A study of the oceanic wave contribution to the Bjerknes feedback in the Atlantic

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Objectif

► Diagnosing the Bjerknes feedback mechanism in the equatorial Atlantic through intraseasonal Kelvin waves propagation during boreal summer.

► Quantify the respective role of different processes associated with intraseasonal SST signature (0-90 day band) using Ocean General Circulation Model(OGCM) sensitivity experiments.

Introduction

The predictability of the Atlantic summer monsoon would depend on relative contribution of Intraseasonal Oscillations(ISOs) to the seasonal mean in compared to the externally forced component. These atmospheric ISOs classified into a broadband spectrum of scale between 10 and 90 days with two preferred bands of periods of 30-90 day and 10-30 day time scales. Former bandwidth generally named as Madden-Julian Oscillation (MJO) e.g., Madden and Julian, 1971] having distinct character in summer from the boreal winter and later as submonthly where westward moving convectively coupled waves dominates (Wheeler and Kiladis, 1999). The local coupled Atlantic Ocean air-sea interaction basically governs the structure and the phase propagation of aforementioned ISOs. Tropical ocean affects the atmosphere via sea surface temperature (SST) through which mainly control the local coupled processes, hence investigating processes associated with the intraseasonal SST is key to understand the African Monsoon Variability.

Data and Methodology

Observation : Regression analysis

We have used 0.25° x 0.25° fields of 1-day mean SST of Reynolds et al. 2007 and daily
Daily Quikscat surface wind stress
Considered period : 2000-2008.
To isolate the signal associated with the summer ISOs, we use band-pass Lanczos filter of daily anomalies with respect to the mean seasonal cycle.

Model : Sensitivity Experiments

NEMO is used and set up for the region between 30°S-30°N and 50°E-15°E and has 41 vertical levels. To highlight the role of winds ISO, two experiments have been set up :

The first one using only climatological data (Reference Run).
Second run : A westerly wind burst is a added in the climatology.
The deference between the two runs help understanding the role of ISO in the thermal structure of the central and eastern part of the basin.

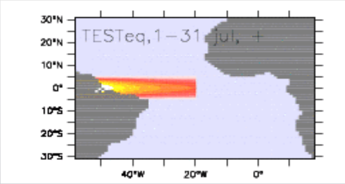
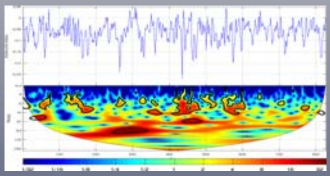
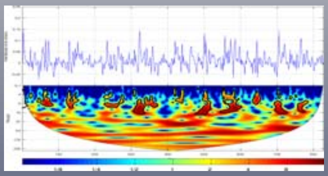


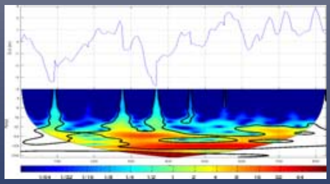
Figure 1 : Characteristics of the zonal wind anomaly used to force the model

Results: Observations

In order to highlight the energy of the different parameters, the summer (JJA) power Spectrum of SLA, Zonal wind stress,and Meridional wind stress average in the box 3°S-3°N, 35°W-25°W are represented in figures below



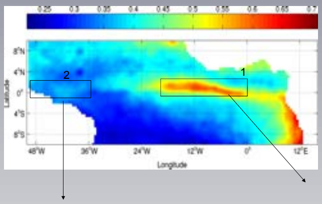




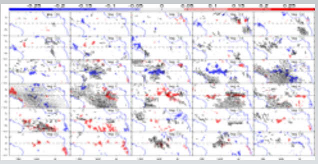
The Torrence and Compo, 1998 algorithm is used to compute the power spectrum. It is found a strong and significant variability in the period 7-15 day for both Zonal and Meridional wind stress. This strong intraseasonal variability may have an important role on the thermal structure of the Equatorial Atlantic (De Coëtlogon et al. 2010). For SLA, the variability is weak compare to wind stress at intraseasonal timescale

Figure 2:   Power Spectrum of a) Zonal (U),
b) Meridional wind stress anomaly
and c) SLA

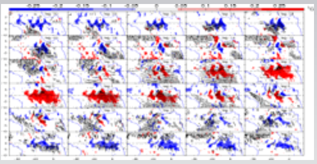
Results : Observations



The variance map of SST at intraseasonal timescale (10-90 days) shows a shift of the maximum variability located north of the equator and mainly in the central part of the basin. This pattern does not coincide with the Seasonal cooling (cold tongue) in this region. Thus, to depict the link between SST and wind stress, regression analysis are performed in the region of maximum variability for SST (box 1) and zonal wind stress (box 2).



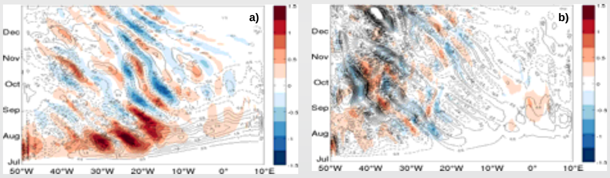
Regression analysis of SST onto Wind stress



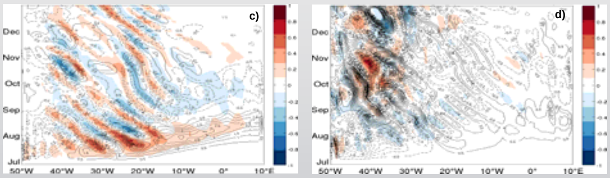
Regression analysis Wind stress onto SST

Results : Model

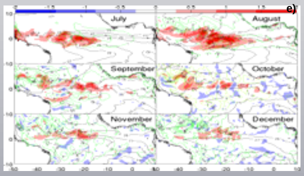
In this section the impact of an idealized intraseasonal zonal wind stress anomaly is studied. This intraseasonal wind stress anomaly has a period of 2 month but only the positive part of the signal is used to force the six month run of the model starting from July 2000.



Hovmüller diagram of SSTA (shaded) and SLA (contour) averaged in a) 0.5°S-0.5°N and b) 3°N-5°N.



Hovmüller diagram of ZCA (shaded) and SLA (contour) averaged in a) 0.5°S-0.5°N and b) 3°N-5°N.



Maximum anomaly of SST for each month

It is found that this westerly wind burst (WWB) triggers an equatorial downwelling Kelvin wave with a phase speed of approximately 1.2 m/s. However this Kelvin has little impact on SSTA east of the basin (figure: a)). The maximum is located west of 10°W and 4 to 5 months later after the WWB. This maximum seems to be associated to a second equatorial upwelling kelvin wave following the downwelling wave

Conclusion and perspectives

1) Close examination of the budget shows that: Subsurface processes and heat fluxes have a little contribution in the signal.

2) Horizontal advection acts to play the most important role in the processes involved.

3) Identifying the characteristics of intraseasonal winds during Atlantic-Niño and Atlantic-Niña.

4) Performs sensitivity experiments with respect to the observed intraseasonal winds for understanding their role in the SST variability in the central and eastern part of the equatorial Atlantic.

5) Part of local vs remote in the signal.

6) The role of preconditioning ?

Bibliography

Madden and Julian, 1971

Wheeler and Kiladis, 1999

De Coëtlogon et al. 2010