

**OMARSAT 2019**

**IEAPM**

**Arraial do Cabo (RJ)**

**01 - 04 outubro 2019**

# ANÁLISE DAS TENDÊNCIAS E VARIABILIDADES DO NÍVEL DO MAR MEDIDO POR ALTIMETRIA DE SATÉLITE NO ATLÂNTICO SUL

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# **ANÁLISE DE SÉRIES TEMPORAIS**

**ATLÂNTICO SUL**

**5° S – 55° S, 70° W – 25° E**

**ALTIMETRIA DE SATÉLITE**

**ADT – ABSOLUTE DYNAMIC TOPOGRAPHY**

**TOPOGRAFIA DINÂMICA ABSOLUTA**

**AVISO ALTIMETRY**

**MODELAGEM / MEDIÇÕES (SATÉLITES E BOIAS)**

**SST – SEA SURFACE TEMPERATURE**

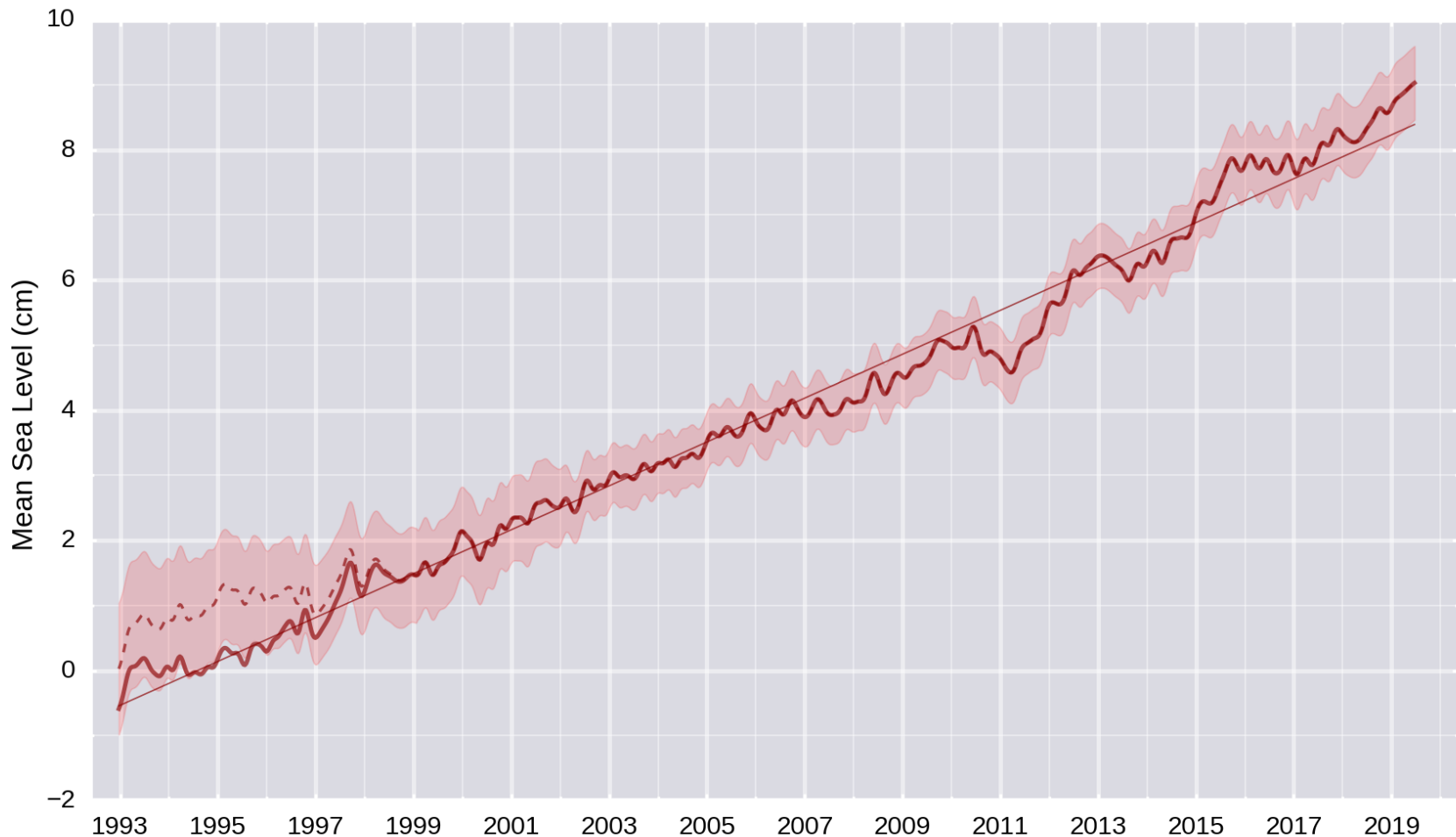
