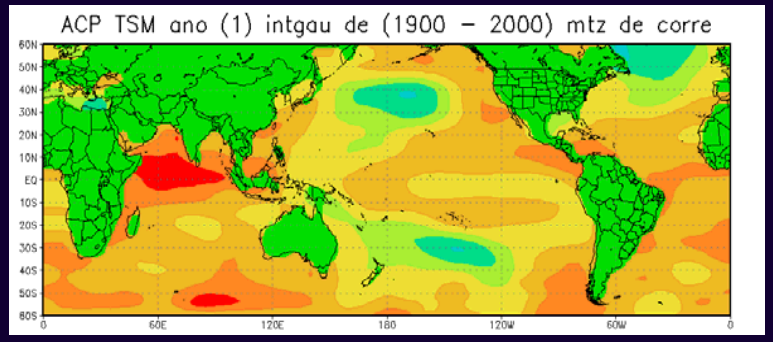


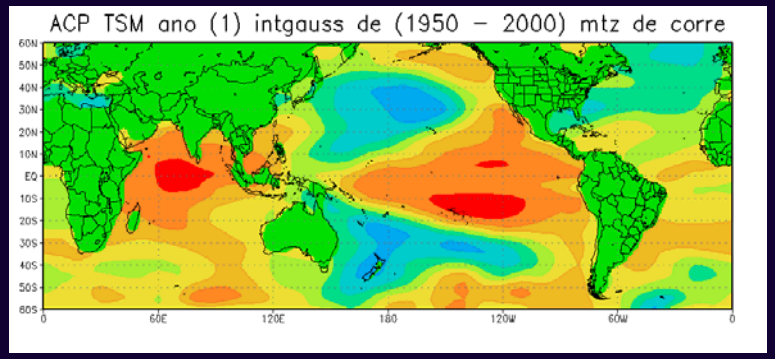
Atlantic Multidecadal Variability (AMO)

