Role of the global oceans and land-atmosphere interaction on summertime interdecadal rainfall variability over Southeastern South America

or

Has rainfall over SESA potential predictability on interdecadal time scales?

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In collaboration with Nicolas Díaz & Madeleine Renom

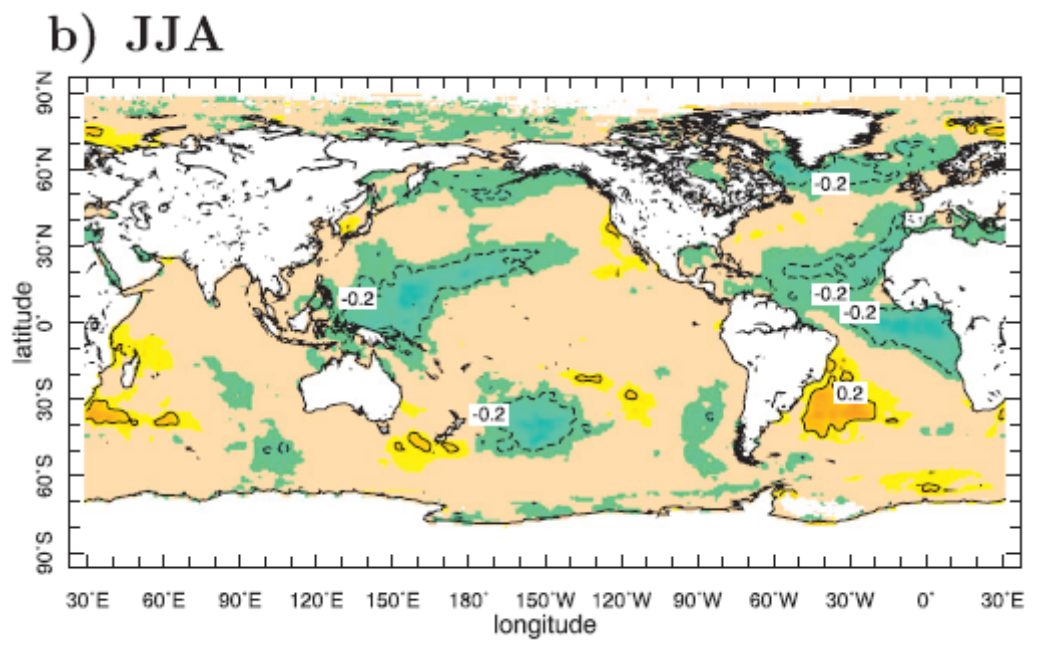
Motivation

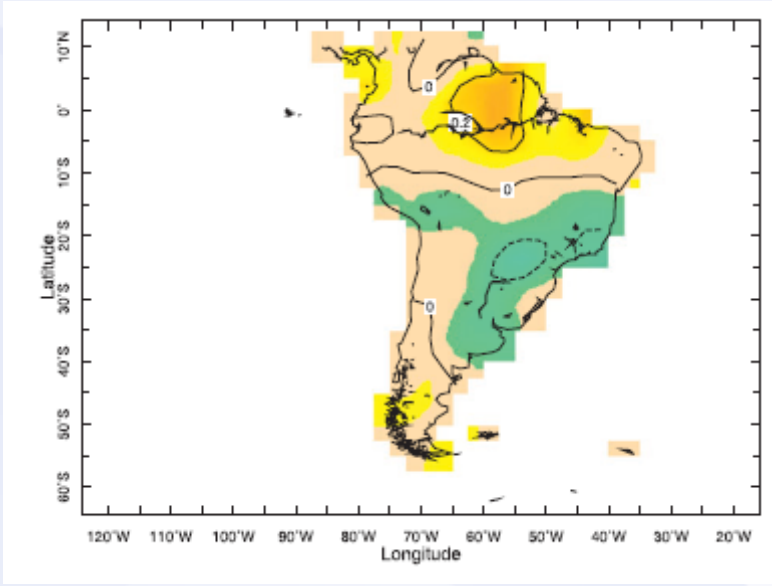
- Southeastern South America is strongly influenced by ENSO on interannual time scales (million references...).
- On interdecadal time scales the story is not as well understood
  - Kayano and Andreoli (2007) – PDO affects ENSO teleconnection (constructive/destructive interference)
  - Barreiro (2010) – rainfall predictability changes in 1970s due to changes in ENSO particularly in fall.

- Seager et al (2010) – Atlantic Multidecadal Oscillation plays dominant role.

  Equatorial SST<0 promote wet conditions over SESA (particularly during winter).

