PROgram for the study of regional climate variability, their prediction and impacts, in the mercoSUR area.

PROSUR
IAI Project CRN 055

PILOT PROJECT:

FLOODS IN THE PLATA BASIN, IMPACTS AND CLIMATE FORCING

October 2002 Report

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1. *Objective*

After the initiation of a Pilot Project on Human dimensions related to the Plata basin floods, the objective of the Pilot Project were reduced to:

1. *CHARACTERIZATION OF FLOODS*
    - Discharges
    - Event analysis
    - Climate forcing, remote and regional
    - Synoptic and mesoescale processes

2. WATER AVAILABILITY IN SOIL

2. Work Team

PI: Vicente Barros (UBA)

1. CHARACTERIZATION OF FLOODS
Uruguay River:
Caffera (Univ. .de la Republica)- Camilloni (CIMA/UBA)

Paraná River
Camilloni (CIMA/UBA) -Barros (UBA)

Paraguay River
(Coronel - Chamorro - Baez) (Univ. de Asunción)- Barros (UBA)

2. WATER AVAILABILITY IN SOIL

Tomasella (CPTEC) -Doyle (UBA)- Berbery (Univ. Maryland)

3. OTHER RESULTS

Predictability
Cavalcanti (CPTEC)
Silva Dias (USPE)

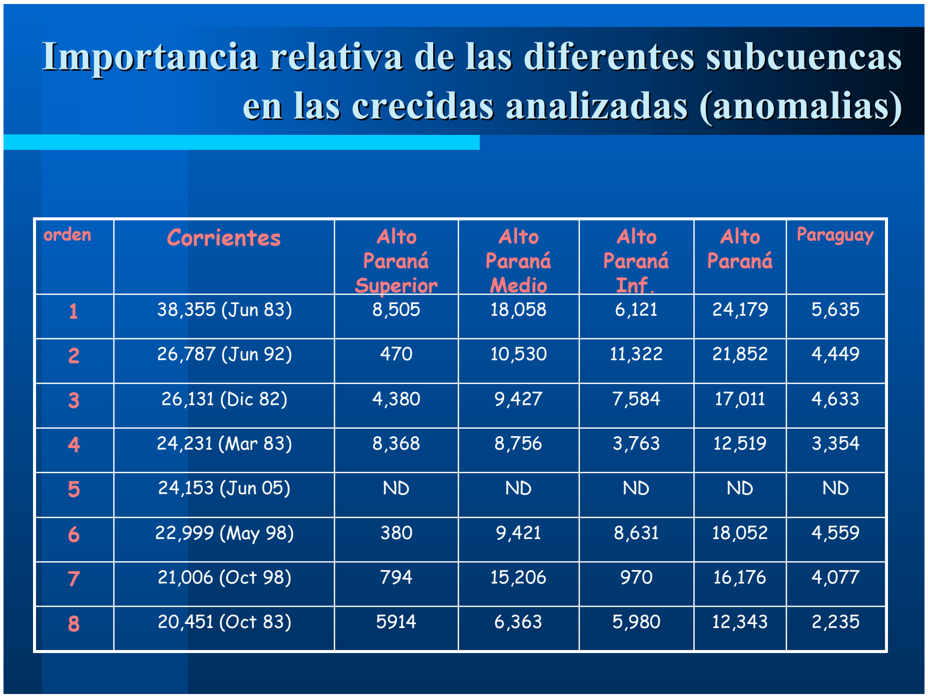
Low frequency analysis
Vargas (UBA)

Hydrological cycle
Berbery (Univ. Maryland)- Barros (UBA)

3. RESULTS

Paraná River

The largest floods on the Argentine territory originate in large rainfalls over the basin in the Brazilian and Paraguayan section between Jupiá and Posadas, Fig 1.



