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THE INFLUENCE OF THE SOUTHERN ANNULAR MODE (SAM) OVER THE SEA SURFACE TEMPERATURES IN THE SOUTHWESTERN ATLANTIC

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1. Introduction:

Sea surface temperature (SST) is shown to be an important key player to the studying of air-sea interaction phenomenon and in the determination of the regional and global climate variability.

Recently, the Southern Annular Mode (SAM) (also referred to Antarctic Oscillation) has been recognized as one the most important modes of variability in the Southern Hemisphere, acting on different time scales which varies from the intraseasonal to the interannual variability (Thompson and Wallace, 2000). SAM is characterized by a modification in the atmospheric circulation pattern between high and mid latitudes, which modifies the meridional position of the westerly winds.

Previous studies have showed that SAM can influence the SST fields on different time and space scales (Lovenduski and Gruber, 2005; Renwick, 2002; Mo, 2000). Therefore, the objective of the present work is to investigate the influence of SAM over the SST fields in the southwestern Atlantic Ocean (SWAO) [18 ºS – 58 ºS, 18 ºW – 70 ºW].

2. Data and Analysis:

Nine years of daily SST images from the “Pathfinder best SST 4.0”, with a spatial resolution of 9 x 9 Km and encompassing the period of January 1993 to December 2001 have been used. SST anomalies (SSTA) were extracted after the removal of the annual and semi-annual components of the seasonal cycle of the original dataset.

The correlation between the SAM index and SSTA was calculated for each grid point and used to construct a synthetic map of the spatial correlation. All correlation analyses were performed over 95% confidence intervals.

The SAM index is defined as the leading principal component (PC) of 850 hPa geopotential height anomalies south of 20^0S and was calculated from the NCEP/NCAR reanalysis, for the period of 1968-98.

In order to understand the influence of the positive and the negative phases of SAM over the SSTA, the mean and the standard deviation of SSTA were found for each of these SAM phases.

The correlation between the SAM and the wind stress anomaly (WSA) is also calculated. The wind stress product is derived

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from Quick Scat and calculated according to Tang and Liu, 1996. The wind stress data presents a spatial resolution of 0.25 x 0.25 degrees and covers the period of July 1999 to December 2004. The WSA was performed removing the climatologically mean.

The mean and the standard deviation of WSA were also calculated to the positive and the negative phases of SAM.

The SSTA was interpolated to a spatial resolution of 0.25 x 0.25 degrees and the correlation analyses were performed between WSA and SSTA over the period of time for which the data sets overlap (July 1999 to December 2001).

3. Results and Discussion:

Correlation indices between SSTA and SAM vary from -0.3 to 0.5 for most of the area of study (Figure 1). High positive values were observed over the Argentinean continental shelf (ACS) between 36 and 56ºS, whereas high negative values occurred in the offshore region between 18 and 32ºS.

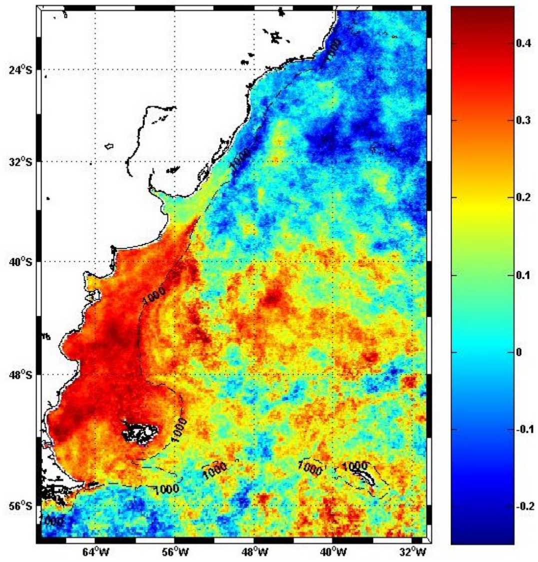

Figure 1: Correlation SAM x SSTA. The correlation coefficients has significance ≥95%

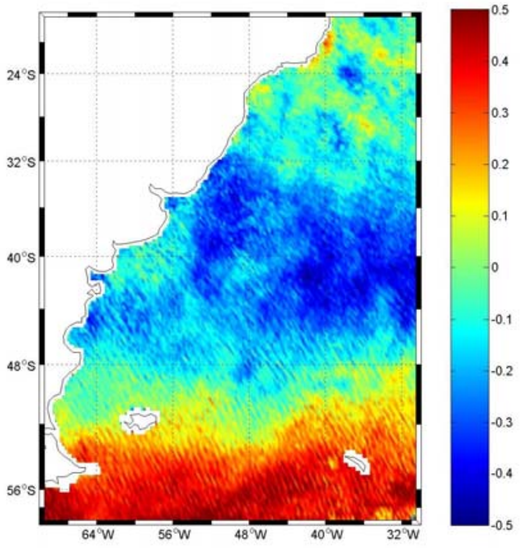

Figure 2: Correlation SAM x WSA. The correlation coefficients has significance ≥95%

Correlation indices between WSA and SAM (Figure 2) were higher than showed on figure 1 and vary from -0.5 to 0.5 for most of the area of study. High negative correlation values were observed in the transition region between the Brazil and Malvinas currents as they leave the coastline and veer offshore. On the other hand, high positive values took place for latitudes higher than 52 ºS. The smallest values were observed in latitudes lesser than 32 ºS.

