# Extremes and Trends in the La Plata Basin (LPB)

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with contributions of
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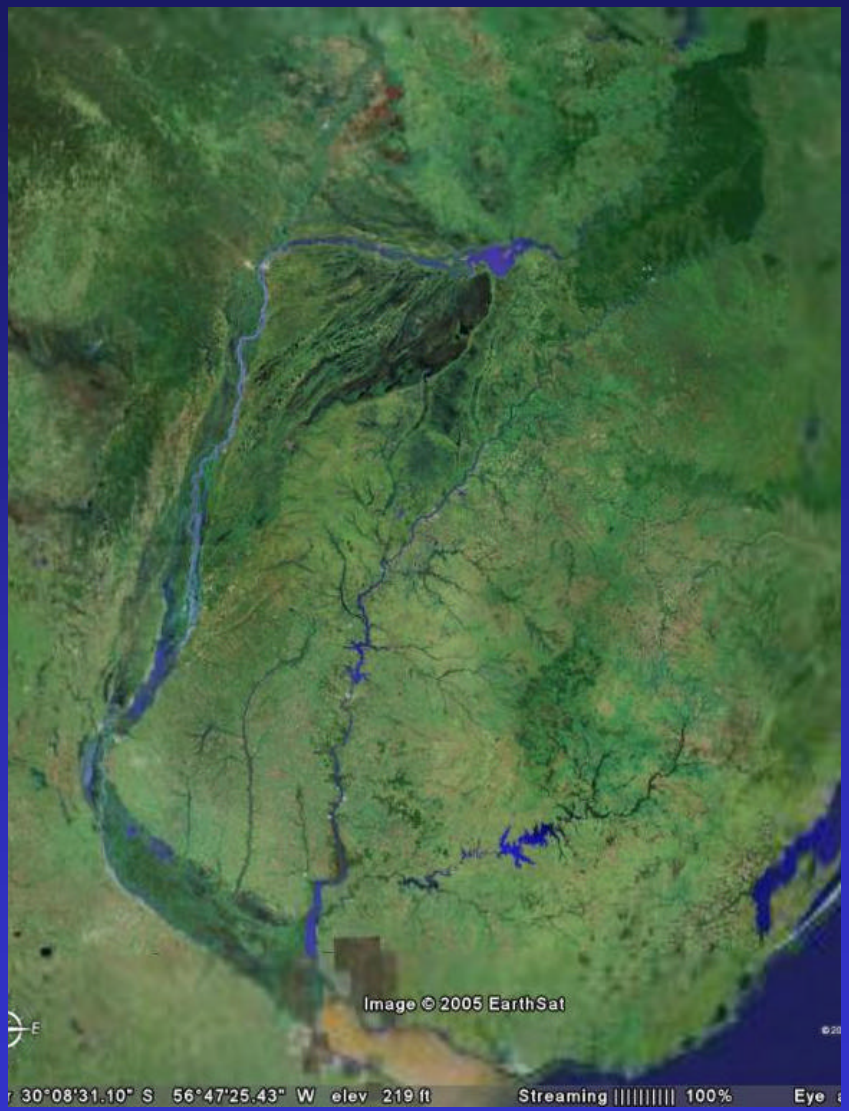
# Main questions in LPB


- What climatological and hydrological factors determine the frequency of occurrence and spatial extent of floods and droughts?

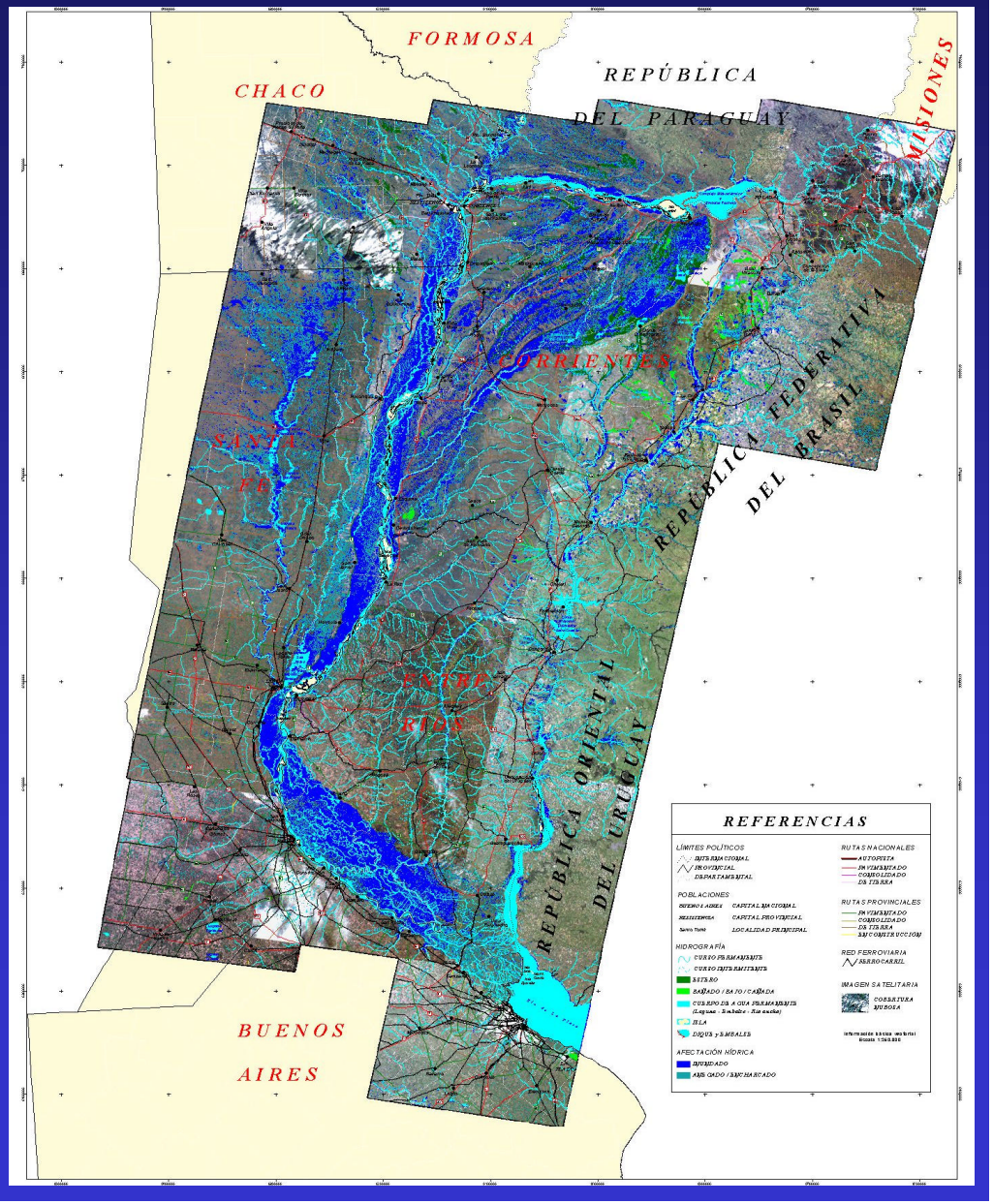
- How predictable is the regional weather and climate variability and its impact on hydrological, agricultural and social systems of the basin?

- What are the impacts of global climate change and land use change on regional weather, climate, hydrology and agriculture? Can their impacts be predicted, at least in part?