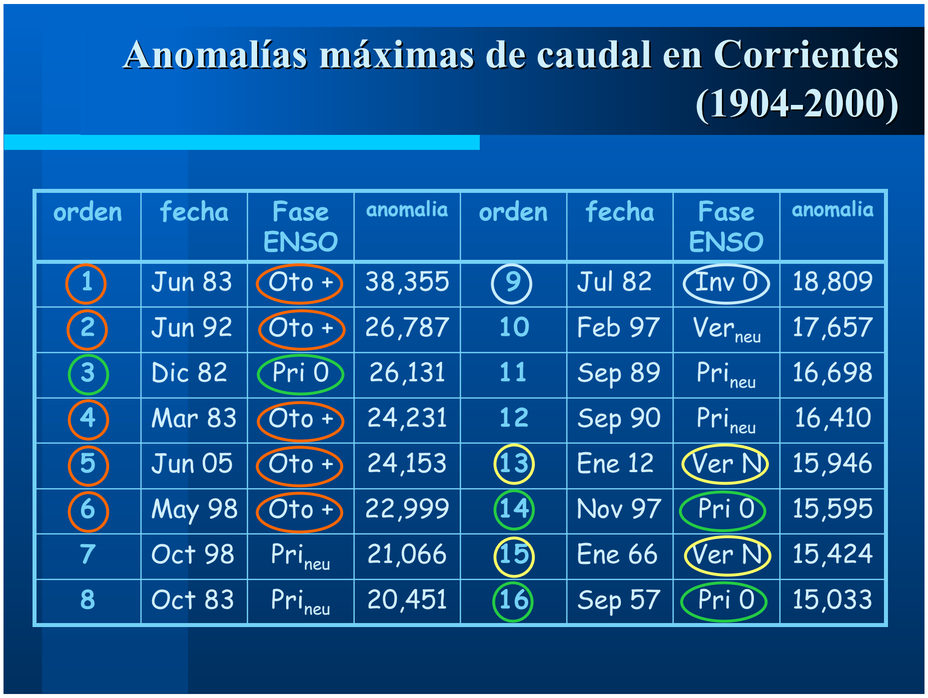
Importancia relativa de las diferentes subcuencas en las crecidas analizadas (anomalias)

orden	Corrientes	Alto Paraná Superior	Alto Paraná Medio	Alto Paraná Inf.	Alto Paraná	Paraguay
1	38,355 (Jun 83)	8,505	18,058	6,121	24,179	5,635
2	26,787 (Jun 92)	470	10,530	11,322	21,852	4,449
3	26,131 (Dic 82)	4,380	9,427	7,584	17,011	4,633
4	24,231 (Mar 83)	8,368	8,756	3,763	12,519	3,354
5	24,153 (Jun 05)	ND	ND	ND	ND	ND
6	22,999 (May 98)	380	9,421	8,631	18,052	4,559
7	21,006 (Oct 98)	794	15,206	970	16,176	4,077
8	20,451 (Oct 83)	5914	6,363	5,980	12,343	2,235

Figure 1

The Paraguay River contribution generally accompanies these overflows, but to a lesser extent. The northern part of the Paraná basin, the most affected by the South Atlantic convergence zone (SACZ), despite its significant contribution to the mean discharge of the Paraná River, is not relevant in the case of the largest discharges, Fig 1.

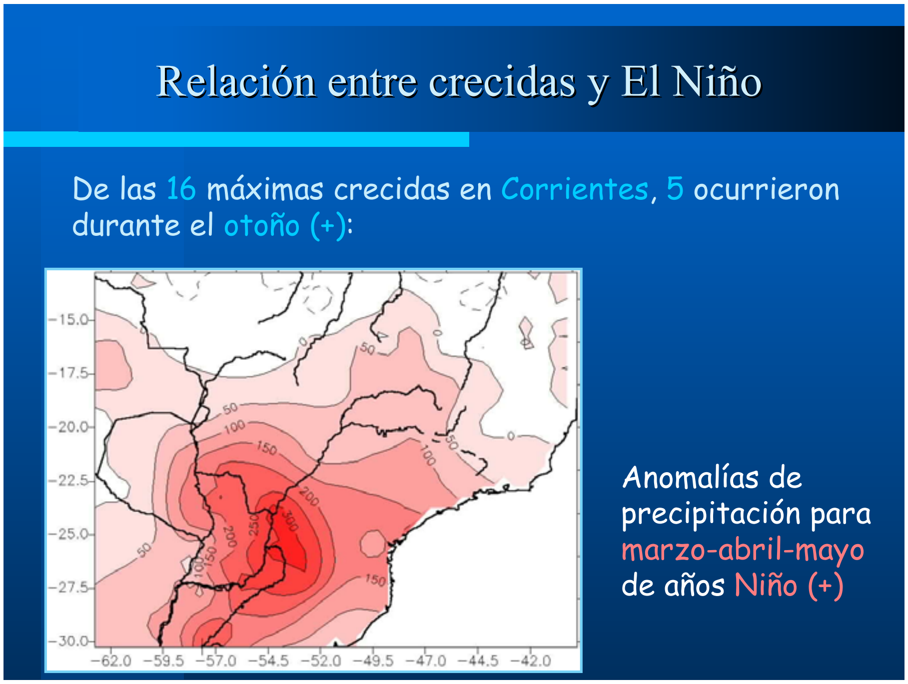
The major floods occurred when El Niño event continued until the autumn of the year following the year of its onset, Figures 2 and 3.