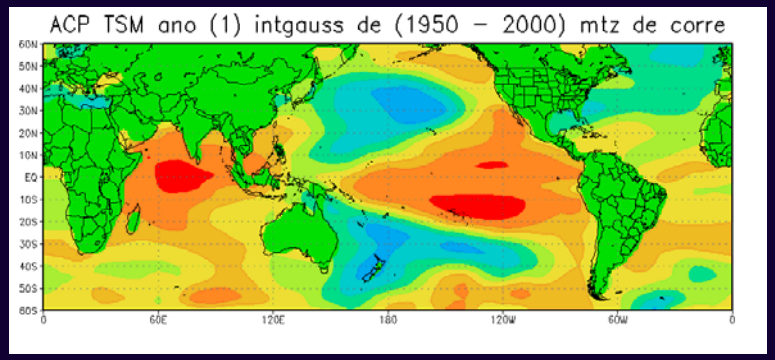


Non-ENSO modes of SST variability

Pacific Interdecadal Variability

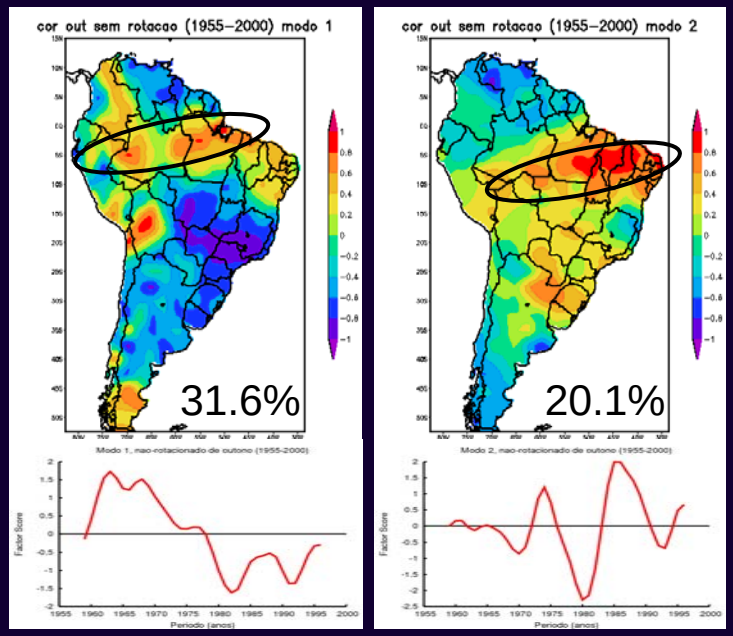




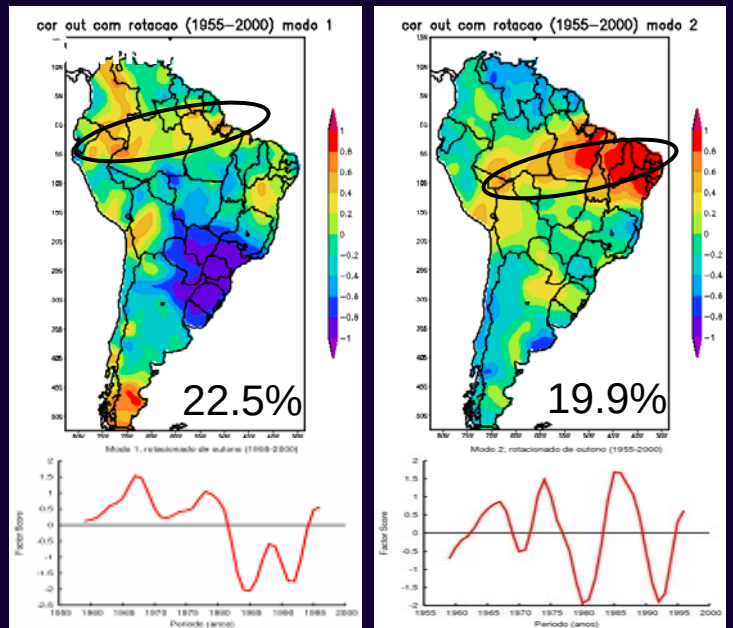


Autumn interdecadal variability

Non-rotated modes

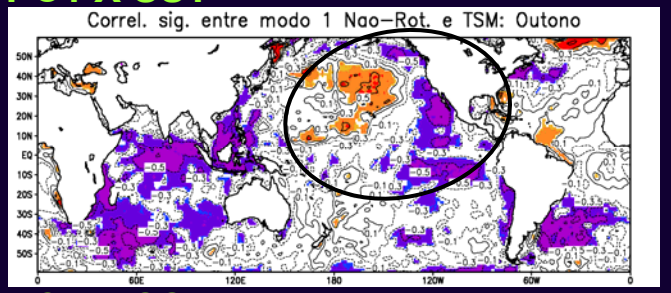


Rotated modes

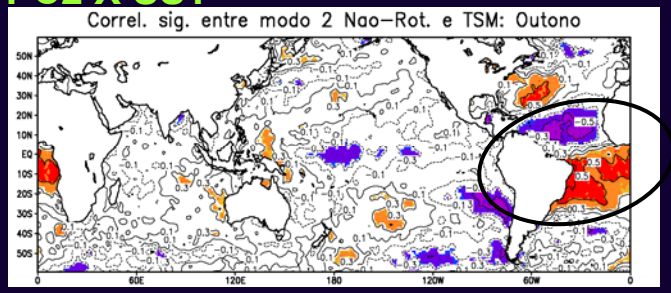


11.9%

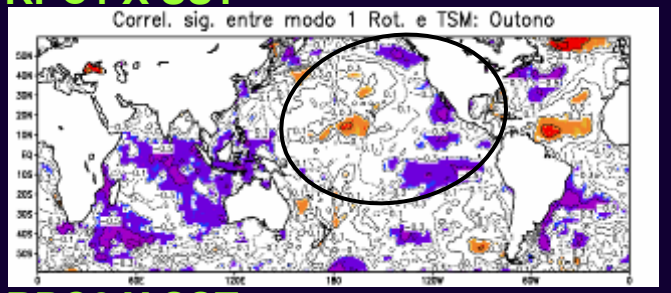
PC1 X SST



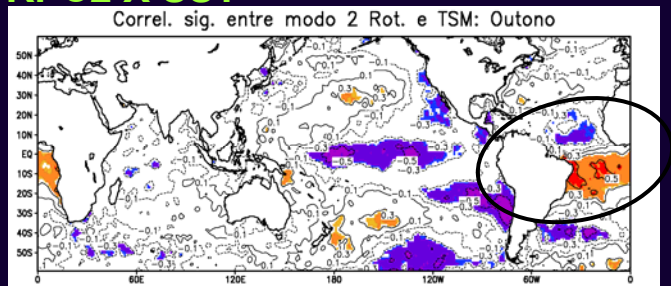
PC2 X SST



RPC1 X SST

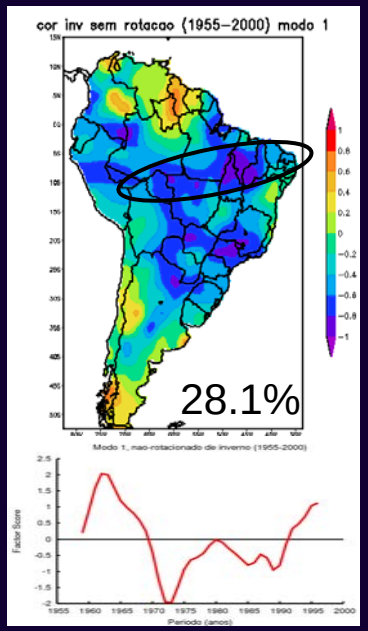


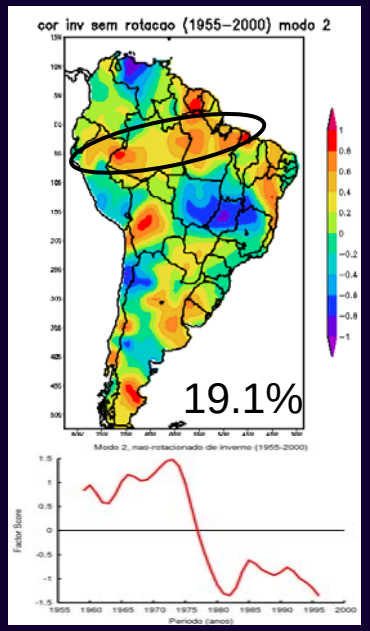
RPC2 X SST



Winter interdecadal variability

Non-rotated modes

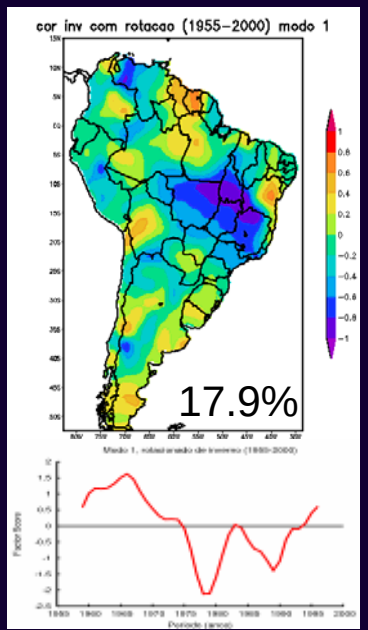


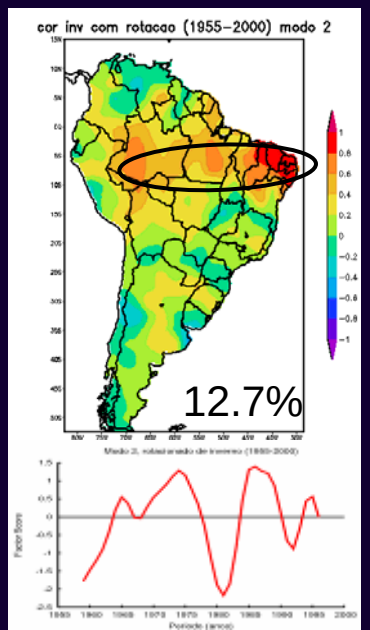


10.0%

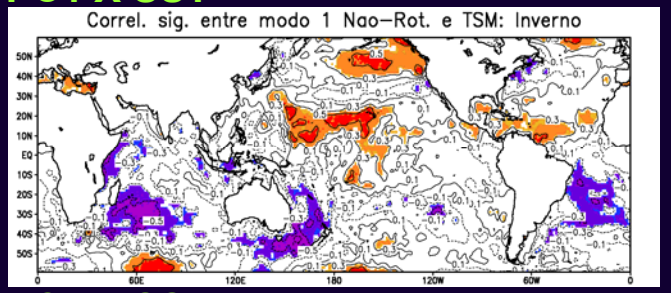
11.9%

Rotated modes





PC1 X SST



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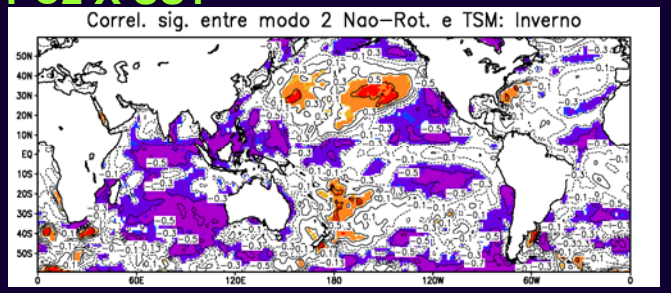
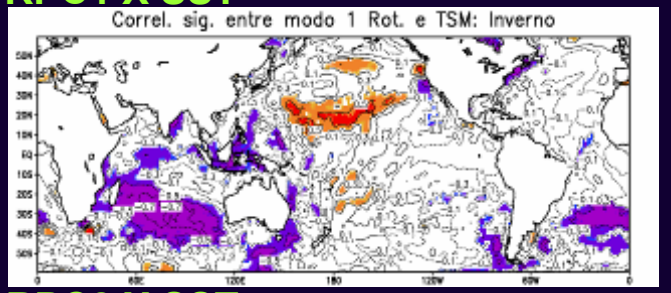
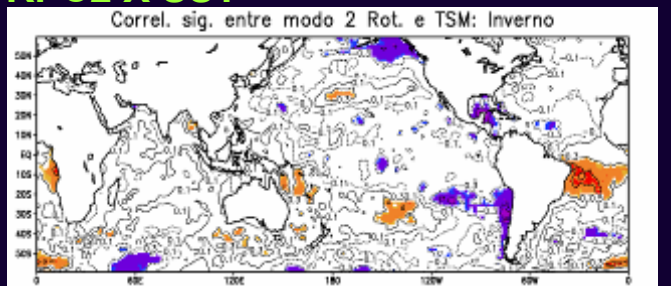