**TEMPERATURA DA SUPERFÍCIE DO MAR**

**NOAA OI SST V2 High Resolution Dataset**

Latest MSL Measurement  
05 July, 2019

**+3.37 mm/yr**

Reference GMSL - corrected for GIA

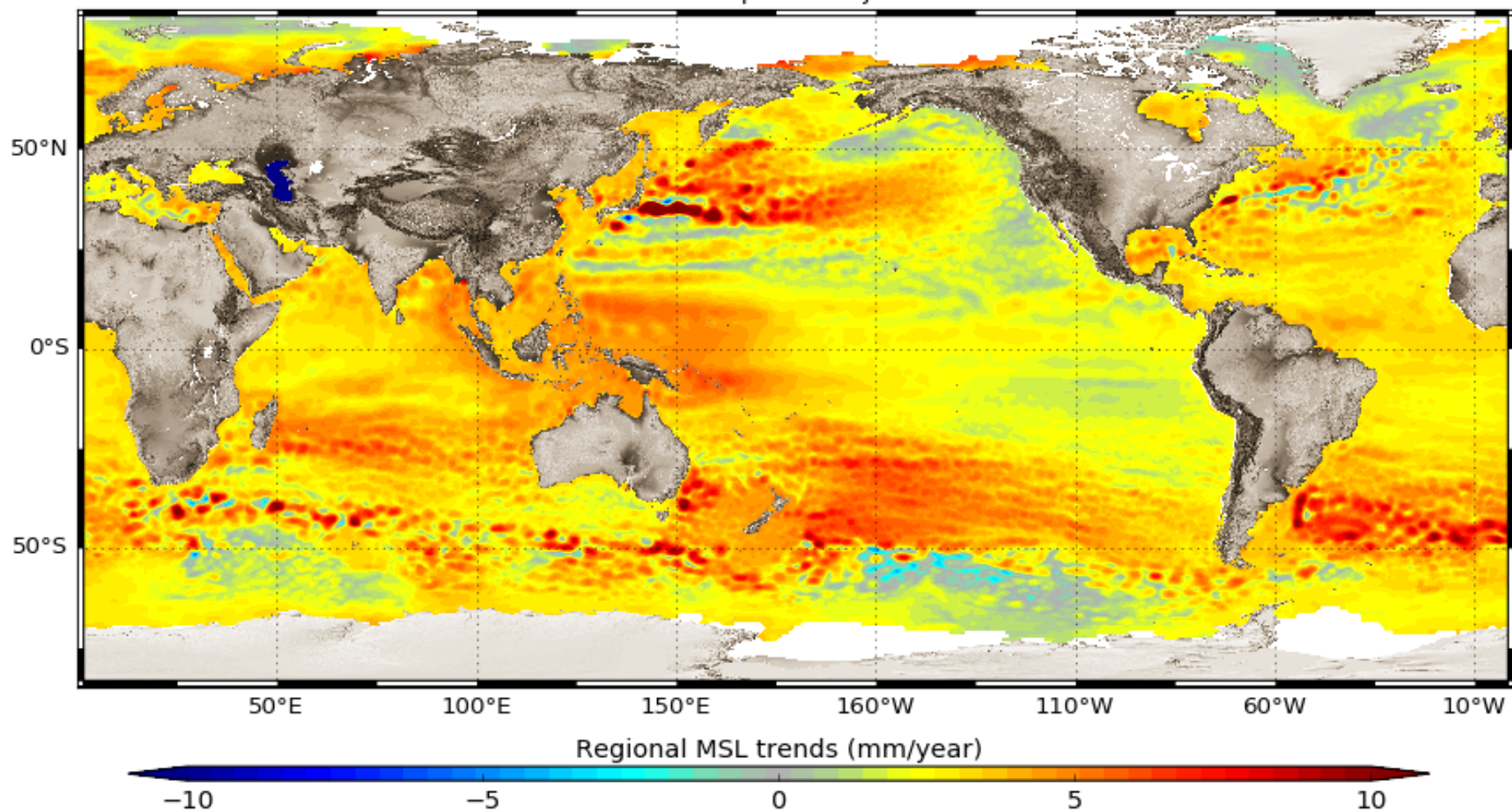


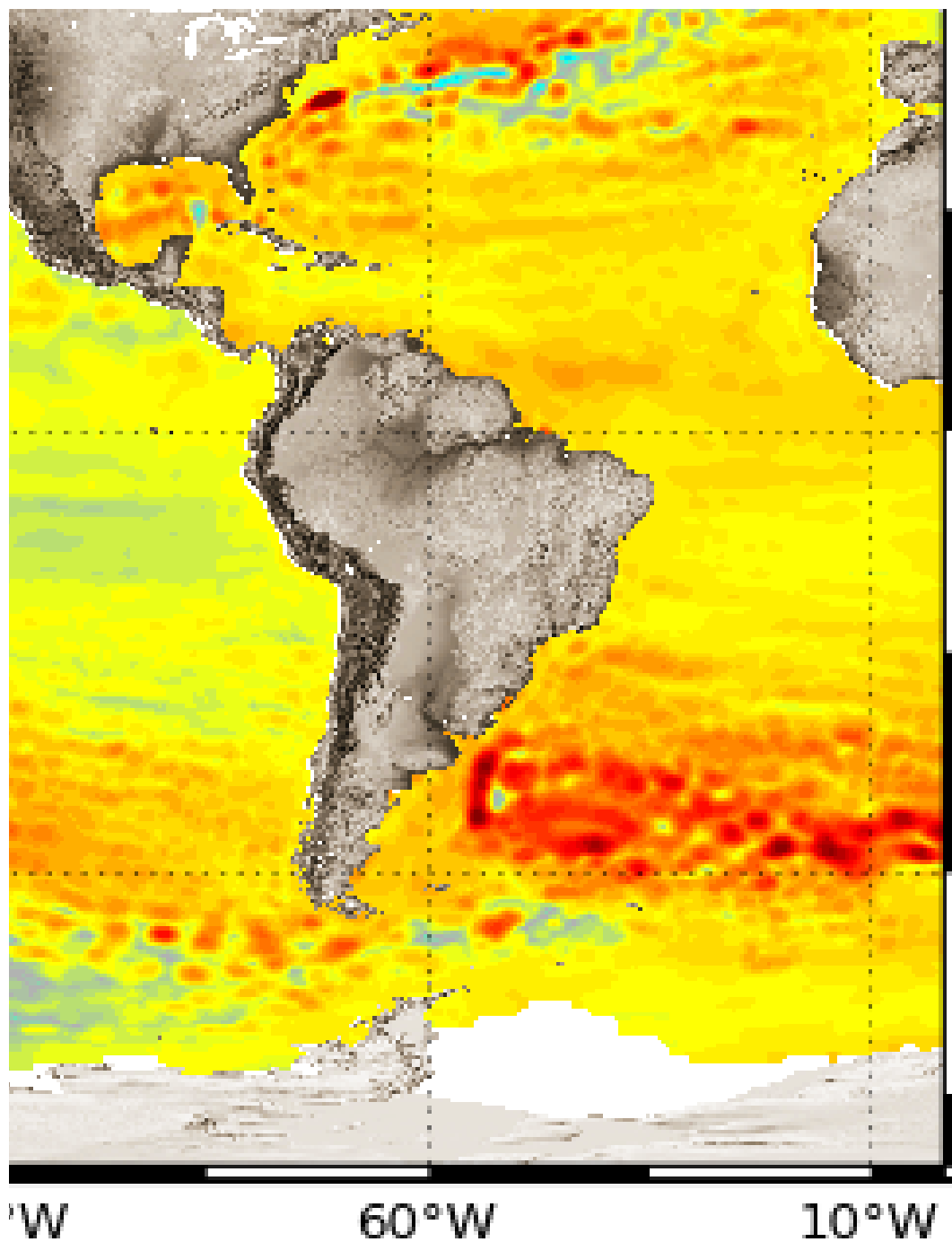
© CNES, LEGOS, CLS

**AVISO ALTIMETRY – GLOBAL MEAN SEA LEVEL,  
3.37 mm/year = 0.37 m / century**

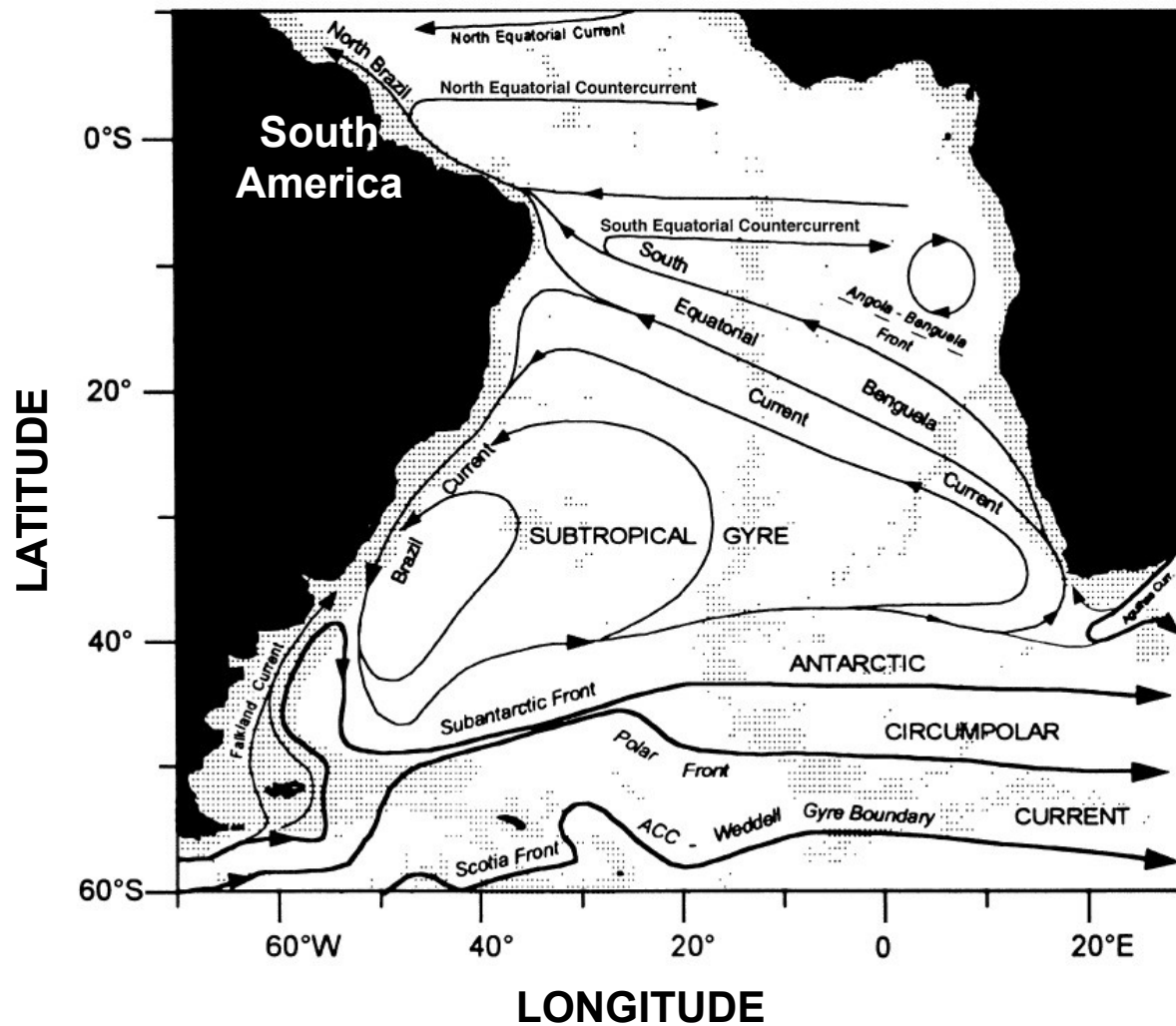
# Multi-Mission Sea Level Trends

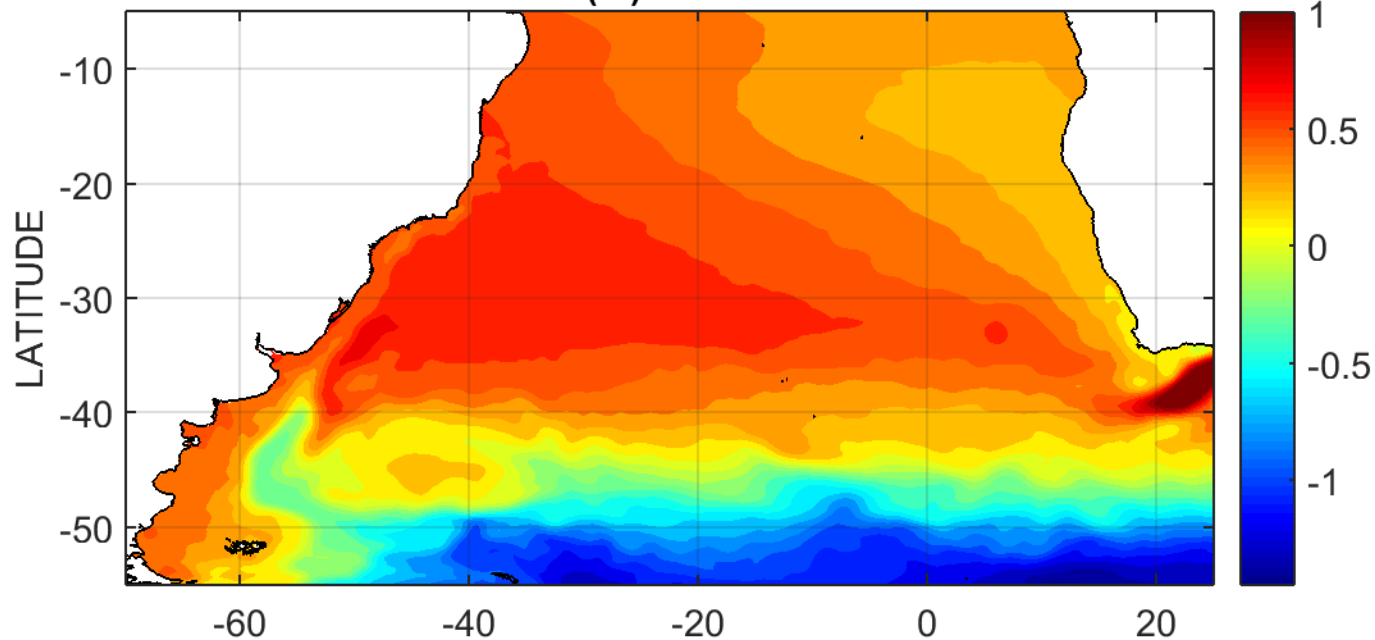
Period: Sep-1992 to Jan-2019



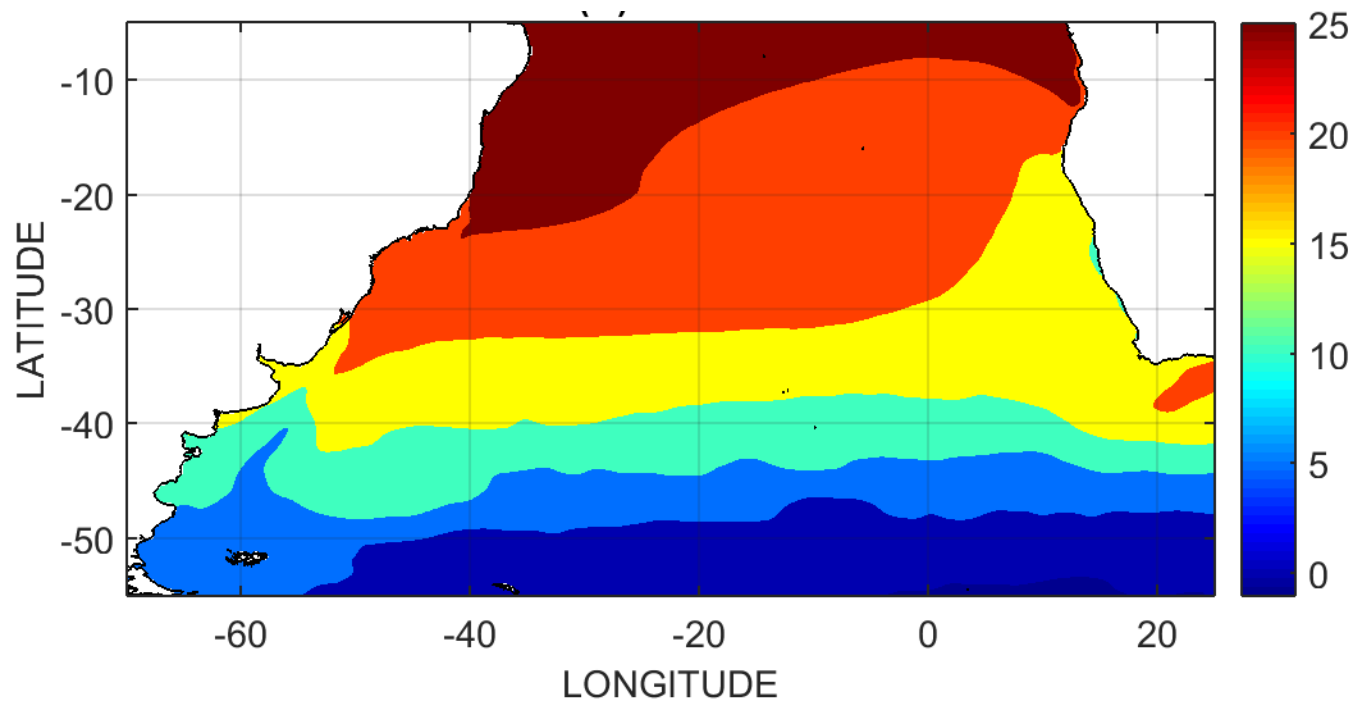


# SOUT ATLANTIC MEAN CIRCULATION

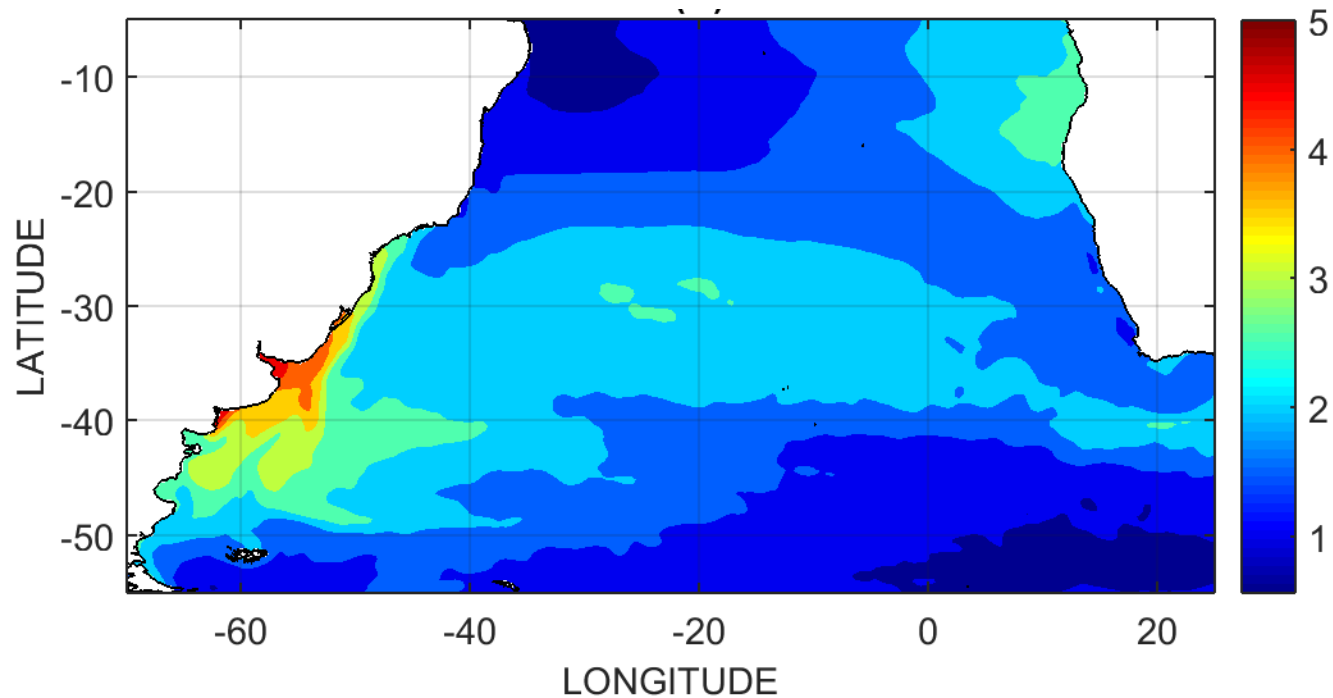
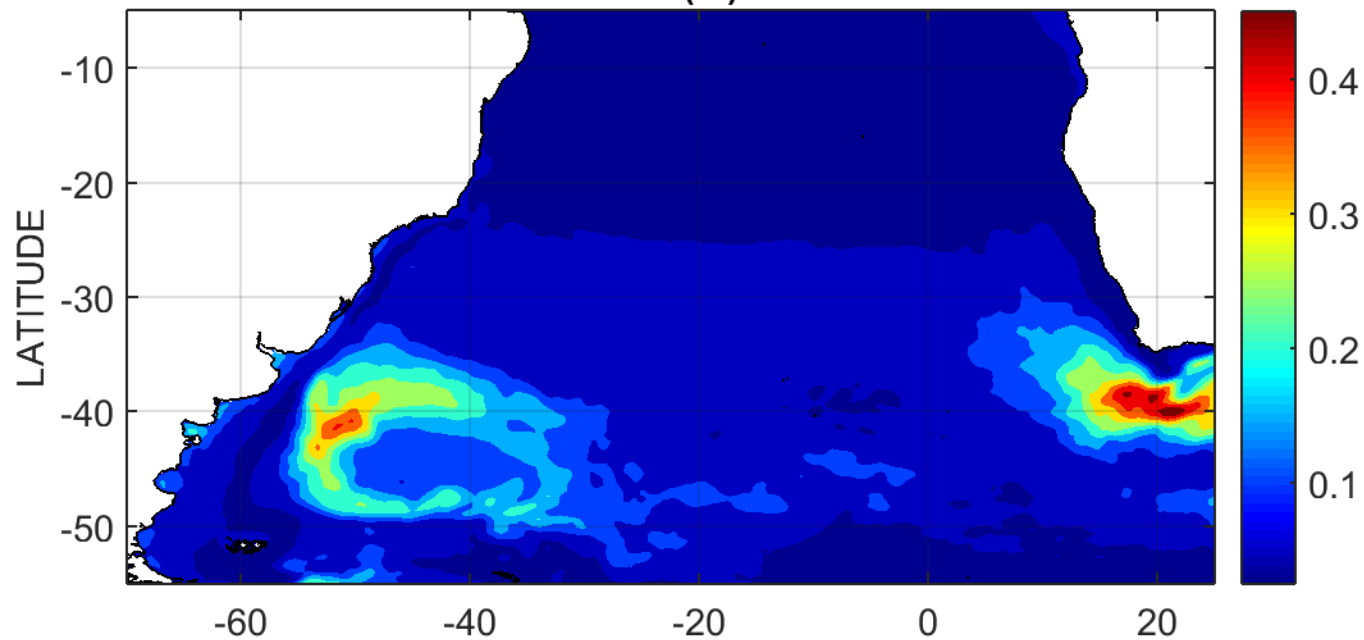