Anomalías máximas de caudal en Corrientes (1904-2000)

orden	fecha	Fase ENSO	anomalia	orden	fecha	Fase ENSO	anomalia
1	Jun 83	Oto +	38,355	9	Jul 82	Inv 0	18,809
2	Jun 92	Oto +	26,787	10	Feb 97	Ver$_{neu}$	17,657
3	Dic 82	Pri 0	26,131	11	Sep 89	Pri$_{neu}$	16,698
4	Mar 83	Oto +	24,231	12	Sep 90	Pri$_{neu}$	16,410
5	Jun 05	Oto +	24,153	13	Ene 12	Ver N	15,946
6	May 98	Oto +	22,999	14	Nov 97	Pri 0	15,595
7	Oct 98	Pri$_{neu}$	21,066	15	Ene 66	Ver N	15,424
8	Oct 83	Pri$_{neu}$	20,451	16	Sep 57	Pri 0	15,033

Figure 2



Relación entre crecidas y El Niño

De las 16 máximas crecidas en Corrientes, 5 ocurrieron durante el otoño (+):

Anomalías de precipitación para marzo-abril-mayo de años Niño (+)

Figure 3

Uruguay River

The largest discharges are more strongly linked to El Niño occurrence that in the case of the Paraná River. In addition, due to its relatively small size and the predominant step terrain over its basin, the Uruguay River has a rapid response to weather storms, Figures 4 and 5.

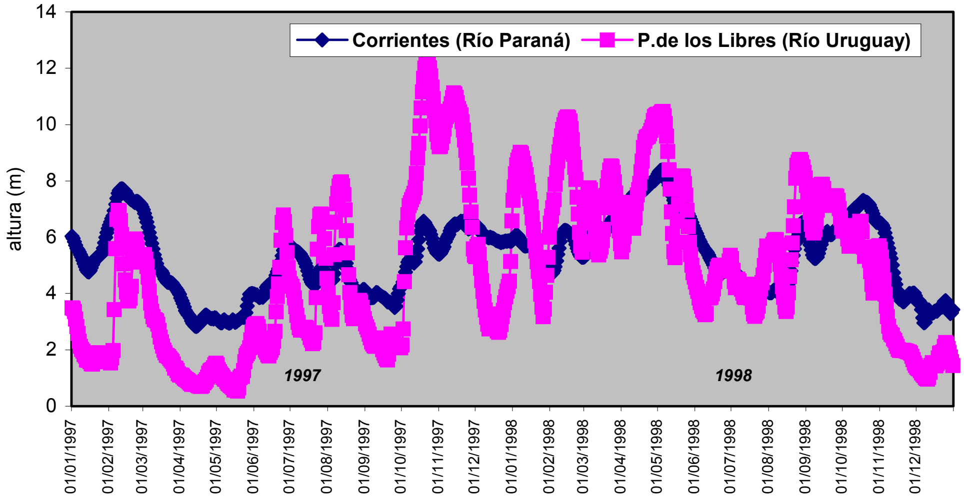


Figure 4

The largest floods in summer time have in common the occurrence of heavy rainfall in the high basin between 8 and 12 days before the peak flood in the lower Uruguay Fig 6. Thus, they can be forecasted a few days in advance if an adequate hydrological modeling is implemented. In the case of winter, most of the heavy precipitation fall in the middle Uruguay basin, only 1 to 3 days before the flood, Fig 6, and thus, the flood forecast requires a good meteorological prediction.