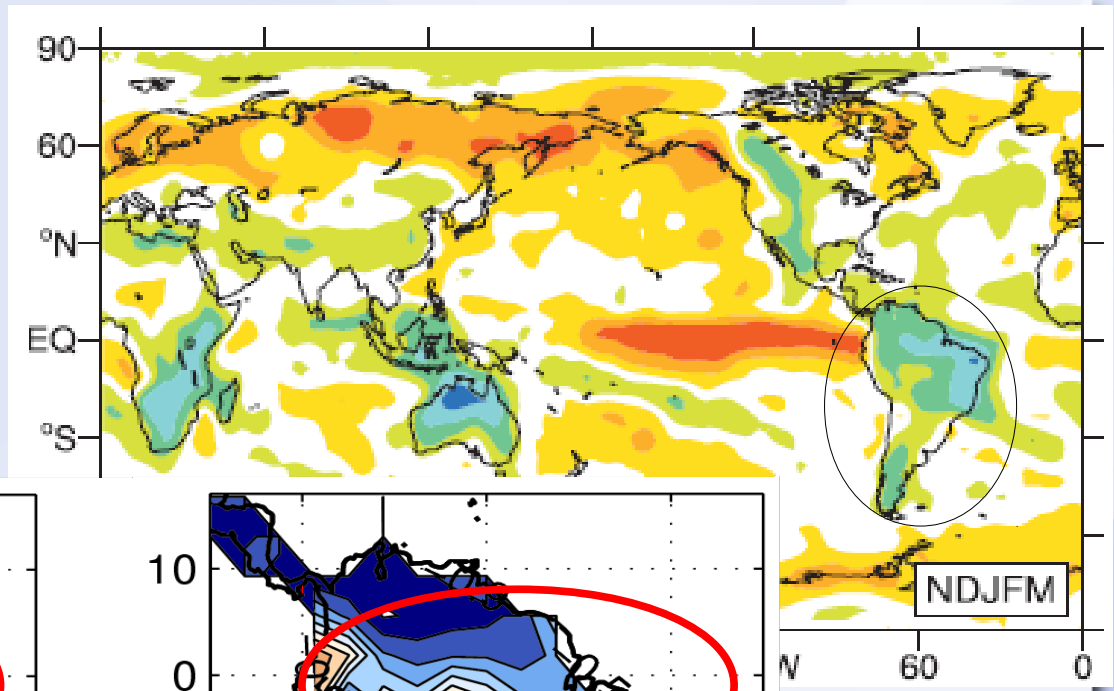
  Observed rainfall trend in SESA partly due to AMO.



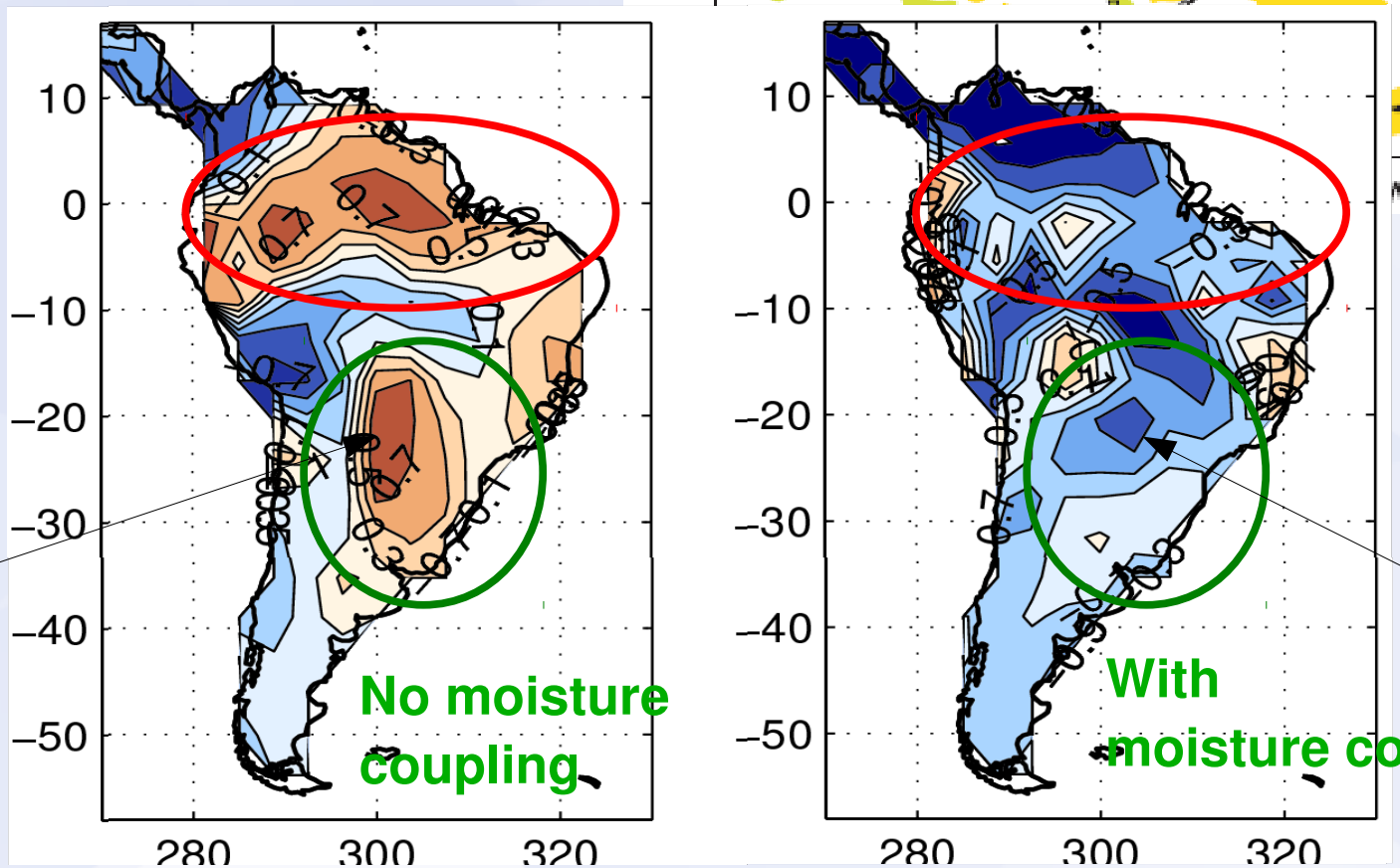


Land-atmosphere coupling

Correlation between Rainfall and SAT in NDJFM (Trenberth & Shea 2005)



