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Report A: Preliminary Report on Benguela Niños
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Benguela Niños are intermittent, acute, extreme warm events at the border between the southward flowing Angola Current and the Benguela upwelling system off south-western Africa (Shannon et al. 1986). These anomalously warm events have dramatic effects on the fisheries and the climate of the region. They induce strong rainfall anomalies (Rouault et al. 2002) and drastically modify fish distribution and abundance (Boyer et al. 2001). The collapse of the Namibian sardine stock after 1974 followed a protracted Benguela Niño in the early 1970s, the effect of which was aggravated by overfishing (Boyer and Hampton 2001). More recently, the 1995 event had a drastic impact on the whole ecosystem with a 4-5° southward shift of the sardine population, associated with high mortality and poor recruitment of the major pelagic fish species (Boyer and Hampton 2001). Benguela Niños express themselves as abnormally and persistent high sea surface temperatures (SST) along the coast of Angola and Namibia.

According to many authors the equatorial interannual variability pattern in the Atlantic is similar to the ENSO phenomenon in the Pacific, but is weaker and not self-sustained (Sutton et al. 2000; Chang et al. 2000; Servain et al. 1999; Zebiak, 1993). Benguela Niños occurred in 1934, 1949, 1963, 1984 (Shannon et al. 1986) and more recently in 1995 (Gammelsrød et al. 1998). Such episodes are less frequent and less intense than their Pacific counterparts, and they tend to develop south of equator. To explain the origin of climate anomalies in the eastern tropical Atlantic Hirst et al. (1983) have suggested a causality chain of atmospheric-oceanic anomalies across the basin. Rather than being locally forced by wind anomalies, equatorial warm anomalies could be linked to a relaxation of zonal wind stress in the western equatorial Atlantic, as shown by Delecluse et al. (1995) in a study of the 1984 event based on a simulation

of the tropical Atlantic ocean. A recent investigation (Florenchie et al. 2002) has demonstrated unequivocally that the 1984 and 1995 Benguela Niños originate as temperature anomalies on the tropical thermocline, propagate zonally from there, turn south on reaching the west African coastline and outcrop only on reaching a specific area, called the Angola-Bengueal frontal zone (Meeuwis and Lutjeharms 1990).

Picaut (1985) had suggested that eastern tropical oceans were primarily governed by remote wind stress effects through equatorial wave dynamics. Abnormal changes of trade wind regimes may trigger Kelvin waves that subsequently propagate eastward along the equator, inducing a deepening or a lifting of the thermocline. Variations of the thermocline depth initiate strong subsurface temperature anomalies all the way long (Delecluse et al. 1994). However, Kelvin waves can be detected at the surface by their sea-level signature and their fast phase speed, of the order of 1 m/s (Picaut and Busalachi 2001). In this study we comprehensively explore this mechanism in the equatorial Atlantic Ocean and assess its ability to create a variety of sea surface temperature anomalies on the south-eastern side of the basin, e.g. the coastal shelf off Angola and Namibia.

Some authors have suggested a possible link between ENSO and the Atlantic equatorial variability through atmospheric teleconnections between the two oceans (Delecluse et al., 1994). In a modelling study Saravanan and Chang (2000) have described a surface wind stress signal over the western equatorial Atlantic associated with ENSO. But Latif and Barnett (1995) have found that the dominant response in the Atlantic to ENSO is a lowering of SST in the equatorial area. In a study based on observations Enfield and Mayer (1997) have shown that easterly winds are intensified in the western equatorial Atlantic in response to Pacific warm events but that they do not produce strong local changes of SST. These teleconnected wind anomalies do not give rise to significant correlations of SST in the eastern equatorial Atlantic with the Pacific ENSO. Curtis and Hastenrath (1995) concluded in their study that warm events in the Pacific induce only a modest warming in the western tropical Atlantic whereas Ruiz-Barradas et al. (2000) and Zebiak (1993) found no significant impact of ENSO on the Atlantic Niños (equatorial Atlantic ocean variability). In this study we show that the seasonal or locally forced fluctuations of the thermocline can modulate

considerably the response of the eastern tropical ocean in terms of SST to zonal wind variations above the western side.

Other minor warm (1986, 1988) and cold events (1969, 1982/83) in the southeast Atlantic have been also partly documented (Carton and Huang 1994; Walker 1987; Boyd et al. 1987). It appears from these studies that the distinction between Benguela Niños and other warm events is not always clear. A quantitative definition of warm or cold events is still missing. This study intends to clarify the differences between Benguela Niños and other warm events and to provide a description of cold events as well.

To investigate the origin and the vertical structure of each episode, various sets of observations (sea surface temperature, sea level and wind anomalies) will be used and complemented by model simulations of the tropical Atlantic Ocean. All warm and cold events that occurred in the southeast Atlantic from 1982 to 1999 will be described and analysed with a special attention given to the major ones. An additional motivation is to assess the possibility of forecasting such events, particularly the extreme cases, on an operational basis. **Hence this first investigation should address the following questions**:

- what are the actual spatial and temporal scales of warm and cold events in the South-east Atlantic?

- what are the underlying mechanisms driving the various events?

- how Benguela Niños differ from other warm events?

- are these events predictable?

Optimal interpolation sea surface temperature data (Reynolds, 1994) will be analysed to assess the location, frequency, duration and spatial coverage of the surface manifestation of various warm and cold events occurring in the eastern Atlantic. Topex/Poseidon sea level and ERS wind anomalies recorded during various events

will be described. Then, OPA model outputs have to be compared to observations and studied at different depths to understand the origin of the different anomalies and their vertical structures.

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