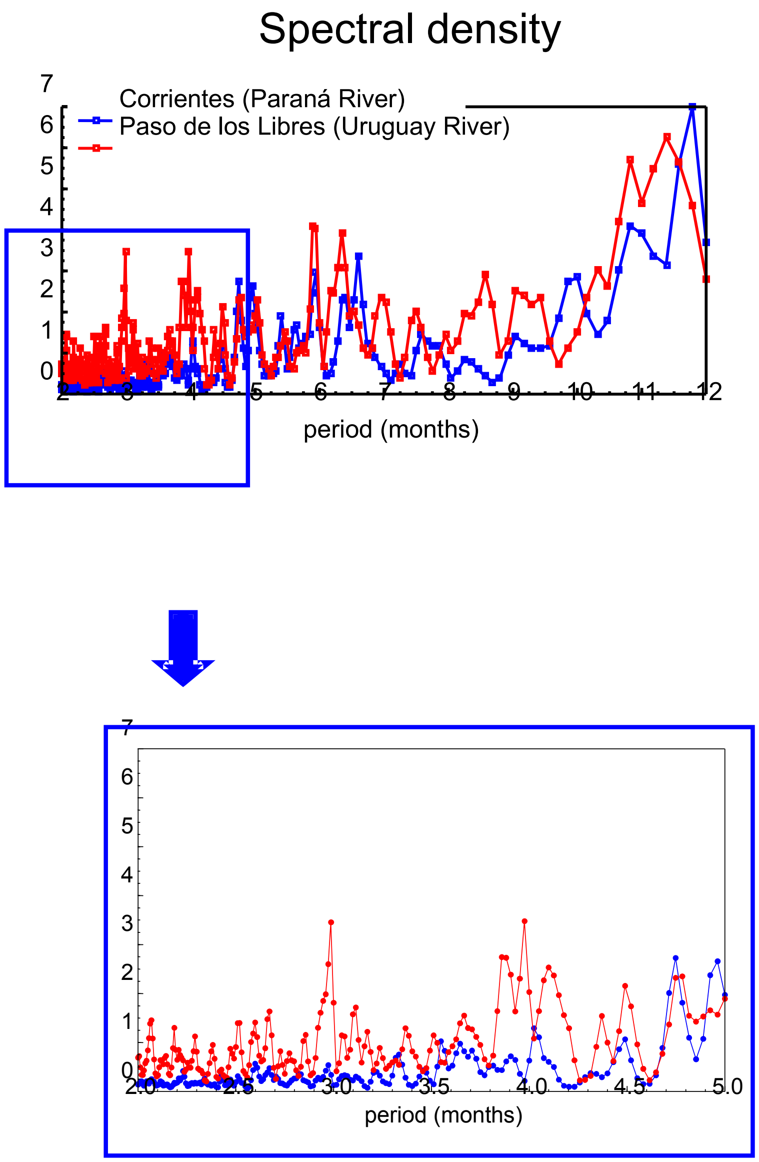
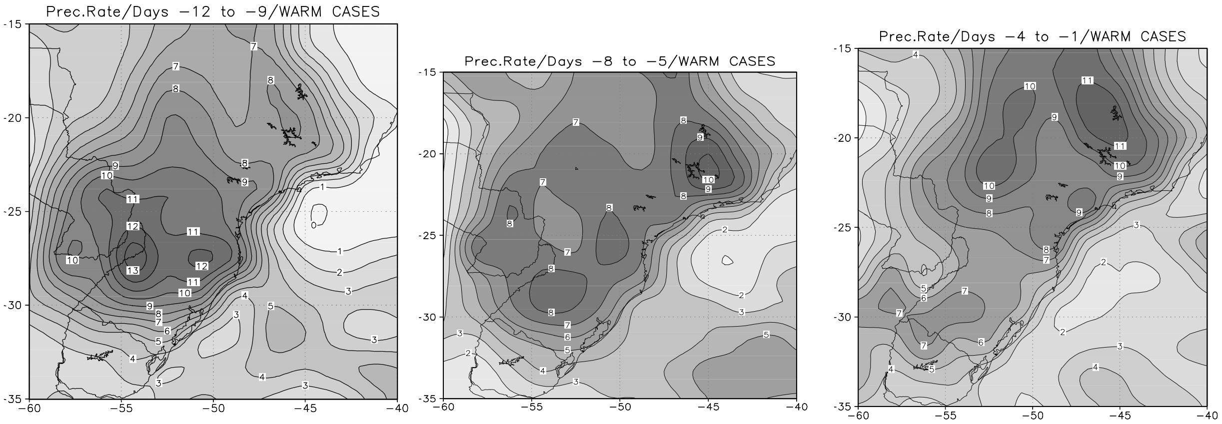