## Normal conditions



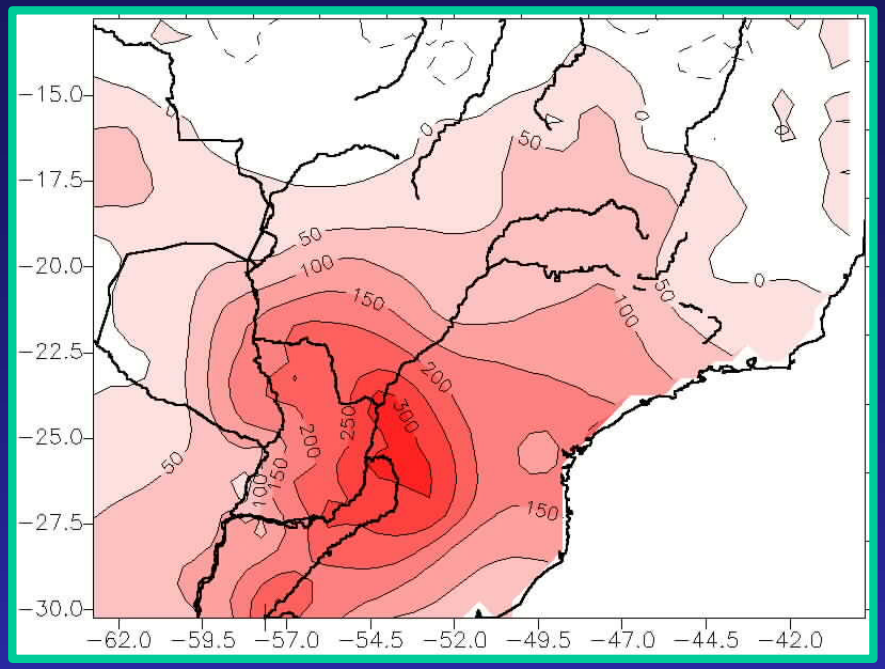

## 1997/98 Flood of the Paraná River (Satellite images from CONAE)



# Extreme discharge anomalies* of the Paraná River at Corrientes (1904-2000)

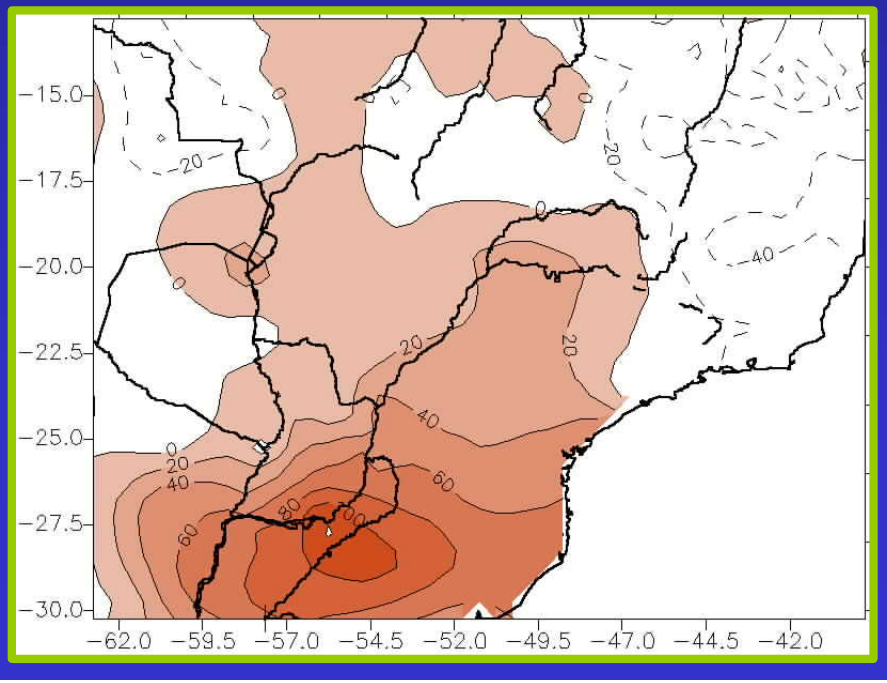
*Anomalies larger than 3 s

| Order | Date | ENSO phase | Discharge (m3/s) | Order | Date | ENSO phase | Discharge (m3/s) |
|---|---|---|---|---|---|---|---|
| 1 | **Jun 83** | **A +** | **38300** | 9 | **Jul 82** | **W 0** | **18800** |
| 2 | **Jun 92** | **A +** | **26800** | 10 | **Feb 97** | **$Su_{neu}$** | **17600** |
| 3 | **Dec 82** | **Sp 0** | **26100** | 11 | **Sep 89** | **$Sp_{neu}$** | **16700** |
| 4 | **Mar 83** | **A +** | **24200** | 12 | **Sep 90** | **$Sp_{neu}$** | **16400** |
| 5 | **Jun 05** | **A +** | **24100** | 13 | **Jan 12** | **Su N** | **15900** |
| 6 | **May 98** | **A +** | **23000** | 14 | **Nov 97** | **Sp 0** | **15600** |
| 7 | **Oct 98** | **$Sp_{neu}$** | **21000** | 15 | **Jan 66** | **Su N** | **15400** |
| 8 | **Oct 83** | **$Sp_{neu}$** | **20400** | 16 | **Sep 57** | **Sp 0** | **15000** |




Composite of rainfall anomalies for March (+) to May (+) of El Niño that persisted until May in EN-3

Composite of rainfall anomalies for September (0) to November (0) of El Niño years



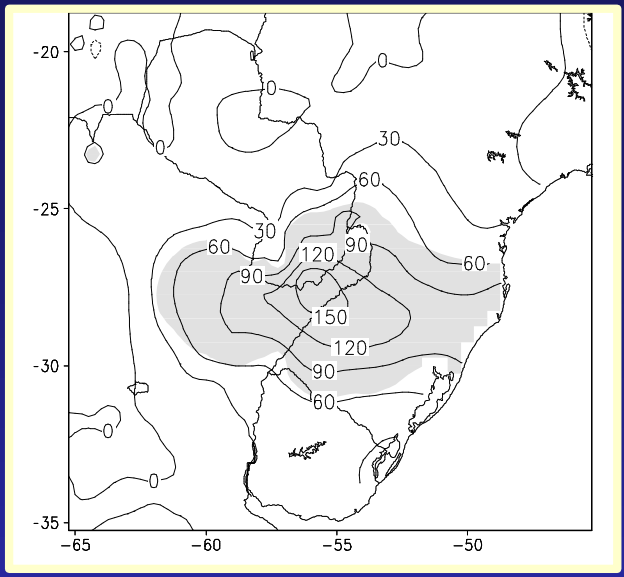
# Extreme monthly discharge anomalies* of the Uruguay river at Paso de los Libres (1909-2000)

| | | Date | Discharge anomaly ($m^3/s$) |
|---|---|---|---|
| **1** | EN | May 41 (A+) | 17338 |
| **2** | EN | Jul 83 (W+) | 15838 |
| **3** | EN | Nov 97 (Sp 0) | 15592 |
| **4** | EN | May 83 (A+) | 15196 |
| **5** | N | Oct 29 (Neu) | 15129 |
| **6** | EN | Nov 82 (Sp 0) | 14689 |
| **7** | EN | Feb 98 (Su+) | 13615 |
| **8** | EN | Oct 97 (Sp 0) | 12946 |
| **9** | N | Jun 90 (Neu) | 12633 |

