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AN IN SITU-BASED CLIMATOLOGY OF THE SEA SURFACE TEMPERATURE FIELD FOR THE SOUTHWESTERN ATLANTIC OCEAN AND ITS ANOMALIES IN ENSO YEARS

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ABSTRACT

Now, the reason why the weather forecasts for the S-SE littoral region of the Brazil are more imprecise than for the continental area is researched. Probably, this is due to problems of data assimilation of the sea surface temperature anomalies (SSTA) in the Southwestern Atlantic in the atmospheric model used by the Center for Weather Forecasts and Climatic Studies (CPTEC). Thus, this paper presents a new climatology of the sea surface temperature (SST) field for the Southwestern Atlantic oceanic basin (10° S - 40° S, and 30° W - 60° W) corresponding to Marsden's squares (MS) 339, 375, 376, 411, 412, and 413. Ships data stored in the National Bank of Oceanographic Data (NBOD) of the Brazilian Navy (http://www.dhn.mar.mil.br/) for the period from January 1960 to 1996 were used to construct this climatology. The data treatment and analysis procedure used for the calculation of monthly and seasonal means, and the respective anomalies is presented. For the considered period, spatial distribution maps of number of observations, monthly, seasonal and annual means, and SST anomalies (SSTA) for years with occurrence of ENSO events (El Niño or La Niña) and for normal years (no El Niño or La Niña occurrences) are shown. The low density offshore observations is evident, emphasizing the necessity to search for another sources of data, as those supplied by satellites images, in order to complement site measurements. The SST climatological mean fields show details of the strong gradients at the South Atlantic Oceanic Confluence Zone (SAOCZ), which are not usually found in other climatologies as da Silva et al., 1994 from the Comprehensive Ocean-Atmosphere Data Set (COADS). The SAOCZ seasonal migration is perfectly identified in the monthly and seasonal maps, as well as the influence during winter of the shelf waters coming from the Plata Estuary. To verify quantitatively the ENSO influence on the Southwestern Atlantic SST field, a comparison between El Niño, La Niña and normal years anomalies is made. It turns out that the difference of the SSTA fields among these 3 cases are greater in months corresponding to extreme season (winter).

Keywords: SST Climatology; Southwestern Atlantic; Brazil South and Southeast Coast; Coastal Zone; Ocean-Atmosphere Interaction.

RESUMO: UMA CLIMATOLOGIA COM DADOS IN SITU DO CAMPO DE TEMPERATURA DA SUPERFÍCIE DO MAR PARA O OCEANO ATLÂNTICO SUDOESTE E SUAS ANOMALIAS EM ANOS ENSO

Atualmente, se procura a razão pela qual as previsões de tempo para a região litorânea do Brasil são mais imprecisas do que as previsões para a área continental. Provavelmente, isto é devido a problemas de assimilação de dados das anomalias de temperatura da superfície do mar (ATSM) no modelo atmosférico usado no Centro de Previsão do Tempo e Estudos Climáticos (CPTEC). Assim, este artigo apresenta uma nova climatologia do campo da TSM para a bacia oceânica do Atlântico Sudoeste (10° S - 40° S, e 30° W - 60° W) referentes aos quadrados de Marsden 339,375,376, 411, 412, e 413. Para formar esta climatologia foram utilizados dados de navios armazenados no Banco Nacional de Dados Oceanográficos da Diretoria de Hidrografia e Navegação (BNDO/DHN - http://www.dhn.mar.mil.br/) no período de 1960 a 1996. São apresentados todos os procedimentos de tratamento e análise de dados para o cálculo das médias mensais, sazonais, e as respectivas anomalias. Para o período considerado são mostrados os mapas mensais da distribuição espacial do número de observações, os mapas das médias mensais, as médias sazonais, e as anomalias de TSM (ATSM) para anos de ocorrência de eventos ENSO (El Niño ou La Niña) e para anos normais (sem ocorrências de El Niño ou La Niña). Nos mapas de distribuição espacial do número de observações fica evidente a baixa densidade de observações em regiões fora da costa, enfatizando a necessidade da recorrência de outras fontes de dados como a fornecida por imagens de satélites. Os campos médios climatológicos de TSM trazem detalhes dos fortes gradientes na Zona de Confluência Oceânica do Atlântico Sul (ZCOAS), e que normalmente não são encontrados em outras climatologias como a de Da Silva et al. (1994) a partir do Comprehensive Ocean-Atmosphere Data Set (COADS). A migração sazonal da ZCOAS é perfeitamente identificada nos mapas mensais e sazonais, assim como a influência no inverno das águas de plataforma vindas do Estuário do Rio da Prata. Para verificar quantitativamente a influência do ENSO no campo de TSM do Atlântico Sudoeste é feita uma comparação das ATSM em anos de El Niño, de La Niña, e em anos normais. Verifica-se que as diferenças dos campos de ATSM entre esses 3 casos, são mais acentuadas nos meses que caracterizam a estação extrema (inverno).

Palavras-Chave: Climatologia de TSM; Atlântico Sudoeste; Litoral Sul-Sudeste do Brasil; Zona Costeira; Interação oceano-atmosfera.

1. INTRODUCTION

The Southwestern part of the Atlantic Ocean basin is important for two main aspects: i) it is a cyclogenetic area (Gan and Rao, 1991), which is sensitive to sea surface temperature (SST) variations (Diaz et al., 1998); ii) the oceanic circulation between 38° S and 42° S is dominated by the confluence of the Brazil and the Malvinas currents. This area is called "South Atlantic Oceanic Confluence Zone (SAOCZ)" (Martos and Piccolo, 1988; Garzoli and Garraffo, 1989; Gordon, 1989; Matano et al. 1993). The boundaries of these two currents are usually associated to high SST horizontal gradients reaching values as high as 1°C/100m (Gordon and Greengrove, 1986; Olson et al., 1988). The SAOCZ migration to the North and to the South along the continental shelf, extending up to 500 km (38° S – 42° S), occurs from the seasonal to the interanual time scales (Provost et al., 1992; Matano et al., 1993). In general, this migration causes impacts in the atmosphere, with effects on the cyclogenesis and the regional distribution of precipitation (Olson et al., 1988; Garzoli and Garraffo, 1989; Venegas et al., 1997 a,b ; Diaz et al., 1998).

The association between the Southwestern Atlantic Ocean and the atmosphere has been evidenced in studies of precipitation variability, by considering the correlations between atmospheric circulation and oceanic parameters, mainly the SST. Nowadays it is well known that the tropical SST patterns in the Atlantic and Pacific Oceans are important to modulate the regional precipitation in South America (Rao et al., 1993; Nobre, 1993; Pisciottano et al., 1994; Rao et al., 1996). Most of these studies show that this relationship between both Atlantic and Pacific SST patterns and precipitation regime is related to El Niño-South Oscillation (ENSO) occurence (Ropelewski and Halpert, 1987; Diaz et al., 1998; Grimm et al., 1998). However, in the context of association between SST and rainfall variability in the Southern region of Brazil and Uruguay, Diaz et al. (1998) verified that when the SST anomalies (SSTA) are considered simultaneously in both Atlantic and Pacific Ocean, their connection to the precipitation anomalies over Uruguay and Rio Grande do Sul State are weaker than when the oceans are considered separately. Silva (2001) shows that the SSTA in the Southwestern Atlantic Ocean have more direct influence on the precipitation anomalies in this area than the Pacific SSTA, and it is related directly with precipitation regime along the South Brazilian coast. Namely, SST below normal is significantly associated to the occurrence of precipitation below normal mainly during local spring and summer, while SST above normal is associated to occurrence of precipitation above normal during the whole year. There are several publications that show the Atlantic SSTA influence on the regional precipitation during the summer (Barros et al., 2000; Doyle and Barros, 2000). Also, the El Niño events are significantly associated to the occurrence of precipitation above normal during local winter and spring along the littoral region (Grimm et al., 2000).