RPC1 X SST

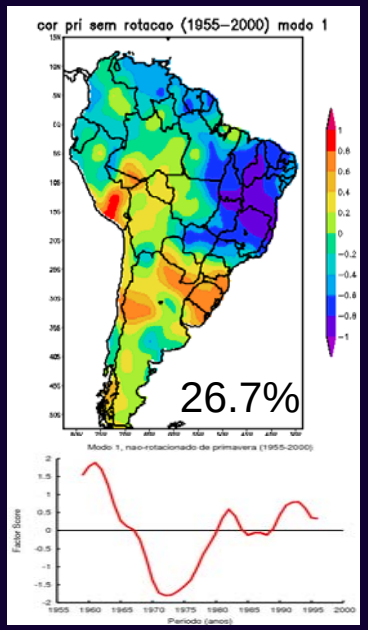


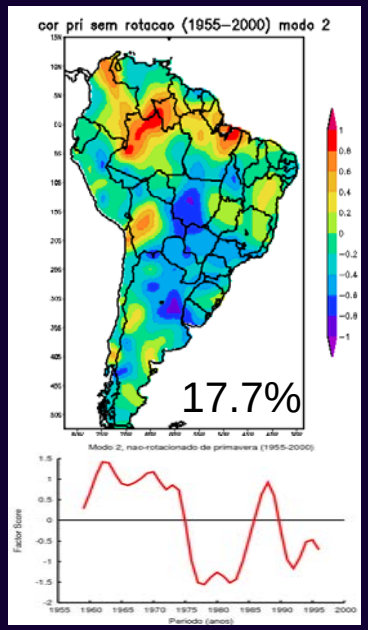
RPC2 X SST



Spring interdecadal variability

Non-rotated modes

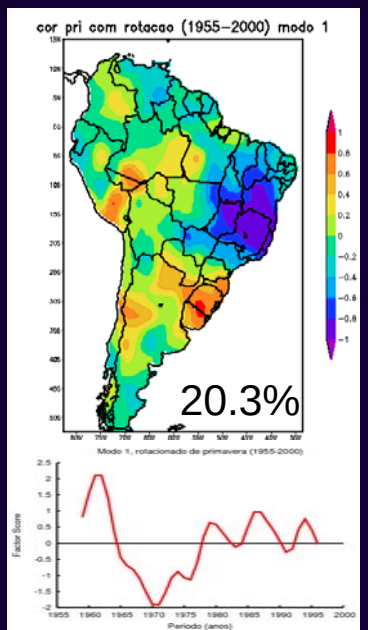


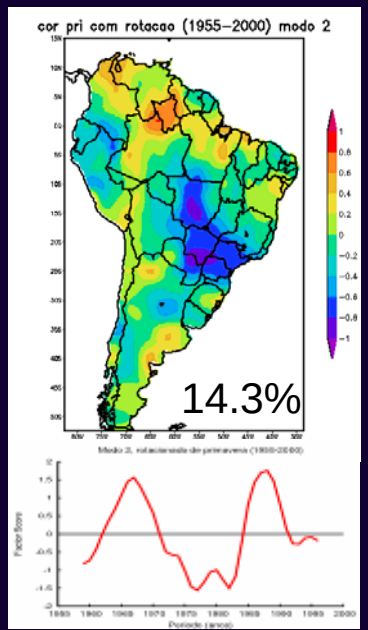


10.0%

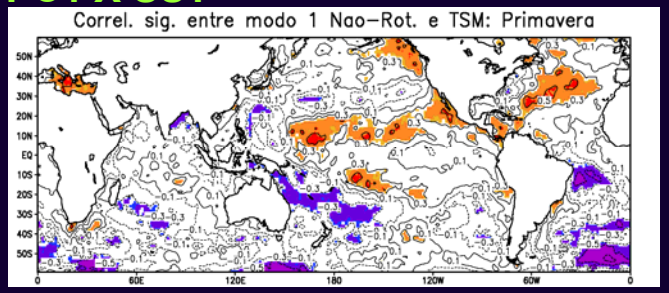
11.9%

Rotated modes

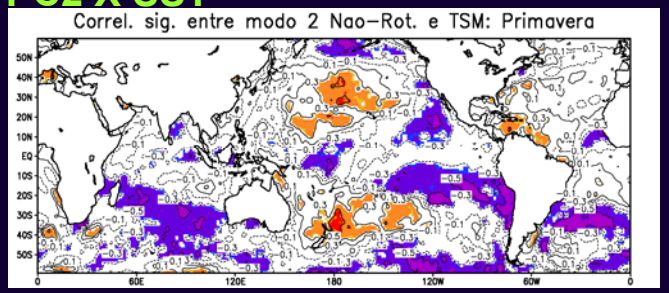




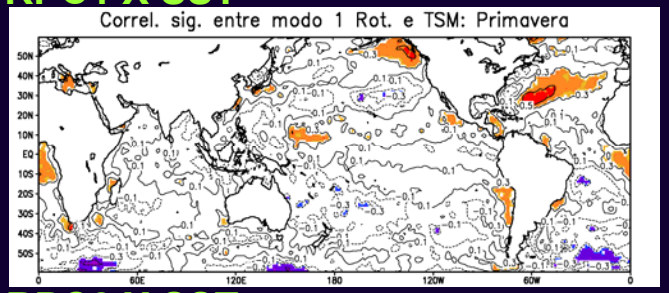
PC1 X SST



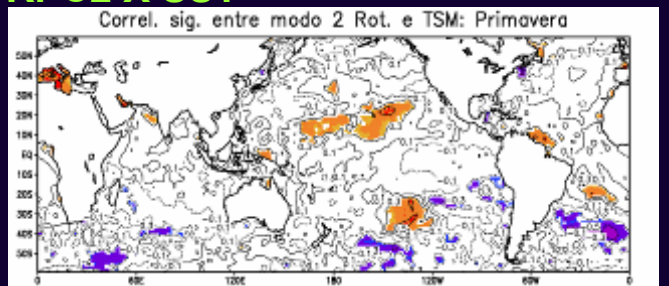
PC2 X SST



RPC1 X SST

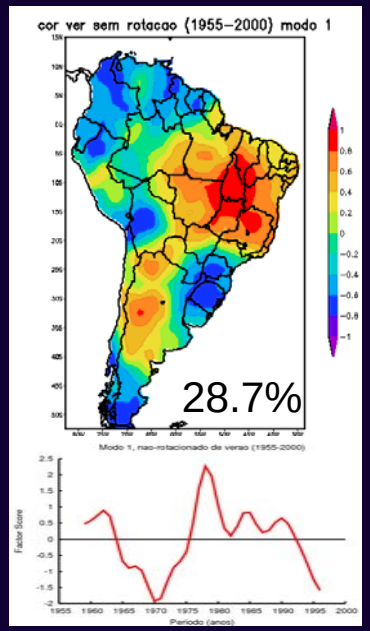


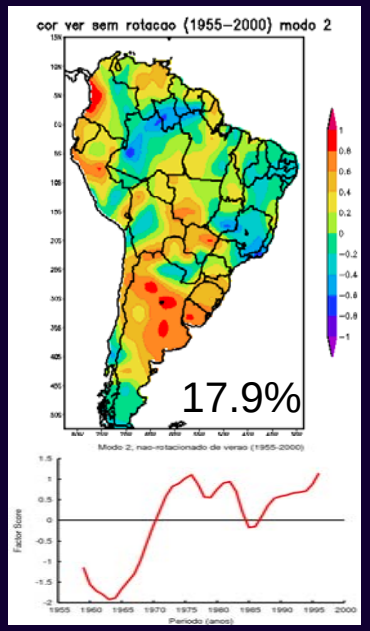
RPC2 X SST



Summer interdecadal variability

Non-rotated modes

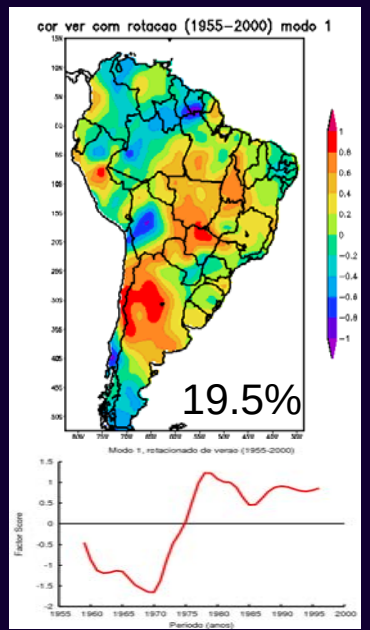


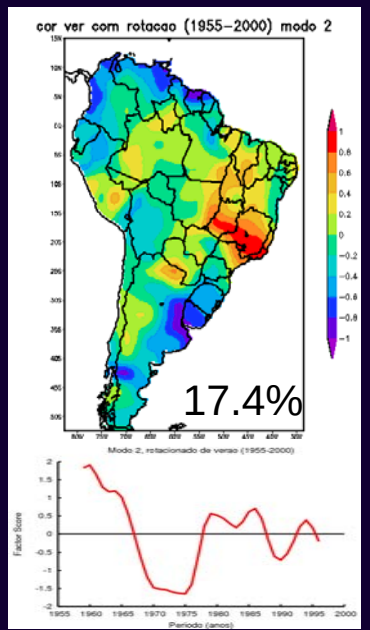


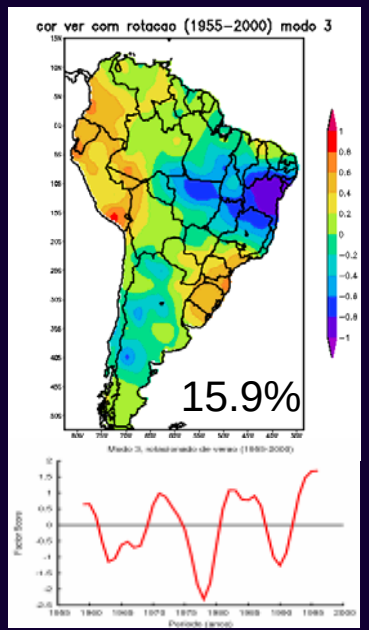