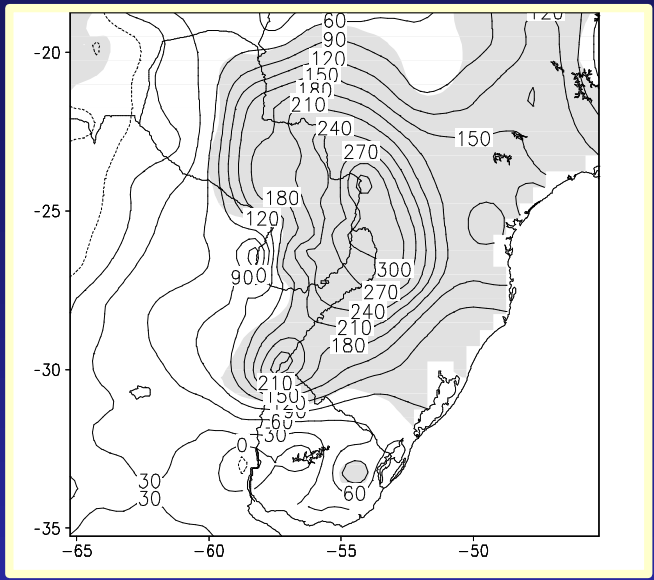
| | | Date | Discharge anomaly ($m^3/s$) |
|---|---|---|---|
| **10** | EN | Apr 98 (A+) | 11932 |
| **11** | N | Sep 28 (Neu) | 11591 |
| **12** | EN | Sep 72 (Sp 0) | 11301 |
| **13** | N | Apr 32 (Neu) | 9926 |
| **14** | EN | Mar 98 (A+) | 9410 |
| **15** | EN | Mar 83 (A+) | 9267 |
| **16** | N | Aug 83 (Neu) | 8894 |
| **17** | EN | Jan 98 (Su+) | 8703 |
| **18** | EN | Jan 12 (Su+) | 7692 |

*Anomalies larger than 3s

SPRING 0

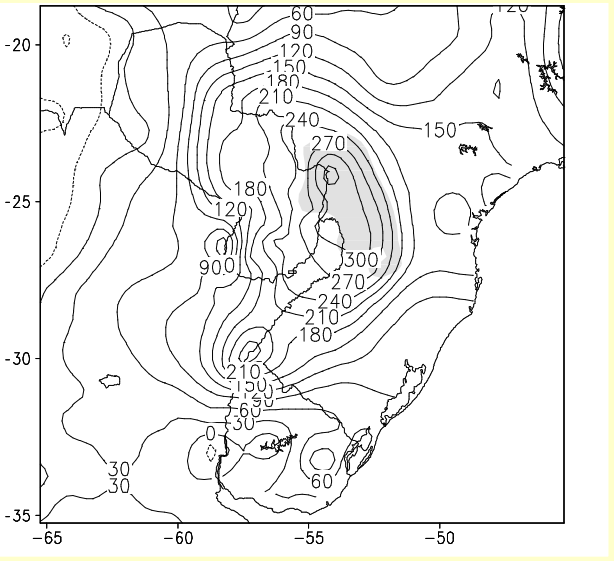



SUMMER +

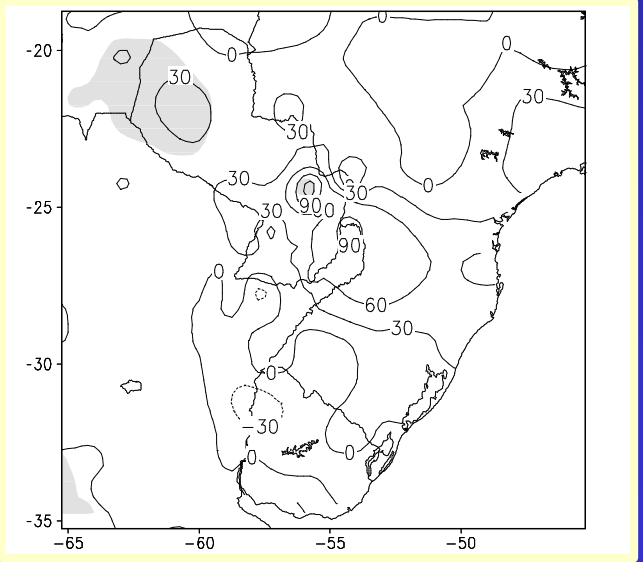



Rainfall anomalies in Southeastern South America during El Niño phases with extreme monthly discharges at Paso de los Libres