ICTP AGCM

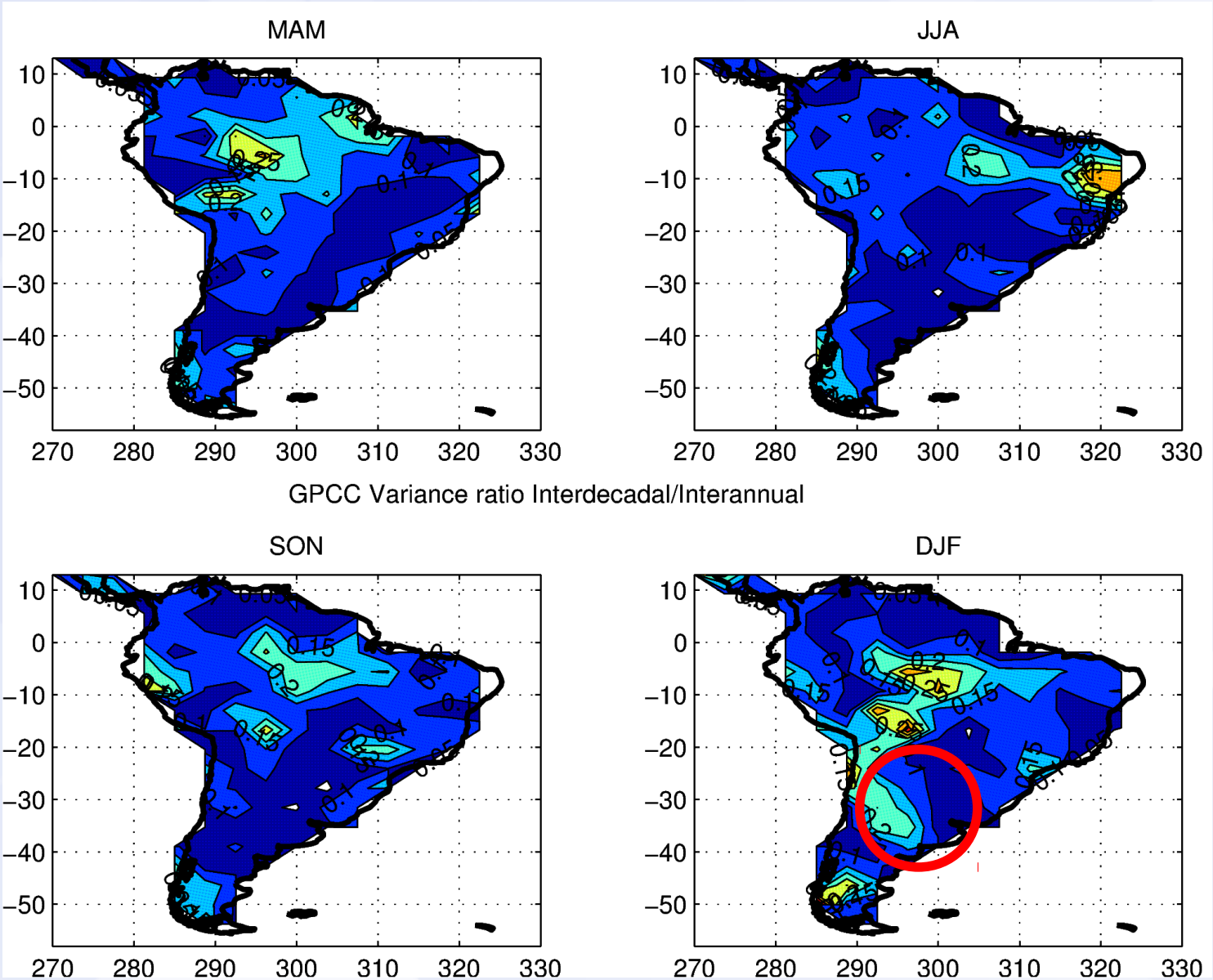


> +0.7

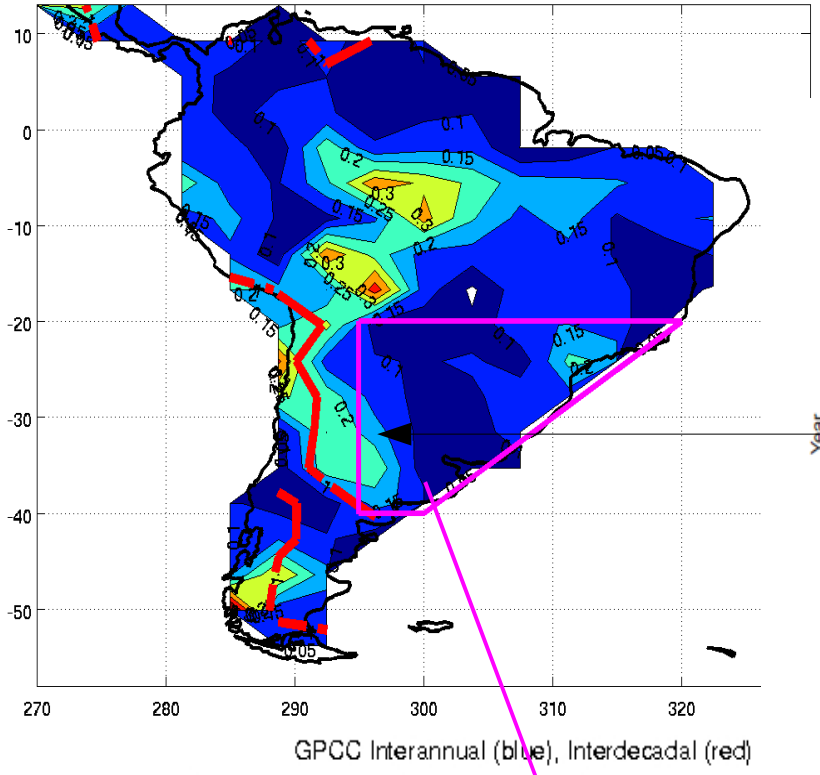
< -0.5
Much better!

