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ARE SOUTHERN SOUTH AMERICAN WINTERS SURFACE CIRCULATIONS NORMAL DURING ENSO EVENTS?

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Los campos de presión de superficie diarios (1200 TMG) del sur de Sudamérica para los inviernos 1972 a 1983, fueron estudiados usando análisis de componentes principales (CPs) no-rotadas con matrices de entrada del modo-T.
La primer CP cuyo modelo es similar al campo medio de presión de superficie a nivel del mar, explica bajos valores de varianza en los inviernos con IOS positivos. Además, en esos casos, los modelos que muestran frentes fríos y sistemas de baja presión que cruzan el continente explican altas varianzas. Por otra parte, los inviernos con IOS negativos muestran la situación inversa.

INTRODUCTION:

ENSO events are those where both a Southern Oscillation(SO) extreme (Darwin pressure high and Tahiti low) and El Niño (major increase in sea surface temperatures (SSTs) in the Tropical Pacific occur together. These events are also refered to as "Warm Events" by van Loon and Shea (1985).

Many recent studies characterize the features of ENSO events (v.g. Rasmusson and Carpenter, 1982; van Loon and Shea, 1985). Spatial teleconnections between the tropical phenomena and middle latitudes were well defined by Horel and Wallace(1981) and the components of ENSO temporal variability were examined by Rasmusson and others(1989) observing a strong biennal component. Therefore, the anomalies in the ocean-atmospheric systems during one year set up the conditions for a transition to the oposite state during the following year (Kiladis and van Loon, 1988).

Rainfall anomalies related to the SO in extratropical South America have been documented (v.g. Caviedes, 1973; Quinn and Neal, 1982; Compagnucci,1989) and a comprensive overview of the SO functioning as mechanisms responsible for climate variations in the area was provided by Aceituno (1988).

During 1972 to 1983 three ENSO episodes, two large events: 1972 and 1982, and one smaller: 1976, occurred and all of them had different characteristics. Besides in 1979 above normal SSTs happened without an SO swing (Trenberth, 1989)and for the other hand during 1977 SO occurred without abnormally higher SSTs.

This investigation is an attempt to inquire into the general winters circulation behavoir in Southern South America with the object of explaining the observed climate anomalies.

Through the daily surface pressure fields we analized the twelve winters for 1972 to 1983 period. The results are compared with the Wright (1989) homogenized SO and SSTs indices.

DATA and METODOLOGY:

Surface pressure fields (1200 GMT) for 123 days from May to August-observed in 81 meteorological stations in the South American Cone were used.

Each of the twelve winters (1972 to 1983) were studied by unrotated PCs analysis with a T-mode input matrix, (123 123, correlations be--- tween days). Performing PCs analysis we calculated two sets of re--- sults, first the component scores and from them we obtained the models of the pressure fields (see Fig.). Each model involved two synoptic - posibilities, the patterns with low pressures in the shadow areas and-the inverses with high pressures, this is know as the PCs flip-flop. Second, we got the factor loadings from which we specify the variance-of the patterns explained for each of the two synoptic posibilities.

More aditional information about principal components analysis and-their algebraic properties are given by green (1978).

RESULTS and CONCLUSIONS:

Patterns of the first six PCs are showed in the figure and the shad ed areas could be alternatively interpreted as low or high pressure -- systems given two different synoptic situations. These components ac-count for nearly 90% of the whole variance as can be see in the table-where the explained variance for each of the first components and ---- their possible models with low or inversely high pressures in the shad ed areas are displayed. Not all the variances are presented because - same of the patterns were imposible to recognize.

There is only one possibility as an actual synoptic situation for - pattern A which is low pressures in the shaded zone. Explained vari-- ances are insignificant in the inverse case. There is a marked resem-blance between this map type and the mean sea level pressure field --- shown in Taljaard and others(1969). It displays zonal westerlies to - the south 40ºS and the subtropical anticyclons of the South Pacific -- and Atlantic Oceans over the coast while a relatively flat fields ---- north 40ºS is in the continent. Besides, this situation involves wet-and warm advections in the NE area of Argentina.

We could think about the surface circulations like a disturbed flow if this pattern explained variance is low and as stable when it is --- higher. Considering this point of view, the other patterns give the - possible perturbations to the mean general circulation since pattern A explaines more than 50% of the whole variance.

In the winters 1982, 1977 and 1972, we observed the highest SOI val ues (Darwin minus Tahiti pressure, Wright, 1989) that mean atmospheric anomalies in the Tropical Pacific zone and in the Walker circulation. These winters are also those which have explained variance less than - 58.6% for the first pattern.