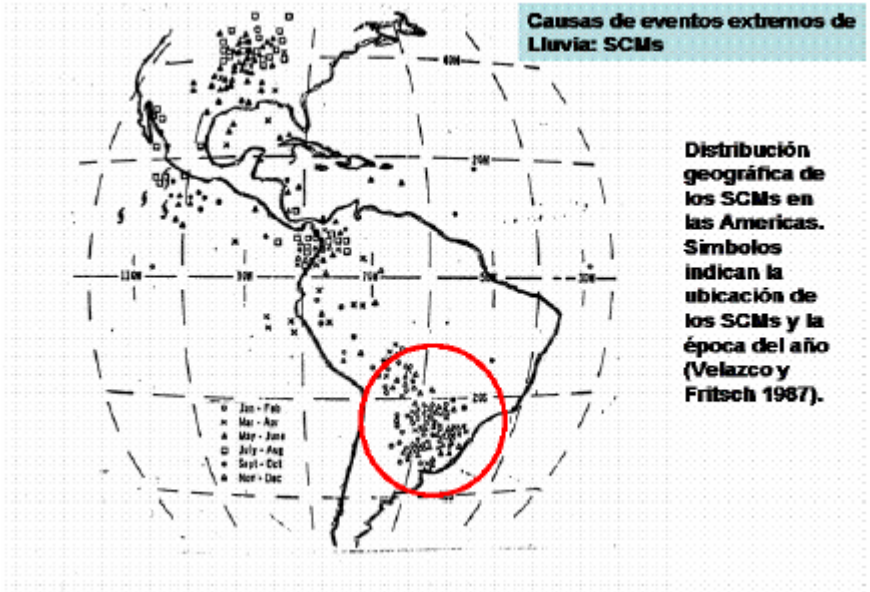
AUTUMN +




WINTER +

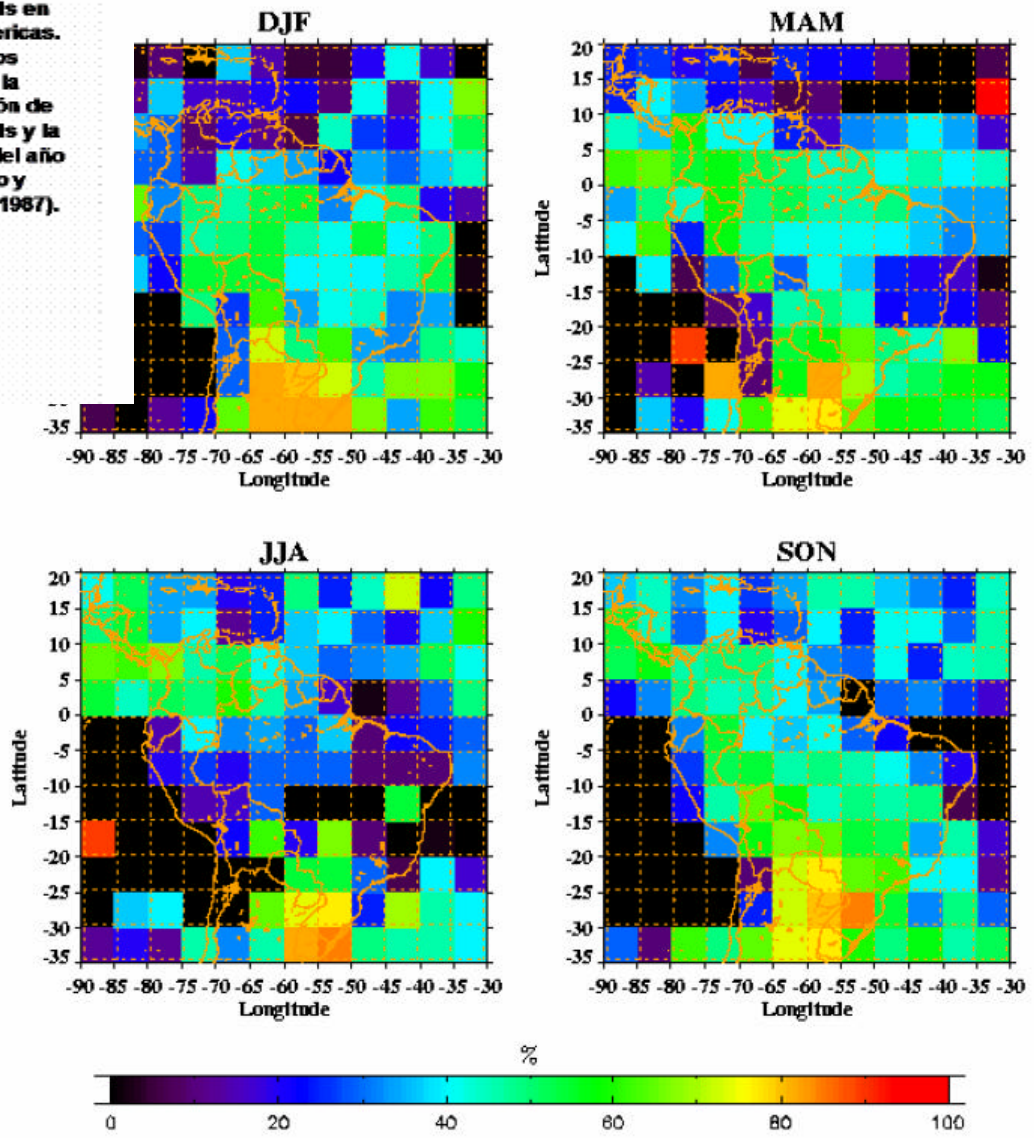


# MCSs




Distribución geográfica de los SCMs en las Americas. Simbolos indican la ubicación de los SCMs y la época del año (Velazco y Fritsch 1987).