Garzoli (1999) studied the relationships between the SST patterns in the area of SAOCZ and the precipitation records in Uruguay, using the principal components analysis, and concluded that these fields are highly coherent (correlations greater than 0.8), with 90° phase lags. It was also seen that an anomalous SST heating on December 1989 preceded a period of intense precipitation extending until the end of April 1990. At the end of this rainy period, Southwestern Atlantic SST was abnormally colder (SSTA exceeded 6°C).

These researchers point out the importance of studying the influence of the spatial and temporal SST variability in South Atlantic, especially in the Southwestern part of the basin, on the precipitation regime over the whole south-southeast coastal area of Brazil, that affects the climate and, consequently, the life conditions on the mostly dense inhabited region of South America (SACC Document, 1996). However, in spite of this importance, there are few studies presenting a climatology of this oceanic area for several meteorological and oceanographic variables.

To produce a monthly climatology for the 12-yr period, from January 1982 through December 1993, Reynolds and Smith (1995) blended in situ (ship and buoy) SST data, from the Comprehensive Ocean-Atmosphere Data Set (COADS) for the period 1950-1979, which was supplemented by four years of satellite retrieval (1982-1985), and 10 years of sea ice data, and make a higher-resolution optimum interpolation on a 1° grid.

Specifically for SST, using ship observations over the area between 17° S to 30° S and 30° W to 49° W for the period 1957 to 1995, Melo and Oda (1998) presented the SST distribution of the Southwestern Atlantic, and compared it to the Levitus (1987), and to the Reynolds and Smith (1995) climatologies. In spite of the lack of information, mainly in areas farther from coast, they verified that these climatologies agree well.

In order to provide this oceanic area with a detailed SST climatology and its associated anomalies, the present work intends to construct a climatology using exclusively in situ data, objectively verified and corrected, of dense gridding (1° x 1°), and inside the area between latitudes 10° S to 40° S, and the longitudes 30° W to 60° W. All the procedures developed for the data treatment are presented. The monthly, seasonal and annual means SST fields, and the respective SSTA of the Southwestern Atlantic are characterized for the period from 1960 to 1996. The monthly distributions of the surface observations are presented in such a way that allows a comparison with other climatologies. The years when ENSO events (El Niño or La Niña) occur, and the years when these occurrences are not registered are discussed separately with respect to variations of the Southwestern Atlantic SST.

It is out of scope of this work to compare in situ data with other climatologies where different techniques of smoothing and blending are involved, but only to present a new dataset that can be useful for the composition of those climatologies, like GIIST (http://www.met-office.gov.uk/research/hadleycentre/obsdata/GISST.html), Reynolds and Smith (1995), and Da Silva et al (1994).

2. DATA, PROCEDURE AND DEFINITIONS

2.1. Data

The ship SST dataset used in this work was supplied by the National Bank of Oceanographic Data (NBOD) of the Brazilian Navy. The informations about position of the ship, year, month, day, hour, and the measured value of the registered variable, are divided into geographical areas of 10° of latitude by 10° of longitude, denominated "Marsden's Squares (MS)". SST data for the 339, 375, 376, 411, 412 and 413 MS, encompassing the oceanic area of 10o S–40o S, and 30o W–60o W, for the period 1960 to 1996, were used here (see Fig. 1).

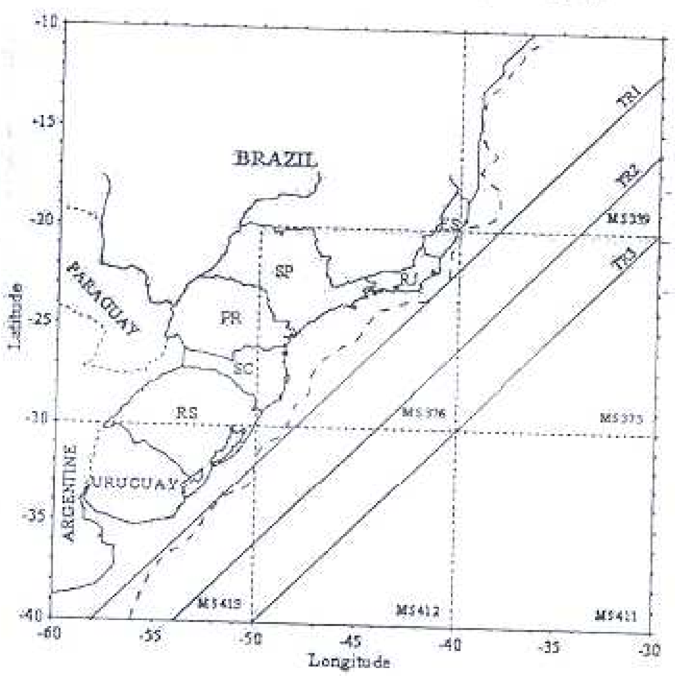

Figure 1: Map showing the six Marsden's squares (MS) in the Southwestern Atlantic, the S-SE Brazilian States, Paraguay, Uruguay, North of Argentine littoral region, and the Plata Estuary, as mentioned in the text. Rio Grande do Sul (RS), Santa Catarina (SC), Paraná (PR) , São Paulo (SP), Rio de Janeiro (RJ), and Espírito Santo (ES) are the six coastal S-SE Brazilian states. Also are shown the three transects and the dashed isoline corresponding to the oceanic depth of 200 meters.

2.2. Procedure

The procedure used for data treatment is listed bello in order to clarify the sequence of operations done:

1) basic automatic preprocessing seeks for mistakes on ann tation of the records with respect to the format, the positio (lat. and long.), and duplicated records. If an error on data identified and its cause is easily recognized, the record may b corrected; otherwise it is rejected completely.

2) each MS is divided into 1° X 1° sub-squares numbered fror 00 to 99, and depending on the latitude and longitude, a sub square number is associated to each record. Each variabl passes through a test of acceptable physical limits. The ac cepted SST values are in the 3°C to 33°C range. Values outsid this range are completely rejected.

3) the number of SST observations on each sub-square fo each month during the whole period is evaluated in order t generate maps of density observations.

4) the data are sorted in ascending order by sub-square numbe followed by time. Once the file is ordered in position and time it is verified for each sub-square the occurrence of more than one observation in the same day. If so the arithmetic mean of the observations is considered and the observation time is set to 12:00h.

5) the monthly and seasonal means are calculated for each sub-square, assuming that these means are representative of the central point of these sub-squares. The seasonal means are weighted by the number of observations done on each month. The austral seasons relate to following months, respectively:
Summer: January, February, March
Autumn: April, May, June
Winter: July, August, September
Spring: October, November, December

6) monthly and seasonal climatological means for the period 1960 to 1996, for each sub-square, with at least one measurement are calculated.

7) the climatological mean and the respective standard deviation (Γ) for each register are calculated. Registers with deviations greater than 3*Γ are automatically discarded.

8) the procedures (5) and (6) are then repeated with the debugged data file.

9) months with occurrence of El Niño, La Niña, and Normal (no occurrence of ENSO events) years during this period are selected, and the climatological means, the monthly means and the respective standard deviation (Γ) for each sub-square are estimated. The SST monthly climatological means are subtracted from the monthly means to obtain the respective anomalies.