There was a local maximum to the both correlation indices present in the coastal area between 19 and 23 ºS.

Figure 3 showed the time series of SAM indices. There were a total of 38 negatives and 70 positive events in the period of time of the SSTA data sets (Jan/1993 – Dec/2001) and a total of 19 negative and 17 positive events for the WSA data set time. A 12 months running mean filter was used to estimate inter-annual variability of SAM index (dashed line). A predominance of positive events was observed over the time series, mainly before January, 2000.

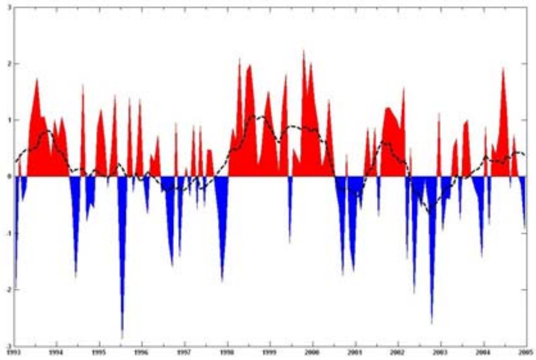

Figure 3: Time series of SAM. The blue patch represents the negative phase and the red patch represents the positive phase. The dashed line is a 12 months running mean filtered data.

The positive phase of SAM showed mean SSTA (Figure 4) values from -0.2 to 0.4 ºC. Largest positive anomalies appeared on the Brazil – Malvinas confluence (BMC) and in the ACS. High values in the offshore region between 39 and 49 ºS were also observed. The largest negative SSTA were seen in latitudes higher than 39 ºS and in the southwestern part of the area.

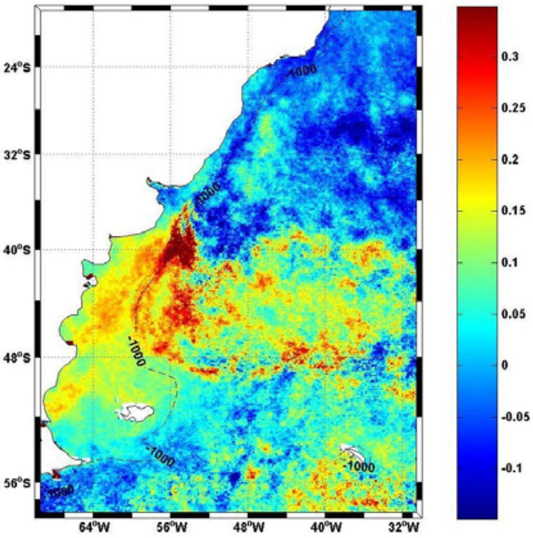

Figure 4: Mean values of SSTA in the positive phase of the SAM (ºC).

During the positive phase the WSA intensity values were small to almost the role region (Figure 5) and the predominant WSA direction were southwest. Largest WSA values were seen in latitudes higher than 52ºS and in the off shore region between 32 and 46 ºS where the WSA directions were southeast and west respectively.

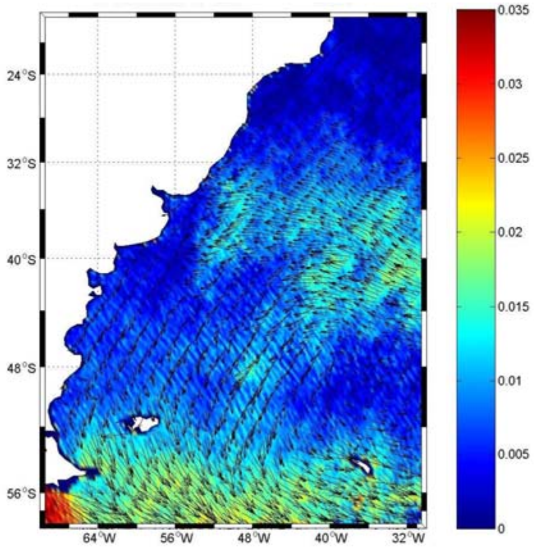

Figure 5: Mean values of WSA in the positive phase of the SAM (N.m^{-2}).