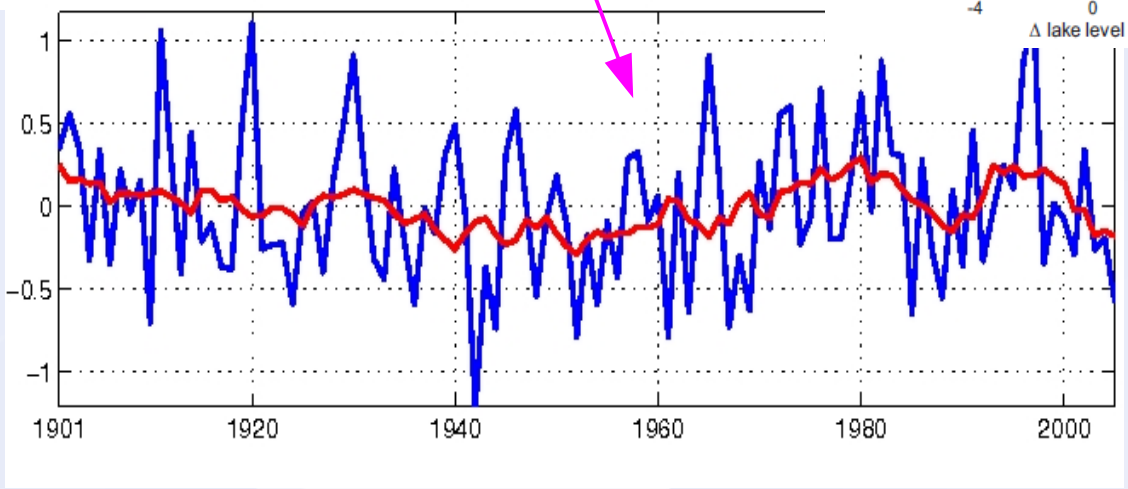
Barreiro and Diaz (2011)

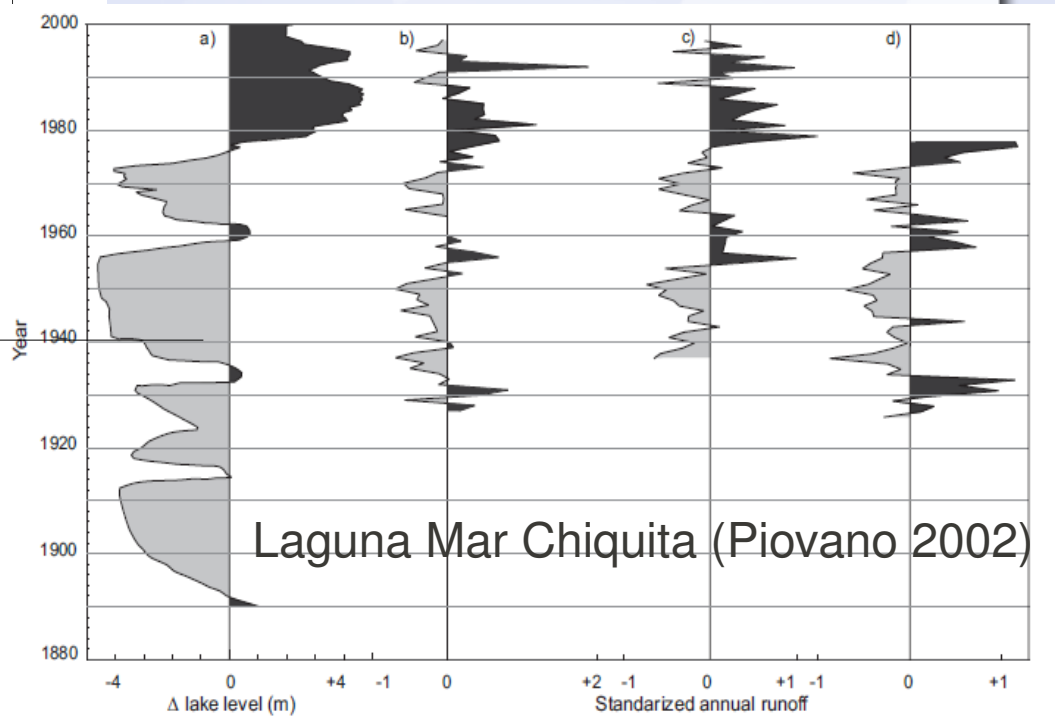
GPCC Interdecadal/Interannual Variance Ratio



DJF rainfall variability







Interdecadal: 9 point running mean.

Datasets

- Rainfall:
  - GPCC (1901-2006) 1°x1°
- Sea level pressure
  - 20th century Reanalysis
- ICTP AGCM (1901-2006), T30L8 (3.875°x3.875°)
  - GOGA: AGCM forced with global historical SST and prescribed soil moisture.
  - GOGA-AL coupled with SLand model (Zeng et al 2000).
  - POGA-AL: AGCM forced with Pacific-only SST with land-atmosphere coupling.
  - 10-member ensembles

Correlation between simulated and observed rainfall in SESA DJF

	Interannual	Interannual detrended		Interdecadal detrended
GOGA-AL	0.21	0.26	0.16	0.50
GOGA	0.07	0.19	-0.35	0.30
POGA-AL	0.42	0.30	0.74	0.05