10.0%

11.9%

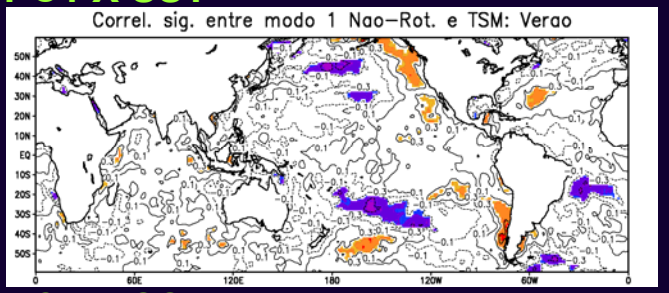
Rotated modes



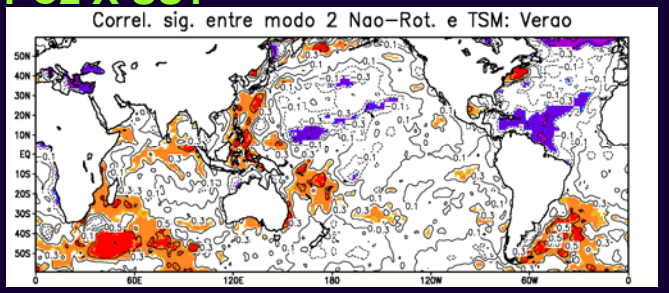




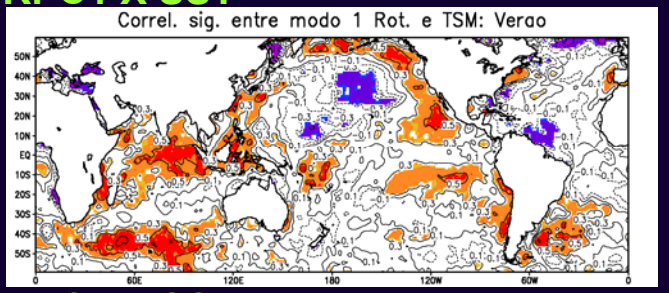
PC1 X SST



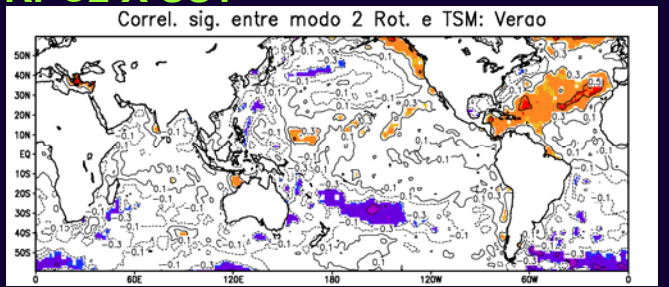
PC2 X SST



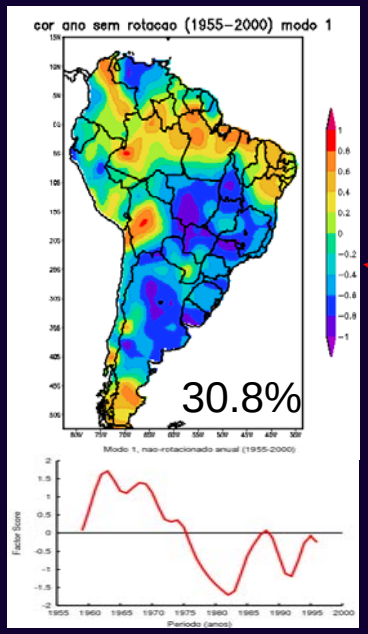
RPC1 X SST



RPC2 X SST



Seasonality of the interdecadal variability



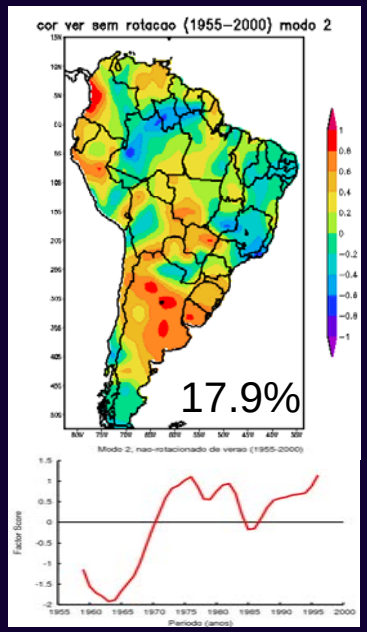
EOF1 - annual

10.0%

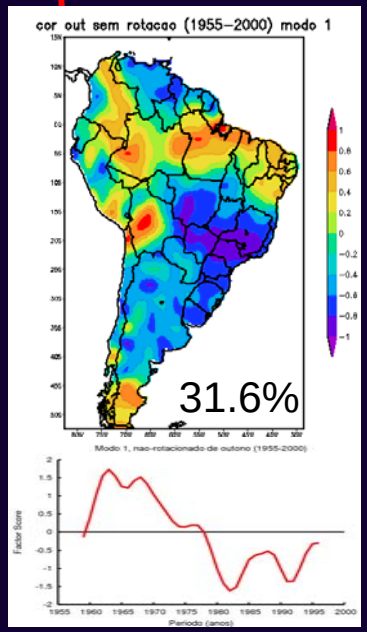
largest contribution

11.9%

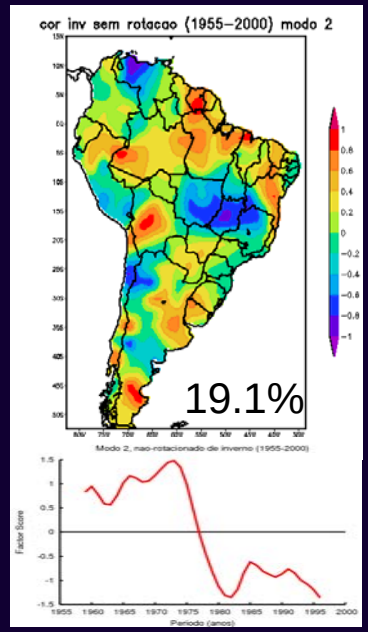
EOF2 summer



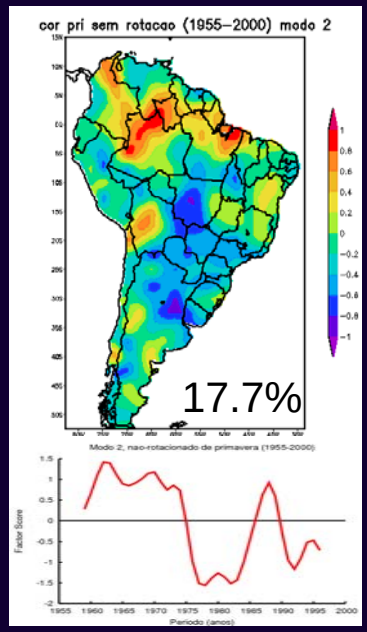
EOF1 autumn



EOF2 winter

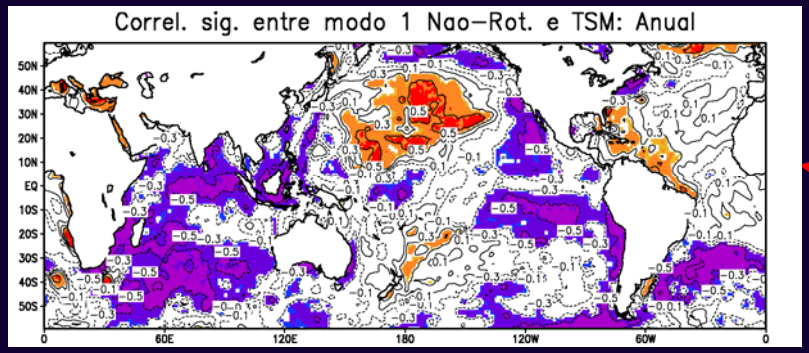


EOF2 spring



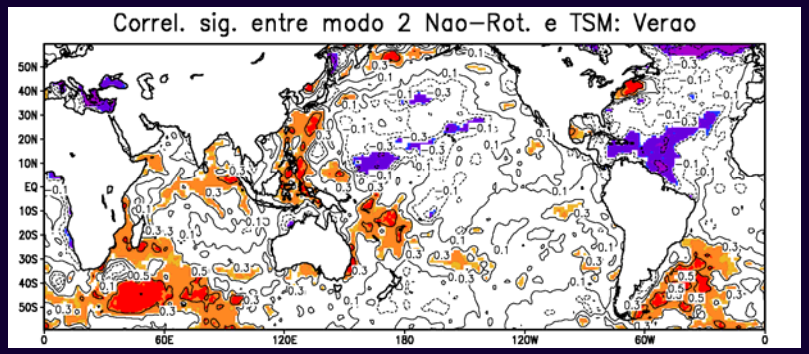
Seasonality of the interdecadal variability

