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SOUTHERN SOUTH AMERICAN ANOMALIES IN RELATION TO SURFACE CIRCULATION PATTERNS DURING 1976-1977 ENSO EVENT

Rosa Hilda COMPAGNUCCI & Maria Alejandra SALLES
UBA-CONICET, Ciudad Universitaria, Pab. II, FCE y N..
Dpto . de Cs. de la Atmósfera, 1428 Nuñez, Bs. As.. ARGENTINA

Mediante los valores de presión y temperatura medios y los totales de precipitación mensuales se calcularon las anomalías estacionales para el sur de Sudamérica de los años 1976 y 1977. Los inviernos muestran anomalías de distinto signo año a año mientras que los veranos no presentan diferencias tan marcadas. Los resultados del análisis por componentes principales de los campos diarios de presión de superficie para el mismo período y área de estudio, revelan que el invierno de 1976 fue más persistente que el de 1977, siendo esto confirmado mediante el análisis espectral de las series de tiempo de los factores de carga.

INTRODUCTION:

The name El Niño was originally applied to a warm coastal current which runs southward along the coast of Ecuador around Christmas time (Mears;1943). The term is now taken to be synonimous with more heal extremes as the Central Equatorial Pacific Ocean and along the coast of South America and not the annual warming in the eastern Pacific from which the name was derived (Wyrtki;1979). Strictly speaking, El Niño(EN) only refers to the oceanic phenomenon but it is closely linked to changes in the South Oscillation(SO). It was originally described by Walker(1923) and represents the sea level pressure anomalies in the low pressure belt over Australia and Indonesia which tend to be directly contrary to the pressure anomalies in the South Pacific anticyclone. Thus ENSO events are those in which both a SO extreme (Darwin pressure high and Tahiti low) and EN occur together and are also refered to as "Warm Events" by van Loon and Shea(1985). Although, according to Trenberth and Shea(1987) the SO and EN are not necessarily linked on a one to one basis, since above normal SSTs(sea surface temperature) can occur without a SO swing.

Using the Darwin pressure as index of SO and the SSTs along the Tropical Pacific Ocean, Trenberth(1989) examined the extent to which the phenomenon is phase-locked to the annual cycle and the extent to which the events are similar or differ from one took as another through this life cycle which is considered as the year before(year -1), during(year 0) and after(year +1) the event. He considered 1976 as a smaller ENSO event and we can see in the figures typical behavior in the SSTs life cycle with positive values during 1976 (year 0) and negative for 1977 (year +1). But, it had atypical SO behavior because Darwin pressure anomalies were moderately high during 1976 (year 0) abnormally falling at the minimum of 1976 and 1977 atypically returned to anomalies higher than occurred in 1976. This ENSO event life cycle wasn't linked on a one-to-one basis between EN and SO almost during 1977 where we could have expected negative Darwin pressure anomalies and besides, the sequence shown in 1976 a moderated maximum. Additionally, other investigations showed unusual behavior in the same climatological parameters for instance: Fu and others(1986) obtained SSTs annual cycle in Tropical Pacific Ocean showed different pattern in 1976 than the others two typical behavior for ENSO events; Compagnucci(1989), Central Andes (30ºS-40ºS) winter precipitations are normally largest during ENSO events and was in 1976 below normal; and Schonher and Nicholson(1989), studied Californian rainfall which was generally wet or normal in the ENSO events and observed reduced precipitation in the 1976 values. Their results suggest that these anomalies were associated with atypical ENSO event.

The present paper displayed winters and summers precipitation, temperature and mean pressure anomalies for 1976 and 1977 and the analysis of surface general circulation through daily surface fields for January 1976 to December 1977 period with the attempt to impruve the understand the 1976 ENSO event effects in Southern South American area.

In this way, Bischoff and Fernandez(1987) analized middle troposphere and lower stratosphere informations for the 1976 and 1977 winters and 1976/1977 summer. This results proposed more pertubed circulation during 1977 than 1976 in other words higher explained variance due short waves in 1977 than 1976 winter for the same research area taken on this study.

DATA and METODOLOGY:

Monthly mean pressure and temperature in addition to precipitation data for the 1976-1977 period and the 1930-60 using as reference period for obtained the anomalies were extracted from the Wold Weather Records. Daily surface pressure fields(1200 TMG) observed in 81 meteorologycal stations in South American Cone were used.

The annual periods January-December 1976 and 1977 and each winter (June, July and August) and summer (January, Febrery and March) were studied by unrotated principal component (PCs) analysis with a T-mode input matrix. Performing PCs analysis we calculated two sets of results, first component scores and from them we obtained the models of the pressure fields. Each model involved two synoptic possibilities, the patterns with low pressure in the shaded areas (SA) and the inverse with high pressure, 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 two synoptic possibilities.