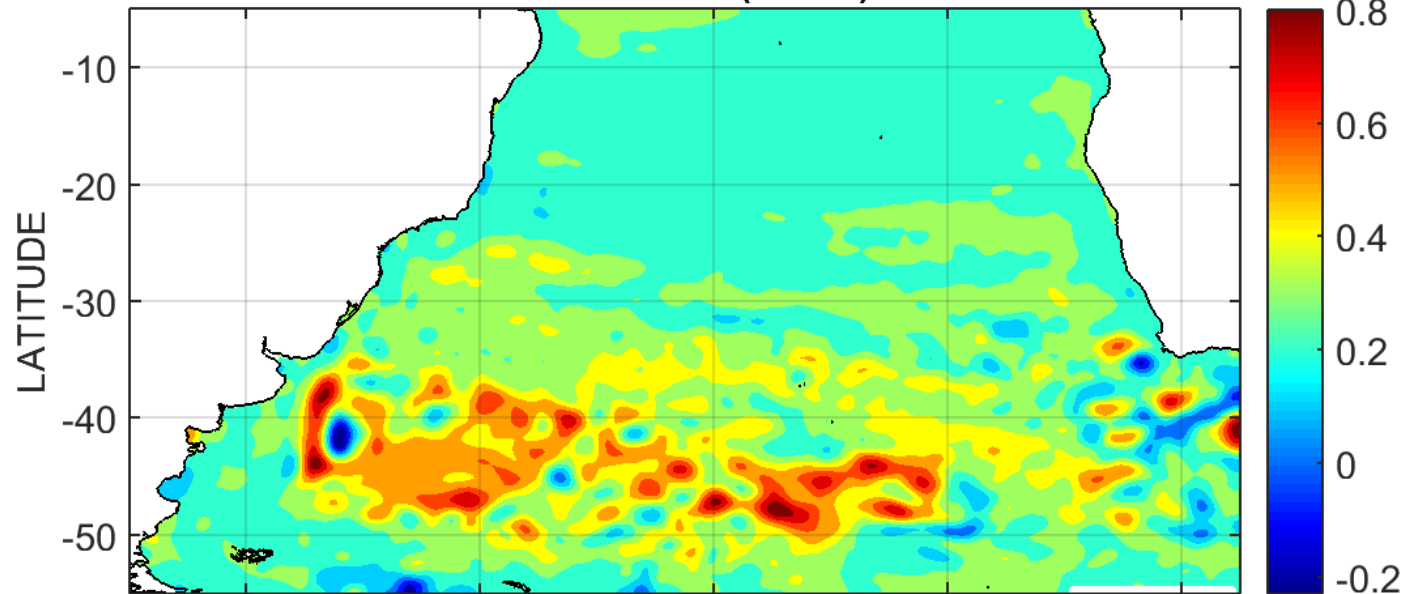
**ADT MÉDIA  
(m)  
01/01/1993  
A  
31/12/2017**



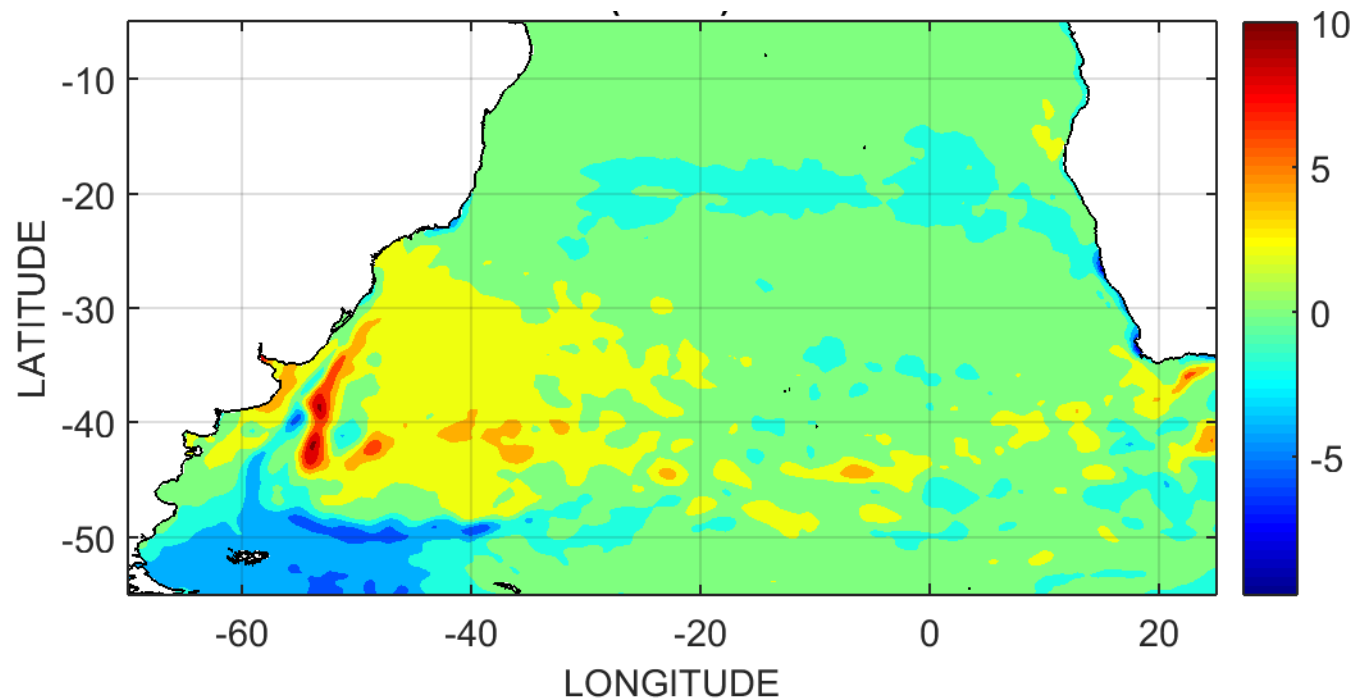
**SST MÉDIA  
(C)  
01/01/1993  
A  
31/12/2017**



ADT - TEND LINEAR (m/sec) intrada

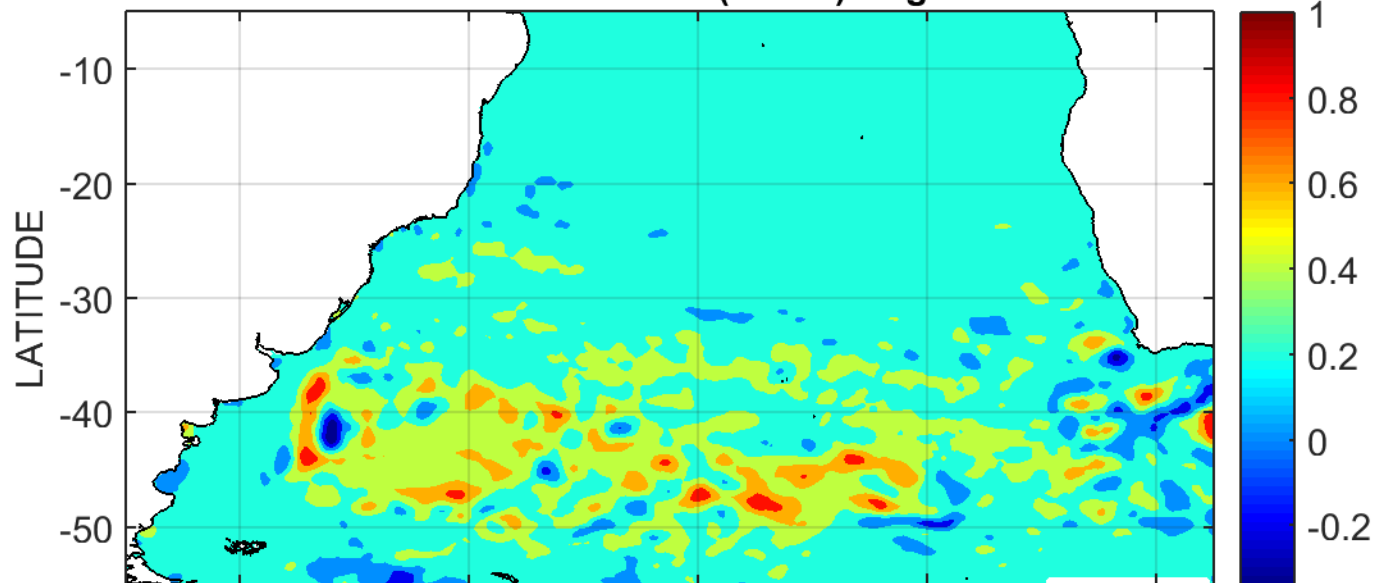


**ADT:  
TENDÊNCIA  
LINEAR  
(m/século)**



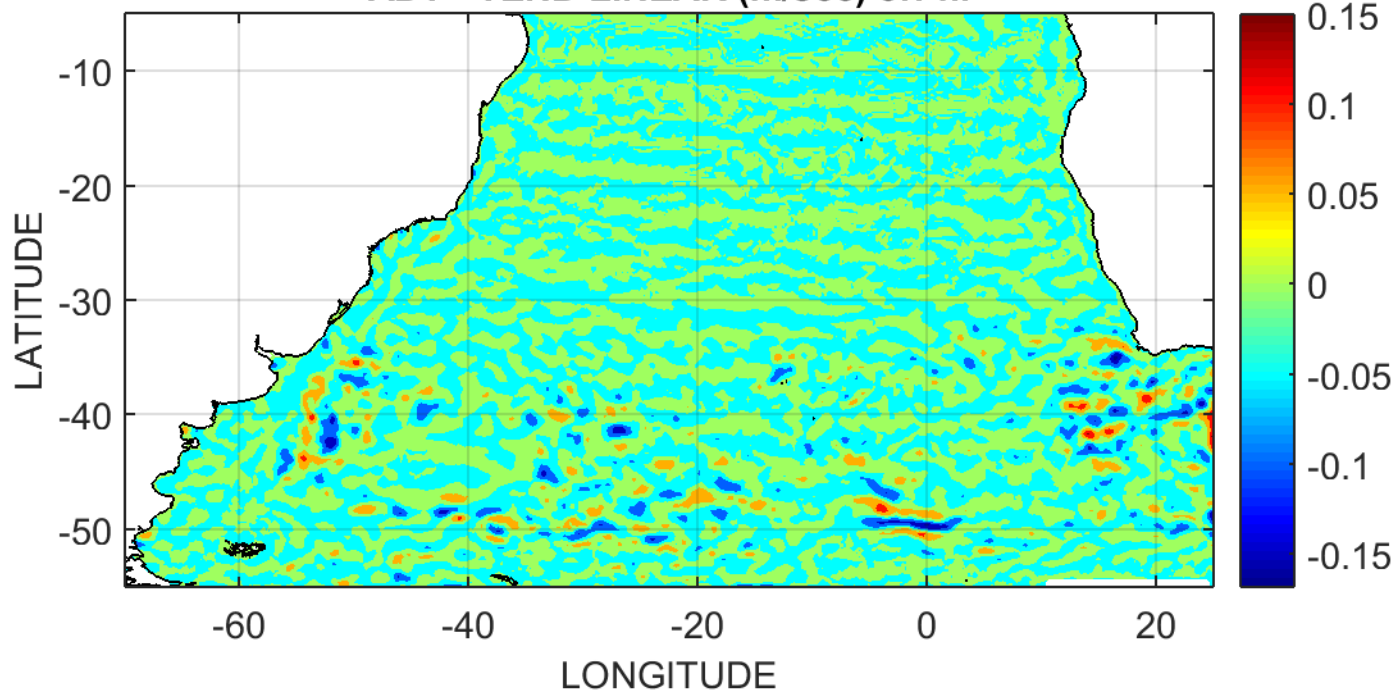
**SST:  
TENDÊNCIA  
LINEAR  
(C/século)**