Velasco and Fritsch 1987

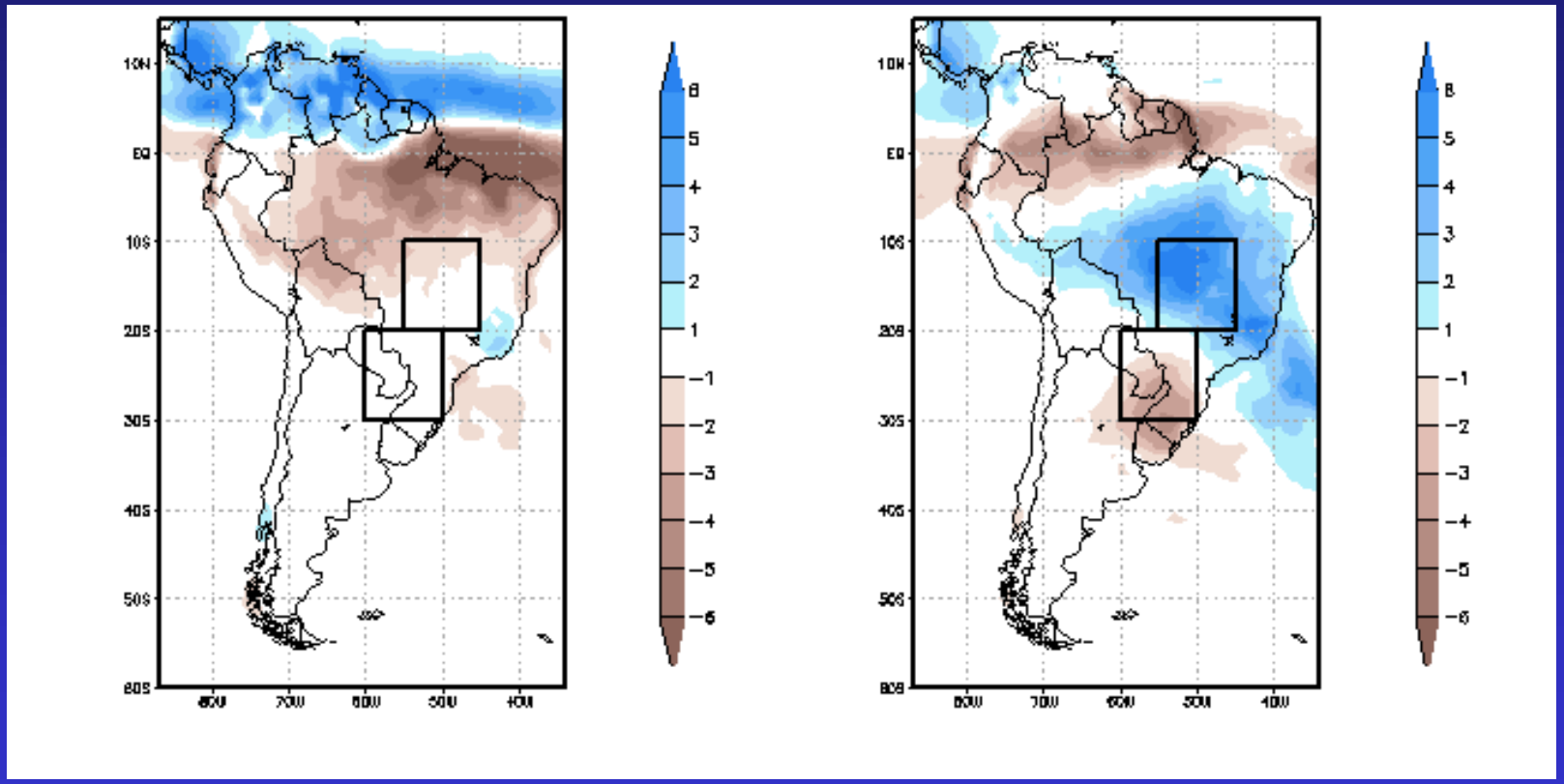



Courtesy of Zipser

*FIGURA 2.15: Porcentaje de precipitación convectiva (Gentileza de E. Zipser)*

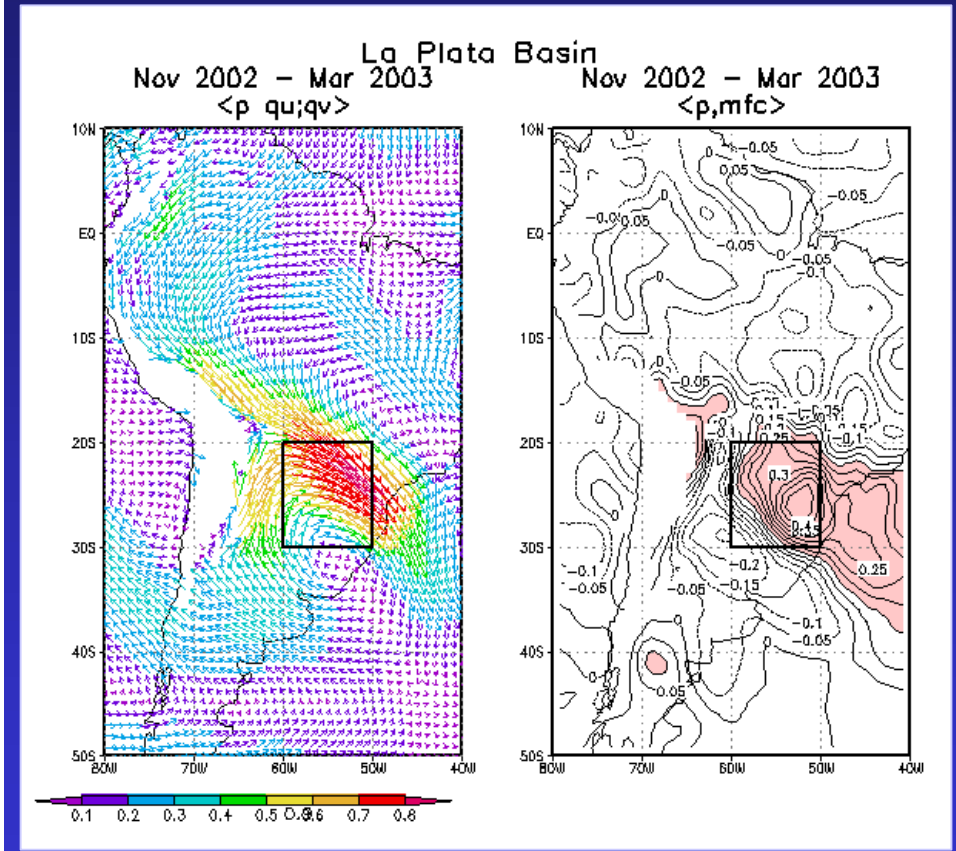
# Modes of variability during summer

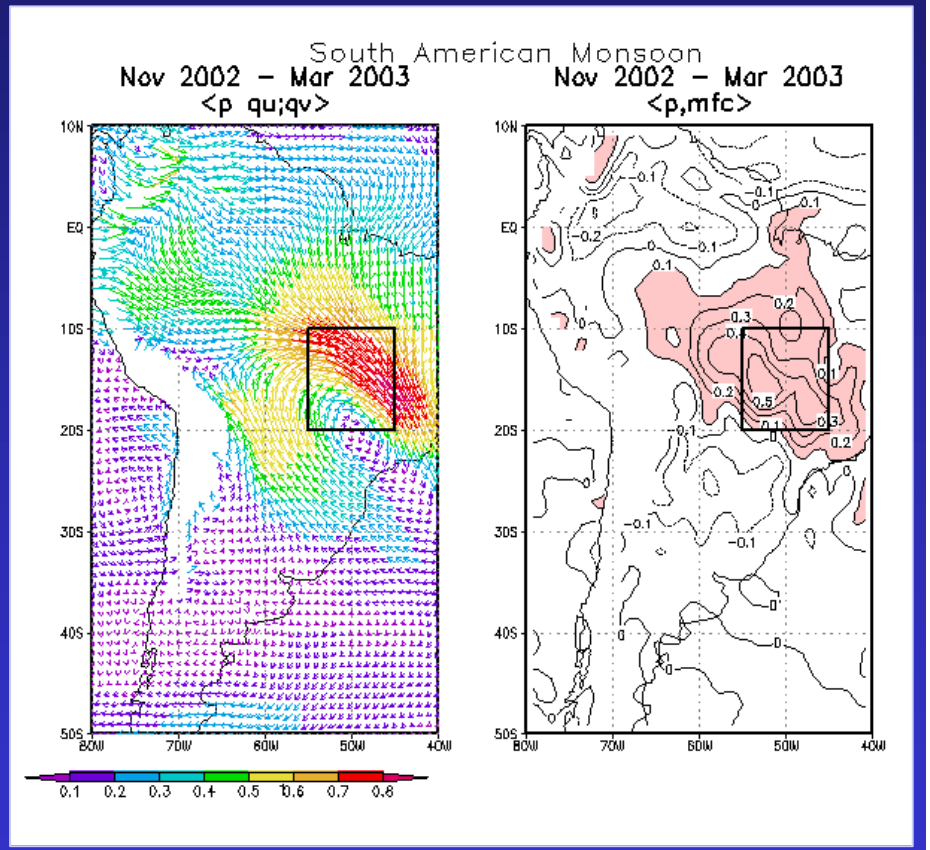
EOF 1 - ITCZ

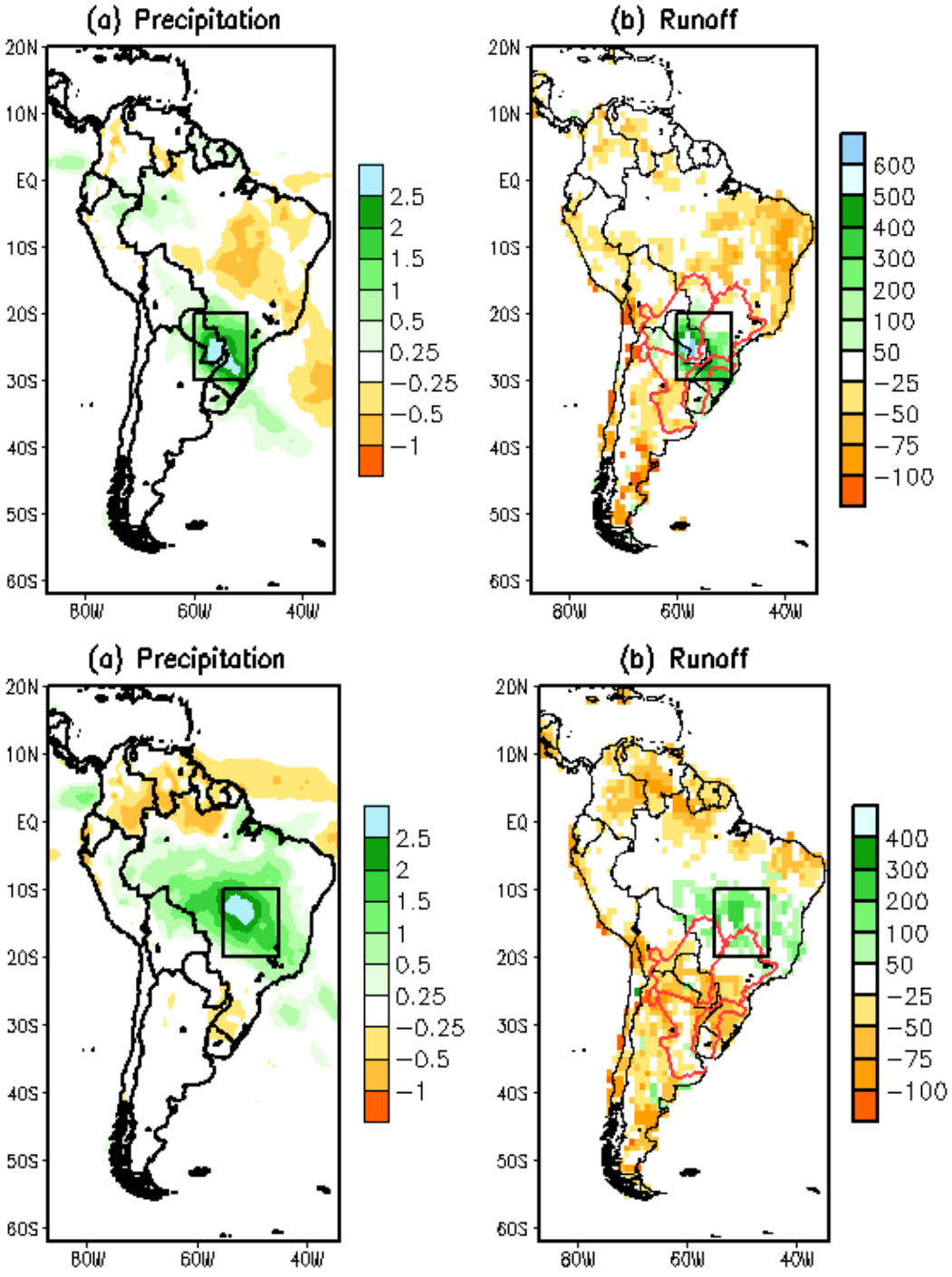



EOF 2 - SAMS

# Moisture fluxes and their convergence associated with intense precipitation events






Intense precipitation events

