Recent climatic trends in the tropical Atlantic: Further analyses from the Servain's data base

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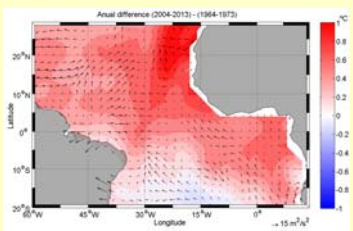
1. INTRODUCTION

In-situ observed sea surface temperature (SST) and pseudo wind stress (PWS) over the tropical Atlantic, previously analysed by Servain et al. (2014), indicated a sea surface warming accompanied by a strengthening of the trades in the whole basin from the 1960's.

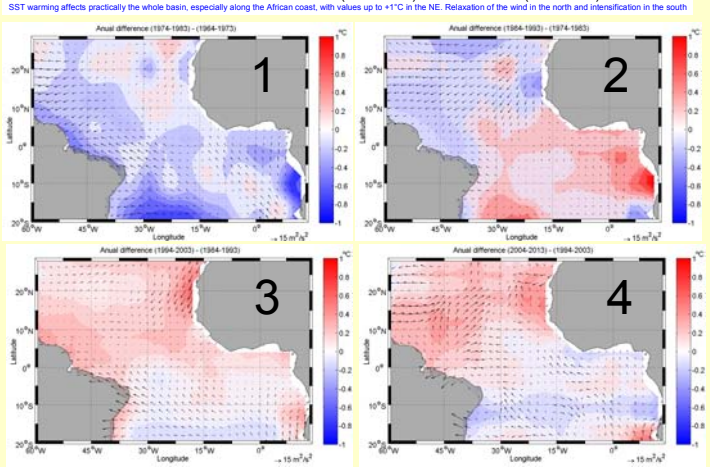
Goal: This study is an update of the previous analysis, focusing on the slow variations of SST and PWS decade per decade between 1964 and 2013. Long-term occurrences of variability are regionalized and seasonally analyzed. During some specific periods, SST anomalies seem to propagate equatorwards while slow variations of subsurface heat content are observed in the Atlantic Ocean.

2. ANNUAL DIFFERENCES BY DECADES



SST and PWS differences between last (2004-2013) and first decade (1964-1973):

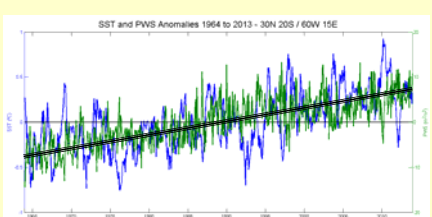
SST warming affects practically the whole basin, especially along the African coast, with values up to +1°C in the NE. Relaxation of the wind in the north and intensification in the south

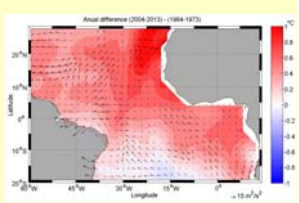


SST and PWS differences between successive decades from 1964-1983 thru 2004-2013

1: Intensification of the wind, especially in the south where a large SST cooling is present (up to -1°C); **2**: Intensification of the wind in the north associated with moderate SST cooling, stability of the wind in the south with noticeable warming; **3**: Modest changes except large intensification of the wind in the NE and SW and moderate SST warming in the NE and NW; **4**: Relaxation of the wind and SST warming in the north, small changes in the south. When looking only at SST: **1** is out of phase with **4**, while **2** is out of phase with 3

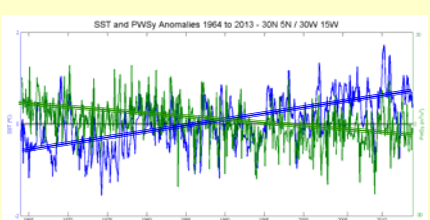
3. MONTHLY ANOMALIES 1964-2013

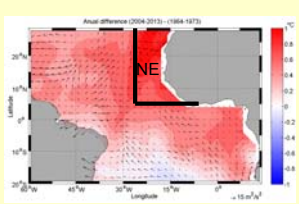




Monthly SST and PWS anomalies 1964-2013 integrated over the whole basin:

Long-term SST warming (+0.8°C) and PWS strengthening (+16 m²/s²) from 1964 to 2013

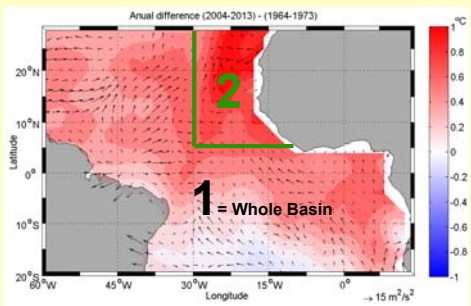


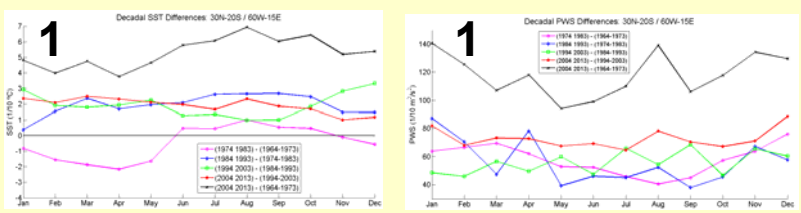


Monthly SST and meridional PWS anomalies 1964-2013 integrated over the NE region:

Long-term SST warming (+1.4 °C) and intensification of the PWS southward component (+14 m²/s²) from 1964 to 2013

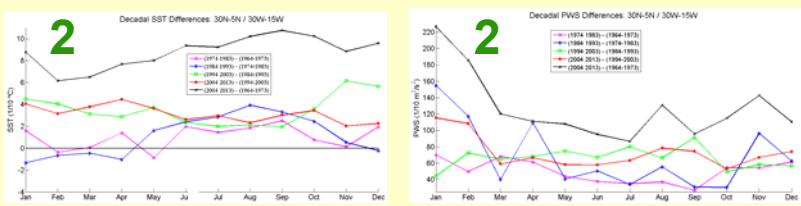
4. MONTHLY DIFFERENCES BY DECADES





[Left] SST: the only SST cooling which occurs between the first and second decades (purple) is very intense (~ -0.2°C) in Feb-May; the non-stop SST warming during the subsequent decades is homogeneous (~ +0.2 °C per decade) all year long. The largest SST difference (black) between the first and last decades is maximum (~ +0.6 °C) during the boreal summer.

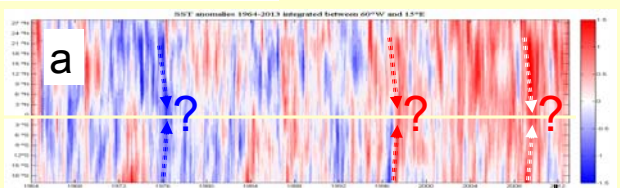
[Right] PWS: The PWS intensification during the 5 decades is rather homogeneous (~ +6 m²/s² per decade) all year long, with a slight stronger intensification (~7-8 m²/s²) between the third and fourth decades (red). The wind strenthening between the first and last decades (black) is not homogeneous: it is maximum (~ +14 m²/s²) in Nov-Dec-Jan and Aug, and minimum (+10 m²/s²) in May.

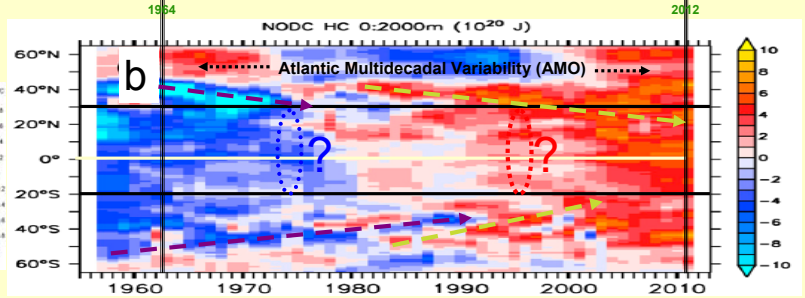


[Left] SST: Strong similarity between the differences of the two first decades (purple and blue), and also between those of the two last ones (green and red). The largest warming (~ +1.0 °C) between the first and last decades occurs in Aug-Sep-Oct.

[Right] PWS: As for SST, except during Jan-Feb, during which a strong similarity is noted between the differences of the two first decades (purple and blue), and also between the two last ones (green and red). The PWS strenthening between the first and last decades (black) was exceptionally high (up to + 18 m²/s²) in Jan-Feb. It was about +12 m²/s² the rest of the year.

5. EQUATORWARD PROPAGATIONS?





(a) SST monthly anomalies (vs. climato 1964-2013, in °C) integrated per 2° of latitude between 60°W and 15°E.

(b) 0-2000m Oceanic Heat Content (OHC) referenced to the year 1955 (in 10^{20} J) per 1° of latitude in the Atlantic *[Adapted from Häkkinen et al., 2015].*

Some episodes of SST anomalies (a) seem to show slow (a few months) cold and warm equatorward propagations. Could they be put in relationship with subsurface (0-2000m) very slow (many years) equatorward propagations of heat content during the same period in the whole Atlantic Ocean (b)?

6. LAST COMMENTS

Annual and monthly analyses by decades allow to refine some major elements of SST warming and wind intensification in the tropical Atlantic during the last 50 years. Further analyses are necessary to study their possible relationship with subsurface slow events.

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REFERENCES: Servain et al., 2014: Clim. Dyn., doi:10.1007/s00382-014-2168-7.
Häkkinen and al., 2015, GRL, doi: 10.1002/2015GL063299.