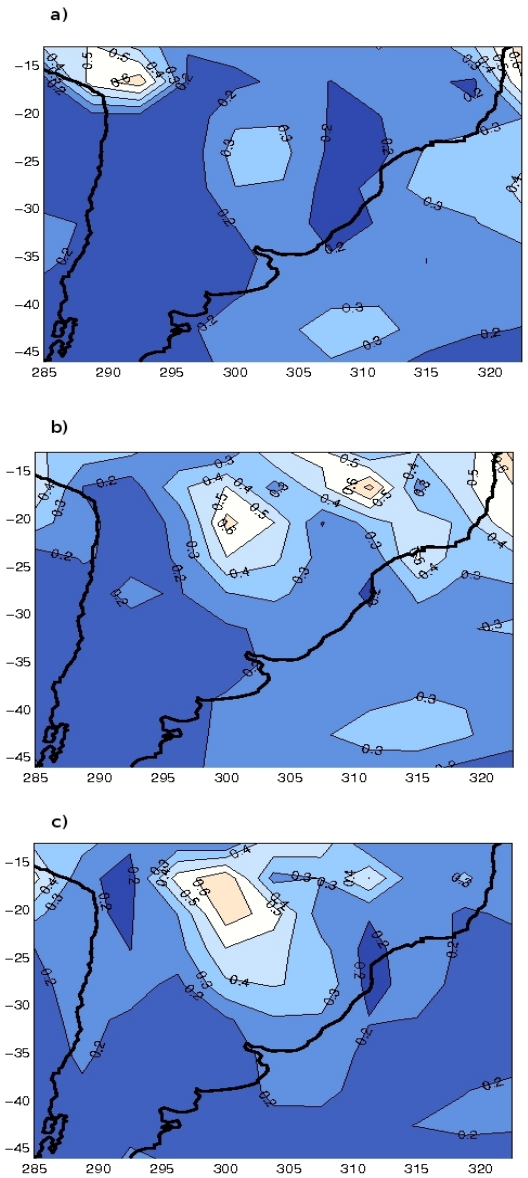
Effect of Pacific

Land-Atmo Interaction

Interdecadal

- The linear trend is governed by the Pacific.
- The interdecadal variability dominated by the global oceans with land-atmosphere interaction playing a role

Signal/noise Variance of Ensemble Interannual



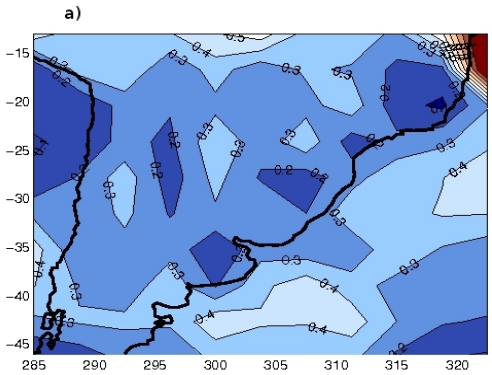
GOGA

GOGA-AL

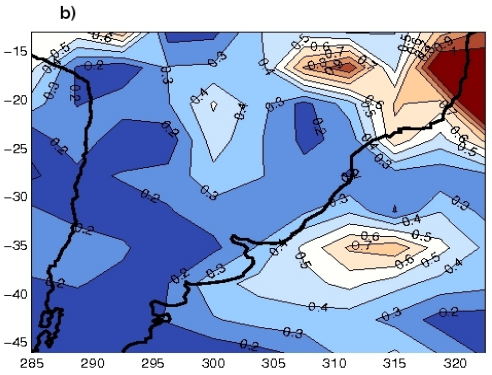
POGA-AL

Land-atmosphere Interaction induces more consistent precipitation anomalies among ensemble members.

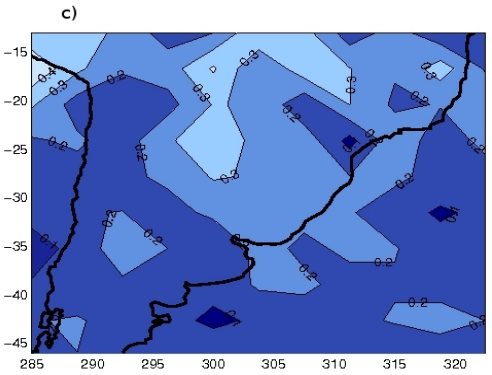
Signal/noise Variance of Ensemble Interdecadal