Spectral density
Corrientes (Paraná River)
Paso de los Libres (Uruguay River)
7
6
5
4
3
2
1
0
2
3
4
5
6
7
8
9
10
11
12
period (months)
7
6
5
4
3
2
1
0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
period (months)

Figure 5



Daily PREC.RATE composites for three four-days periods before the flooding date (Day 0) (*upper panel*: warm semester dates, *lower panel*: cold semester dates).

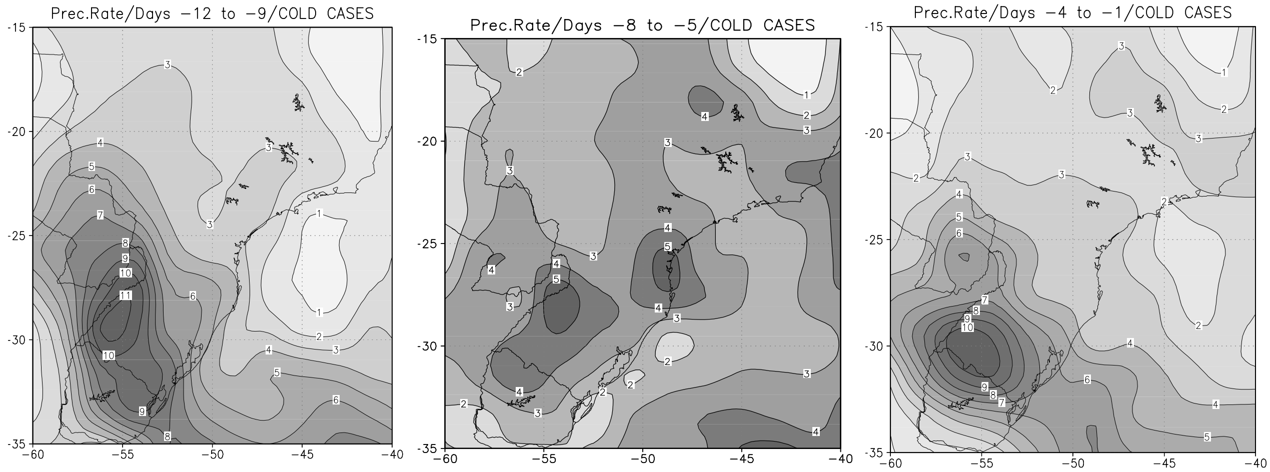


Figure 6

Paraguay River

The largest discharges originate in the basin within the Paraguayan territory. Against the generalized belief about the importance of the Pantanal, this area does not contribute significantly to these overflows. Most of the largest discharges originated during early winter, Fig.7.