**ADT - TEND LINEAR (m/sec) original**



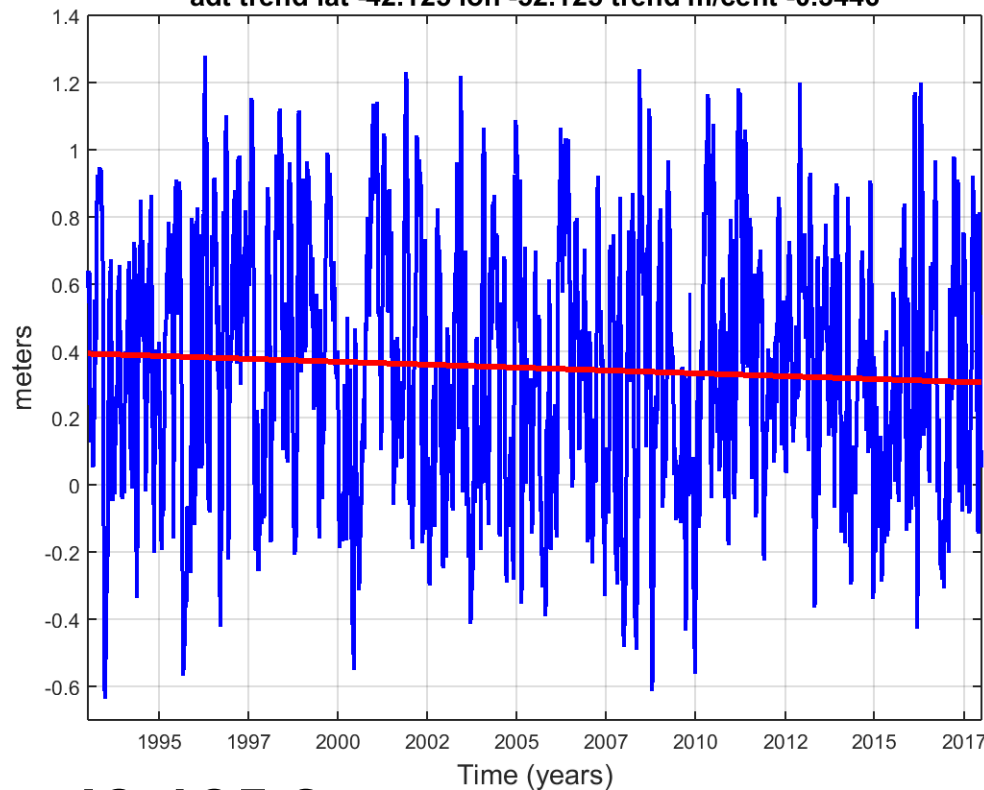
**ADT:  
TENDÊNCIA  
ORIGINAL,  
SEM  
FILTRAGEM  
NO  
ESPAÇO**

**ADT - TEND LINEAR (m/sec) ori-fil**



**DIFERENÇAS  
DAS  
TENDÊNCIAS  
(ORIGINAL  
MENOS  
FILTRADA)**

adt trend lat -42.125 lon -52.125 trend m/cent -0.3446



**42.125 S**

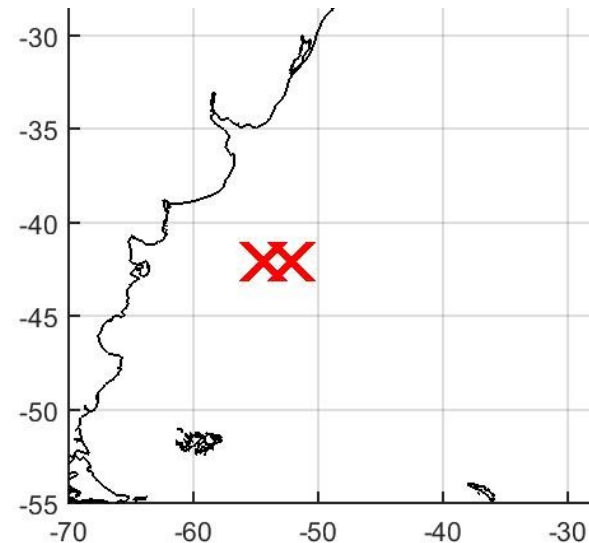
**52.125 W**

**-0.3446 m/século**

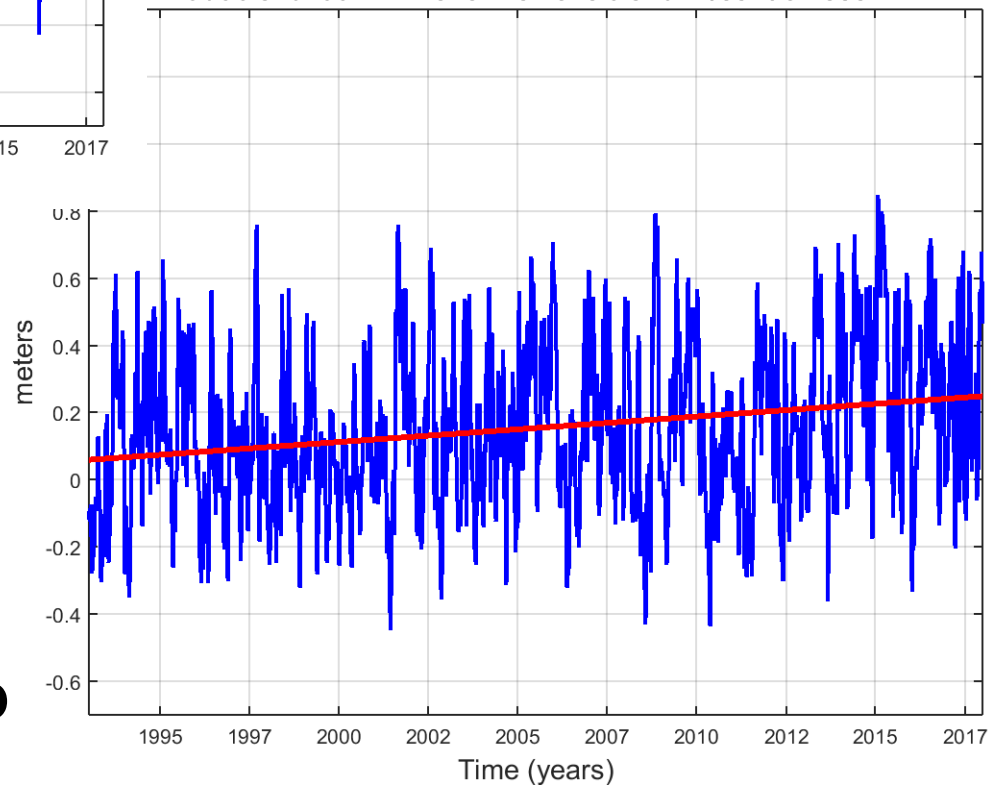
**42.125 S**

**54.375 W**

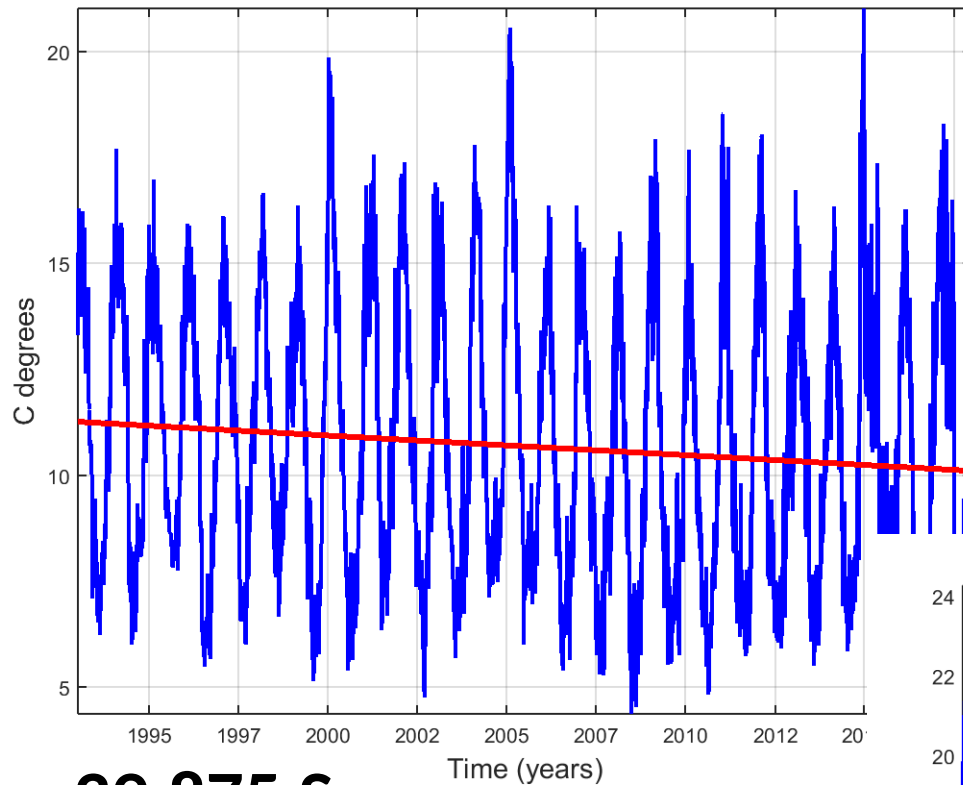
**+0.75854 m/século**



adt trend lat -42.125 lon -54.375 trend m/cent 0.75854



sst trend lat -39.875 lon -55.375 trend C/cent -4.6324



**39.875 S**

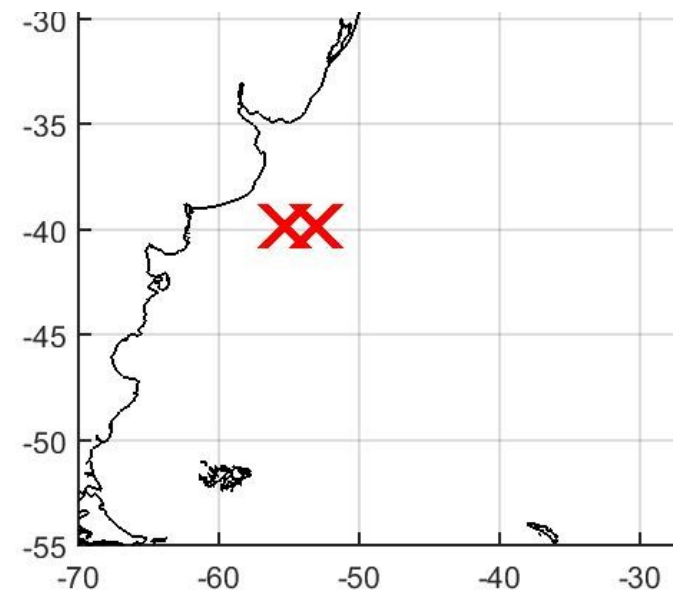
**55.375 W**

**-4.6324 C/século**

**39.875 S**

**53.125 W**

**+7.677 C/século**



sst trend lat -39.875 lon -53.125 trend C/cent 7.677

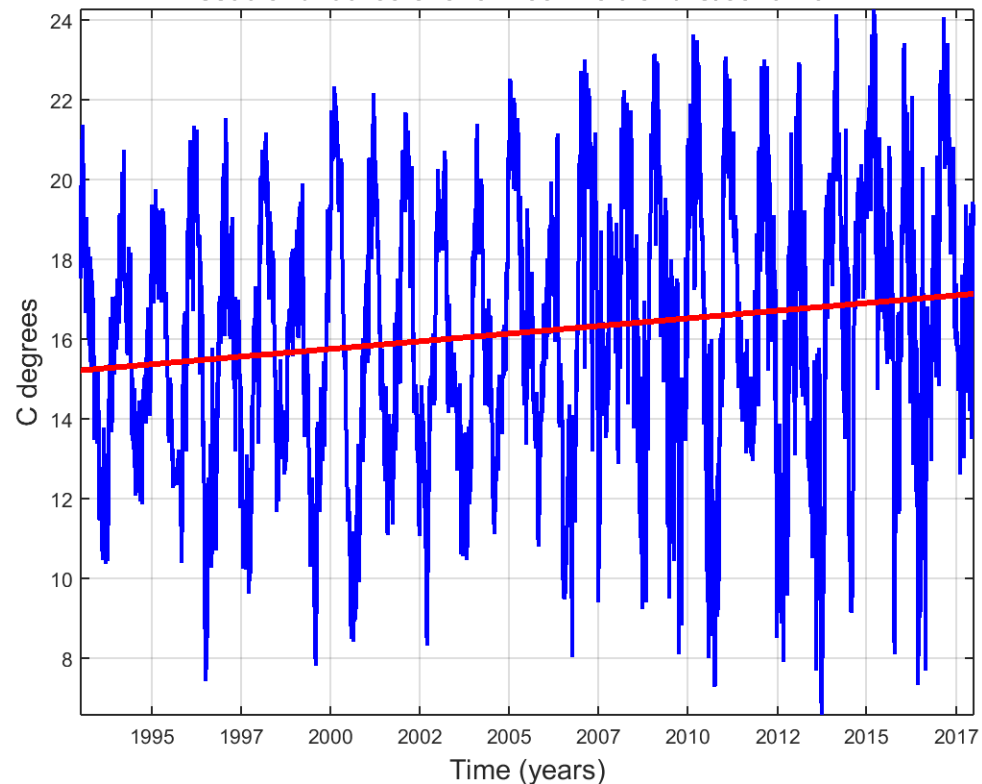
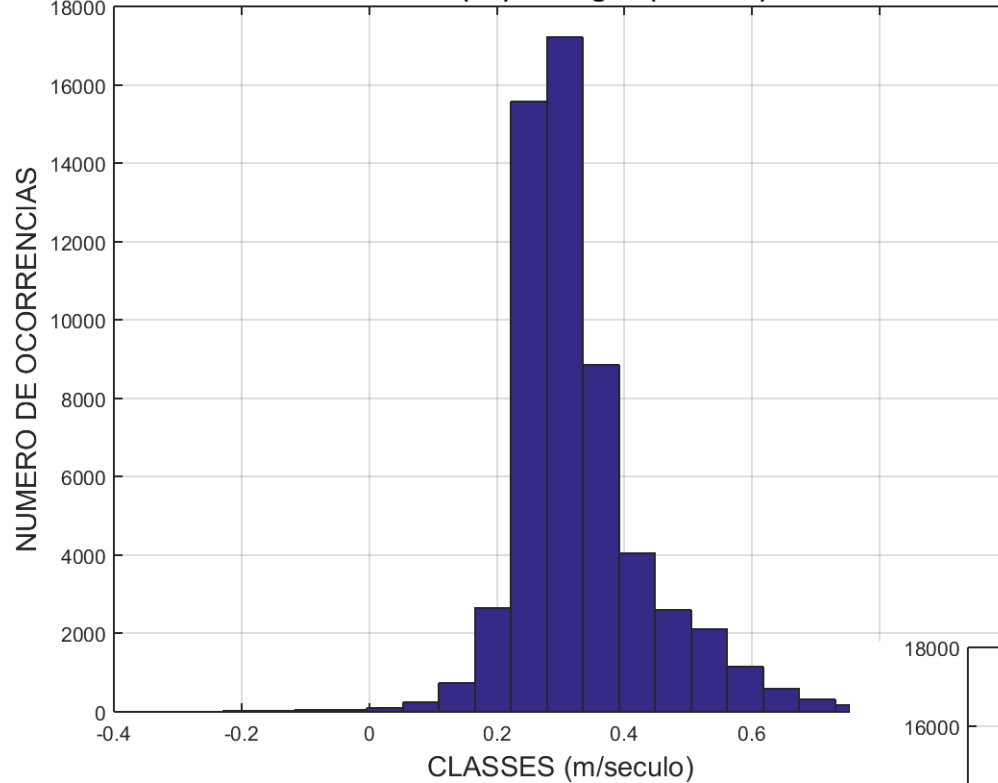