More additional information about PCs analysis and their algebraic properties is given by Green(1978).

Besides, using the factor loadings time series the espectral analysis by Tukey with Parzen window (Jenkins and Watts,1968) were obtained in order to study the circulation behavior.

RESULTS and CONCLUSIONS:

Winter anomalies fields are displayed in Fig.(1) and the shaded areas corresponds to positive desviations of values for the 1930-60 reference periods. Briefly, the results shown oposite sign from 1976 to 1977 in other words the area which have negative anomalies during one winter present positive anomalies in the another being the same for pressure(1), temperature(2) and precipitation(3).

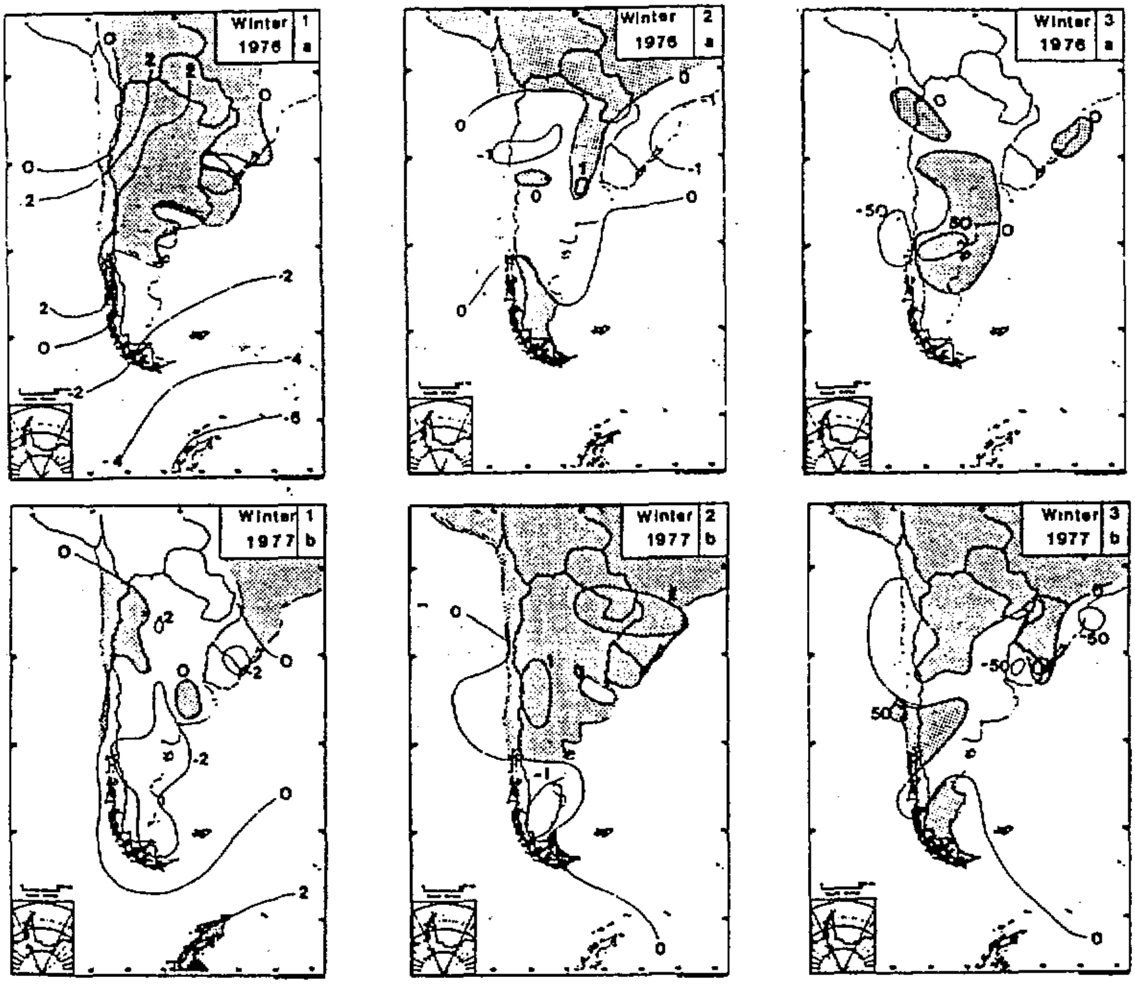

Figure 1: Pressure(1), temperature(2) and precipitation(3) anomalies obtained with 1930-1960 as reference period for the 1976(a) and 1977(b) winters (June, July and August).

In other hand, summer anomalies presents similar structures for the both years in all cases analyzed. The more important difference occur in the temperature negative over the continent which are 1ºC less in 1976 than 1977. Furthermore, both summers have pressure anomalies positive in almost all the continent. Precipitation, were generally over normal values with exception of Argentine Notheast and Chile Central area during 1977 in almost all Chile and West and Central area of Argentina in 1976 summer.