To get the SST monthly and seasonal fields, the triangulation with linear interpolation method was used. This algorithm presented in Guibas and Stolfi (1985) is implemented in the SURFER software. To perform the SST analysis along the transects, the Kriging interpolation method was used (de Marsily, 1989). On these generated maps a visual inspection is made to verify the consistence of the fields, and if corrections are required. This visual technique allows for corrections to avoid unrealistic physical gradients. It is worth to point out that no smoothing techniques were applied to the SST fields, in order to preserve the strong spatial and temporal gradients, which is a common characteristic of this oceanic area.

2.3. Definitions of ENSO Events

For the definition of El Niño event the Trenberth criterion (1997) was adopted. It is based on 5-month running means of SSTA in the Niño 3.4 region (5° N – 5° S, 120° – 170° W). An El Niño event is set when these means exceed 0.4 °C during 6 months or more. Other definitions based on the Southern Oscillation Index (SOI) (fttp:/ftp.cru.uea.ac.uk/data) (Meyers et al., 1999), or based on Multivariate ENSO Index (MEI) (Wolter and Timlin, 1993), or yet that utilized by the Japan Meteorological Agency (JMA) discussed by Trenberth, (1997), should be used.

This paper intends to address the characteristic of SST field in the Southwestern Atlantic at Normal and ENSO years events. However, since the definition of the La Niña event is still in discussion, we have used the symmetric definition also by Trenberth (1997), i.e. the SSTA lower than the -0.4 °C in the Niño 3.4 region during 6 months.

Table 2.1 depicts the main characteristics (the starting and ending month and the duration of event) of the El Niño, La Niña, and Normal years, respectively, in the period January/1960 to March/1996. By these criteria, 12 El Niño events, in a total of 146 months, were found, representing 33.6% of the total period. Seven (7) La Niña events (92 months) and 9 normal years period (170 months) were also found, representing 21,1% and 39,1%, respectively.

3. RESULTS

3.1. Climatological Means

Figure 1 shows the Brazilian S-SE sea coast from 12° S to 33° S, including the States of Espírito Santo (ES), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS). At the Southeast of Rio Grande do Sul, the Brazilian most important lakes region is located. It is composed of two extensive coastal lagoons and a sort of smaller ones: the "Lagoa dos Patos" (the more extensive with 50 Km of mean width and 250 Km in length) and the "Lagoa Mirim" (located in the border of Brazil and Uruguay). Uruguay, Argentine, and Paraguay which are neighbors to some of the S-SE Brazilian States, the Plata Estuary, and the Marsden's Squares (MS) considered for analysis, are also shown. Each 10° x 10° MS is divided for analysis, into one hundred of 1° x 1° blocks size. This figure also shows three transect lines (TR1, TR2, TR3) which are chosen parallel to the coast and about 4o from each other. They range from 20° S to 40° S, because this latitude interval characterizes the coastal S-SE region of Brazil.

Figure 2 shows the spatial distribution of the number of available observations in each sub-square, for each month during the whole period (1960-1996).

For the whole South-Southeast coast of Brazil, the region near the shore presents larger density of observations, with some sub-squares presenting more than 80 monthly observations during the period 1960-96, decreasing towards open sea. During the analyzed period, the squares 376 (20°–30° S; 40°–50° W) and 339 (10°–20° S; 30°–40° W) present larger density of observations, and along the littoral zone of the Rio de Janeiro and Espirito Santo states (18° S to 23° S, approximately) the density is greater than 400 observations by month. Out the total of 600 sub-squares only 13 (~ 2%) usually present more than 400 observations on every months, with prevalence in summer months. The density of observations gets even lower below 30° S, between the meridians 30° W and 45° W, corresponding to MS 411 and 412.

Figure 3 shows the time series of the number of trimonthly observations during the period 1960-1996 along TR1, TR2, TR3 transects. It is evident in this figure the scarcity of data on the SW Atlantic region, mainly farther from the coast (TR3 transect). Along the TR1 transect, closer to the coast, mainly in the littoral of ES, RJ, and SP States, there is a reasonable number of SST observations, which can be used confidently as the base of a data bank. One surprising aspect is the total absence of data during the 1970 decade, along all the observed transect lines. An inventory to the NBOD data set should be made to figure out the reason to this lack of data during this extensive period of time.

Figure 4 shows the mean SST and standard deviation fields for the Southwestern Atlantic, for the whole period of analysis (1960 – 1996). A general characteristic seen at all latitudes is that along a fixed latitude line, the water gets warmer when moving from the open sea to the border of the continental shelf, unless for the water next to the coast. Also, starting at 30° S latitude towards South, strong meanders appear which should be associated to SAOCZ. Most of the area shows a SST standard deviation lower than 2.0° C. SST standard deviation in the 2° – 3° C interval and at even higher values occurs at few blocks, probably representing regions with very scarce "in situ" measurements.

Figure 5 shows the monthly mean SST fields with more details than usually found in other climatologies, as for instance, the COADS (of Silva et al., 1994), which also uses resolution of 1° x 1°, or the one specifically used for the oceanic area of the Southwestern Atlantic Ocean expressed in the paper of Zavialov et al. (1999 and 2002), about the same region considered here in this work. Maps of monthly SST and standard deviation are shown side by side to quantify the monthly SST variability in the Southwestern Atlantic Ocean.