and their impact on model runoff

***"The signal of precipitation events is amplified in the total runoff"***

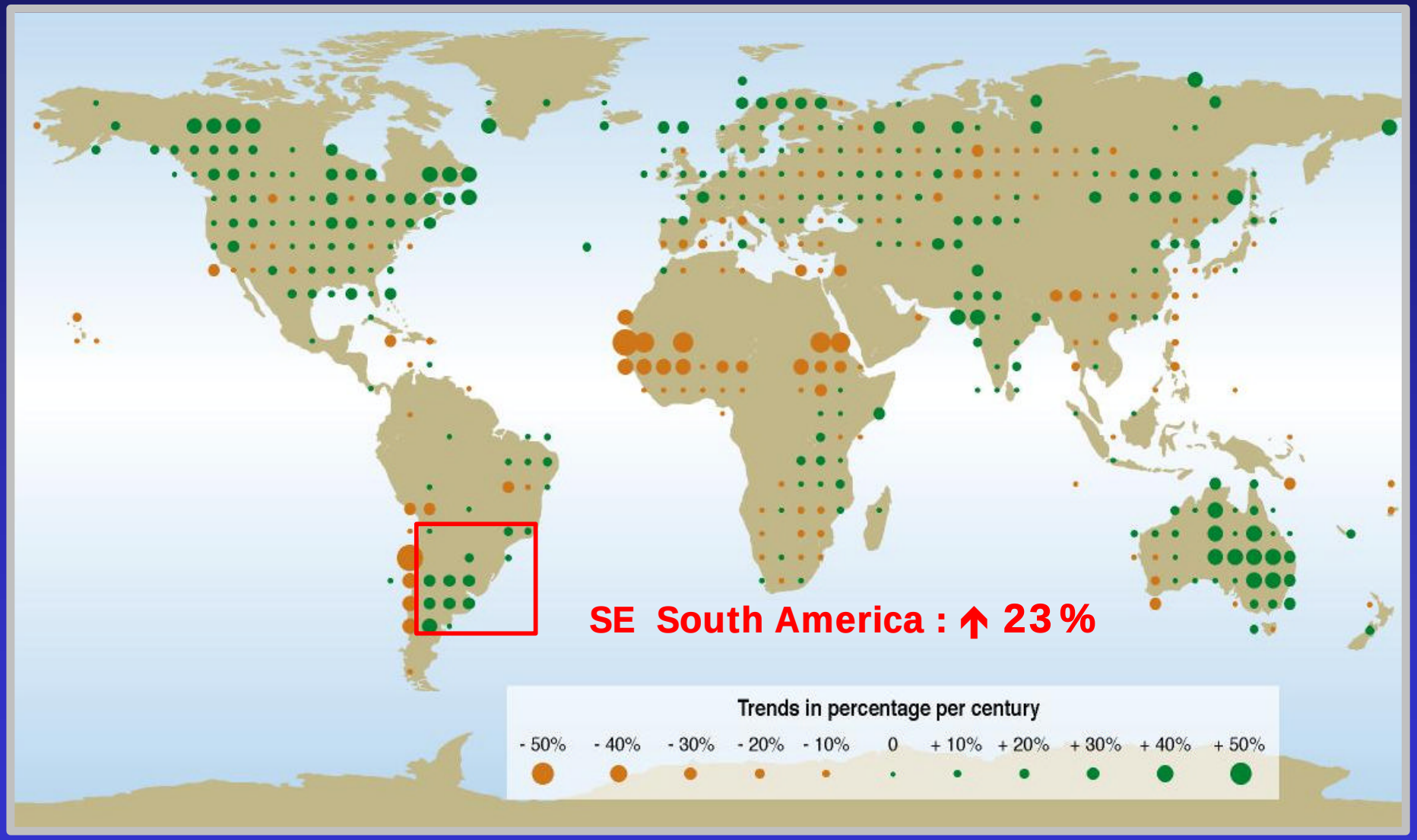
# Relative frequency (%) of SALLJ for three four-day periods before the flooding dates

| | period before the flooding date | | |
|---|---|---|---|
| | **-12 to -9 days** | **-8 to -5 days** | **-4 to -1 days** |
| **Warm season events** | 41.7 | 33.3 | 47.2 |
| **Cold season events** | 50.0 | 22.2 | 55.6 |