Table 1 – Basic statistic parameters of sea level time series at the points of minimum and maximum trends near the Brazil – Malvinas Confluence (minimum, maximum, mean, median, standard deviation, kurtosis, asymmetry and linear trend).

| Lat.<br>(°S) | Lon.<br>(°W) | Min.<br>(m) | Max.<br>(m) | Mean<br>(m) | Median<br>(m) | Std.<br>(m) | Kurt.<br>(-) | Asym.<br>(-) | Trend<br>(m/cent.) |
|--------------|--------------|-------------|-------------|-------------|---------------|-------------|--------------|--------------|--------------------|
| 42.125       | 52.125       | -0.64       | 1.28        | 0.35        | 0.34          | 0.37        | 2.26         | 0.04         | - 0.34             |
| 42.125       | 54.375       | -0.45       | 0.85        | 0.15        | 0.13          | 0.24        | 2.46         | 0.26         | + 0.76             |

Table 2 – Basic statistic parameters of sea surface temperature time series at the points of minimum and maximum trends near the Brazil – Malvinas Confluence (minimum, maximum, mean, median, standard deviation, kurtosis, asymmetry and linear trend).

| Lat.<br>(°S) | Lon.<br>(°W) | Min.<br>(C) | Max.<br>(C) | Mean<br>(C) | Median<br>(C) | Std.<br>(C) | Kurt.<br>(-) | Asym.<br>(-) | Trend<br>(C/cent.) |
|--------------|--------------|-------------|-------------|-------------|---------------|-------------|--------------|--------------|--------------------|
| 39.875       | 55.375       | 4.37        | 21.02       | 10.68       | 10.21         | 3.30        | 2.11         | 0.34         | – 4.62             |
| 39.875       | 53.125       | 6.57        | 24.27       | 16.17       | 16.18         | 3.37        | 2.35         | -0.11        | + 7.68             |



# HISTOGRAMA TENDÊNCIA ADT NA REGIÃO DE ESTUDO CLASSES (m/século)

# HISTOGRAMA TENDÊNCIA SST NA REGIÃO DE ESTUDO CLASSES (C/século)

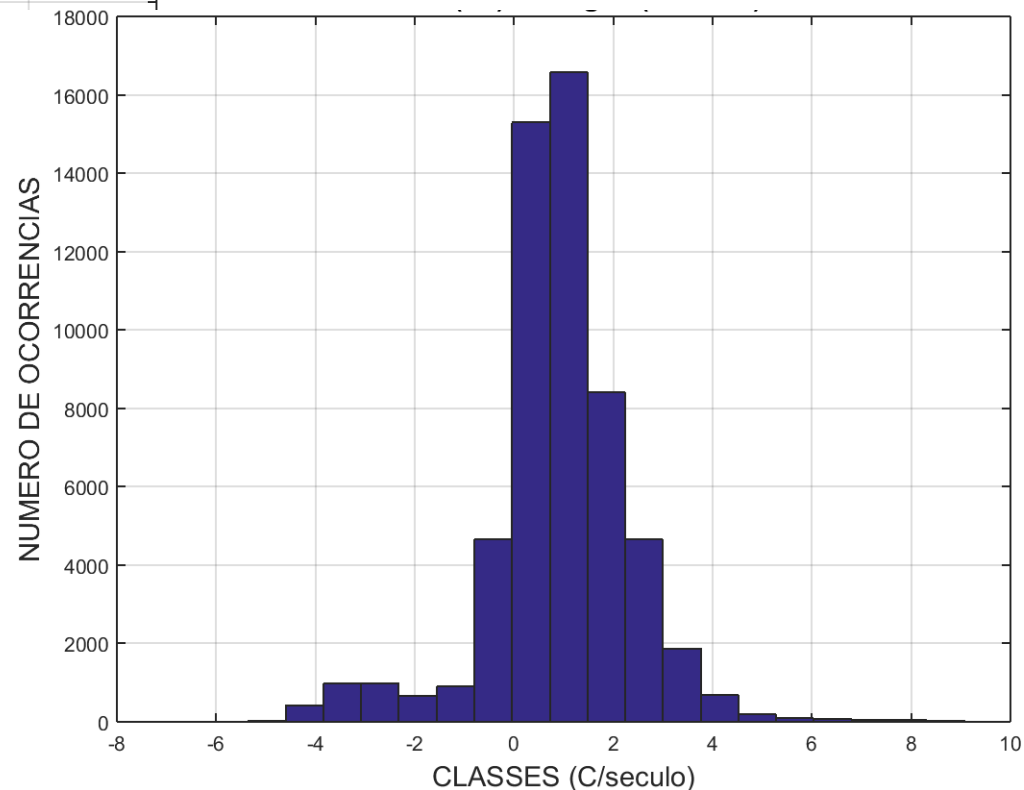
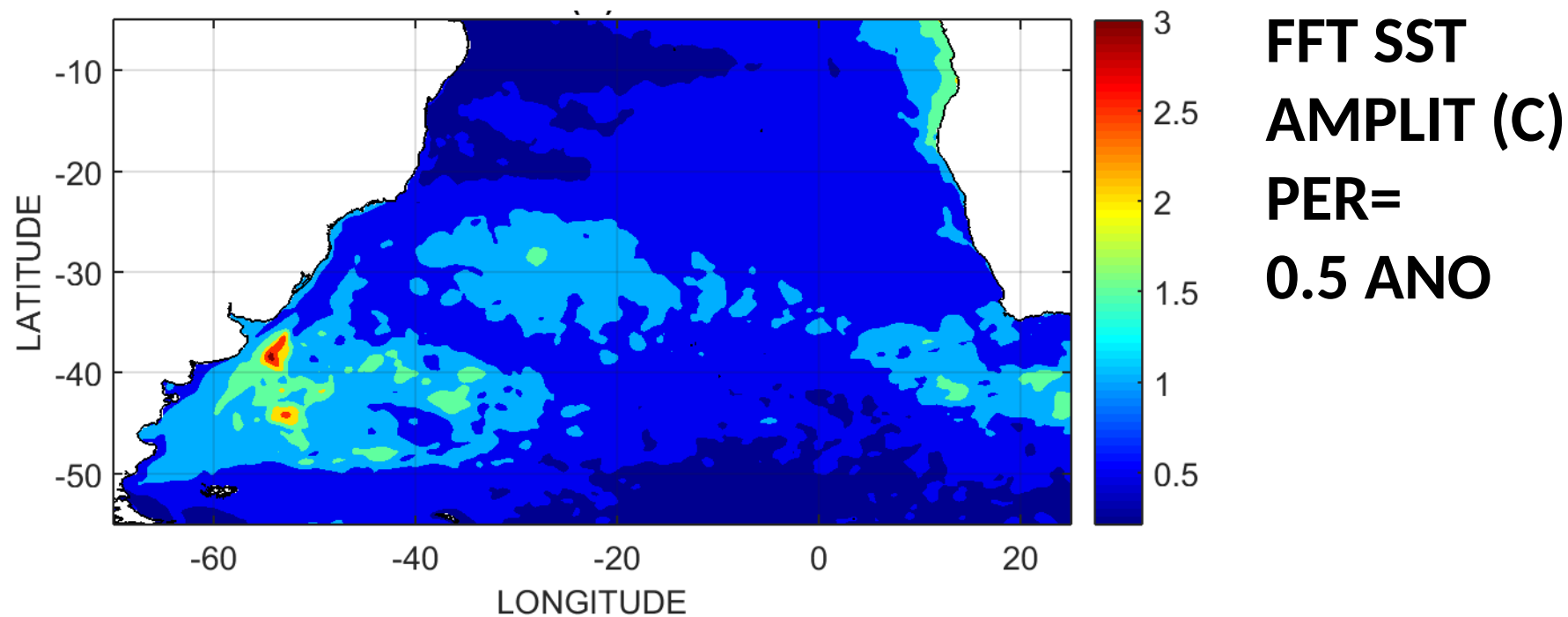
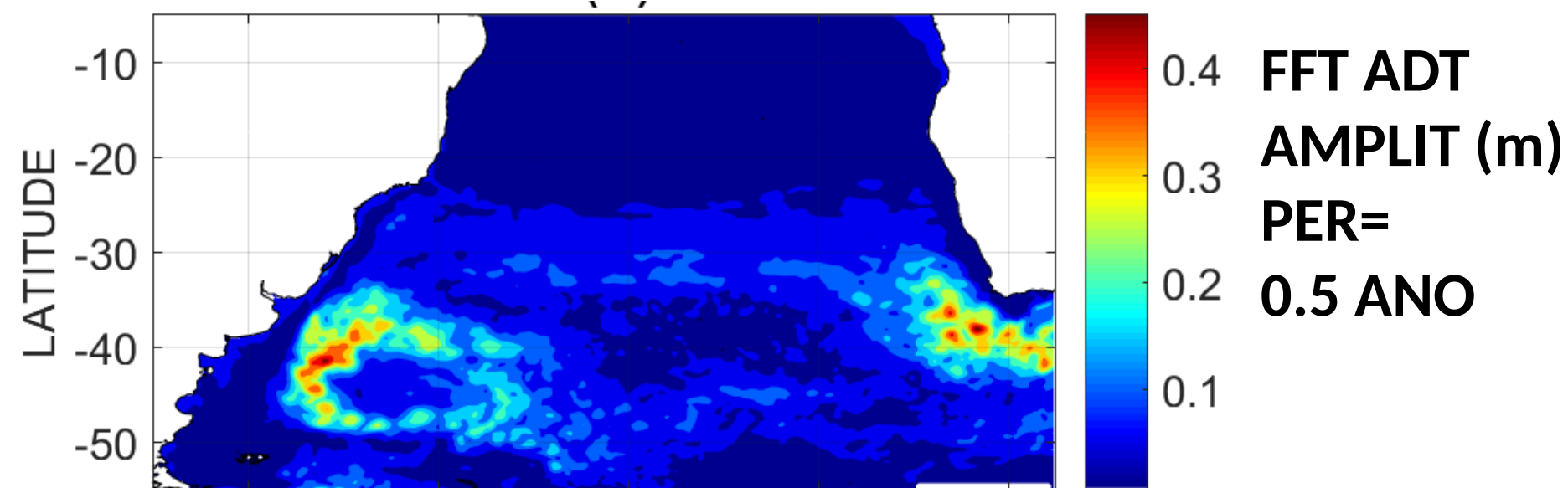
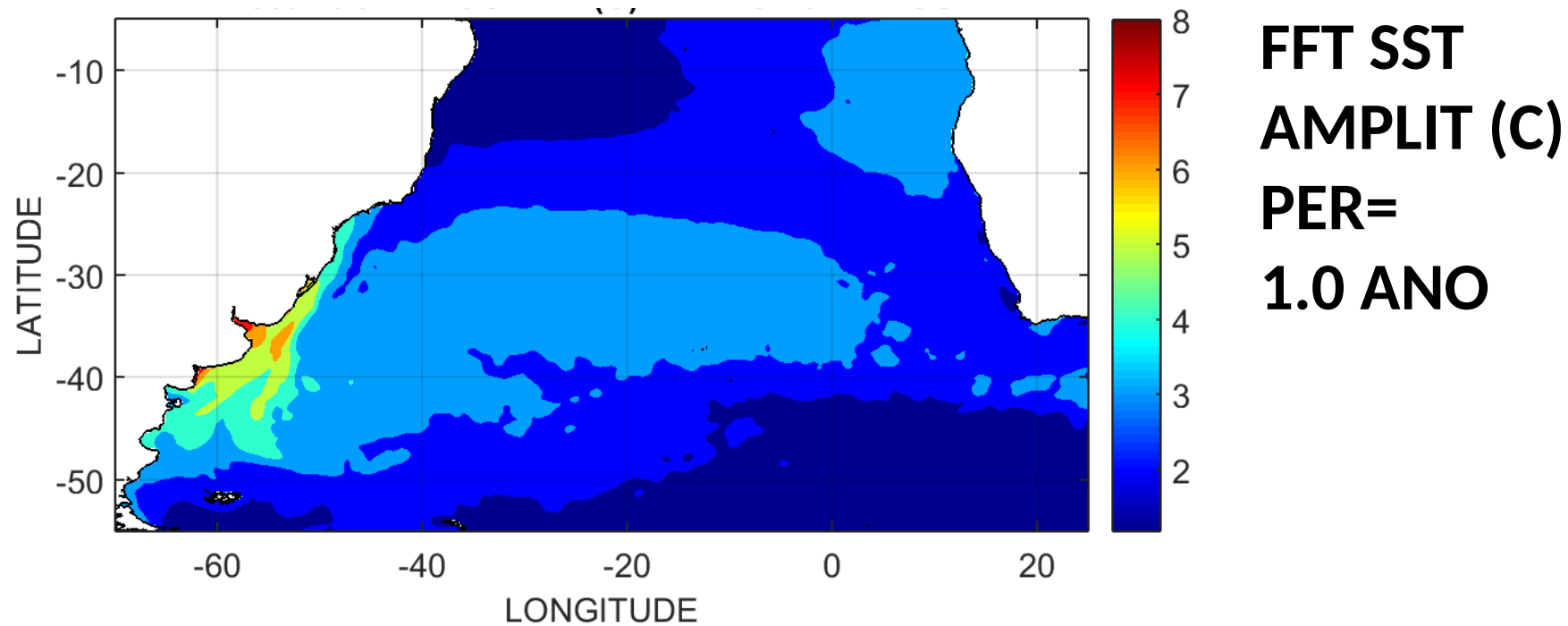
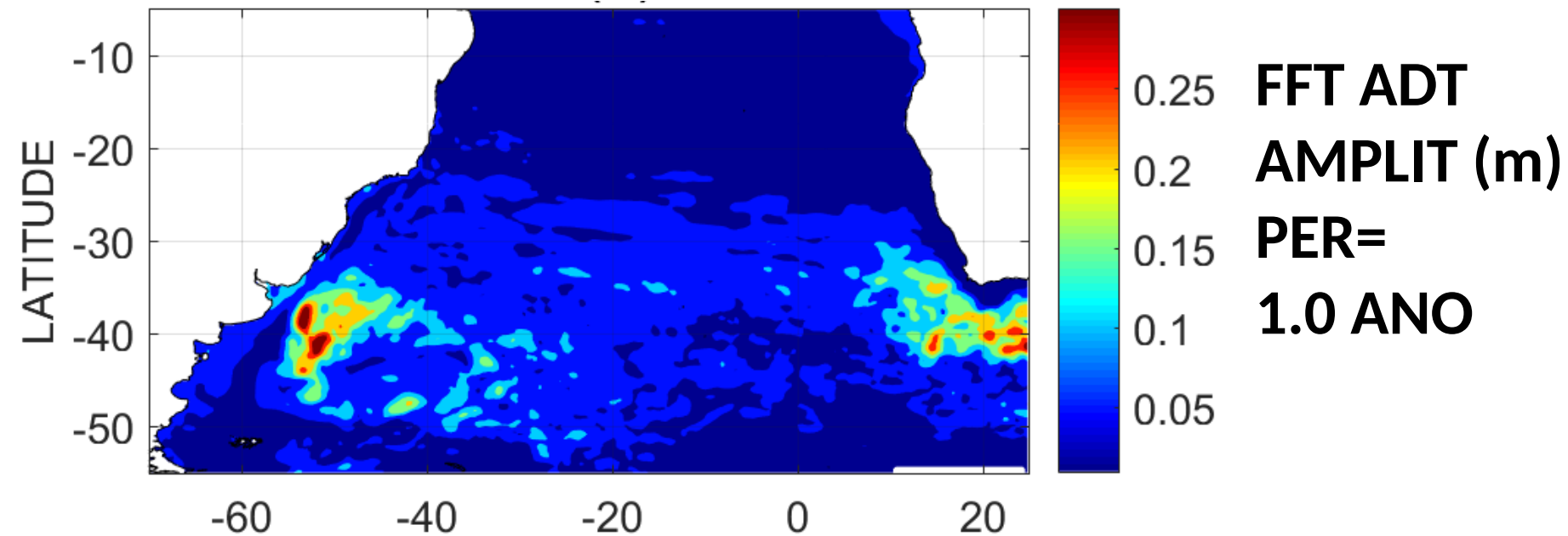