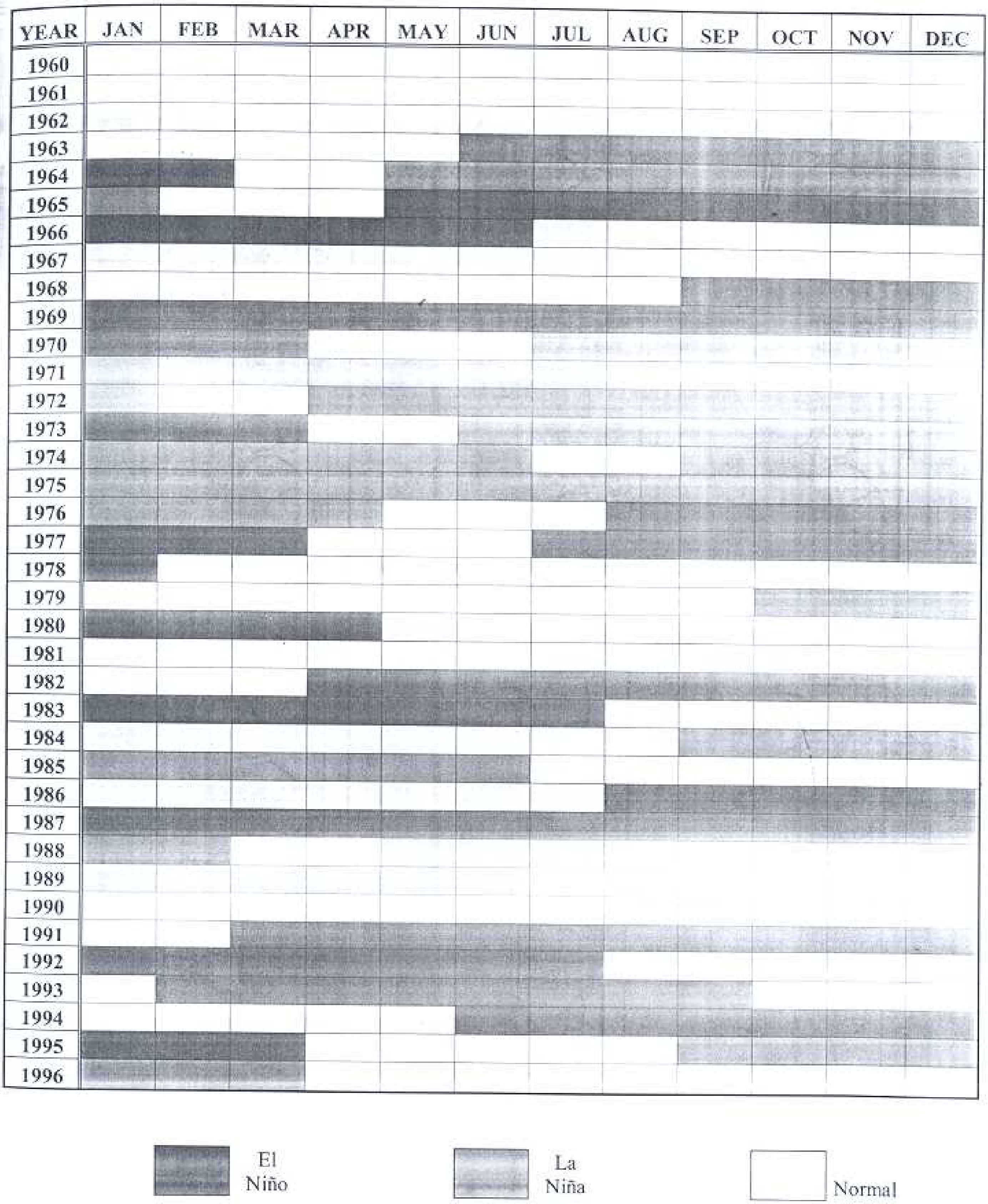

Table 2.1: Periods of occurrence of El Niño (blue) and La Niña (pink) events according to Trenberth (1997) criteria based on SST, and the years with no development of these ENSO events by at least 6 months (yellow). White cells represent situations where the persistence time is shorter than 6 months or data series is insufficient for classification. The NBOD data set is for the period 1960-1996.

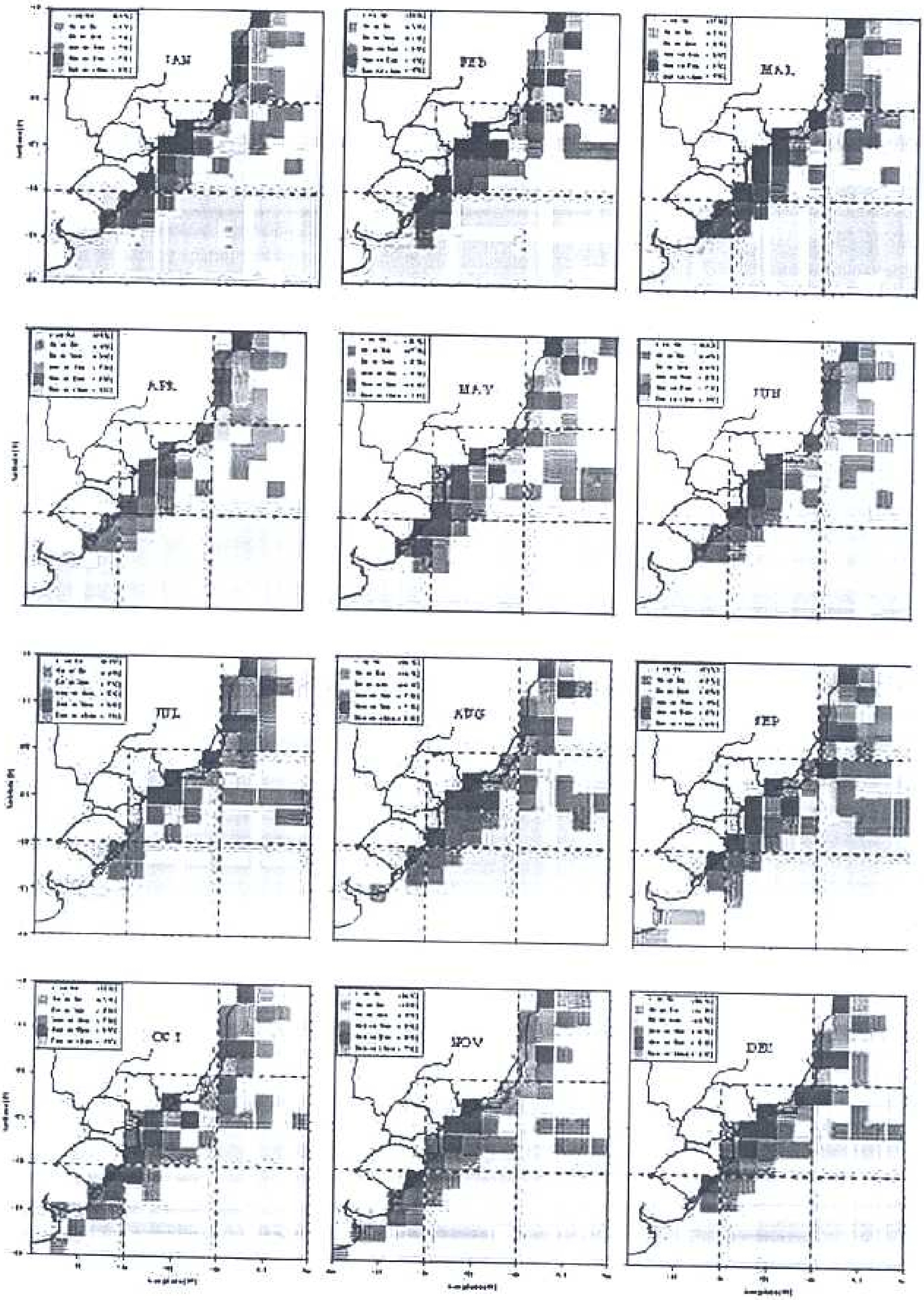

Figure 2: Spatial distribution of the number of observations on each month at each Marsden´s sub-square. The NBOD data set is for the period 1960-1996.