**40.7 %**

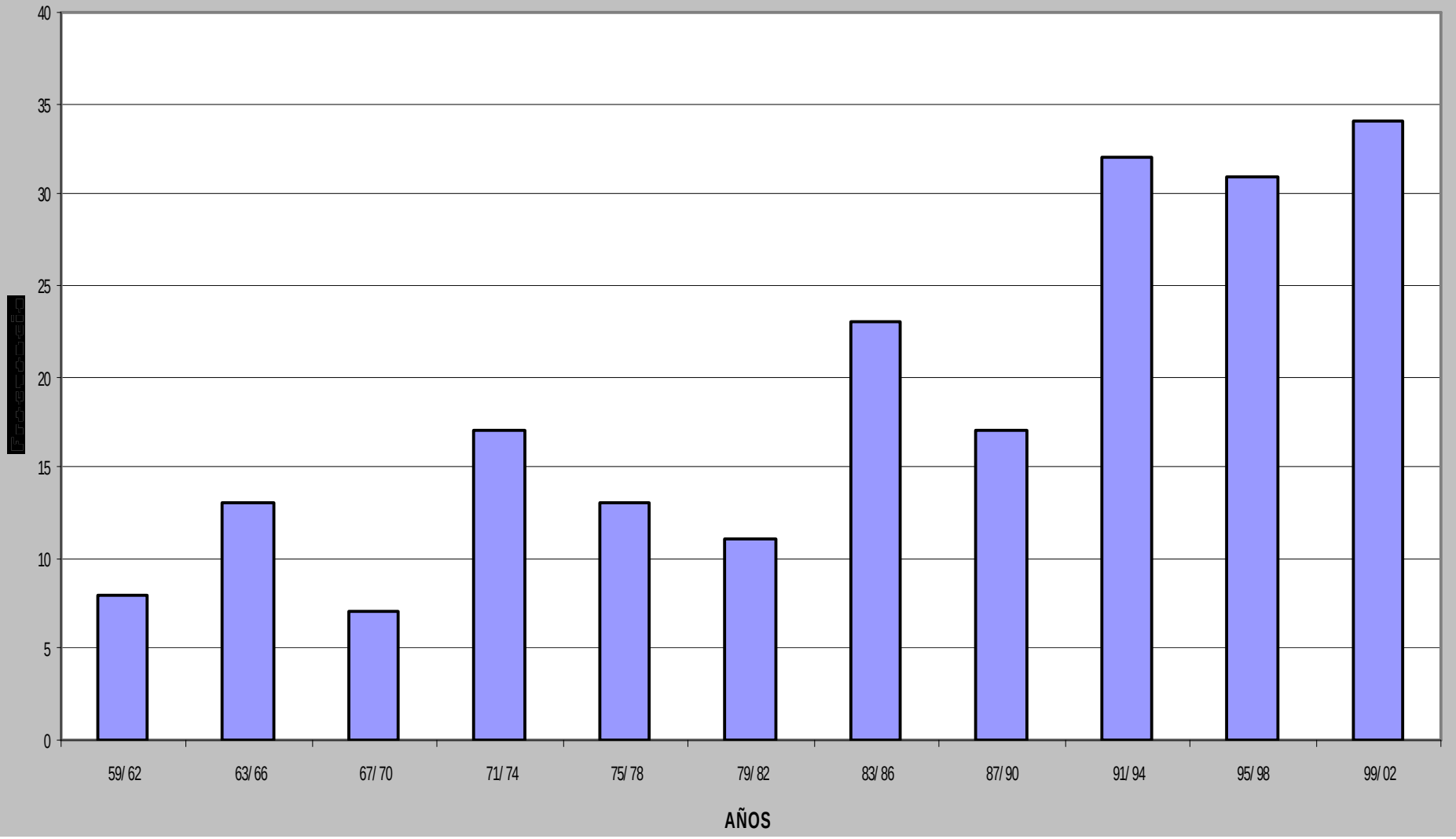
**42.6 %**

# Trends in annual precipitation 1900-2000

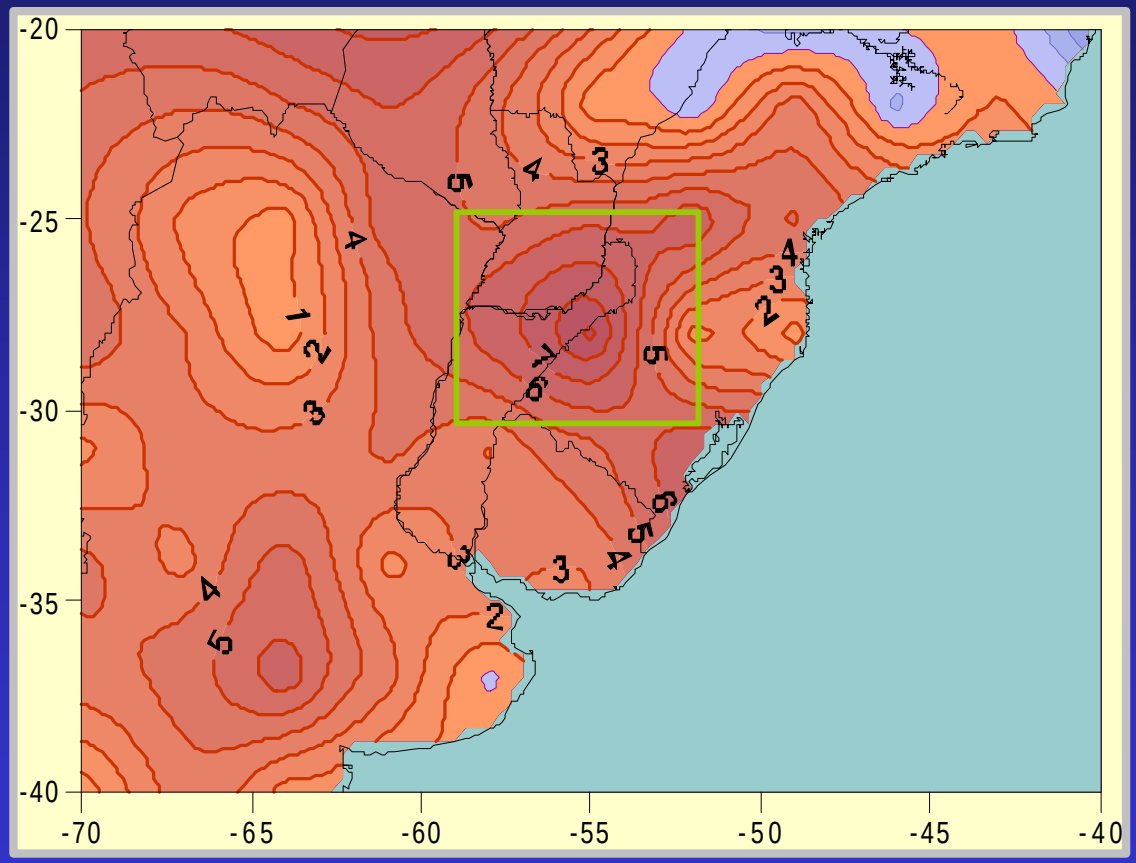



IPCC (2001)

# Number of cases with P> 100 mm/(2 days) for 16 gauging stations over central and northeastern Argentina



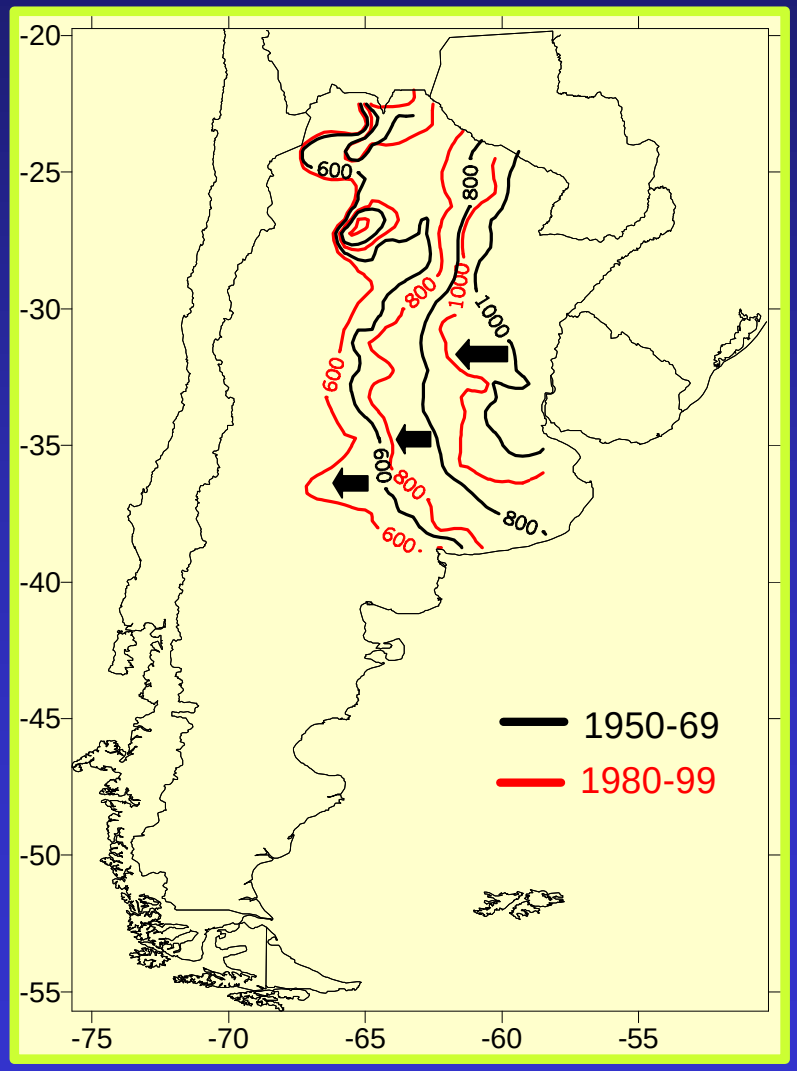
# Annual precipitation trends (mm/year): 1960-2000




Precipitation increases were between 10% and 40%.

The increase in some regions is as large as 200-300 mm in 40 years.

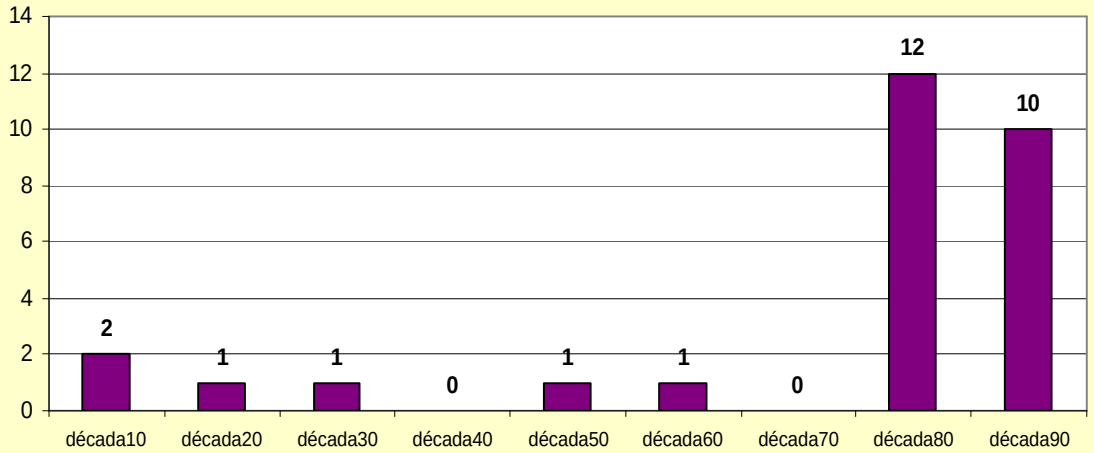
# A beneficial consequence of the increased precipitation