On the other hand, winters 1975, 1973 and 1983 have the lowest nega tive SOI and account for more than 60% of the variance for this model. Winter 1976 does not obey the rule arisen above because the highest -- value of the explained variance (65.6%) occurs simultaneusly with SOI-positive. This can be one of the reason for the untypical behavoir -- for this event and the associated anomalies during the winter 1976 be-cause the middle latitude circulation wasn't disturbed in South ---- America.

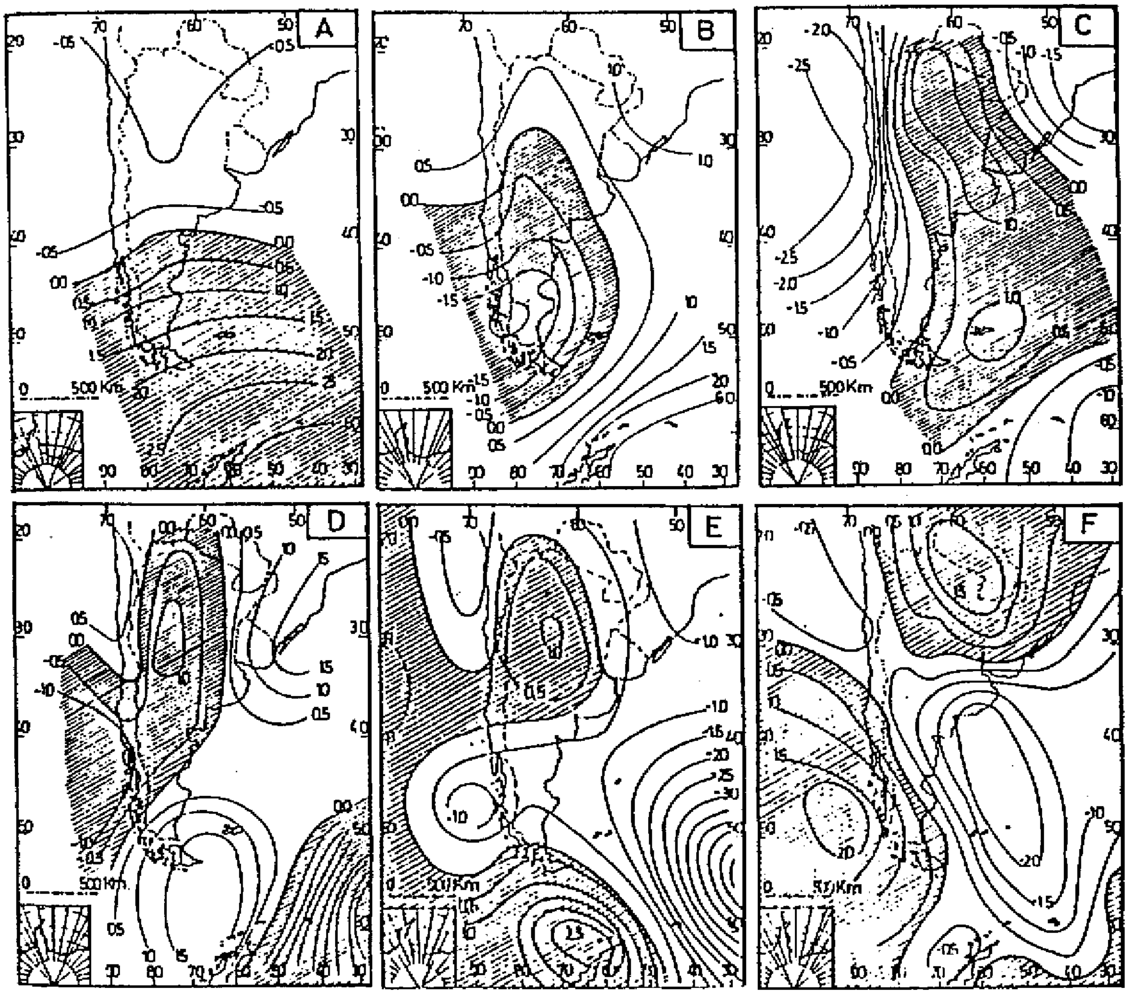

Fig. A to F: The patterns obtained from factor scores by principal component analysis of each winter (May to August) for 1972 to 1983.

