14B.6 QUASI-BIENNIAL VARIABILITY IN THE TROPICAL SOUTH ATLANTIC SIMULATED BY AN ATMOSPHERIC GCM COUPLED TO AN OCEAN MIXED LAYER.

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1. INTRODUCTION

Seasonal climate forecasts over tropical Africa and South America are hampered by the lack of skillful predictions of sea surface temperatures (SST) in the Tropical Atlantic. The mechanisms sustaining the internal modes of variability in the tropical Atlantic, such as the meridional mode, and the atmospheric bridge carrying the teleconnections from the eastern Pacific involve thermodynamic coupling between the atmosphere and the oceanic mixed layer (e.g. Chang et al. 1997, 2000, Saravanan and Chang 2000). This suggests potential benefits in the seasonal prediction from including simple air-sea interactions in this region in the prediction systems.

2. METHODS

Variability due to the air-sea interactions in the Atlantic is investigated using the UCLA atmospheric General Circulation Mode (Mechoso et al. 2000), which includes a state of the art stratus parametrization, coupled to a simple, uniformly 50m deep mixed layer ocean in the Atlantic basin. A monthly climatology of SST is prescribed outside of the basin and poleward of 50N or 50S in the Atlantic. A control run is made using the uncoupled AGCM forced by prescribed monthly climatological SST. Land-surface parameters are held at their climatological values in both runs. After discarding the first 5 years for spin-up, 29 years of the coupled simulation are analyzed and used to identify the modes of variability arising from the atmosphere-ocean mixed layer interactions over the Atlantic.

3. RESULTS

The coupling is found to give rise to a 'dipolar' leading mode of rainfall variability straddling the equator (not shown), not present in the control run. This structure exhibits a red spectrum and is associated with SST anomalies on either side of the equator. Singular Value Decomposition (SVD) of standardized surface temperature and SLP allows further insight in the variability arising from the coupling. While the first mode over the whole Atlantic domain resembles the NAO pattern, the second mode concerns mainly the equatorial and south Atlantic. This is also the first mode of coupled variability when northern mid and high latitudes are excluded from the analysis. It accounts for about 74% of the squared covariance of the two fields in the equatorial and South Atlantic.

Figure 1a shows this first SVD mode in the tropical and southern Atlantic. It shows the well-known opposition between surface temperature (contours) in the south-western and north-eastern regions of the tropical and southern Atlantic (e.g. Venegas et al. 1997, Robertson et al. 2003, Sterl and Hazeleger 2003), although the spatial pattern slightly differs from the previous studies with stronger weights in the tropical and equatorial regions. In contrast, the SLP pattern (shading), with mainly negative anomalies throughought the equatorial and southern basin, differs markedly from the previous studies in which emphasized the SLP variability in the core region of the subtropicalhigh. The SLP structure showed in fig.1 is also found as the first EOF mode in the coupled and the control run.

The spectral characteristics of the SVD time series (not shown) show peaks at quasi-biennial, quasi-triennial and pentennial time scales. There is a significant enhancement of the variance in the quasi-biennial range of SLP variability in the coupled run as compared to the control, suggesting that the coupling between the atmosphere and the ocean mixed layer favors this time-scale. The corresponding surface temperature SVD time series (cf. fig. 1b, bars) is dominated by longer time-scales. Still, quasi-biennial variability is identified as the third pair in the Singular Spectrum Analysis decomposition (SSA) of the surface temperature SVD time series, along with the low frequency modes (not present in the atmospheric counterpart) and pentennial components (cf. fig. 1b).

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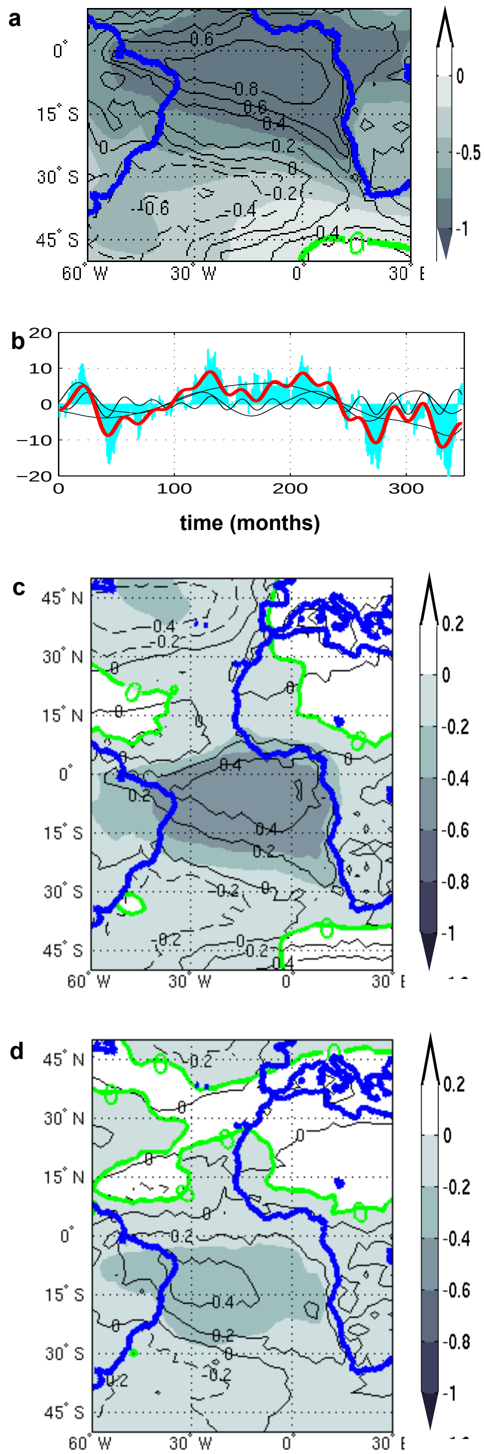

***Figure 1**. a) correlations between the monthly deseasonnalised surface temperature(contours) and SLP (shading) fields and the respective SVD-PC1; contour and shading spacing 0.2. b) SVD-PC1 for SST (grey bars); SSA decomposition pairs 1-2, 3-4 and 5-6 (solid thin lines); reconstructed signal (solid bold line); c and d) as panel a but correlation with the SSA pairs 3-4 and 5-6 respectively.*

The signal reconstructed from these three components correlates at r=0.89 with the SVD time series for surface temperature.

Both the low-frequency and the pentennial components project strongly onto the equatorial regions, resembling the equatorial Atlantic "zonal mode" despite the lack of ocean dynamics (fig.1c), and suggest some interactions with the northern Atlantic. By contrast the quasi-biennial mode concerns mainly the South Atlantic and has strongest weights located towards the west of the basin (fig.1d).

The lead-lag relationships with other atmospheric variables (not shown) indicate that the main mechanism for generating the sea surface temperature anomalies in the core region of the biennial mode (box 8S-15S, 40W-15W) involves reduced south-easterlies and latent heat flux leading to SST warming; the warming is damped a few months later by a reduction in net shortwave radiation and enhanced latent heat flux. On the other hand, the generic mechanism in the eastern tropical South Atlantic (box 8S-15S, 0-10E) appears to be predominantly radiative associated with changes in the stratus cloud cover while the anomalies are damped by changes in latent heat flux.

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