PC1annual X SST

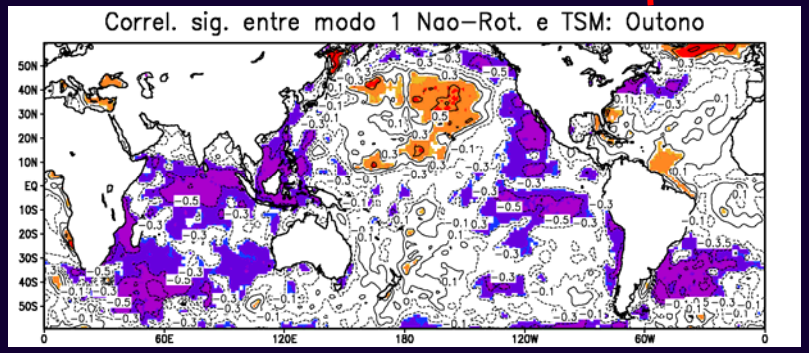


Highest contribution

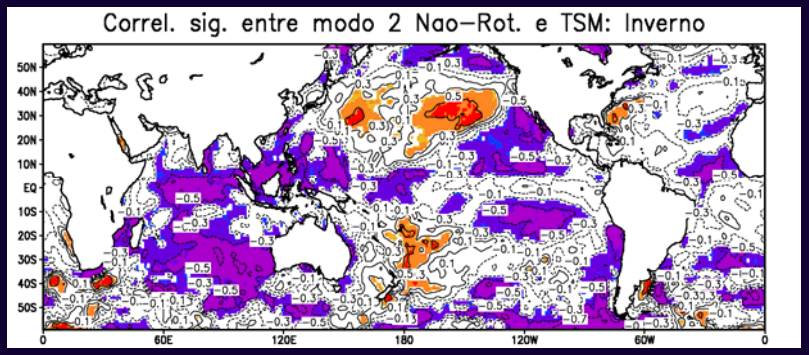
PC2summer X SST



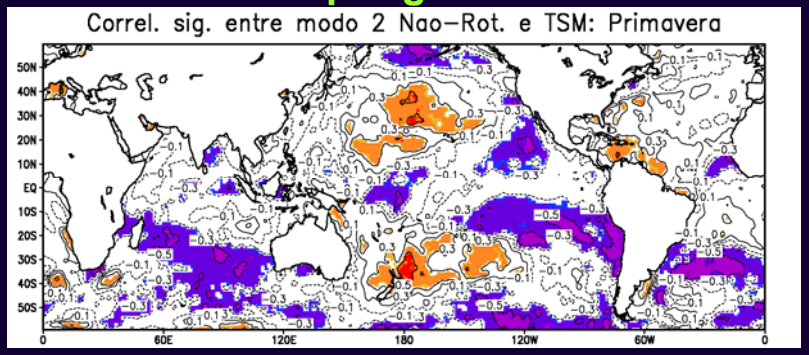
PC1autumn X SST



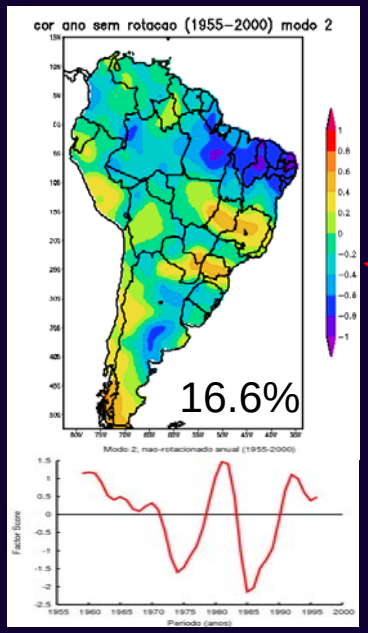
PC2winter X SST



PC2spring X SST



Seasonality of the interdecadal variability



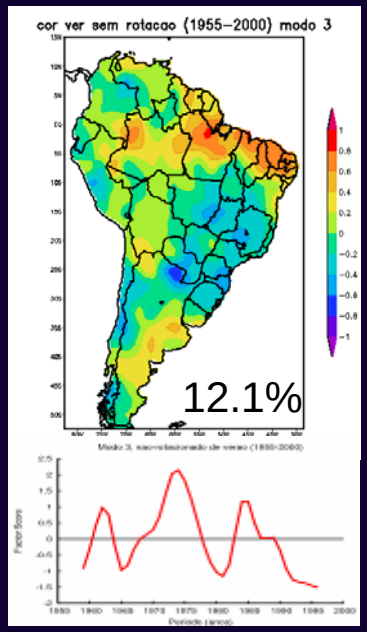
EOF2 annual

10.0%

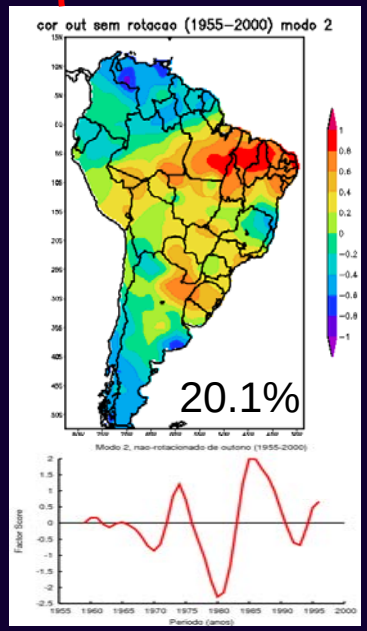
largest contribution

11.9%

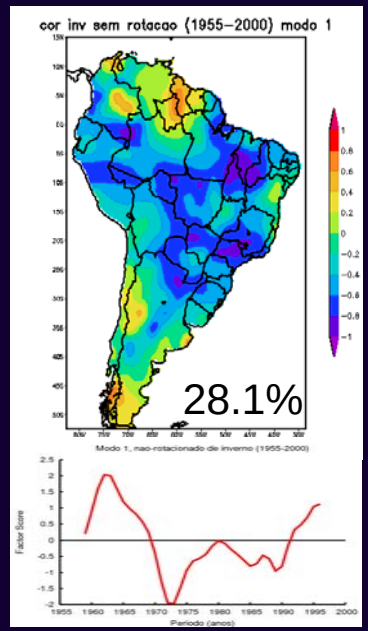
EOF3 summer



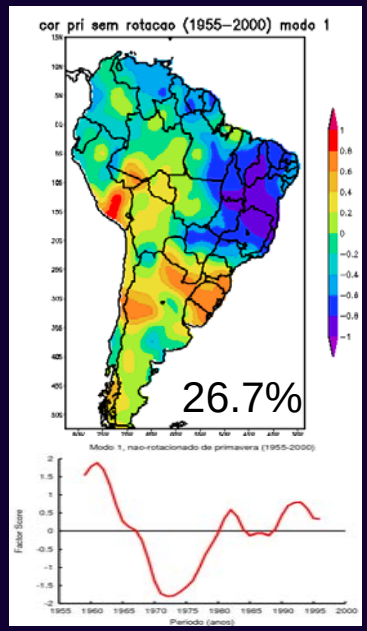
EOF2 autumn



EOF1 winter

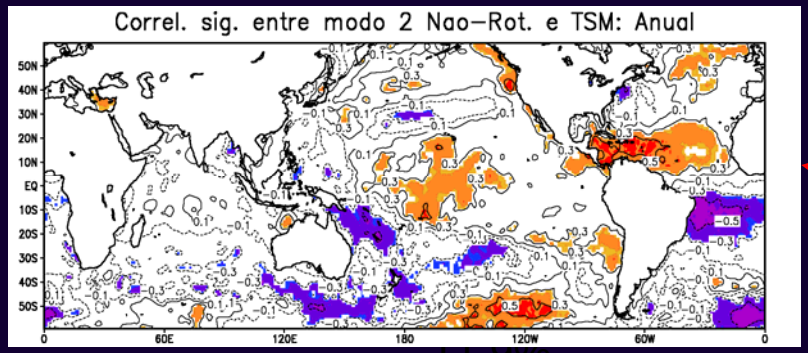


EOF1 spring



Seasonality of the interdecadal variability

PC2annual X SST

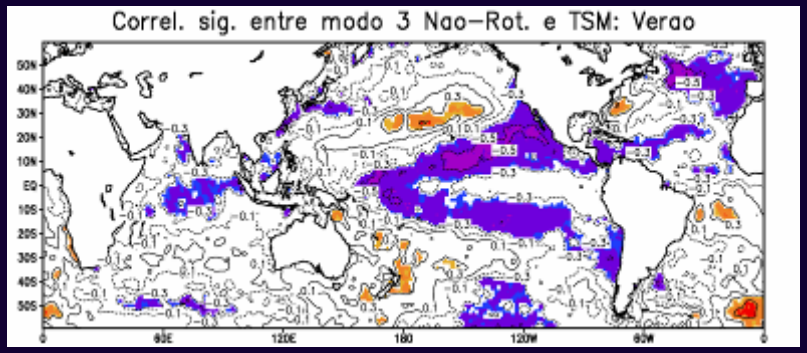


Highest contribution

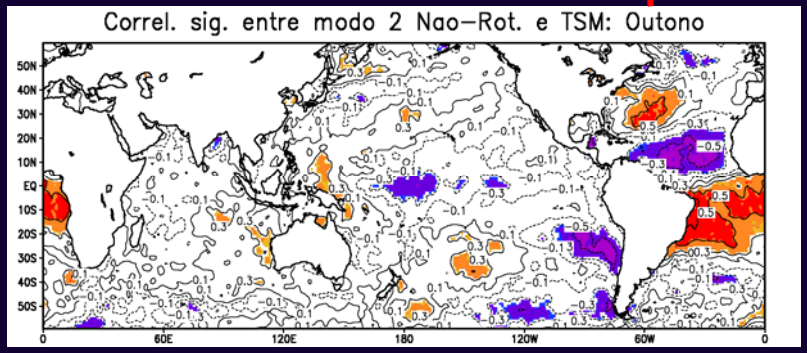
11.9%

11.9%

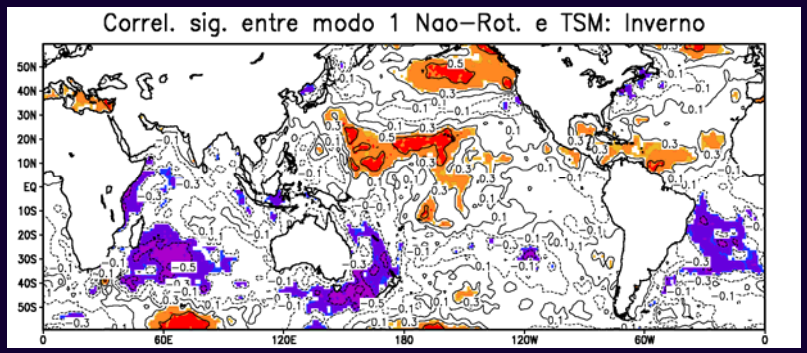