GOGA

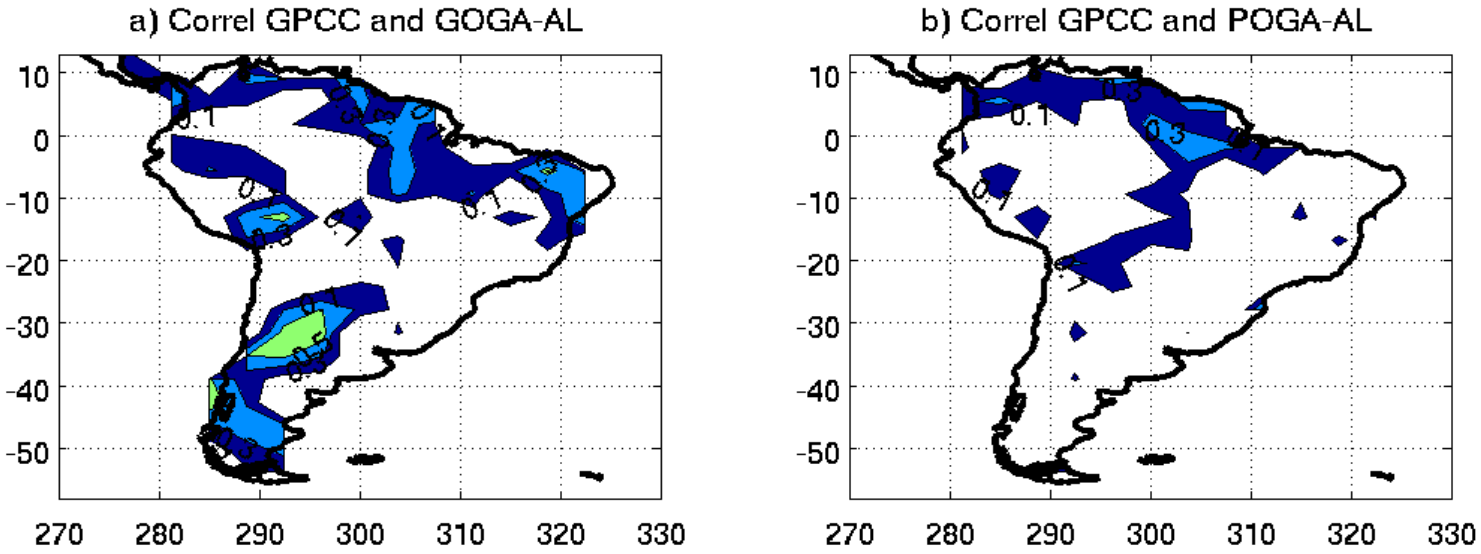


GOGA-AL



POGA-AL

Same as on interannual time scales, but now SACZ has stronger signal (not necessarily right).

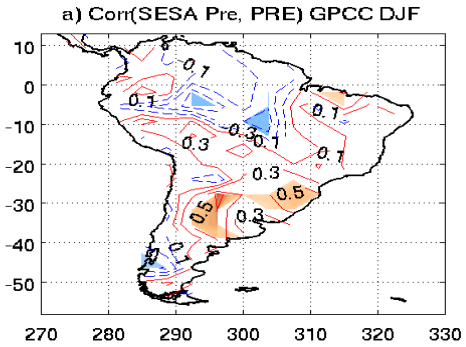


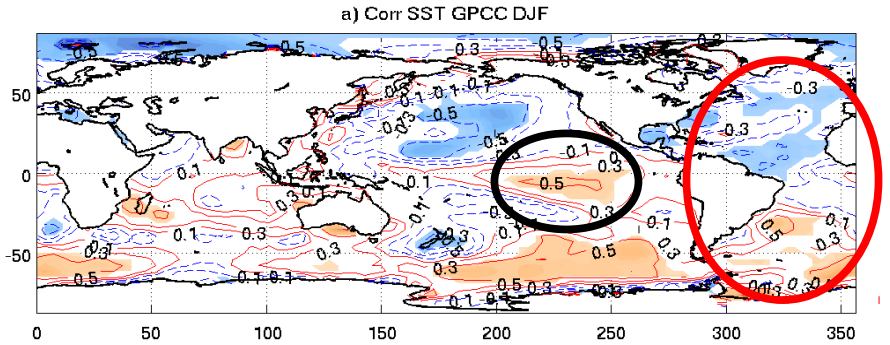
Point-to-point correlation between GPCC and ensemble mean

The westernmost part of SESA, the western Pampas, is the region where precipitation is well reproduced by the model when forced with global SST.

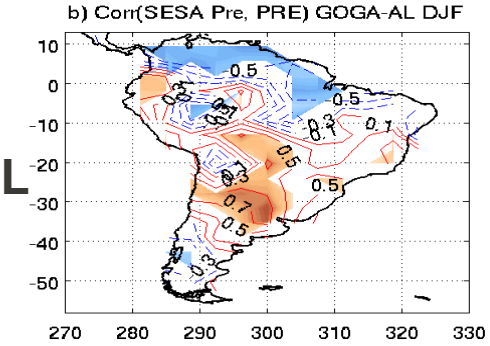
Correlation between SESA rainfall and South America rainfall and SST