There were almost total inversions of the mean SSTA (Figure 6) and the mean WSA direction (Figure 7) in the negative phase of SAM. The highest positive SSTA values now took place over latitudes higher than 39 ºS and in the southwestern part of the dominion and the largest negative values appeared in the BMC and in the ACS.

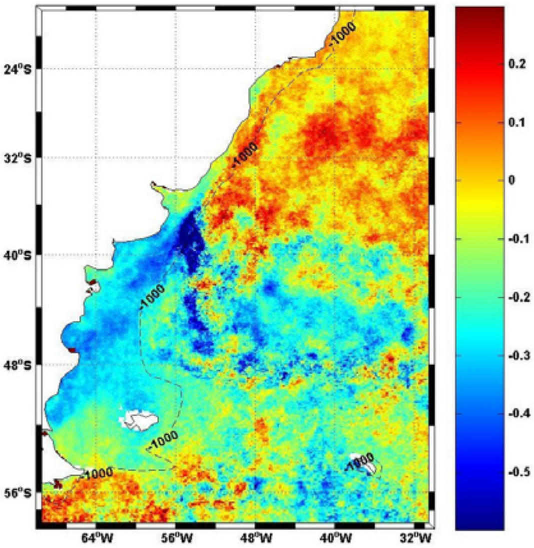

Figure 6: Mean values of SSTA in the negative phase of the SAM (ºC).

Mean WSA intensity values (Figure 6) were higher in the negative phase than in the positive phase. The largest WSA intensity values were placed in the same regions than in the positive phase map.

There were an inversion in the WSA direction and now the predominant direction is northeast. The directions that were southeast in latitudes higher than 52 ºS and west between 32 and 46 ºS during the positive phase, now are northwest and east.

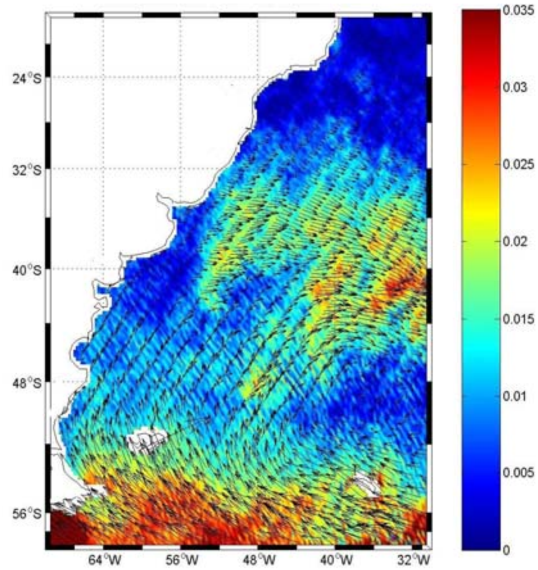

Figure 7: Mean values of WSA in the negative phase of the SAM (N.m^{-2}).

According to Lovenduski and Gruber (2005), the high positive SSTA value over ACS should be related to the Ekman transport anomalies.

To test this hypothesis a correlation analyze was performed between the SSTA and WSA. The correlation indices vary from -0.5 to 0.5 for the SWAO (Figure 8). The largest positive correlation values were observed in the offshore region between 18 and 32 ºS and latitudes higher than 52 ºS, whereas the largest negative values took place in the offshore region between 36 and 48 ºS.

Opposite to what was expected, the correlation was not significant over the ACS, which, in turn, suggests that other physical processes should be driving the SST variability in this region.

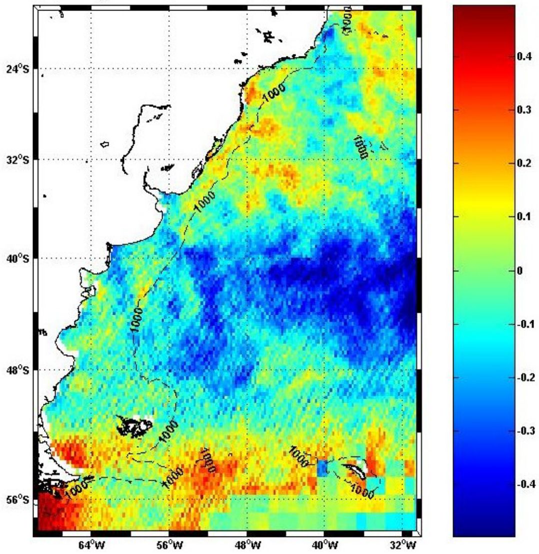

Figure 8: Correlation SSTA x Wind intensity. The correlation coefficients has significance ≥95%

4. Conclusions:

Our results suggest that the SAM influences and contributes to the WSA behavior in the SWAO. This WSA may cause SSTA, but due the small values of WSA this variability may be caused by other physical mechanisms which deserve further investigation.

To assess some of these questions, the analyses presented here has been improved and the datasets have been extended to 20 years worth of infrared satellite data and wind reanalysis data.

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