Table 2 – Histogram of sea level, temperature linear trend  
(classes in m/century, C/century x % of occurrences x cumulative %).

| Trend<br>(m/century) | Percent (%) | Cumulative<br>Percent (%) |
|----------------------|-------------|---------------------------|
| -0.2017              | 0.02        | 0.02                      |
| -0.1452              | 0.04        | 0.06                      |
| -0.0887              | 0.07        | 0.13                      |
| -0.0322              | 0.08        | 0.21                      |
| 0.0243               | 0.19        | 0.40                      |
| 0.0808               | 0.43        | 0.83                      |
| 0.1373               | 1.31        | 2.14                      |
| 0.1938               | 4.66        | 6.80                      |
| 0.2503               | 27.51       | 34.31                     |
| 0.3068               | 30.38       | 64.69                     |
| 0.3633               | 15.62       | 80.31                     |
| 0.4198               | 7.16        | 87.47                     |
| 0.4763               | 4.60        | 92.07                     |
| 0.5328               | 3.74        | 95.80                     |
| 0.5893               | 2.05        | 97.86                     |
| 0.6458               | 1.05        | 98.90                     |
| 0.7023               | 0.57        | 99.48                     |
| 0.7588               | 0.29        | 99.77                     |
| 0.8153               | 0.17        | 99.94                     |
| 0.8718               | 0.06        | 100                       |

| Trend<br>(C/century) | P<br>Percent (%) | Cumulative<br>Percent (%) |
|----------------------|------------------|---------------------------|
| -5.7790              | 0.05             | 0.05                      |
| -5.0170              | 0.15             | 0.20                      |
| -4.2550              | 0.79             | 0.99                      |
| -3.4930              | 2.00             | 2.98                      |
| -2.7310              | 2.34             | 5.32                      |
| -1.9690              | 3.16             | 8.49                      |
| -1.2070              | 3.97             | 12.45                     |
| -0.4450              | 9.95             | 22.40                     |
| 0.3170               | 25.20            | 47.60                     |
| 1.0790               | 27.72            | 75.32                     |
| 1.8410               | 13.71            | 89.03                     |
| 2.6030               | 6.66             | 95.69                     |
| 3.3650               | 2.65             | 98.34                     |
| 4.1270               | 0.99             | 99.32                     |
| 4.8890               | 0.28             | 99.60                     |
| 5.6510               | 0.14             | 99.74                     |
| 6.4130               | 0.10             | 99.84                     |
| 7.1750               | 0.06             | 99.91                     |
| 7.9370               | 0.05             | 99.96                     |
| 8.6990               | 0.04             | 100.00                    |





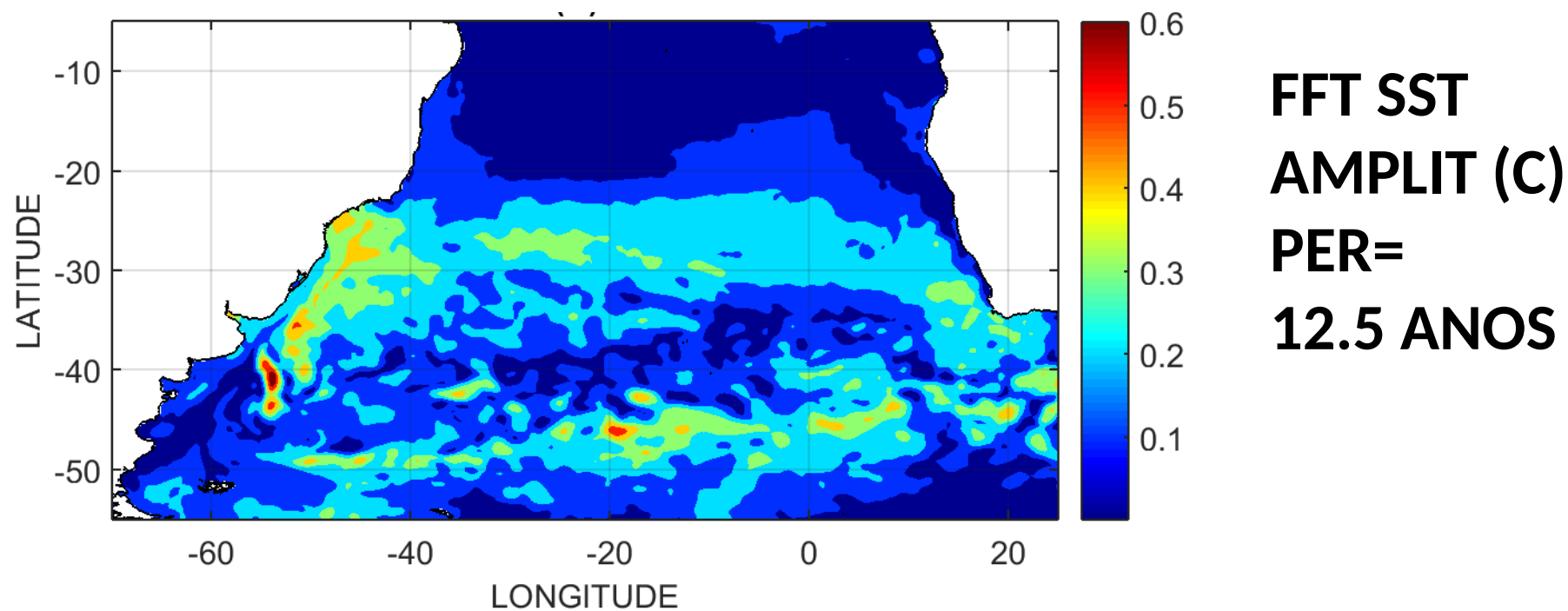
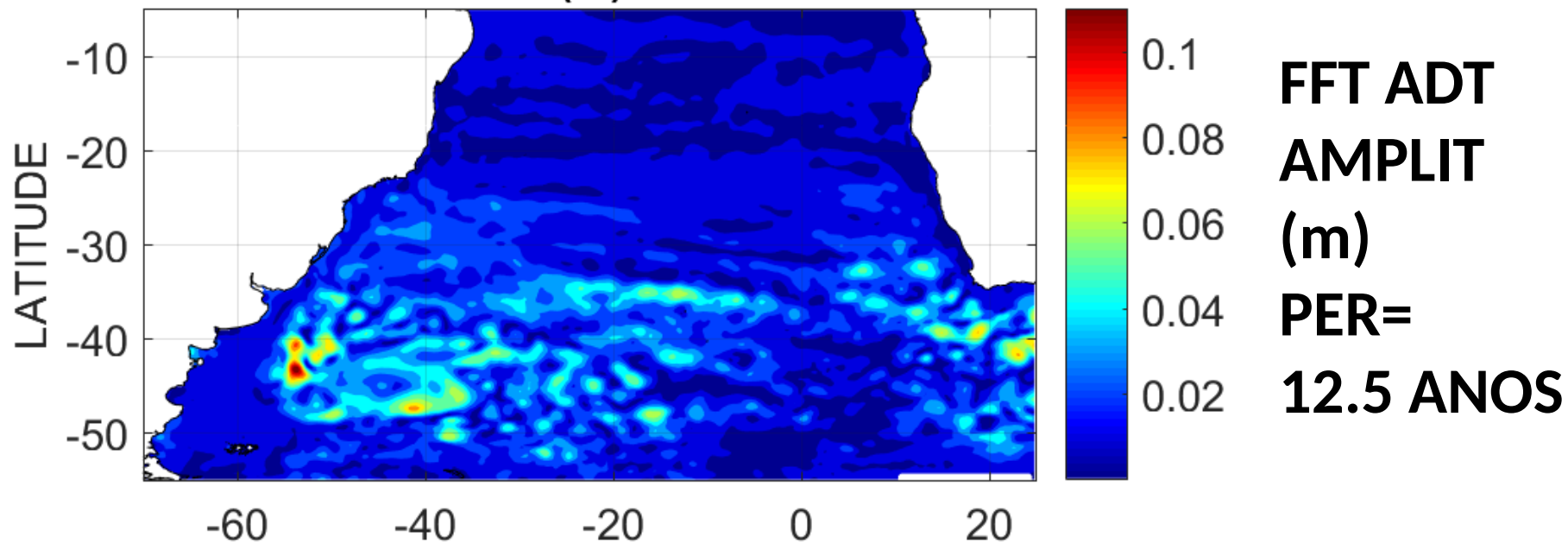
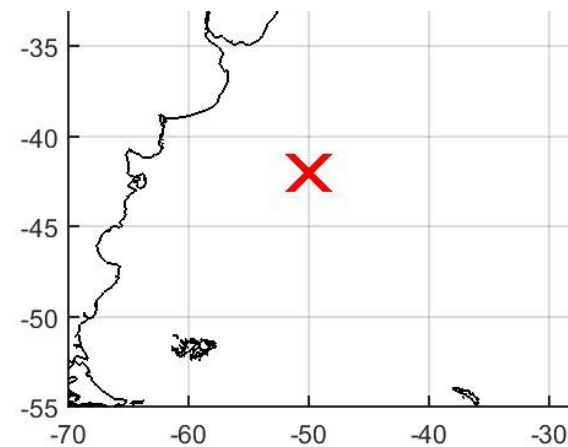
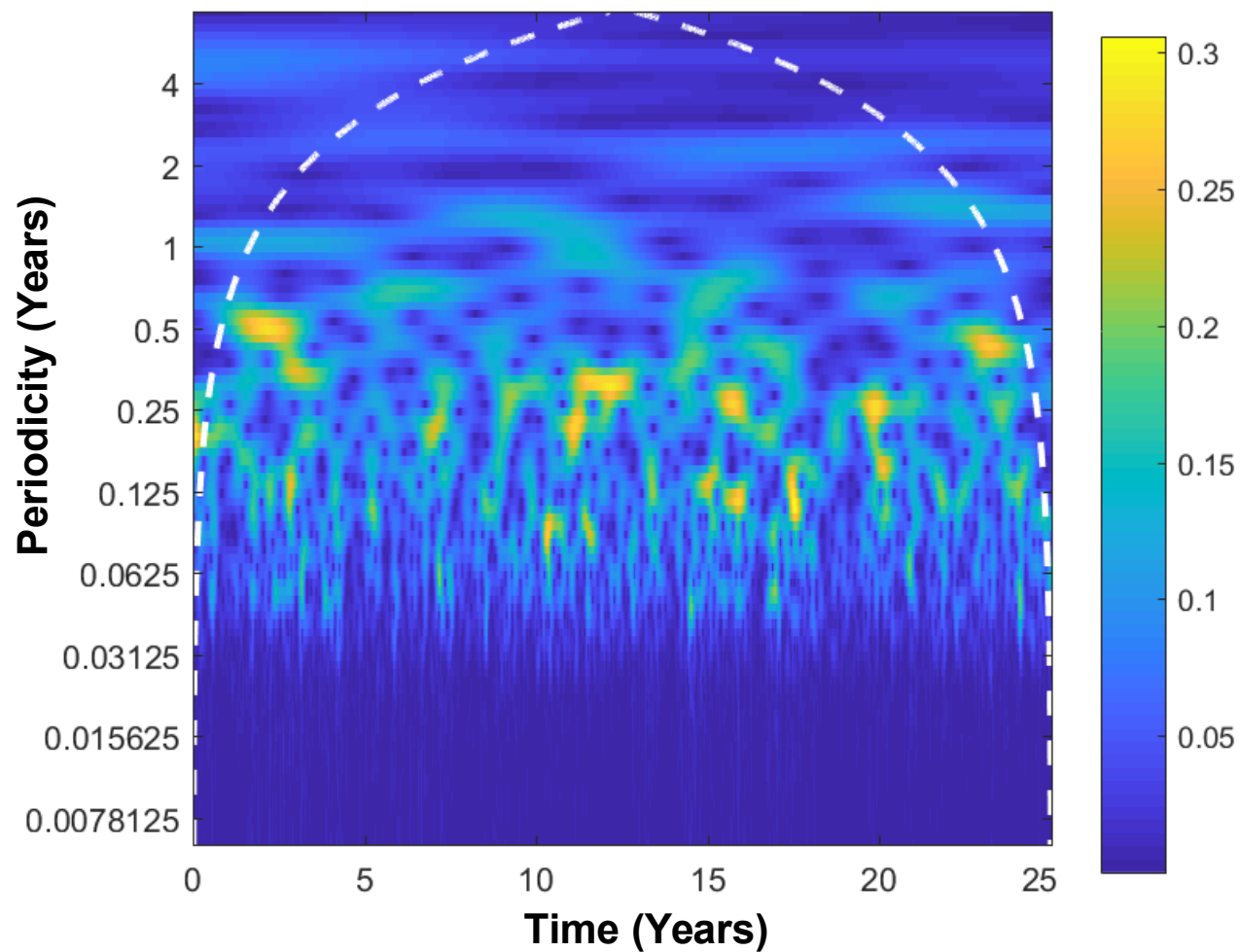