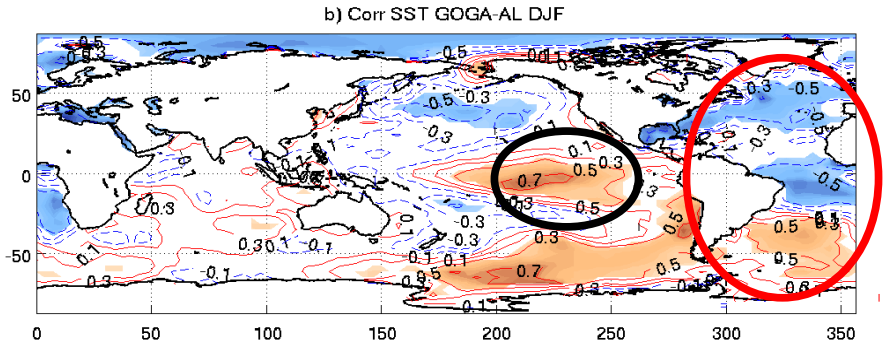
OBS



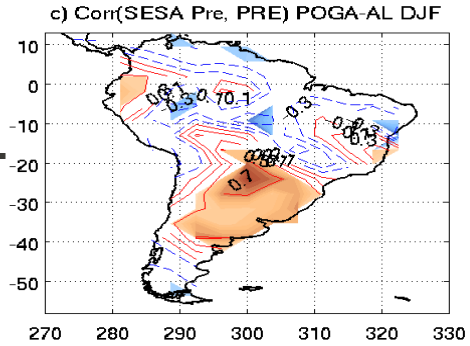


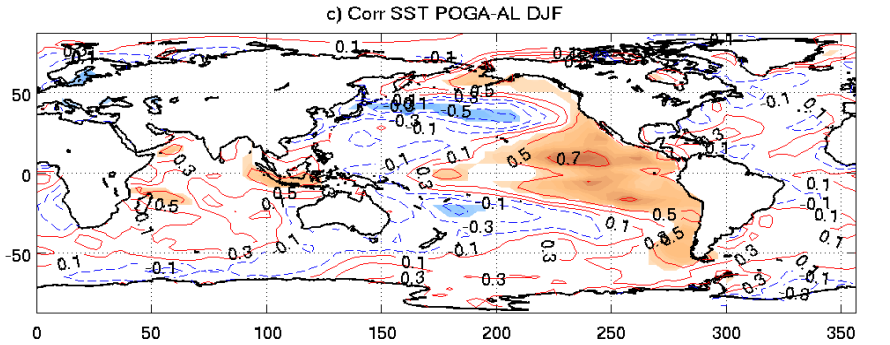
GOGA-AL





POGA-AL

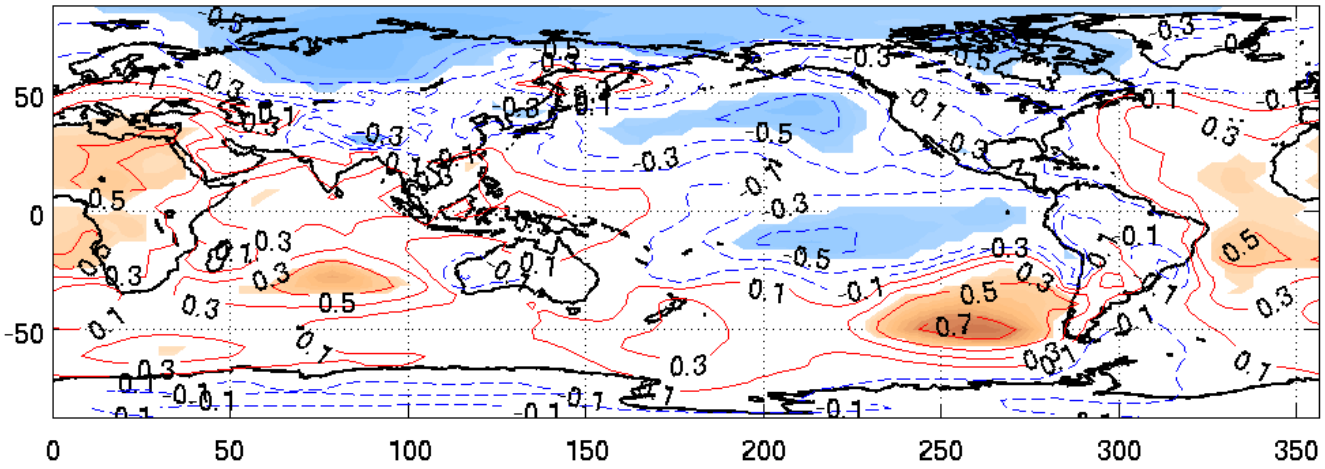




GOGA-AL reproduces the right connections of the western Pampas to the global oceans

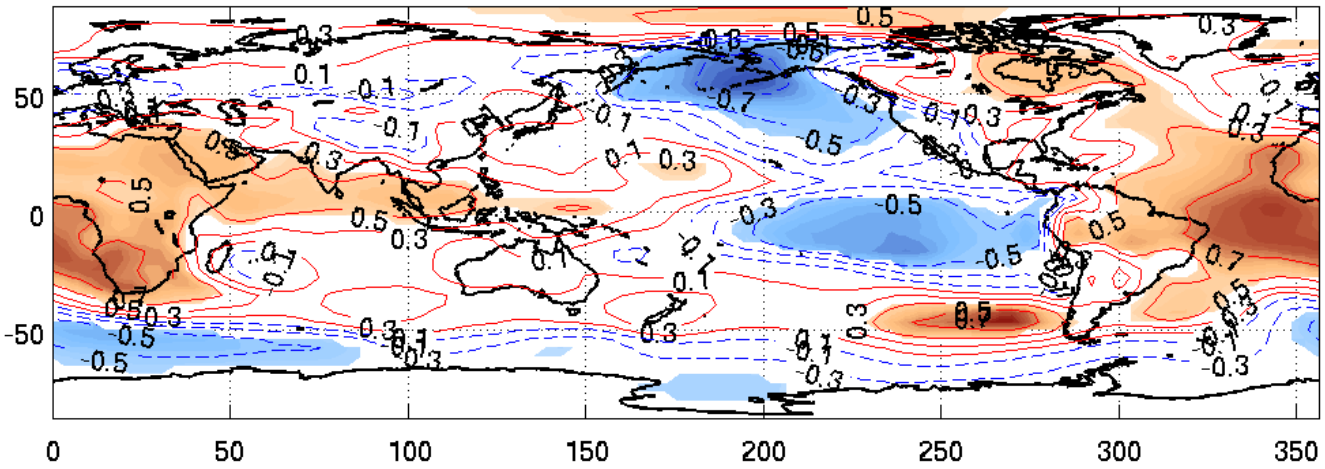
Correlation between SESA rainfall and SLP