WINTERS

YEARS		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
P mm.		549,2	137,2	405,3	167,9	129,7	343,6	336,9	175,6	293,6	259,2	548,3	294,8
A	LOW	51,60	60,96	58,46	51,03	65,66	58,59	54,39	61,96	57,55	59,45	52,96	58,81
	HIGH	*0,42*	*0,54*	*0,00*	*0,00*	*0,22*	*0,46*	*0,76*	*0,09*	*0,11*	*0,02*	*0,03*	*0,67*
B	LOW	6,32	4,14	5,83	7,18	4,88	7,36	8,88	5,78	4,46	6,46	7,62	6,53
	HIGH	*10,28*	*9,24*	*8,44*	*9,98*	*8,07*	*7,19*	*6,45*	*7,35*	*7,63*	*8,61*	*10,73*	*9,90*
C	LOW	4,60	3,58	3,76	3,35	2,79	4,47	5,51	2,77	4,25	3,87	4,90	4,39
	HIGH	*3,55*	*3,06*	*3,68*	*3,15*	*2,42*	*1,54*	*2,35*	*2,65*	*3,75*	*2,43*	*2,30*	*2,38*
D	LOW	4,01	3,21	2,74	2,70	2,27	4,11	4,89	4,08	5,60	3,51	5,13	3,16
	HIGH	*1,92*	*1,51*	*2,23*	*2,34*	*1,98*	*1,48*	*1,72*	*1,83*	*1,52*	*1,58*	*2,94*	*1,23*
E	LOW	1,70	1,29	2,64	0,91	1,83	1,84	1,20	1,89	2,26	1,66		1,11
	HIGH	*2,38*	*2,10*	*1,87*	*1,50*	*1,20*	*1,69*	*1,97*	*1,75*	*1,70*	*1,77*		*2,21*
F	LOW	1,77	1,09	1,76	0,95		1,52	1,03	0,67	2,12	1,25		1,37
	HIGH	*1,42*	*0,84*	*0,81*	*1,01*		*1,10*	*0,83*	*1,09*	*1,06*	*1,14*		*0,86*
S MAY		122	108	104	93	129	119	73	111	130	112	139	93
S JUNE.		130	83	101	101	132	105	78	120	127	128	107	160
S JULY		148	37	122	80	138	131	72	99	118	69	154	142
S AUGUST		159	79	85	66	150	119	73	108	133	103	197	106
D		19	13	-9	-26	14	23	-5	-5	4	11	32	7

Table: Total precipitation (P) for May to August in Santiago of Chile. Explained variance for six first patterns (A to F) (low pressure in the shadow of the fig.) and the inverse (high pressure) during the winters for 1972 to 1983. The --- Wright(1989) index of SSTs for May to August (S May, S June, S July, S August) and SOI (Darwin minus Tahiti) (D) averaged over June to August.

The other out standing exception is the winter 1977 because, on the other side, it had a pertürbated circulation, since pattern A only accounts for 58.6% of the variance, while the SOI is higher than 1976 - but 1977 was colder than 1976 as shown in the table. Total winter precipitation in Santiago of Chile confirms this hypothesis because it is clearly higher in 1977 than in 1976.

Furthermore, SSTs above normal occurred in the winters 1972, 1976,-1977, 1979, 1982 and 1983 but the precipitation in Santiago showed --- closer relationship for the SOI than the SSTs index. Negative or weak-SOI is a signal of a semipermanent anticyclon in Pacific Ocean with -- Strong intensity, and a smaller frecuency of cold fronts north of 40ºS in South America.

The following patterns can be analizer like perturbations of the -- mean circulation. Patterns B, C and D for low pressures in the shaded areas corresponding to cold fronts and low pressure systems crossing - the continent with lower zonal circulation indices which implied advection of vorticity norther 40ºS.

In the winters 1978, 1982, 1977 and 1972 these patterns account for the greast values of the variance while in 1976 and 1973 the smallest-value were explained.

There is clearly a close inverse relationship between the frecuency of cold fronts and low pressure systems and the explained variance by-the first pattern. These was confirmed computing the number of actual synoptic situations and confronting it with the variance.

In addition, the second and third PCs patterns represent the in---- verse situations in case that high pressure center are over the southern part of the continent (pattern B) qnd in the Argentina northeast - (pattern C) both post frontal situations with advection of cold air -- masses. These situations were more frecuent during 1972, 1976 and --- 1982 than in 1973, 1977 and 1983 winters.

The remained significant patterns represent low frecuency situa---- tions and explain less than 3% of the variance.

Briefly, with high values of SOI generaly the surface circulation - in South America middle latitudes is disturbed and frecuent cold --- fronts cross the continent norther 40ºS and consequently there are --- great values in Santiago of Chile precipitations and vice versa.

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