Asunción		**Anomalias**		**Anomalias**	
Año	**Mes**	**(m3/s)**	**Mes**	**Q Asu-Lad(*)**	**Ladario**
1905	jun	6798	jun	6740	57
1983	jun	6454	jun	5770	683
1992	jun	5503	jun	5074	429
1919	jun	4055	jun	4755	-701
1912	ene	4414	ene	4467	-53
1982	ago	4862	ago	4397	466
1913	may	3270	dic	4316	-1046
1998	may	3512	may	4229	-717
1984	dic	1645	dic	4159	-2514
1988	jul	4735	jul	3940	796
1906	ene	879	dic	3112	-2233
1931	jun	3686	jun	3056	630
1979	jul	3427	sep	2958	469
1995	feb	2940	feb	2940	0
1908	mar	2467	mar	2880	-414
1965	jun	2160	jun	2846	-686
1956	nov	2205	may	2832	-627
1989	oct	3085	oct	2514	571
1980	ago	2726	ago	2437	289
1920	dic	3392	nov	2414	977
(*) un mes atrás del pico de Asunción					

Figure 7

Water availability in soil

With the help of CPTEC, a water soil model was implemented for the Buenos Aires Province. This model is now operative for some applications, Figures 8 and 9.

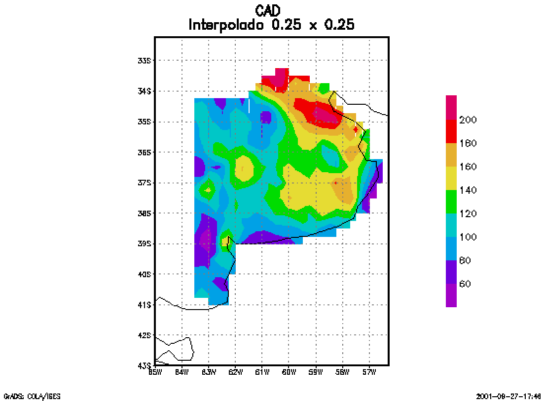


Figure 8

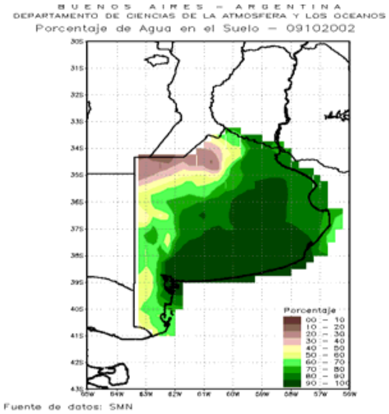


Figure 9

Predictability

The CPTEC model permits an appreciable improvement over Climatology in the Uruguay basin when its outcomes are combined with a hydrological model if its systematic errors are eliminated. However, its general good results on the Paraná basin, the CPETEC model fails to forecast a few cases that seem to be related to unpredictable conditions, Figures 10 and 11.