Table 3 – Energy density (integrated in the whole geographic area) associated with each periodicity obtained in the Fourier transform of sea level, temperature measurements.

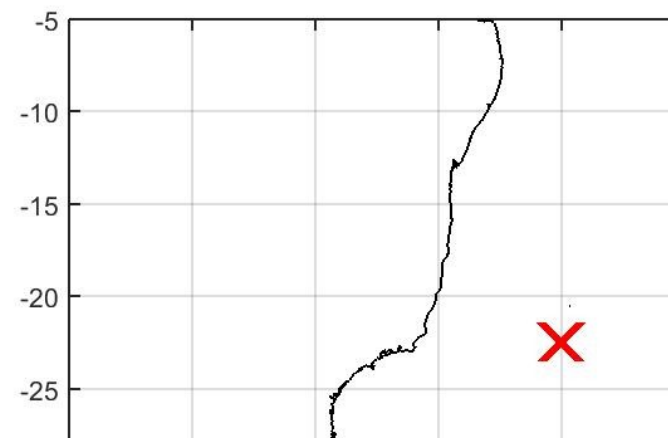
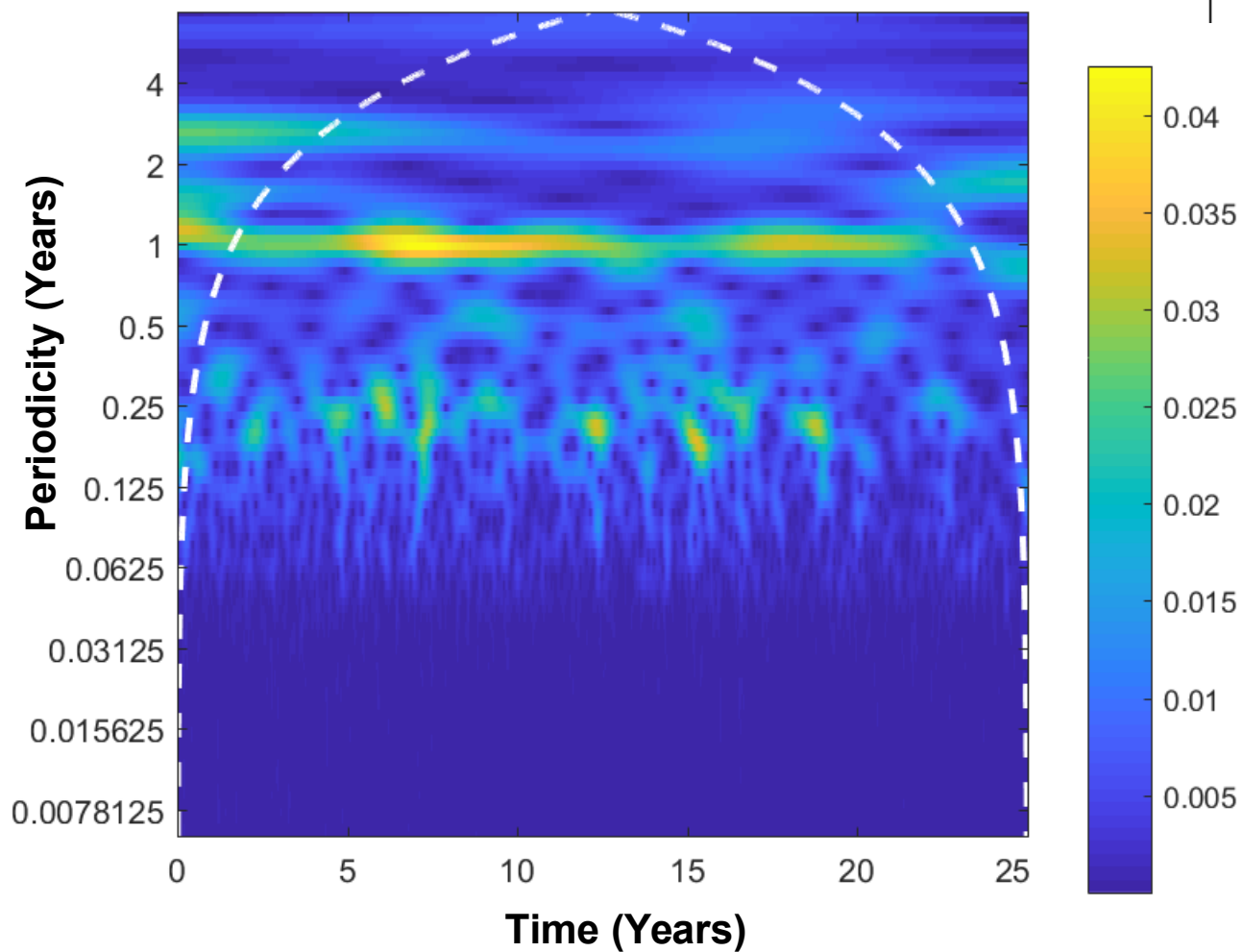
| Periodicity<br>(Years) | Energy<br>( $\times 10^4$ J/m <sup>2</sup> ) |
|------------------------|----------------------------------------------|
| 0.50                   | 59.60                                        |
| 1.00                   | 83.93                                        |
| 2.00                   | 21.35                                        |
| 3.12                   | 12.71                                        |
| 4.20                   | 13.59                                        |
| 5.00                   | 11.50                                        |
| 6.20                   | 16.76                                        |
| 8.30                   | 17.77                                        |
| 12.50                  | 27.13                                        |

| Periodicity<br>(years) | Relative<br>energy |
|------------------------|--------------------|
| 0.50                   | 10425.69           |
| 1.00                   | 390681.16          |
| 2.00                   | 1606.82            |
| 3.12                   | 1474.81            |
| 4.20                   | 1151.12            |
| 5.00                   | 1288.59            |
| 6.20                   | 1976.27            |
| 8.30                   | 1778.41            |
| 12.50                  | 2440.62            |

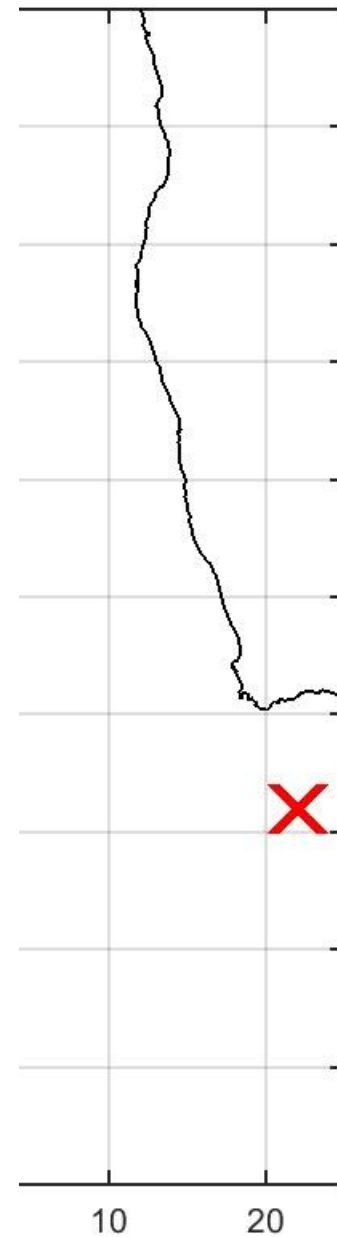
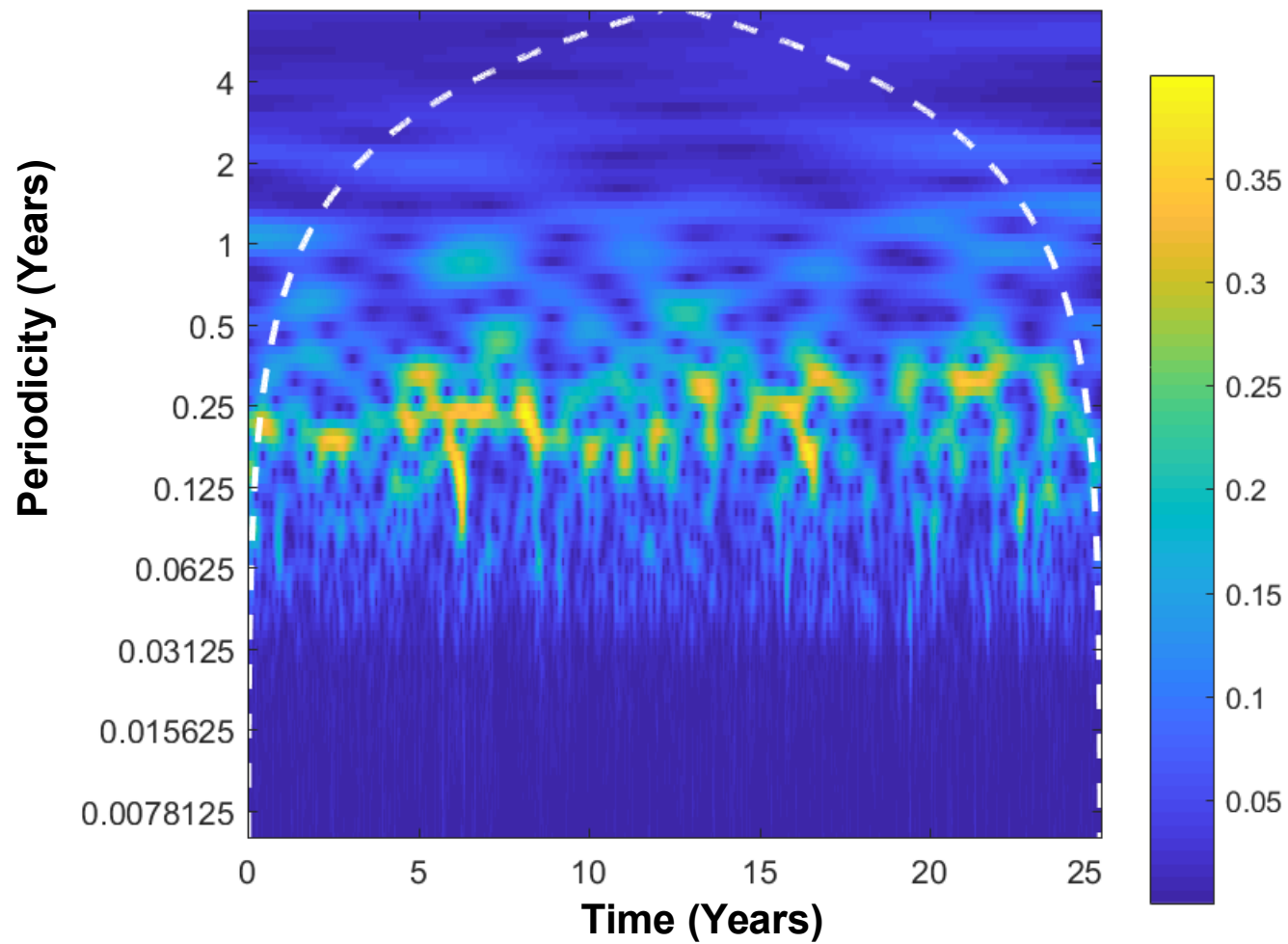
**Wavelet Transform (m): Lat = 42°S ; Lon = 50°W**