a) Corr SLP OBS DJF



20th Century Reanalysis

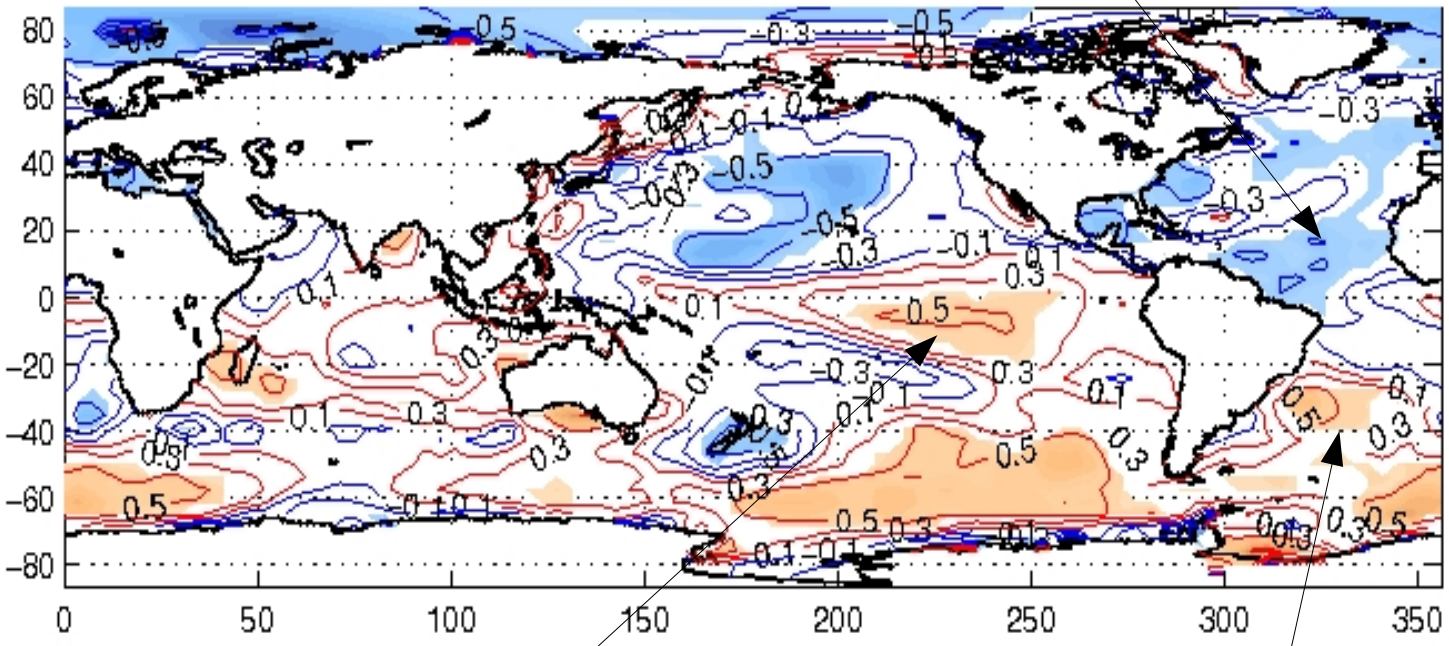
b) Corr SLP GOGA-IC2 DJF



GOGA-AL

GOGA-AL reproduces atmospheric circulation anomalies associated with rainfall in western Pampas

AMO? (r=-0.46)



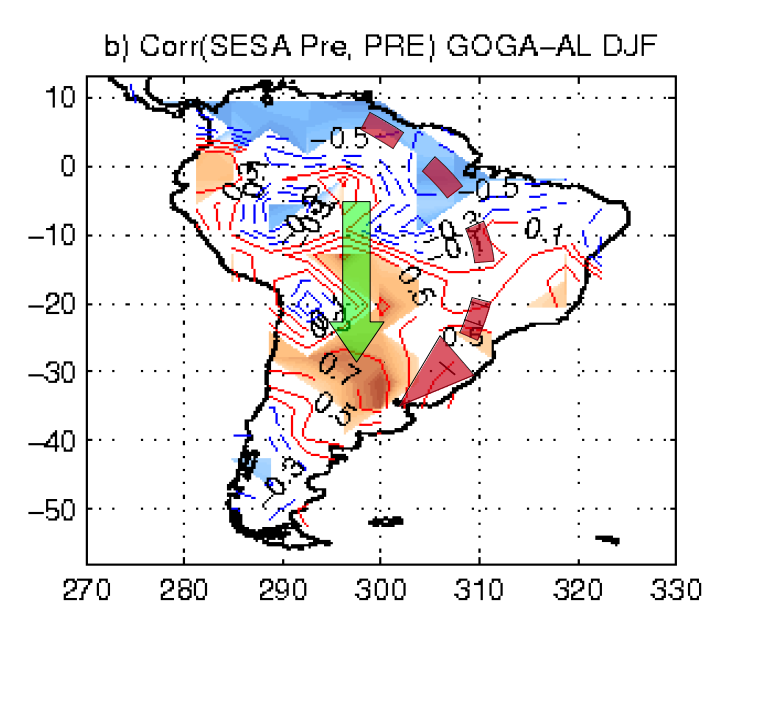
PDO? (r=0.09)

Changes in Atlantic Anticyclone / SACZ?

Mechanisms

- Barreiro and Tippmmann (2008)

  Those El Niños that coincide with cold equatorial Atlantic induce stronger rainfall anomalies in DJF due to larger moisture supply from Amazon and convergence over SESA.



- Mo and Berbery (2011)

  The combination warm Pacific-cold TNA induces persistent wet spells in subtropics due to

  - Stronger southward flow from Amazon,
  - Weakens regional Hadley cell and thus weakens subtropical subsidence.

Summary

- The western Pampas is the region with largest interdecadal/interannual variance ratio over SESA during DJF.
- The interannual variability and the linear trend are well captured by a model forced with Pacific-only SST (agrees w. Haylock et al 2006).
- The interdecadal variability over the western Pampas is the result of Pacific and Atlantic SST anomalies such that a positive C. Pacific-negative TNA see-saw induces increased rainfall.
- Origin of SSTa?

Improve the present understanding of atmospheric teleconnection processes by employing as a framework complex network theory and analysis