PC3summer X SST



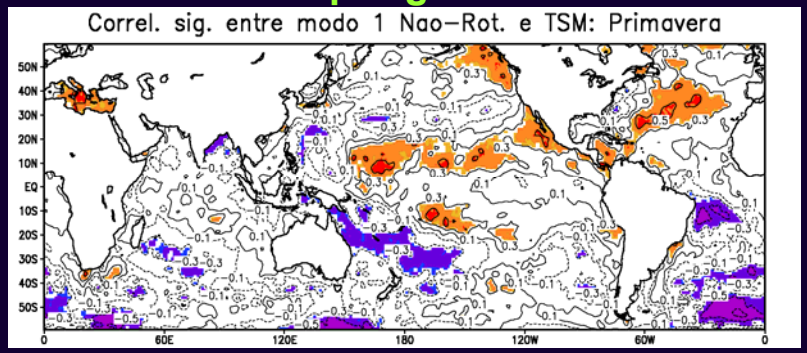
PC2autumn X SST



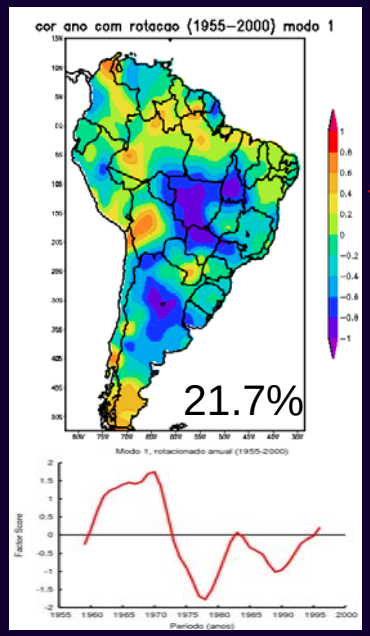
PC1winter X SST



PC1spring X SST



Seasonality of the interdecadal variability

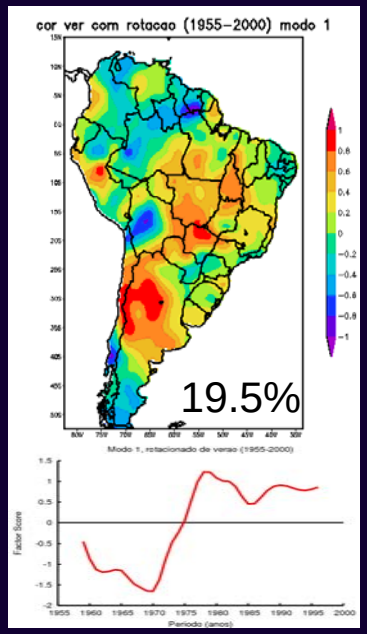


REOF1annual

10.0%

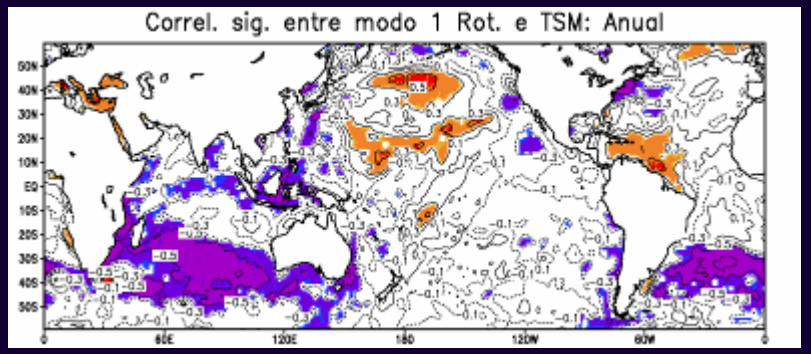
largest contribution

REOF1 summer

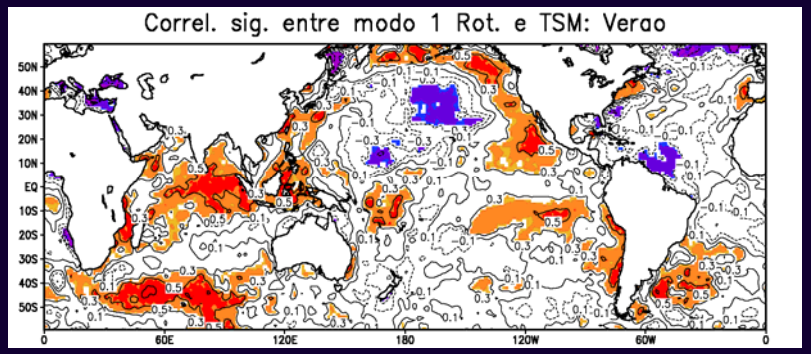


RPC1annual X SST

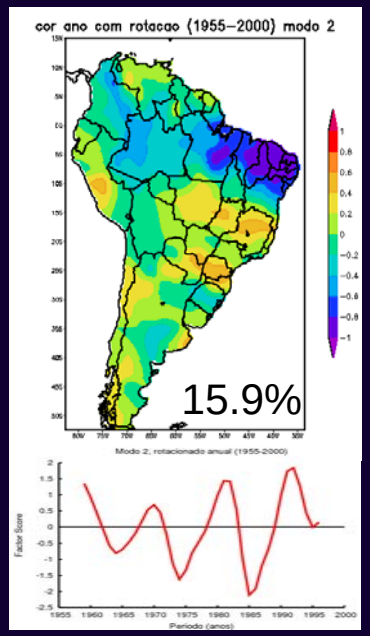
11.9%



RPC1summer X SST

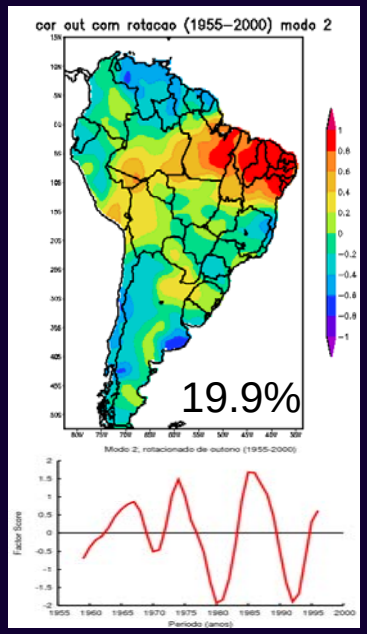


Seasonality of the interdecadal variability



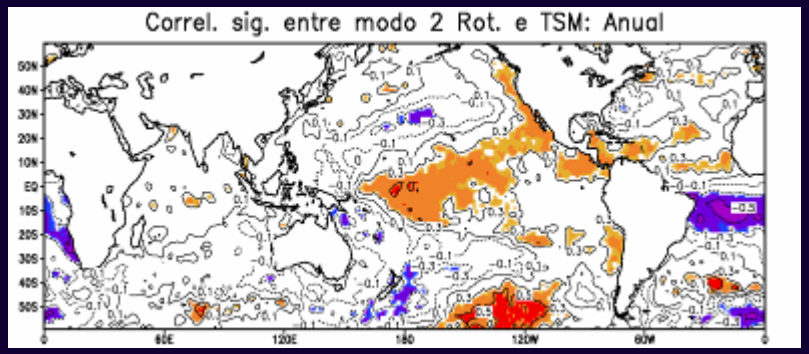
REOF2 annual

REOF2 autumn

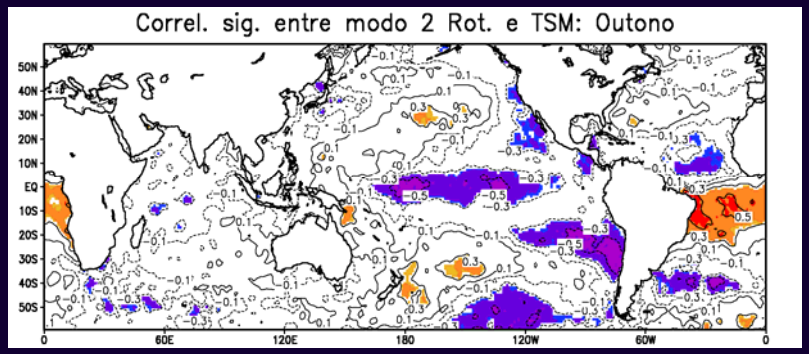


RPC2annual X SST

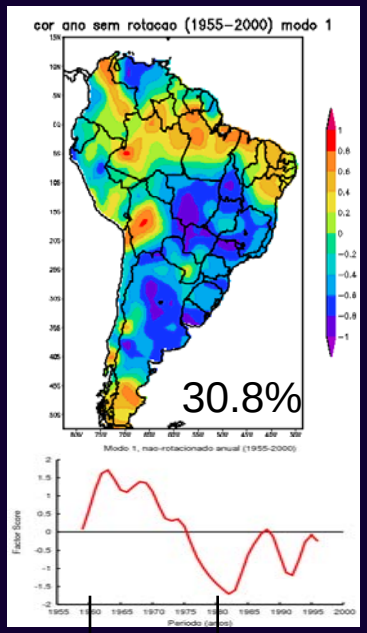
11.9%



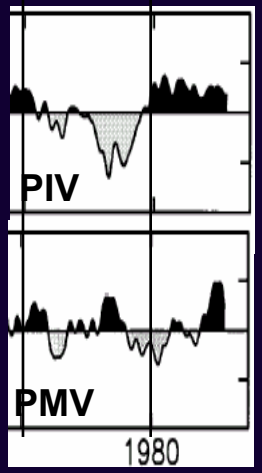
REOF2autumn X SST



Seasonality of the interdecadal variability