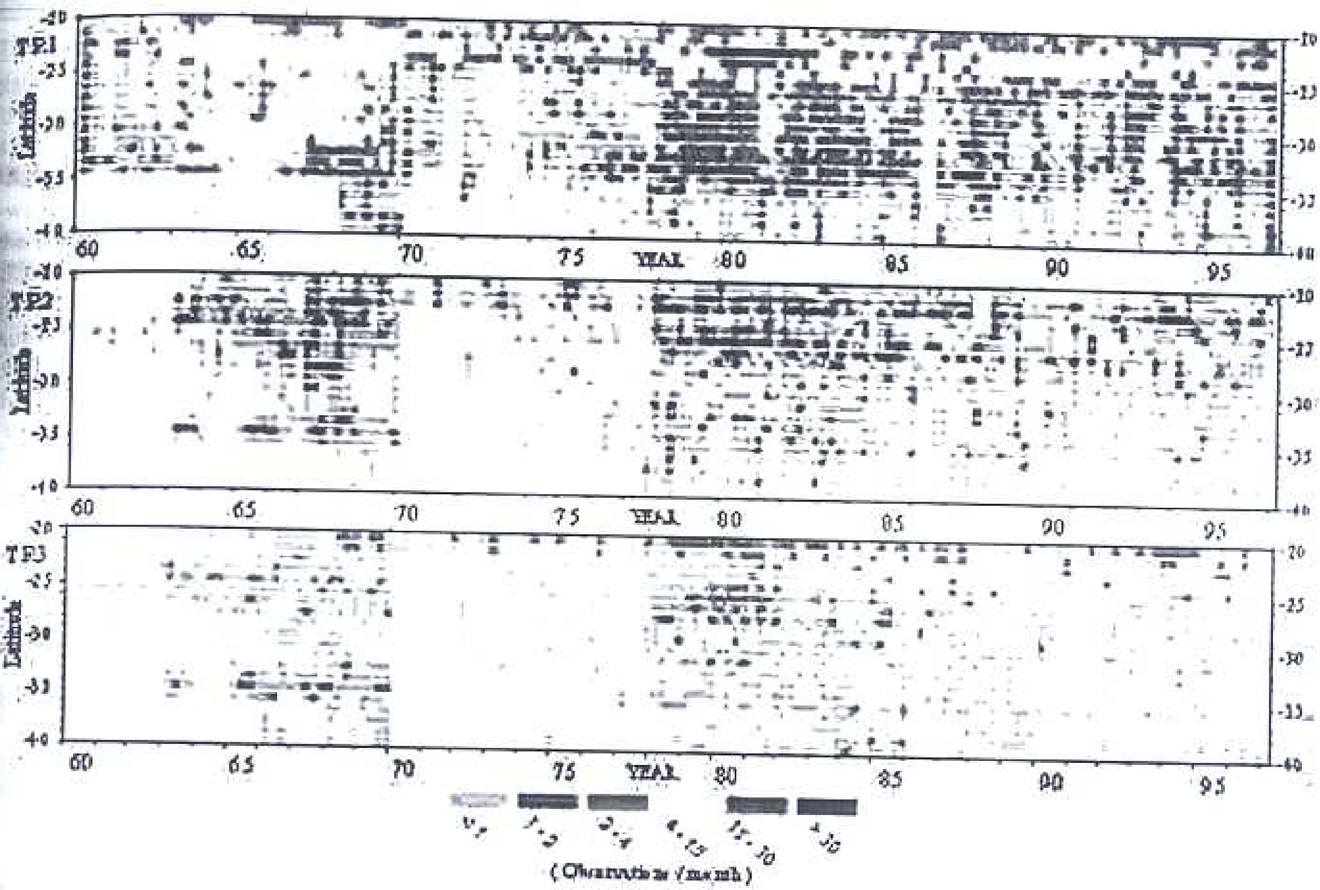

Figure 3: Number of registered observations on each trimester during the period 1960-1996, along the three transects (TR1, TR2 and TR3).

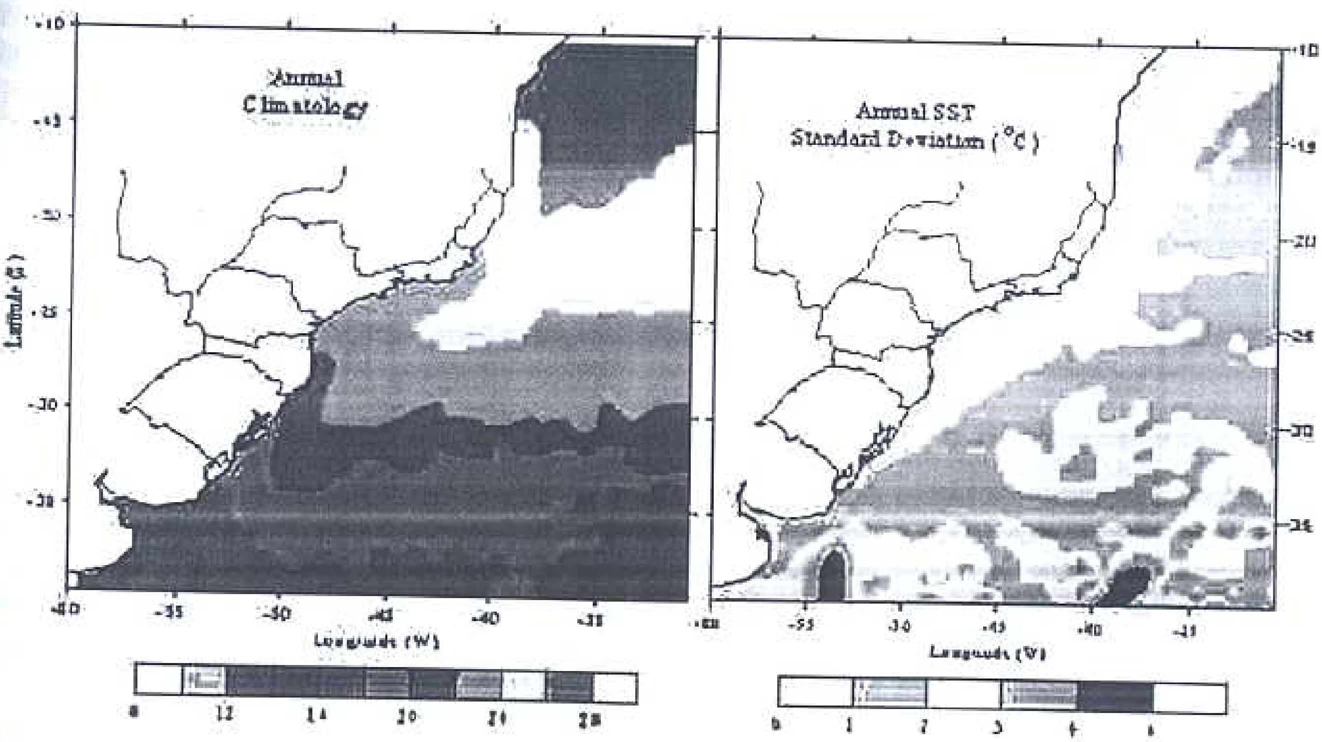

Figure 4: Annual SST mean and standard deviation (°C) for the period 1960-1996.