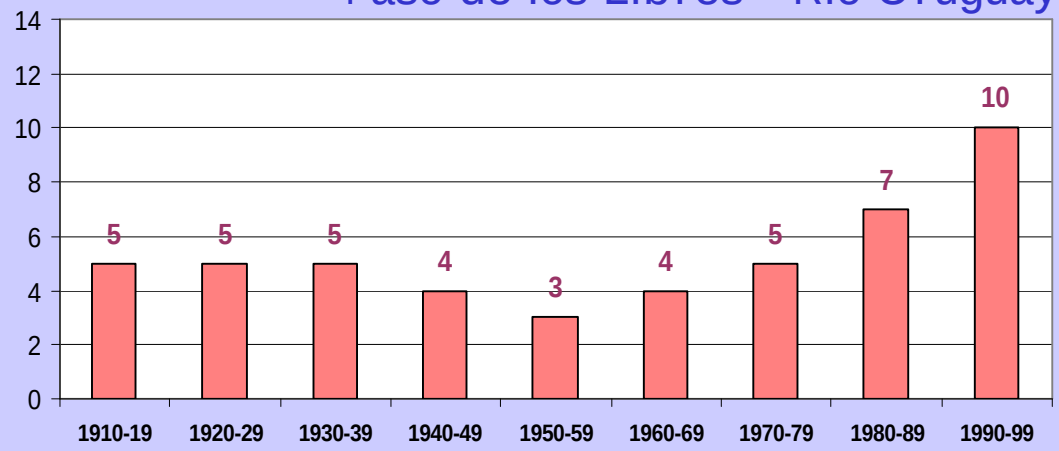

Agriculture activities have expanded westward.

# Number of months per decade with a river discharge Larger than two standard deviations

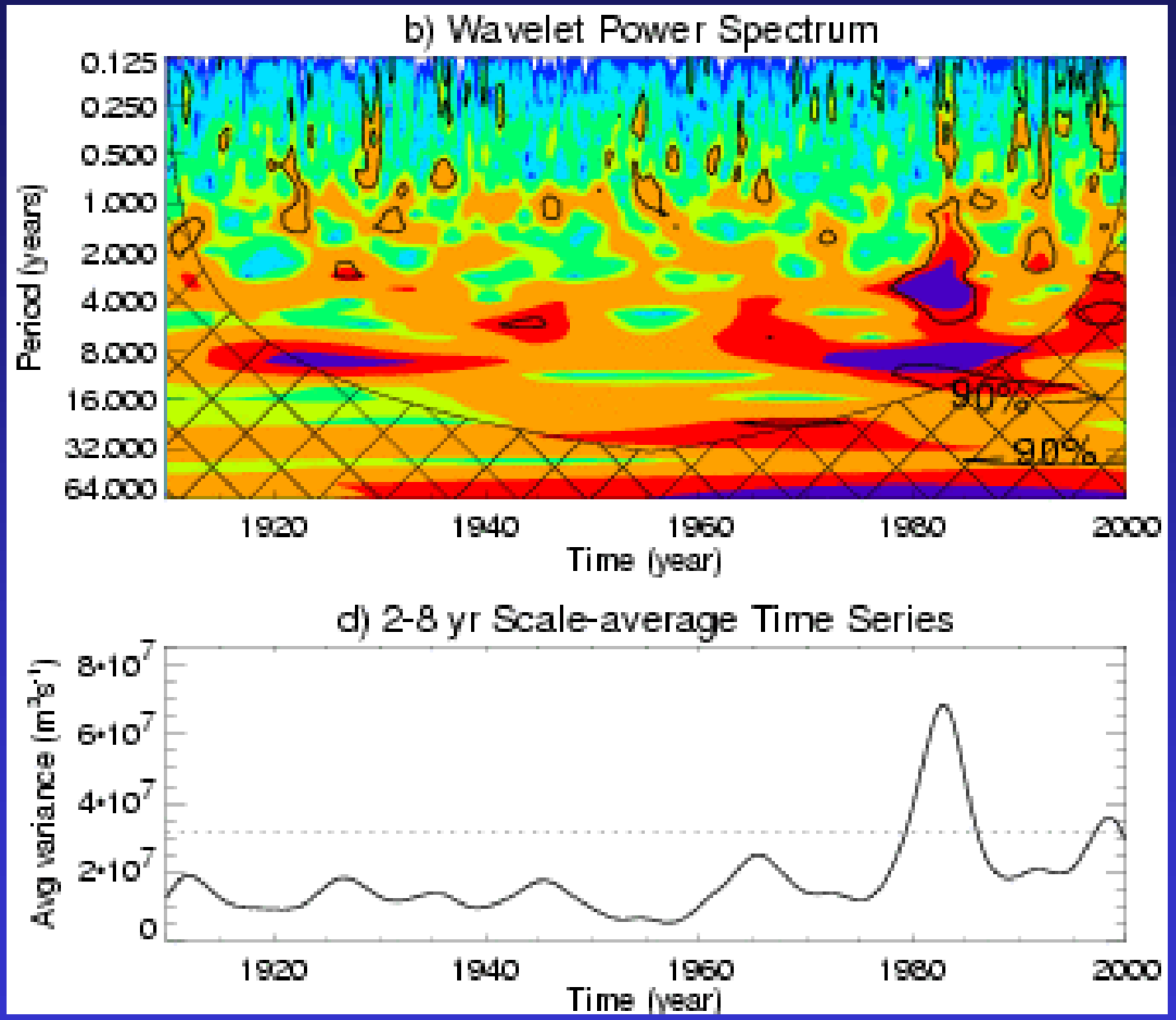
## Corrientes - Río Paraná




## Paso de los Libres - Río Uruguay



# La Plata river discharge



# Summary

- The Paraná and Uruguay basins are part of a region in SESA that has strong precipitation signal during ENSO events: most of the extreme monthly discharge events occurred during El Niño and none during La Niña

- During the twentieth century the top discharges of the Paraná River occurred during autumn (+). The Uruguay River does not have a dominant season

# Summary (cont.)

- Almost half of the extreme Uruguay River levels at Salto Grande could be related to enhanced precipitation due to moisture flux convergence in the SALLJ region

- The frequency of occurrence of SALLJ during the 12 days prior the flooding dates is slightly larger during the cold semester

# Largest daily levels at Salto Grande (1950-2000)

**CRITICAL RIVER LEVEL = 8 m**

| | | DATE | LEVEL |
|---|---|---|---|
| 1 | C | 16 April 1959 | 20.18 |
| 2 | C | 25 July 1983 | 17.85 |
| 3 | C | 16 April 1986 | 17.71 |
| 4 | C | 7 June 1992 | 17.71 |
| 5 | C | 19 June 1972 | 17.16 |
| 6 | C | 8 May 1983 | 16.91 |
| 7 | W | 10 January 1998 | 16.70 |
| 8 | C | 8 September 1972 | 16.43 |
| 9 | C | 26 April 1998 | 16.26 |

| | | DATE | LEVEL |
|---|---|---|---|
| 10 | W | 20 October 1997 | 16.01 |
| 11 | W | 17 November 1982 | 16.01 |
| 12 | C | 25 April 1987 | 15.91 |
| 13 | W | 13 November 1997 | 15.76 |
| 14 | W | 9 March 1998 | 15.59 |
| 15 | W | 18 October 1979 | 15.46 |
| 16 | W | 13 February 1998 | 15.33 |
| 17 | W | 9 November 1979 | 15.04 |
| 18 | W | 30 October 1954 | 14.63 |