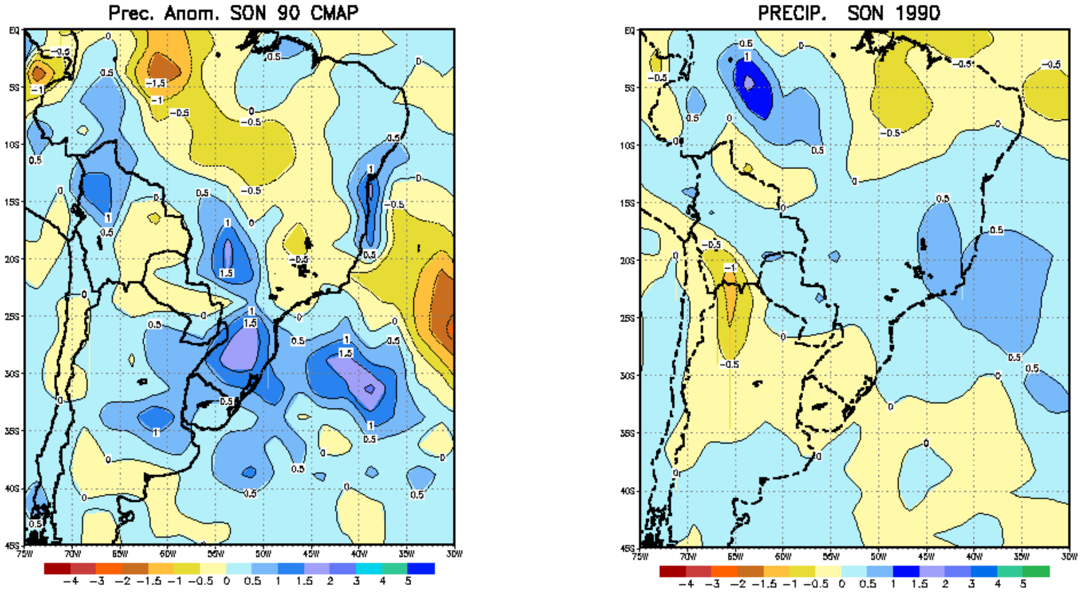

Prec. Anom. SON 90 CMAP
PRECIP. SON 1990

Figure 10

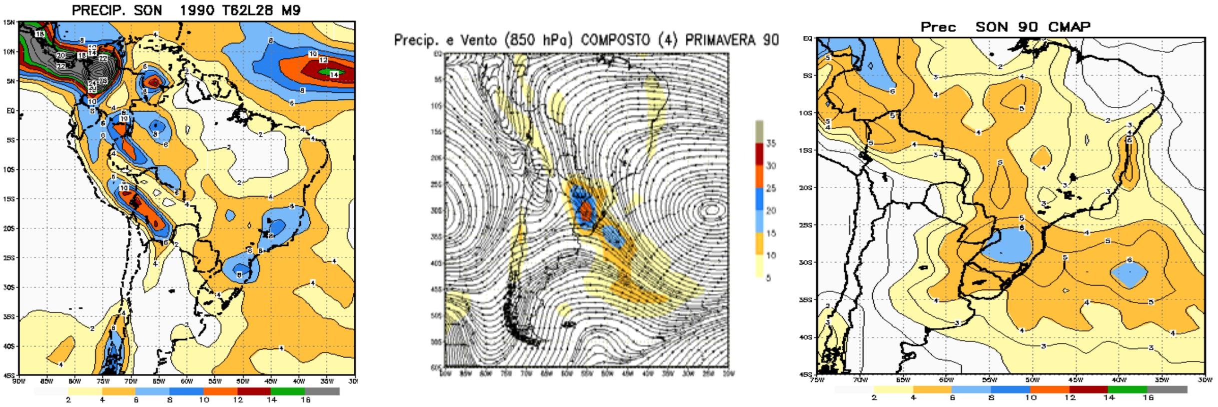

PRECIP. SON 1990 T62L28 M9
Precip. e Vento (850 hPa) COMPOSTO (4) PRIMAVERA 90
Prec SON 90 CMAP

Figure 11

Low frequency

It seems that low frequency in precipitation appears in the time domain when a large area including the Plata basin is considered, Fig 12.

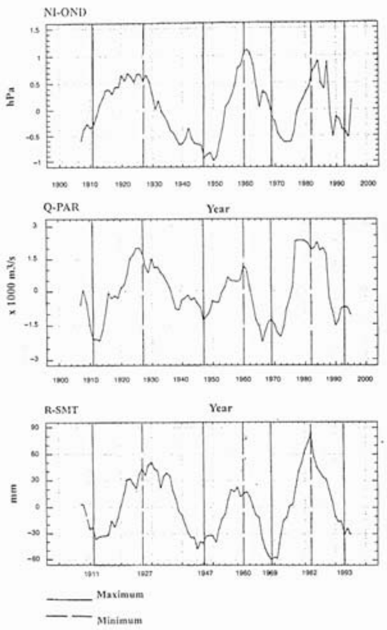


Fig. 9. Eleven-year moving average of anomaly in spring NI, annual streamflow Paraná river and December precipitation on San Miguel de Tucumán. The trend was filtered. Dates for maximum and minimum oscillations are indicated, for the 1907–1995 period

Figure 12

Hydrological cycle

The annual cycle of the Plata Basin is well related to the water vapor flux from continental low latitudes. Contrary to what happens in North America, the low-level jet is present all the year and in particular over the Uruguay River is related to more frequent and intense floods than in summer Fig 13.