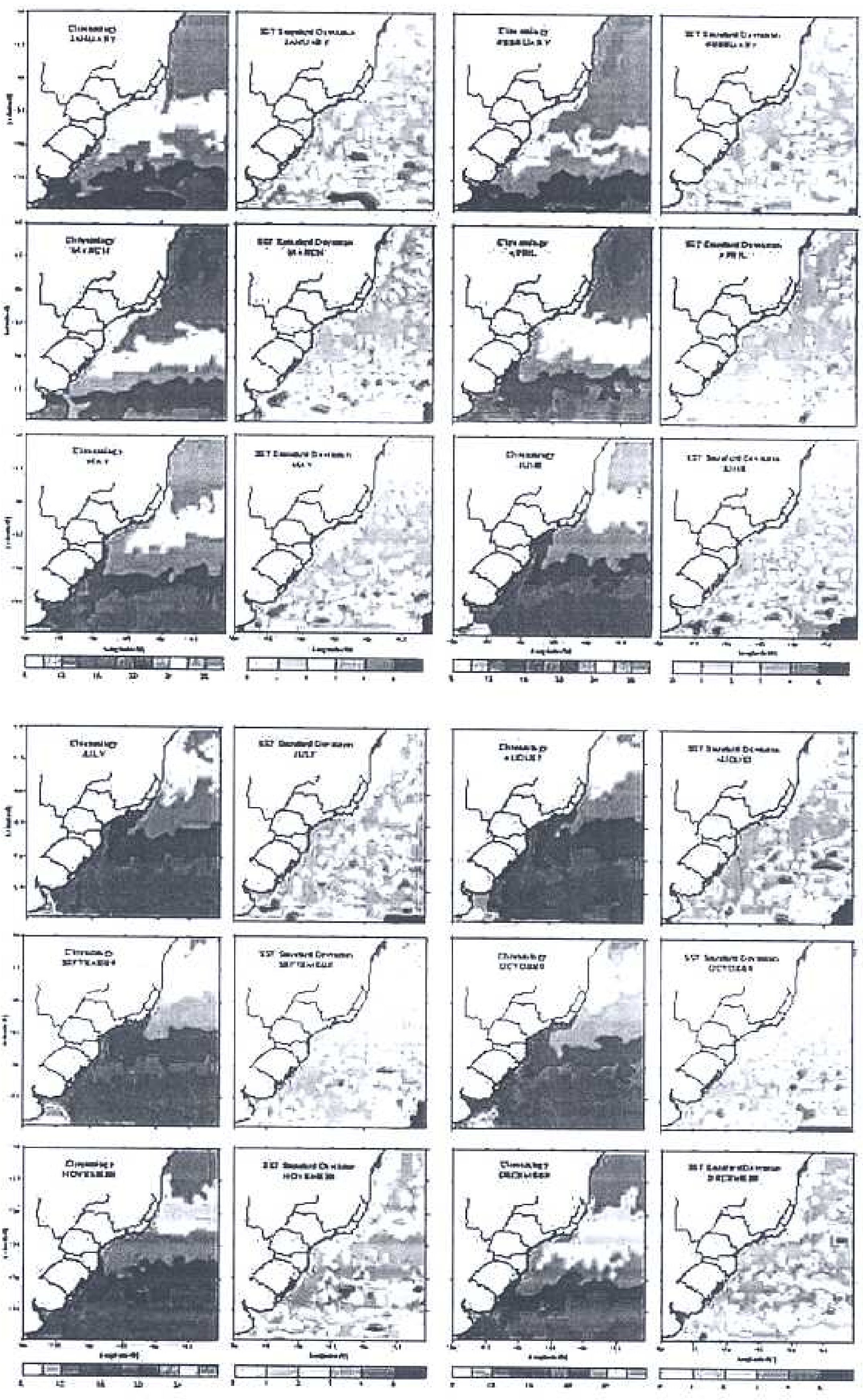

Figure 5: Monthly mean SST and standard deviation (°C). The NBOD data set is for the period 1960-1996.

The warm and cold oceanic currents are indicated by zones of strong SST gradients along the continental borders, associated to Brazil (BC) and Malvinas (MC) currents, and to the cold shelf waters coming from the Plata Estuary. One may notice that on February waters with SST above 24° C reach up to about 35° S, as BC representative. On May-June, with the weakness of the winds over South Atlantic Ocean basin, there is a reduction in the intensity of the large oceanic gyre with the consequent weakness and retraction of the BC (Stramma, 1987; Peterson and Stramma, 1991; Matano et al., 1993). This retraction with maximum in August-September can be observed in the displacement of cold waters (values lesser than 18° C) toward north. With the weakness of the BC, cold waters associated to the MC and the coastal waters from the Plata Estuary penetrate into continental shelf and, in the transition boundary, intense gradients of SST appear evidencing the SAOCZ. These SST gradients show an annual cycle associated with a smaller horizontal contrast of temperature during the summer months. It is also evident that during months from June to November the sea shore waters are well colder than the waters far from the coast.

The whole oceanic area shows an uniform distribution of SST standard deviation values, except a small region near the Plata Estuary with standard deviation values greater than 3° C occurring mainly on December.

The annual movement of the SST gradient in Southwestern Atlantic is well evidenced in Figure 6 where maps of SST seasonal means are presented. It is hard to figure any seasonal variations out due to the low densities of data involved, mainly in MS 411 and 412. In most of these sub-squares the SST values are interpolated in space, mainly during winter and spring seasons. But it is worthwhile noting the meridian oscillation of the temperature gradients, which characterizes the well known Brazilian Current: the intrusion of cold waters coming from the South of Plata Estuary, during winter and spring, running Northward very close to the sea coast. The seasonal migration of SAOCZ (Tseng et al., 1977; Olson et al., 1988; SACC, 1996; Zavialov et al., 1998) is represented in this climatology by the southern displacement of the intense SST gradients.

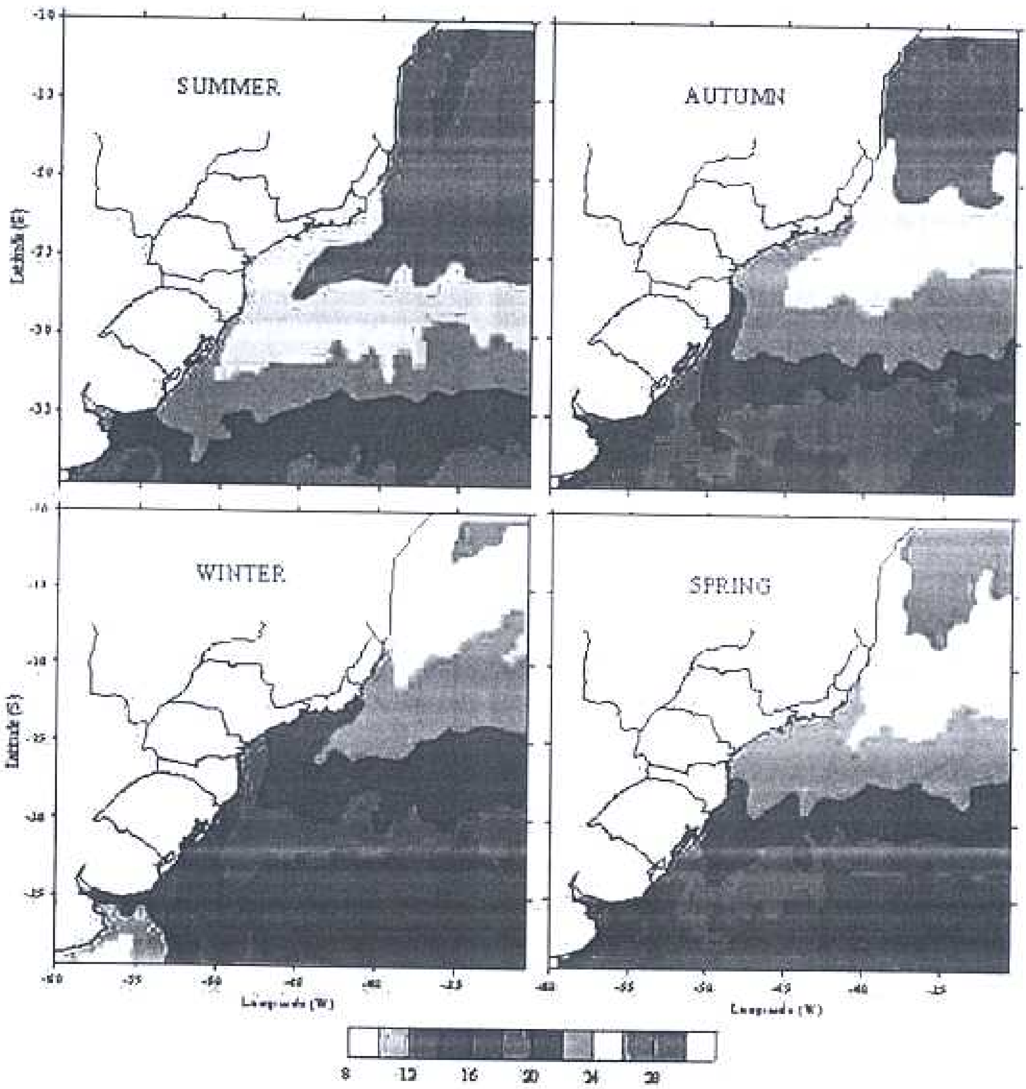

Figure 6: Seasonal mean SST (°C) for the period 1960-1996.

3.2. El Niño, La Niña and Normal Years

In order to figure out if the occurrence of events in the Equatorial Pacific Ocean, reflects over any SST field alterations on the Southwestern Atlantic, maps of seasonal averages for selected ENSO years according to the Trenberth (1997) criteria was drawn. The seasonal SST averages are calculated considering no time lag to the ENSO event. The seasonal averages were used instead of annual due to the lack of data, mainly during La Niña events and on winter months, when relevant informations are even scarce.