First four patterns are given by the factor scores are displayed in the Fig.(2). The first only is possible in the case with zonal westerlies extends south to 40ºS as indicate the explained variance (table) that are insignificant in the other case. This pattern has a marked resemblance with the maen sea level pressure fields. Furthermore, Norther to 40ºS shows the subtropical anticyclones of South Pacific and Atlantic Oceans explaining more than 50% of the variance.

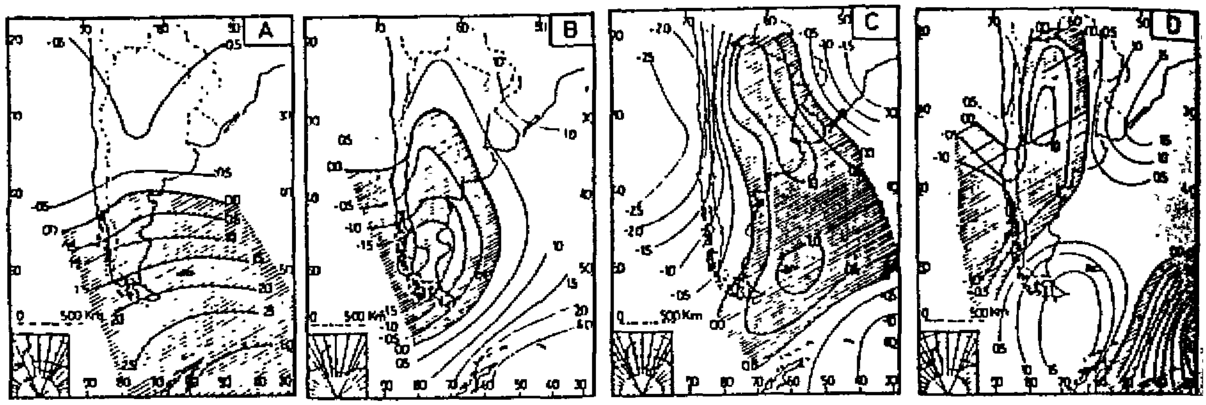

Figure 2: The patterns obtained from factor scores by principal component analysis of each summer (January to March) and winter (June to August) for 1976 and 1977.

The patterns B, C and D are taken as the principal perturbations to the mean circulation pattern, With low pressure in SA represent cold front and low systems crossing the continent and opposite case with high pressure are associated with anticyclone post frontal synoptic situations and consequently cold air advection.

Confronting the computing numbers of actual synoptic situations and the explained variance for each pattern the relationship was confirmed.

	SUMMER 1976				SUMMER 1977			
	CPs.	%Acum	%High	%Low	CPs.	%Acum	%High	%Low
A	1	57.5	0.04	57.4	1	64.1	0.04	64.1
B	2	72.6	10.7	4.4	2	76.4	7.9	4.4
C	3	81.4	4.4	4.4	3	82.5	2.2	3.8
D	5	85.2	1.8	2.1	4	87.1	2.2	2.4

	WINTER 1976				WINTER 1977			
	CPs.	%Acum	%High	%Low	CPs.	%Acum	%High	%Low
A	1	64.7	0.29	64.4	1	54.1	0.49	53.6
B	2	78.9	9.3	4.9	2	69.7	7.6	8.0
C	3	84.7	2.4	3.3	3	77.5	1.6	6.1
D	4	88.9	1.8	2.4	4	84.2	1.9	4.7

Table: Accumulated variance and explained variance for four first patterns (A to D) (low pressure in the shaded of the fig.2) and the inverse (high pressure) during the summers and winters of 1976 and 1977.

Pattern A explained more variance during the winter 1976 than in 1977 suggesting more persistent circulation during 1976 and more frecuently perturbated in 1977 winter. More over, the patterns B, C and D with low pressure in SA account for rougly 10% of the variance in 1976 and during 1977 more or less the double value (17%) are explained confirmed more frecuently perturbated in the surface circulation during the winter. Comparing the summers, the 1ºC warmer temperature in 1977 than 1976 (see Fig.2-a-b) could have been explained by the more variance account for the first patterns in 1977 than in 1976 because these synoptic situation is associated with wet and warm air addvection in the South Atlantic anticyclone influence zone. In addition, it enhances the possibilities of air mass storms and increases the rainfall over the zone. Besides, the above indicated, less temperature during 1976 summer, is in according with the more explained variance for the situations B and C with high pressure in the SA which are 23.9% for 1976 and 18.4% for 1977. This situations are associated with cold post frontal air advection.