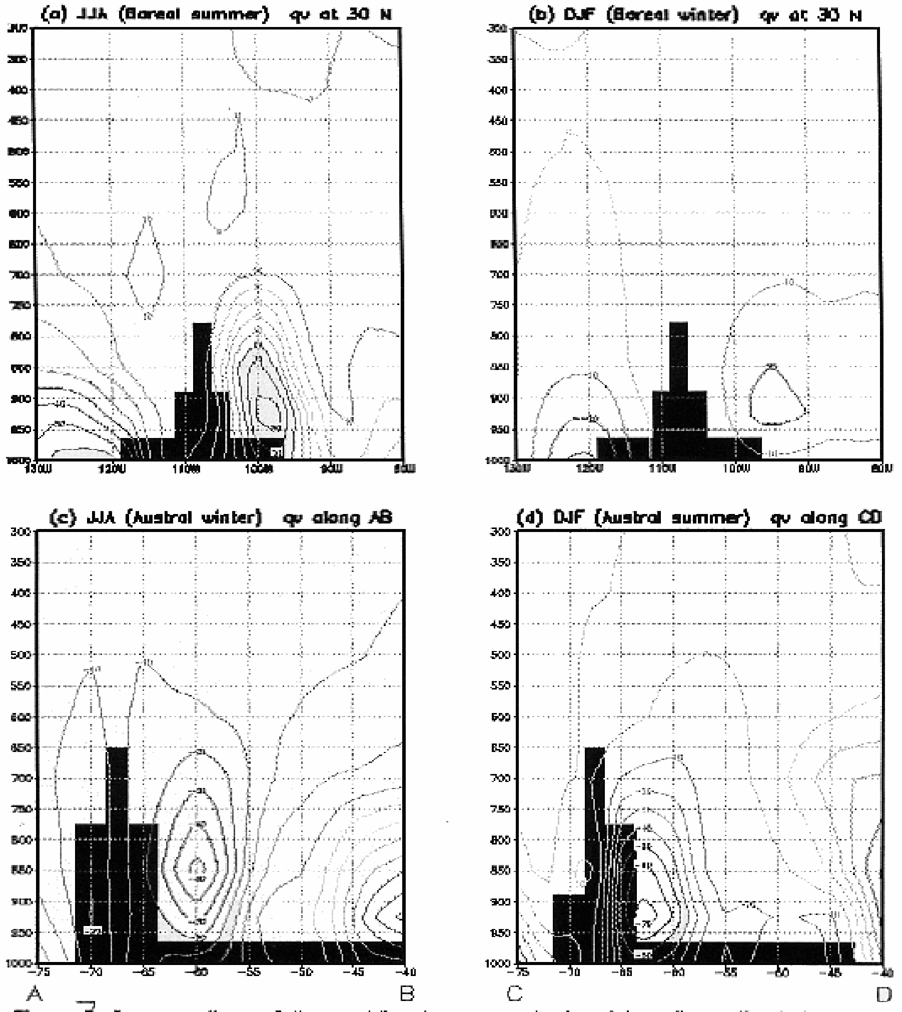


Figure ~~8~~ 7: Cross sections of the meridional component of moisture flux estimated from NCEP reanalyses at 30 N (Great Plains Low-level Jet) during (a) JJA and (b) DJF; cross sections at 20 S (South American Low-level Jet) are presented in (c) and (d). Units are g kg^{-1} m s^{-1}.

Figure 13

On the eastern part of the Plata basin, there is amplification on the rivers flow variation percent with respect to the respective percent variation of the rainfall, Fig. 14.

	Rainfall rate[1] over La Plata	**Streamflow (m^3 s^{-1})**	**Evaporation + Infiltration (m^3**
1998	107000	36600	70400
1999	81600	20440	61600
Difference	23 %	44 %	13 %
El Niño	76000	25250	50750
La Niña	71000	21640	49360
Difference	7 %	17 %	3 %
1951-1970	72000	19300	52700
1980-1999	83500	26000	56500
Difference	16 %	35 %	9 %

Figure 14

This amplification factor is slightly higher than two. Within the present context of Climate Change, this feature may have important consequences in the basin hydrology as relatively modest variations in the mean precipitation might lead to important variations in the mean river discharges.