Figures 7 (a,b,c) are maps showing the spatial field of the SST seasonal averages for El Niño, La Niña and N mal years. A seasonal behavior can easily be seen no mat the occurrence of the event or not. During austral sumn (jan, feb, mar) there is a predominance of warm waters the most part of the oceanic area, reaching a minimum d ing winter months (jun, jul, aug), evidencing a well defin seasonal cycle. A more pronounced SST gradient arou 30° S may be noticed during El Niño years on offshore w ters. On winter, during La Niña years cold water can rea farther from the continental shelf. This result is not conc sive, because the scarcity of number of events during La Ni years and lack of information mainly on winter months.

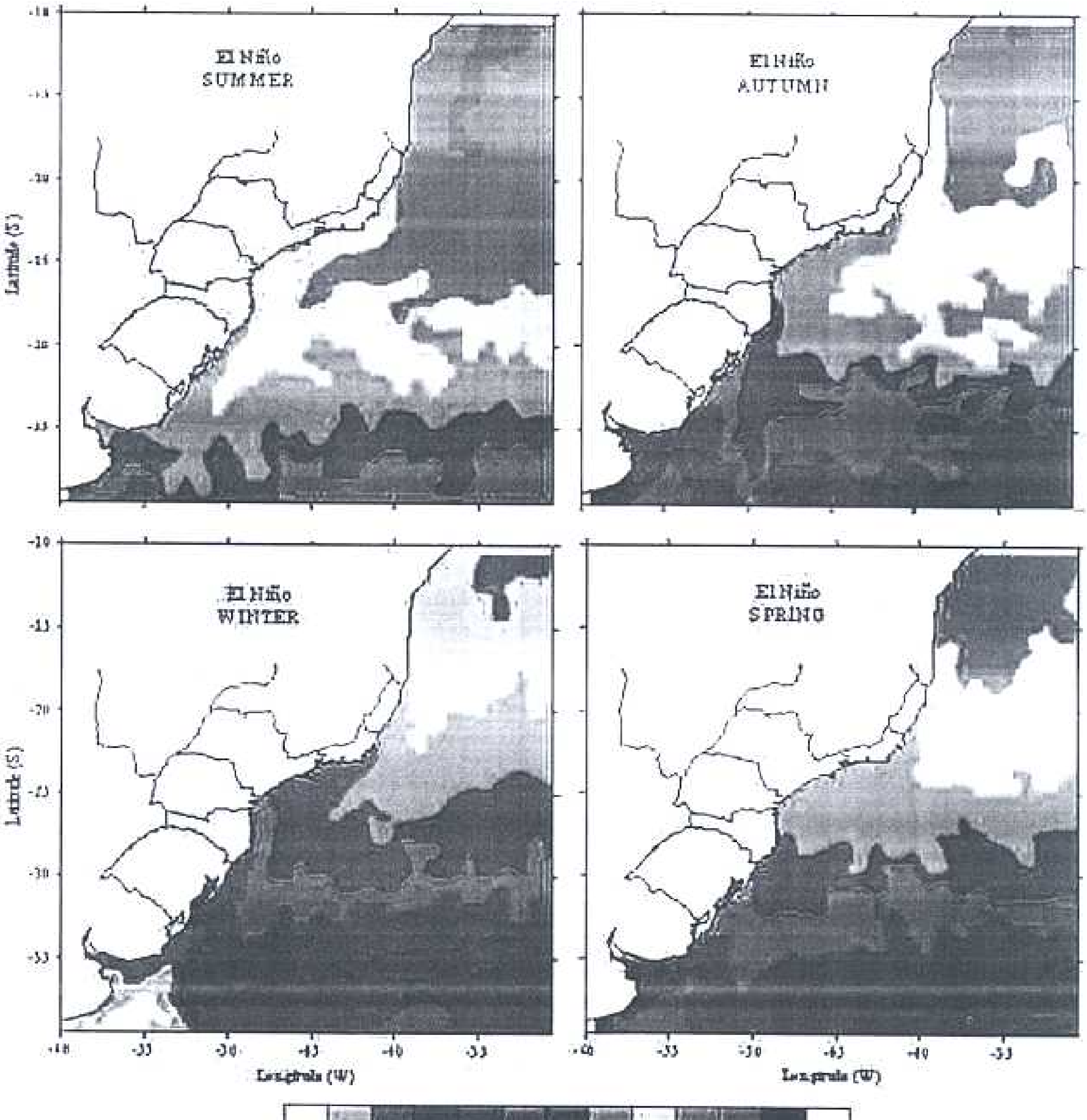

Figure 7 a): Seasonal mean SST (°C) for El Niño years. The NBOD data set is for the period 1960-1996.

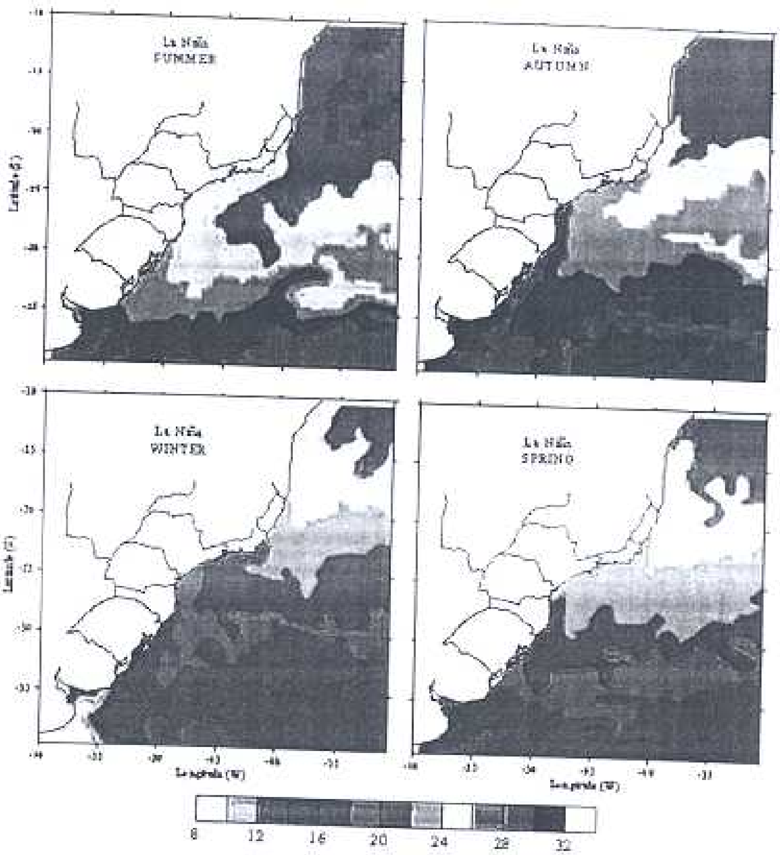

Figure 7 b): Seasonal mean SST (°C) for La Niña years. The NBOD data set is for the period 1960-1996.