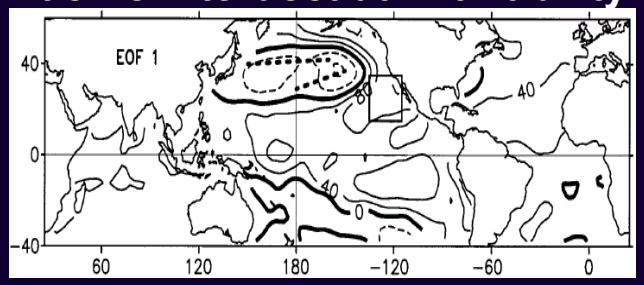


PC1 annual

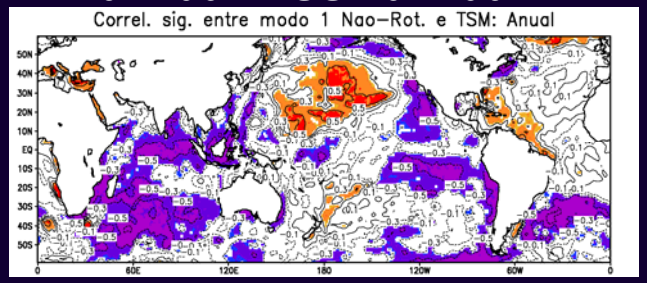


Significant correlation with PDO

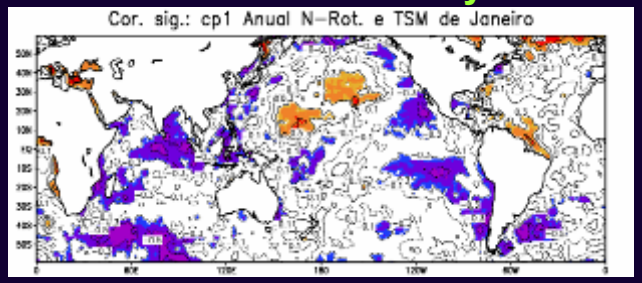
Pacific Interdecadal Variability



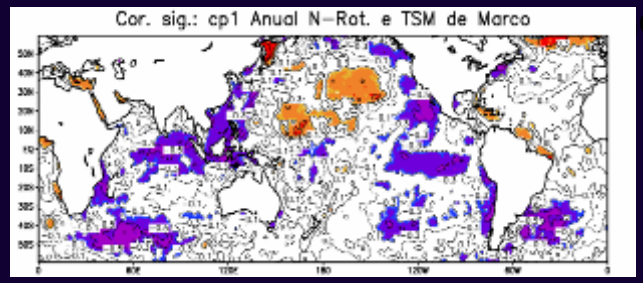
PC1 annual X SST annual



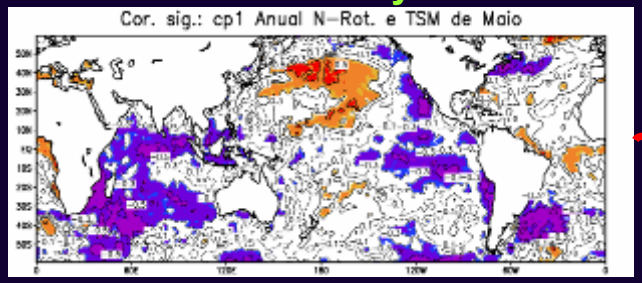
PC1 annual X SST January



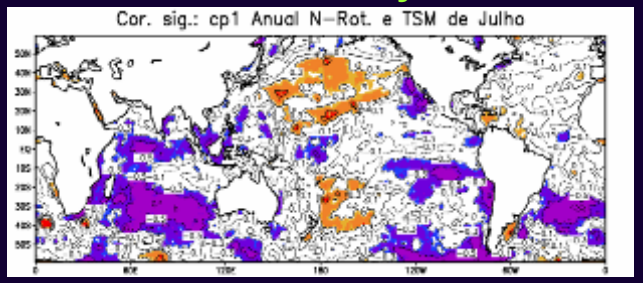
PC1 annual X SST March



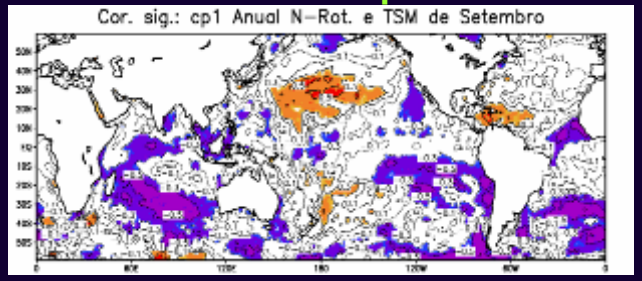
PC1 annual X SST May



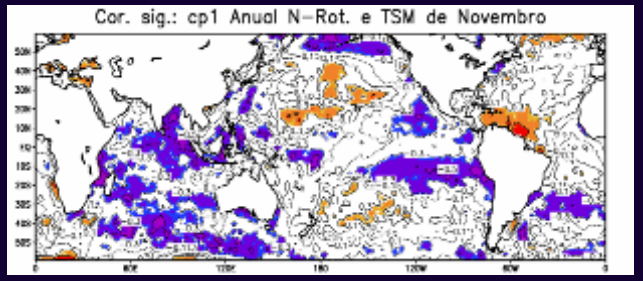
PC1 annual X SST July



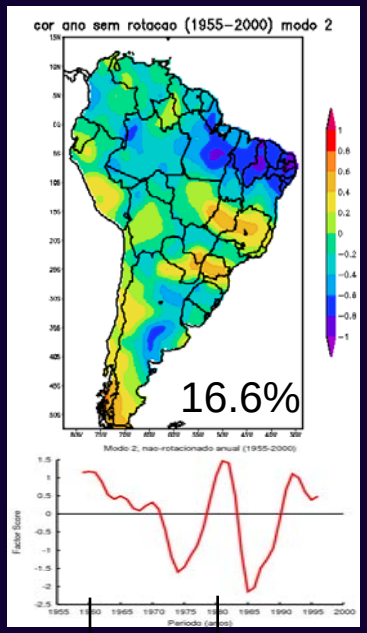
PC1 annual X SST September



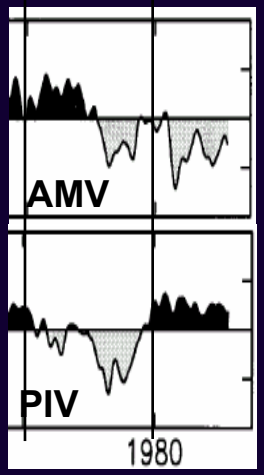
PC1 annual X SST November



Seasonality of the interdecadal variability

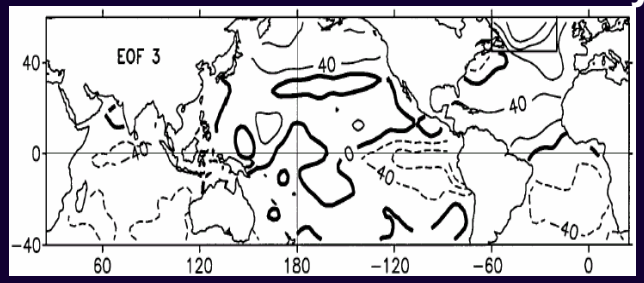


PC1 annual

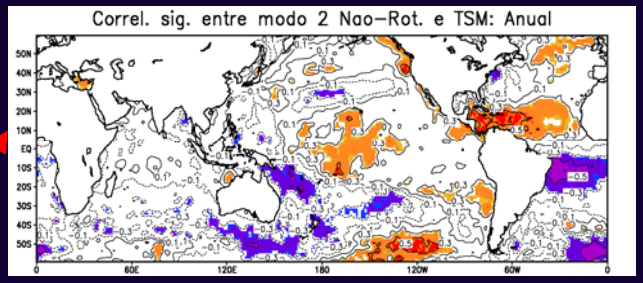


Significant correlation with AMO and also PDO.