**Wavelet Transform (m): Lat = 22.5°S ; Lon = 30°W**

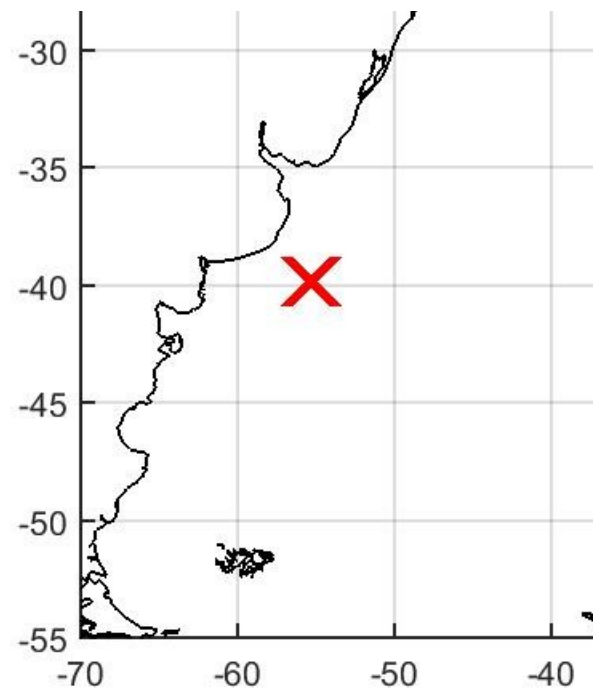
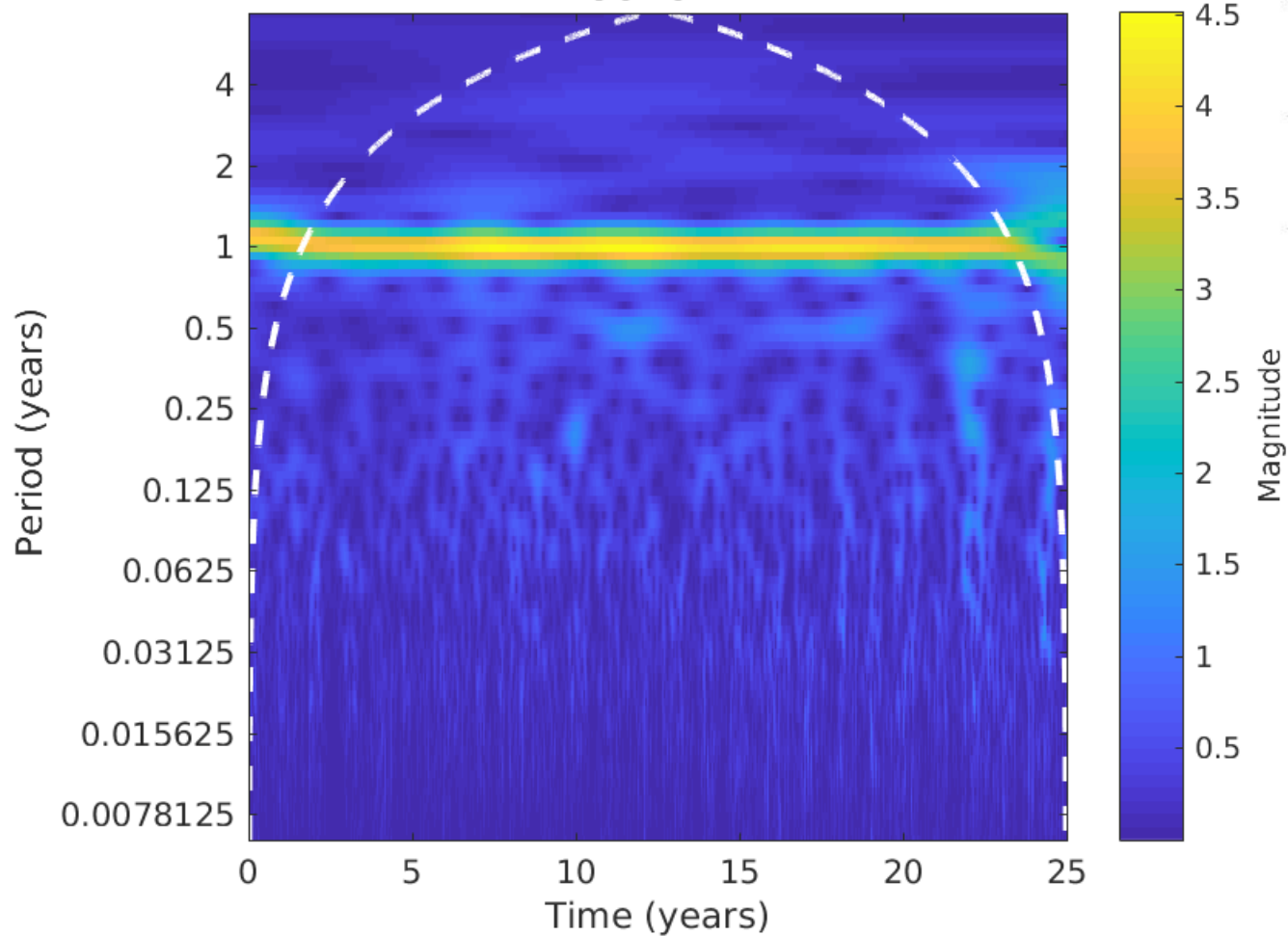


**Wavelet Transform (m): Lat = 39°S ; Lon = 22°E**



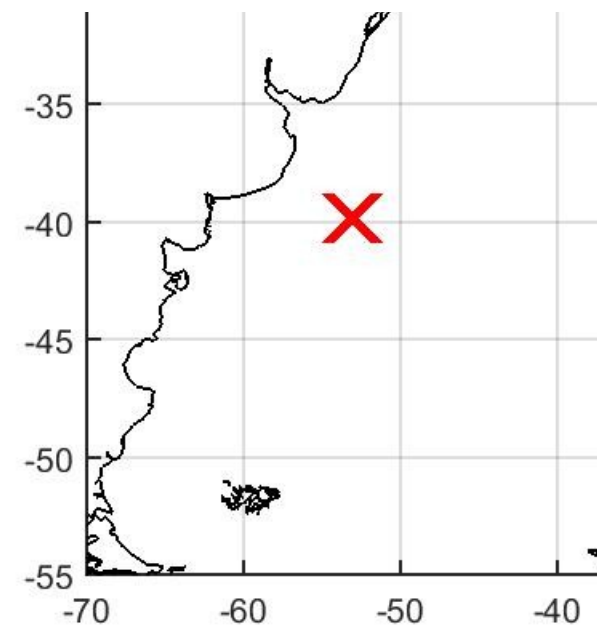
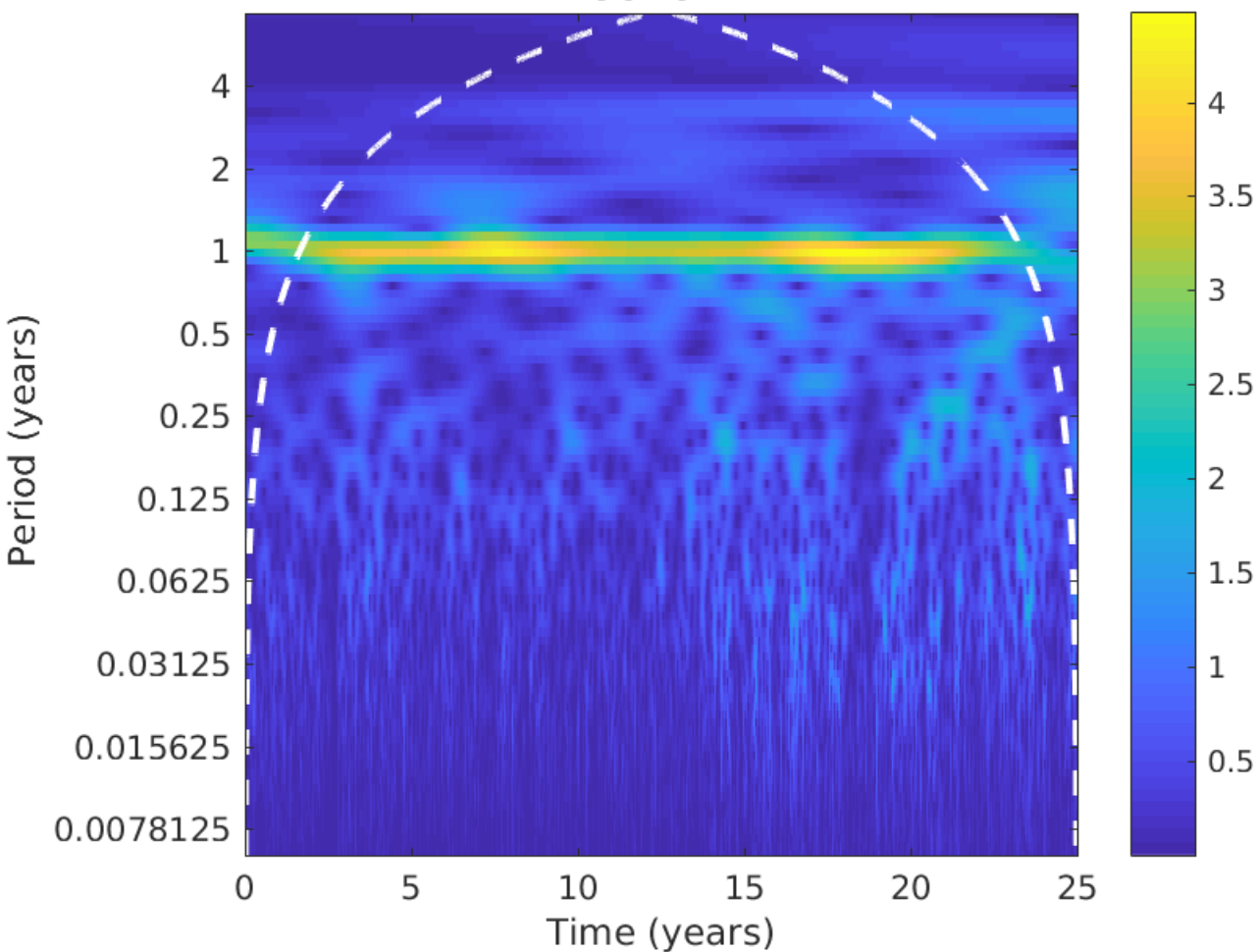
# Wavelet (C)

39.8750 S 55.3750 W



# Wavelet (c)

-39.8750 -53.1250



# **CONCLUSÕES**

**GRANDE VARIABILIDADE DE ADT E SST NAS LATITUDES MÉDIAS,  
ESPECIALMENTE DE ADT**

**GRANDE VARIABILIDADE DE TENDÊNCIAS LINEARES DE ADT E SST  
NAS LATITUDES MÉDIAS**

**NA REGIÃO DA CONFLUÊNCIA BRASIL – MALVINAS,  
PONTOS VIZINHOS COM FORTES TENDÊNCIAS OPOSTAS DE ADT E SST**

**MENOS QUE 0.25% DA ÁREA TEM TENDÊNCIA DE DIMINUIÇÃO DE ADT  
MAIS QUE 22% DA ÁREA POSSUI TENDÊNCIA DE DIMINUIÇÃO DE SST**

**ADT POSSUI COMPONENTES ANUAIS SIGNIFICATIVAS, MAS  
SEMI-ANUAIS SÃO MAIS ENERGÉTICAS EM ALGUMAS REGIÕES**

**SST POSSUI COMPONENTES ANUAIS SIGNIFICATIVAS,  
MAS NÃO SEMI-ANUAIS**

# COMPARAÇÃO MARÉGRAFOS X ALTIMETRIA

**MARÉGRAFOS: ALGUMAS SÉRIES MUITO LONGAS,  
MAS PROBLEMAS COM DESCONTINUIDADES,  
DATUM VERTICAL, DESLOCAMENTOS DA CROSTA  
(MUITAS VEZES DESCONHECIDAS) E  
COBERTURA NÃO HOMOGÊNEA.**

**ALTIMETRIA: NÍVEL DO MAR ABSOLUTO, COBERTURA  
HOMOGÊNEA QUASE GLOBAL (EXCETO REGIÕES POLARES),  
MAS INCERTEZAS NAS CORREÇÕES GEOFÍSICAS, ERROS NAS  
MEDIÇÕES COSTEIRAS E SÉRIES RELATIVAMENTE CURTAS (25 ANOS).**

**EXPECTATIVA:**

**REGISTROS DE ALTIMETRIA MAIS LONGOS (60 ANOS) E  
SWOT (SURFACE WATER AND OCEAN TOPOGRAPHY).**