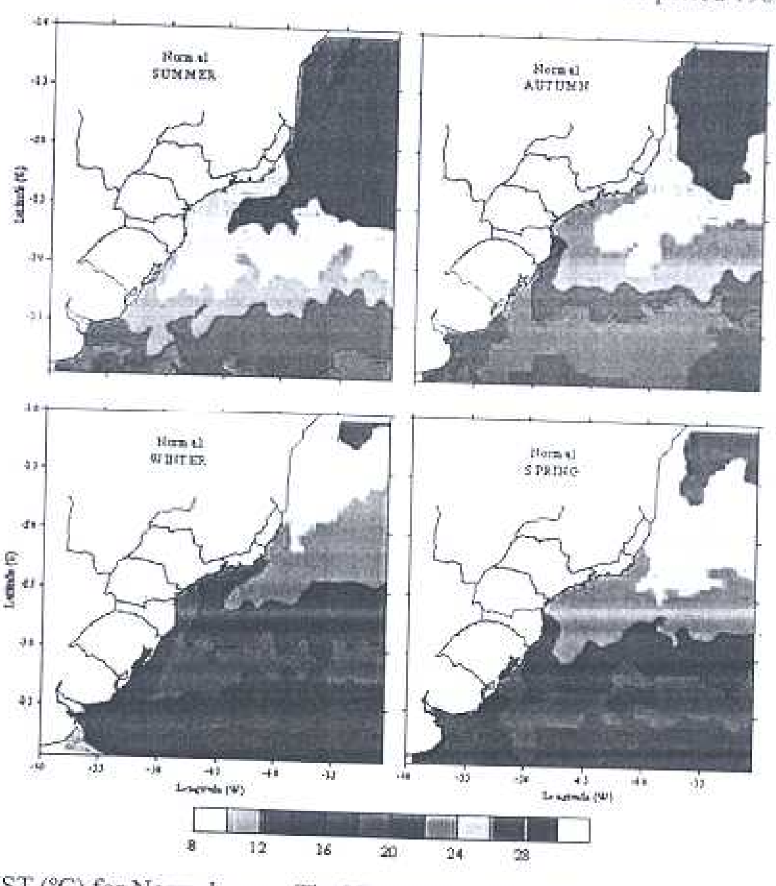

Figure 7 c): Seasonal mean SST (°C) for Normal years. The NBOD data set is for the period 1960-1996.

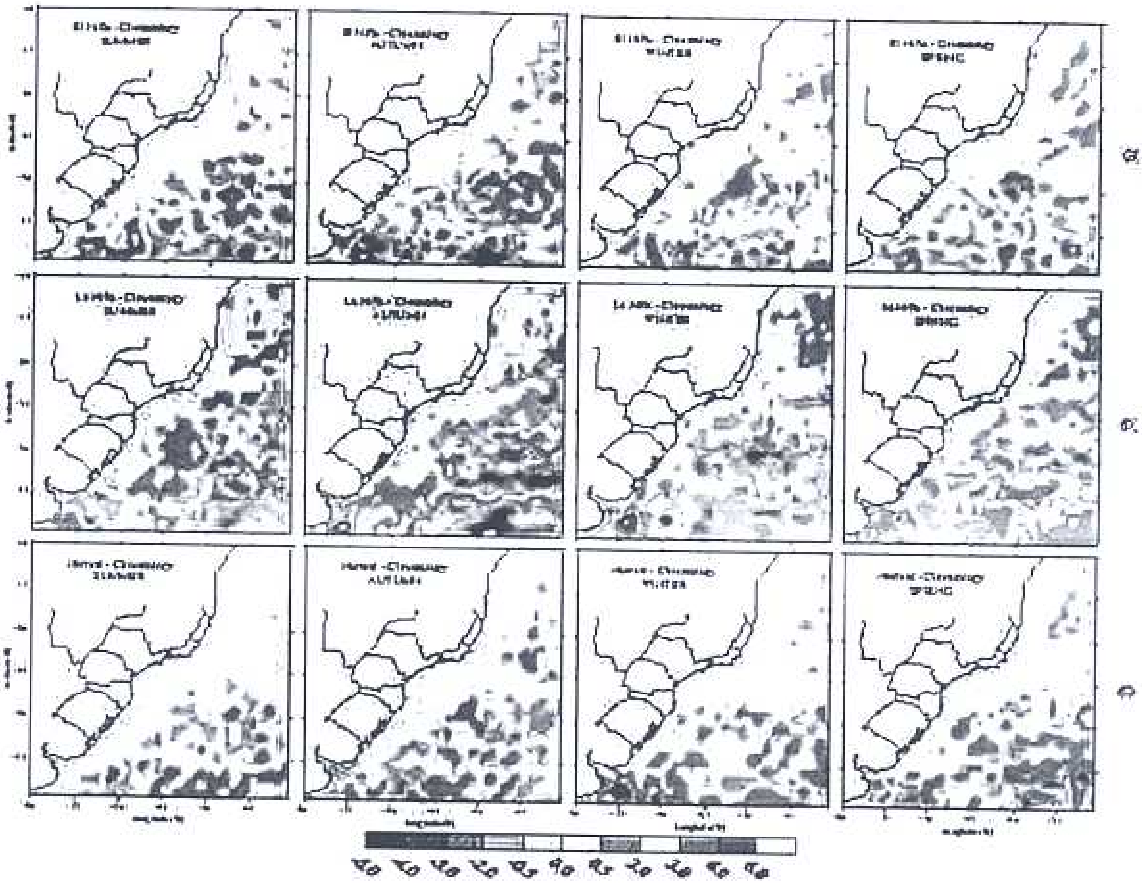

Figure 8: Difference between SST (°C) values and climatology for years of El Niño (a), La Niña (b) and Normal (c) for th period (1960-1996).

The SSTA (Fig. 8) based on the 1960-1996 SST climatology shows no evident temporal or spatial SST pattern in the Southwestern Atlantic that could be related to any Tropical Pacific Ocean event (ENSO phenomenon). Higher difference values shown in Figure 8b (mainly 8b) are probably due to lack of observations rather than caused by any atmosphere-ocean interaction. Based on this present climatology, there is no evidence of any instantaneous (zero time lag) response on the Southwestern Atlantic Ocean due to a climatic disturbance at the Equatorial Pacific Ocean.

According to Diaz et al. (1998) there is an increase of the precipitation over the continental area (Uruguay-South of Brazil) in years of El Niño, but this phenomenon is not evidenced in the SSTA values presented in figure 8. In the Plata Estuary region there is a high positive SSTA during the autumn and winter season at La Niña period, and during winter at Normal years. The increasing of SST near the coast may reflect on local in shore precipitation variations, in accordance to Garzoli (1999).

4. CONCLUSIONS

This paper is mainly concerned in debugging and treating only "in situ" data over the coastal oceanic area of the S-SE Brazilian region, more precisely focusing the oceanic waters on the continental shelf, to characterize more accurate ly the SSTA. The results presented showed that the supplie NBOD data set brings information on details of the SST fiel for the Southwestern Atlantic oceanic basin, which in gener al, are not found in other climatological databases. This ne group of SST climatological data, that evidences the stron gradients in the SAOCZ area, may contribute to the improve ment of climatic models results, especially for the Brazilia South-Southeast coastal area.

The time series of SST anomalies along the transec lines (not shown), reinforce the fact that in the Southwester Atlantic, besides the SST be predominantly seasonal, the SST is relatively weak comparing to the Pacific. Along the TR line, with more data availability, most of the SST anomaly val ues are in the interval ± 2 °C. Based on the time distribution o oceanic observations on the SW Atlantic Ocean, any researcl involving measured SST, may rely only on time series afte 1980, and even so, with caution when dealing with far fron coastal regions like the TR3 transect line.

The procedure used to this dataset treatment allow to evaluate quantitatively the behavior of the SST fields ir anomalous years of ENSO events. In the scientific bibliogra phy, it has been documented that El Niño event modifies th rainfall regime on the Southern region of Brazil and Uruguay It is strongly suggested that ENSO events modify the atmospheric circulation directly, and therefore, the local precipitation. Based on currently available "in situ" observed data, this work shows that the influence of these events on the surrounding ocean is not observed. In other words, there is not a direct effect of these events related to modification of the SST field on these oceanic waters that could be associated to a resultant change of the water vapor flux to the continent. The Southwestern Atlantic Ocean response to the phenomenon of global scale needs more detailed studies with special attention on the lag time on existing correlations with the superficial atmospheric circulation and its influence on the regime of precipitation of this coastal area.

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