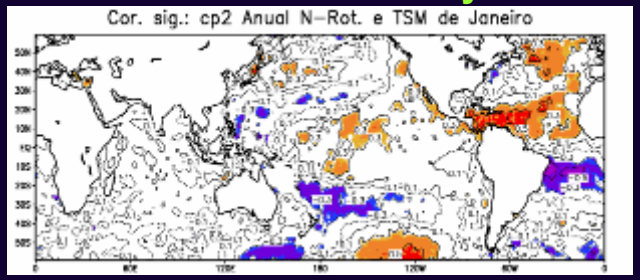
Atlantic Multidecadal Variability



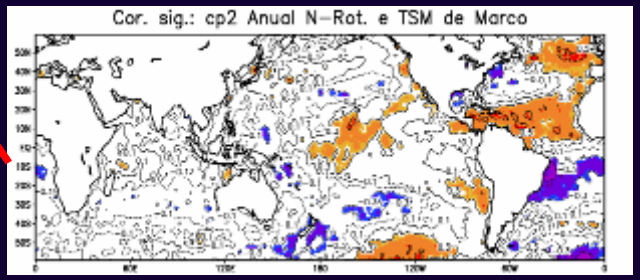
PC2 annual X SST annual



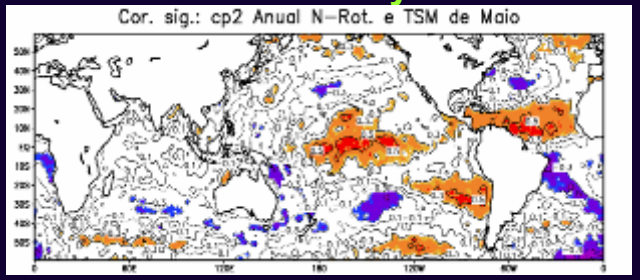
PC2 annual X SST January



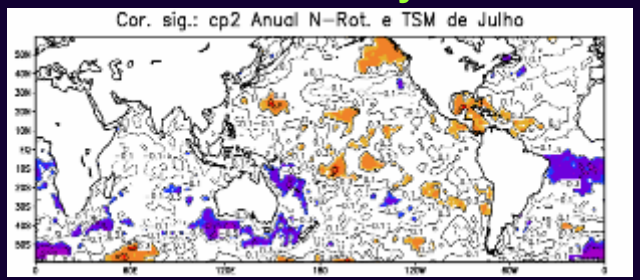
PC2 annual X SST March



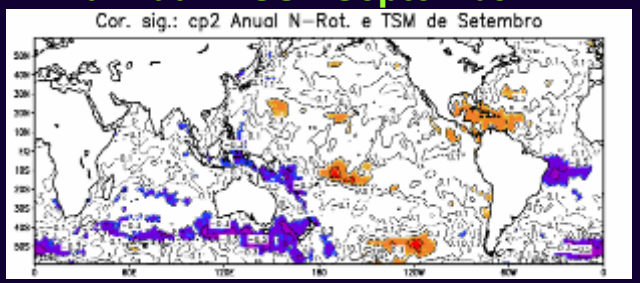
PC2 annual X SST May



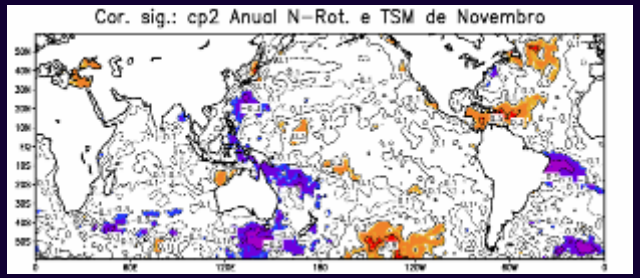
PC2 annual X SST July



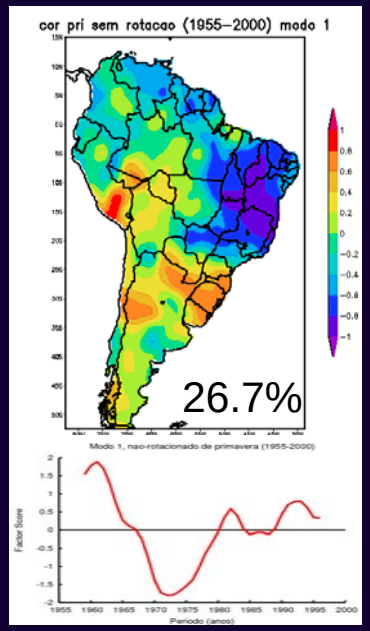
PC2 annual X SST September



PC2 annual X SST November



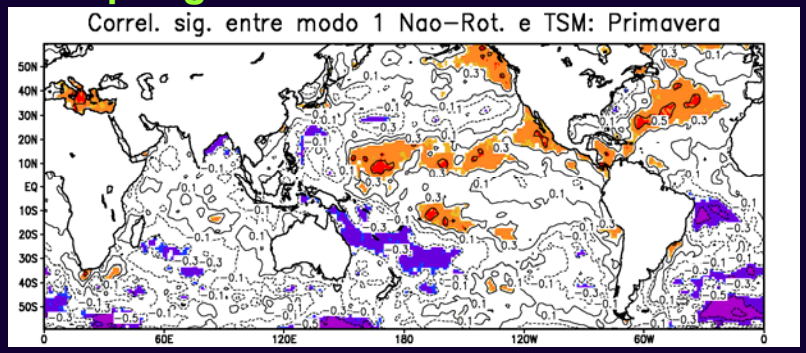
The inverse relationship between spring and summer



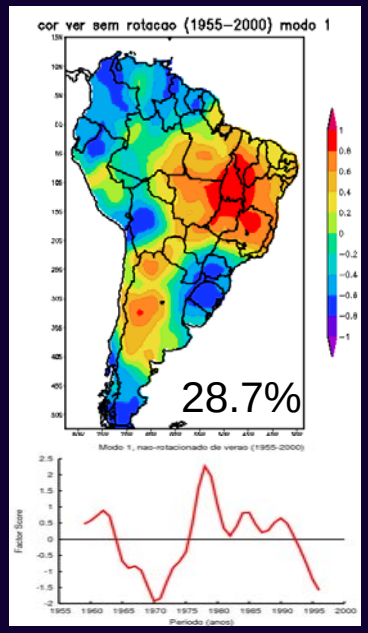
PC1 spring

10.0%

PC1spring X SST

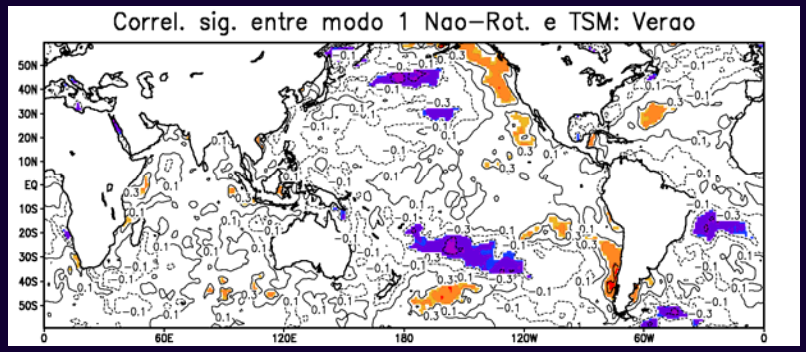


11.9%

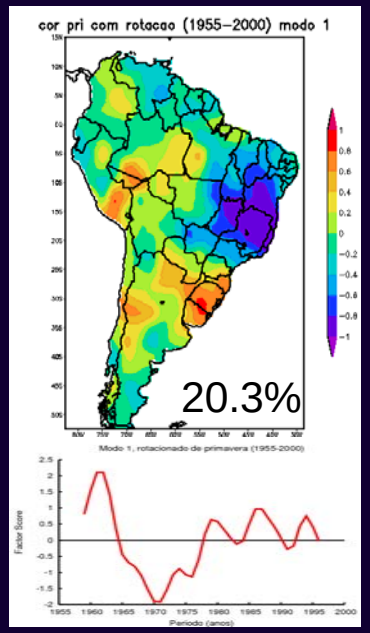


PC1 summer

PC1summer X SST



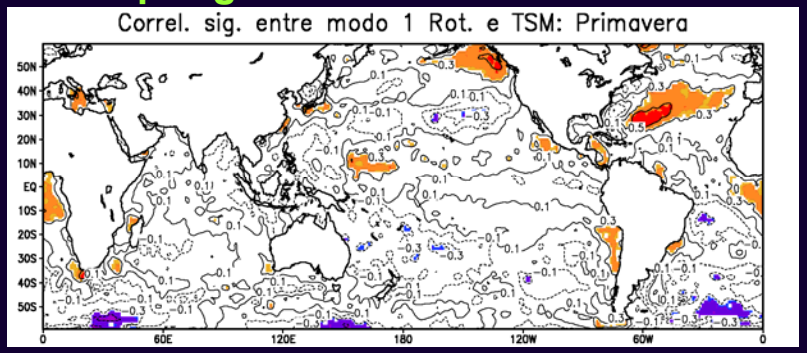
The inverse relationship between spring and summer



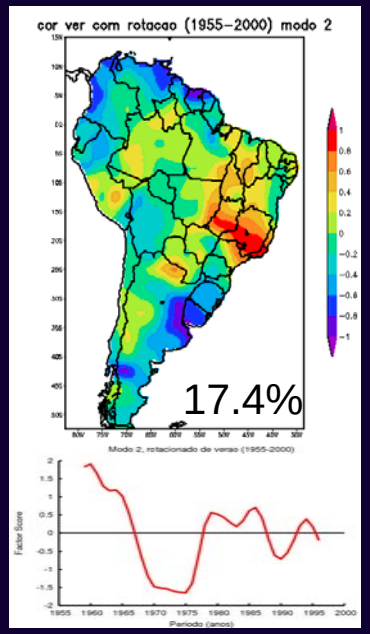
RPC1 spring

10.0%

RPC1spring X SST

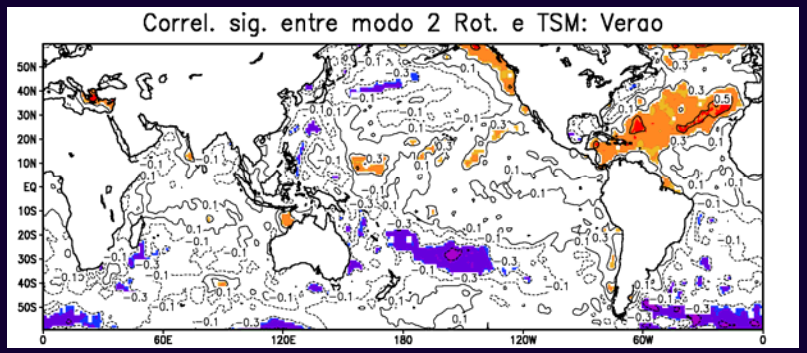


11.9%



RPC2 summer

RPC2summer X SST



CONCLUSIONS

- The interdecadal variability of precipitation in South America shows significant seasonality. It is, however, not strictly tied to the rainy season in each region, although there is relationship between the distribution of rainfall and the interdecadal variability, specially during the summer monsoon.

- The season of strongest contribution to interdecadal variability is autumn, and the regions where it is strongest are Amazonia and Northeast Brazil, where the autumn precipitation is important.

- The interdecadal precipitation modes in South America show correlation patterns with SST that resemble well known modes of SST variability, and their temporal variability is consistent with the variability of these modes.

- The main interdecadal variability of spring and summer shows inverse anomalies in Central-East Brazil (and SSA), as the interannual variability.