The Paraná River response to El Niño events

Vicente Barros and Inés Camilloni
Department of Atmospheric Sciences. University of Buenos Aires
Centro de Investigaciones del Mar y la Atmósfera (CIMA – CONICET/UBA)

The Paraná River basin, the most important of the Río de la Plata tributaries, is part of a region that has a strong precipitation signal during ENSO events as it was reported by many authors, i.e: Ropelewski and Halpert (1987, 1996), Kiladis and Diaz (1989) and Grimm et al. (2000). Moreover, Aceituno (1988) showed that the Southern Oscillation Index (SOI) and the discharge of the Paraná River at Corrientes were negatively, although weakly correlated during November-April.

The correlation between convection in the Upper and Middle Paraná and Iguazú basins, as measured by outgoing long-wave radiation, and SST in both EN-1+2 and EN-3 regions is statistically significant from November to June, with a gap in February-March, reaching the maximum in the three basins during May. However, the analysis of the higher Paraná streamflows during EN events since 1904 indicates that they were decisively influenced by the EN-3 SST and not by the EN-1+2 SST.

According to this response to the EN SST, the discharge peak downstream should be expected after May. In fact, maximum streamflow anomalies at Corrientes and Posadas occurred in May-July in all the events with SST anomalies larger than 0.4°C in the EN-3 region during April+-June+, except in the 1997-98 and 1925-26 cases when the peak was observed a little earlier, Table 1.

The peak discharge at the middle Paraná basin is also clearly related to the magnitude of EN-3 SST anomaly. The strongest anomaly in both the EN-3 SST and in the streamflow occurred in 1983. The other strongest anomalies in EN-3 SST in 1992 and 1905, were followed by the other two highest streamflows of the entire record. The EN-3 SST corresponding to events of a period before the regulation of the river, namely 1904-76, have significant correlation in rank with streamflows at Corrientes and Posadas, indicating that there is a tendency to higher peak discharges with increasing EN-3 SST.

Therefore, great discharges in the middle Paraná basin during EN events should be expected in May+-July+ whenever there are an important positive anomaly in EN- 3 region during April+ -June+. The magnitude of these discharges tends to increase with greater STT anomalies.

The exceptional streamflow of the Middle Paraná during May-July 1983 provoked the most severe flooding of the twentieth century in the Argentine section of the Paraná producing a huge economic loss and social impacts. This event was consistent with the also exceptional SST anomaly observed in the EN-3 region during April- June 1983.

Note however that, for every EN event since 1976, SST anomalies in the Niño-3 region have been positive during April+ to June+, indicating some possible change in the phase of the EN events, table 1. From this perspective, the 1983 EN-3 SST anomaly does not seem too extraordinary. Consequently the occurrence of a similar event in the next few decades might have more probability of what may arise from the simple statistical analysis of the last century record.

Acknowledgements

This work was supported by University of Buenos Aires under Grant UBACYT JX084.

References

Aceituno, P. 1988: On the functioning of the Southern Oscillation in the South American sector. Part I: Surface climate. *Mon.Wea.Rev*.,**116**, 505-524.

Camiloni, I. And V. Barros. 2000: The Paraná River response to El Niño 1982-83 and 1997-98 events. J. Hidrometeorology (in press). Reference paper for this suscint presentation.

Grimm, A.M. Doyle, V.R. Barros, and M.E. Doyle. 2000: Climate variability in Southern South America associated with El Niño and La Niña events. *J. Climate*, **1**, 35-58.

Kiladis, G.N. and H.F. Diaz. 1989: Global climatic anomalies associated with extremes in Southern Oscillation. *J. Climate*, **2**, 1069-1090.

Ropelewski, C. H. and S. Halpert. 1987: Global and regional scale precipitation patterns associated with EN/Southern Oscillation. *Mon. Wea. Rev*., **115**, 1600-1626.

Ropelewski, C.H. and S. Halpert. 1996: Quantifying Southern Oscillation-precipitation relationships*. J. Climate*, **9**, 1043-1059*.*

TABLE 1. SST anomalies (ºC) in the Tropical Pacific (MOHSST5) and monthly mean discharge anomalies (m^3s^{-1}) at Corrientes and Posadas during EN events. SST anomalies indicated in brackets were obtained from the Climate Prediction Center – NOAA and were included for comparison with the 1997 EN event.

EN year 0	EN 1+2 April +-June +	EN 3 April +-June +	Corrientes Discharge anomaly May + -July +	Maximum discharge anomaly at Corrientes (month)	Posadas discharge anomaly May + -July +	Maximum discharge anomaly at Posadas (month)
1904	0.80	0.87	16465	22671 (Jun +)	14318	20350 (May +)
1911	-0.27	0.13	-571	15393 (Jan +)	-328	11218 (Dec 0)
1913	-0.57	0.13	-2737	6194 (Dec +)	-1884	2339 (Jan 0)
1918	0.10	0.20	4620	6600 (Jun+)	1535	6723 (Nov +)
1923	-1.60	-0.30	-1878	10304 (Nov 0)	-661	8798 (Jun 0)
1925	0.00	0.47	3540	9675 (Feb +)	3308	8836 (Apr +)
1930	-0.27	0.57	9998	11566 (May +)	5841	10177 (Mar +)
1932	-0.60	-0.40	-3960	6864 (Apr 0)	-3574	6312 (Apr 0)
1939	0.20	0.17	1649	11329 (Dec 0)	-1140	8137 (Dec 0)
1951	-0.37	0.00	-3518	9430 (Mar 0)	-3124	8314 (Mar 0)

TABLE 1. Cont.

EN year 0	EN 1+2 April +-June +		EN 3 April +-June +		Corrientes discharge anomaly May + -July +	Maximum discharge anomaly at Corrientes (month)	Posadas discharge anomaly May + -July +	Maximum discharge anomaly at Posadas (month)
1953		-2.00		-0.53	6349	10195 (Jun +)	4578	6955 (Jun +)
1965		-0.93		0.13	-1640	15509 (Mar +)	-977	9177 (Dec 0)
1969		-0.77		-0.20	-6039	-204 (Jun 0)	-1839	2378 (Nov 0)
1972		-0.70		-0.50	433	12025 (Oct 0)	1377	12198 (Oct 0)
1976		0.03		0.17	-2290	12840 (Feb +)	-1336	9500 (Feb +)
1982	(4.45)	3.57	(2.06)	1.47	34215	37853 (Jun +)	25718	28561 (Jun +)
1986	(1.67)	1.57	(1.39)	0.83	8560	10885 (Jun +)	6914	9755 (May +)
1991	(1.97)	1.23	(1.18)	1.20	17821	25305 (Jun +)	11797	14963 (Jun +)
1997	(3.31)		(0.99)		11929	23258 (May +)	7156	14819 (Apr +)