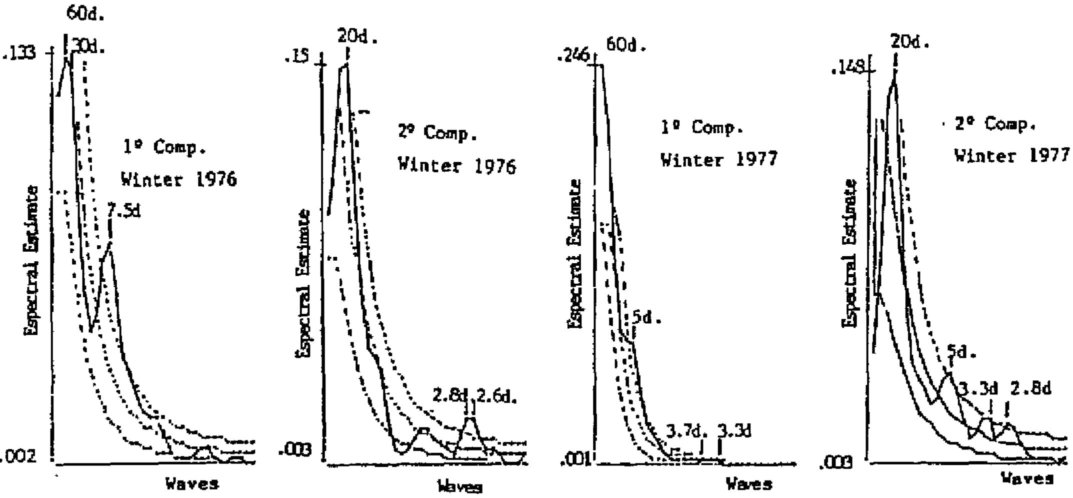

Figure 3: Power spectrum according Tukey with Parzen window and the amplitudes for Markov "red noise" with the 80 percent significance levels for the two first factor loadings time series.

The power spectrum for the factor loadings time series are given by the two principal components from 1976 and 1977 winters (Fig.3). This are shown arrows locate peak near more short wavelength in the 1977 than in the results for 1976 in agreed with the variance account for the first PC. It suggests that during 1976 winter had situations more persistents in almost surface circulations than in 1977. This results are according with those obtained by Bischoff and Fernandez (1987) from low stratosphere and troposphere data.

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PRESENT AND PAST CRYOGENIC CONDITIONS IN SOUTH AMERICA

Arturo E. CORTE
Instituto Argentino de Nivología y Glaciología
C.C 330, 5500 Mendoza - Argentina

Twenty-five cryogenic processes are analyzed in their active or fossil condition. Present cryogenic forms are observed all along the Andes from 10°NL till 55°SL in Tierra del Fuego.

Past cryogenic phenomena are more widespread in the patagonian plains; more to the north they became restricted to the mountains and Andes region. The permafrost lowest boundary in the Andes, is based on the lower limit of the steep fronts of the active rock glaciers. It runs parallel and below the average limit for the northern hemisphere.

A cryogenic chronology is presented for the Central Andes and Patagonia. Both glaciogenic and cryogenic episodes are considered for the initio glacial or cryogenic at 3,5 MYBP. A cold event at 2,3 MYBP is indicated for the Central Andes. The next cold stage (Las Peñas Glacial Episode) in the Precordillera de Mendoza is relatively dated at 1,2 MYBP; it is equivalent to the Cerro Aspero rock glaciers. The next cold episode at 0,7 MYBP is indicated by the ice wedge casts in the upper terrace in the Rio Diamante in San Rafael and also by ice wedge casts in Tierra del Fuego.

The second terrace ice wedge casts in Rio Diamante, San Rafael, is related to the Angostura Glaciation (120.000 - 700.000 YBP). The third terrace on the Rio Diamante ice wedge casts are correlated to the Puerto Madryn ice wedges at greater than 14.000 YBP or last glacial or equivalent to Vallecitos I - II of the Cordón del Plata.

Recent cold events based on dendrochronological studies are indicating the presence of the "Little Ice - Age" at about 1.600 AD.

Cryogenic events are considered important for paleoenvironmental reconstructions.

The most significative active cryogenic processes are: 1- rock glaciers; 2- debris-slopes; 3- gelifluction. The most significative past forms which are kept in the geological record are: 1- ice wedge casts; 2- fossil rock glaciers; 3- debris slopes and 4- gelifluction.

Rock glaciers and gelifluction are indicating a mean year temperature of 0°C and about 600 mm precipitation. Ice wedges are used as indicators of a mean year temperature of about 4-5°C, and low precipitation.

Debris slopes are a very common sedimentary features in mountain subtropical cryogenic regions. There are various kinds of debris slopes. We can not adscribe a climatic or environmental value to these debris slopes until we understand the formation conditions of the various types: 1- vertically sorted debris; 2- stratified debris; 3- massive debris.