OS33C CC: 524 C Wednesday 1330h

Scientific Results From the PIRATA Program (1997-2004) I

Presiding: **J Servain,** Fundacao Cearense de Meteorologia e Recursos Hidricos (FUNCEME)**; S Xie,** IPRC/SOEST, University of Hawaii

OS33C-01 1330h

PIRATA and our Understanding of the Tropical Atlantic

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In this talk we concentrate on the mean seasonal cycle of the mixed layer heat and salt balances as well as air sea surface fluxes produced by the pirata moorings in comparison to other products. The tropical Atlantic has a number of interesting features. The main band of tropical rainfall is displaced north of equator throughout most of the year, approaching the equator only in boreal spring. As it migrates it modulates surface thermodynamic, radiative, and momentum fluxes, as well as net freshwater input. The tropical Atlantic is influenced by continental effects such as massive river discharge. On longer year-to-year timescales the tropical Atlantic atmosphere and ocean exhibit variability with features resembling El Nino, as well as interactions that involve primarily thermodynamic exchanges. The records from the PIRATA moorings provide our first opportunity to examine observationally the key exchanges in this scientifically intriguing region.

OS33C-02 1350h

An Overlooked November-December Cooling in the Equatorial Atlantic: PIRATA Observations

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Seasonal cycle of sea surface temperature (SST) in the equatorial Atlantic is characterized by a rapid cooling from April to July. With the onset of summer monsoon over West Africa, enhanced cross-equatorial southeasterly winds cool the equatorial ocean through Ekman upwelling and thermocline shoaling in the east. Previous studies suggest that the ocean dynamics plays more important role in this Atlantic seasonal cooling than in its Pacific counterpart. Surface winds over the ocean, on the other hand, are strongly influenced by the surrounding continents. Our GCM experiments show that the summer easterly acceleration is largely forced by the continental rainfall distribution in the Gulf of Guinea while the air-sea interaction is essential in the central/western basin, much like in the Pacific (Okumura and Xie, 2004). Whereas the annual harmonic is dominant in equatorial Atlantic SST, the easterly wind and thermocline depth show significant semiannual signals in the east. The easterlies accelerate in October-November, resulting in a shoaling of the thermocline. Using high-resolution satellite data, we show that the central Atlantic SST decreases from late November to early December in response to the accelerated easterlies and the shoaling thermocline. This secondary cooling has not been captured well in some widely used climatologies because of their low monthly resolution. The six-year PIRATA observations support the existence of a secondary seasonal cooling in November-December, suggesting a stronger thermocline feedback on SST than previously thought. Further studies will be needed to elucidate the mechanism for the easterly reacceleration and its influence on the ocean. **Reference**

Okumura, Y. and S.-P. Xie, 2004: Interaction of the Atlantic equatorial cold tongue and African monsoon. *J. Climate*, revised.

OS33C-03 1405h

Mechanisms of northeastern Brazil rainfall anomalies due to Southern Tropical Atlantic variability

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Observational studies have shown that the rainfall anomalies in eastern equatorial South America, including Nordeste Brazil, have a positive correlation with tropical southern Atlantic sea surface temperature (SST) anomalies. Such relationships are reproduced in model simulations with the quasi-equilibrium tropical circulation model (QTCM), which includes a simple land model. A suite of model ensemble experiments is analysed using observed SST over the tropical oceans, the tropical Atlantic and the tropical southern Atlantic (30S-0), respectively (with climatological SST in the remainder of the oceans). Warm tropical south Atlantic SST anomalies yield positive precipitation anomalies over the Nordeste and the southern edge of the Atlantic marine intertropical convergence zone (ITCZ). Mechanisms associated with moisture variations are responsible for the land precipitation changes. Increases in moisture over the Atlantic cause positive anomalies in moisture advection, spreading increased moisture downwind. Where the basic state is far from the convective stability threshold, moisture changes have little effect, but the margins of the climatological convection zone are affected. The increased moisture supply due to advection is enhanced by increases in low-level convergence required by moist static energy balances. The moisture convergence term is several times larger, but experiments altering the moisture advection confirm that the feedback is initiated by wind acting on moisture gradient. This mechanism has several features in common with the recently published "uppedante" mechanism for El Nino impacts on this region. In that case, the moisture gradient is initiated by warm free tropospheric temperature anomalies increasing the typical value of low-level moisture required to sustain convection in the convection zones. Both mechanisms suggest the usefulness of coordinating ocean and land in situ observations of boundary layer moisture.

OS33C-04 1420h

Comparison of the 2003 Atlantic Ocean Warm Event With Previous Warm Events

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The tropical Atlantic Ocean exhibits warm events in the eastern region of the basin bounded by the Gulf of Guinea to the north and extending to the Benguela region. Since 1982 about eight warm events have shown sea surface temperature anomalies (SSTA) greater than 1 degree Celsius with meridional asymmetry and variable time evolution among them. These events occurred in 1984, 1988, 1991, 1995, 1997, 1998, 2001 and 2003 and varied in strength between the eastern equatorial region and the Benguela region. In this presentation we discuss the recent Atlantic Ocean warm event of 2003 within the context of previous warm events in the basin. PIRATA observations of this event, and even more so in the past, are limited by the point wise distribution in time and space of the data record. PIRATA data are complemented with other data sets of sea surface temperature (SST), sea level, surface currents and surface wind stress to provide a larger spatial and longer historical context. In particular, PIRATA, AVHRR and TMI SST observations, Topex/Poseidon-Jason-1 sea surface height anomalies, altimetry-derived surface currents, and remotely-sensed wind stress observations are used to characterize the 2003 SSTA magnitude, evolution, possible links to the relaxation of the equatorial wind stress in the western portion of the basin, and related response of the equatorial subsurface thermal structure. The attributes of this event are then compared with previous warm events captured by these same data sets.

OS33C-05 1435h

Impacts of PIRATA Mooring Observations in the MERCATOR Operational Ocean System

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Since January 2003, PIRATA mooring data in the tropical Atlantic are assimilated routinely in the Mercator operational ocean model. A series of 4 experiments have been carried out to test the impact on PIRATA data on the MERCATOR system (http://www.mercator-ocean.fr/). The control run is basically the operational system, assimilating in a multivariate scheme the temperature and salinity profiles (XBT, ARGO floats and at PIRATA moorings), and altimeter data. A second experiment is run assimilating in-situ data only outside the tropics (20°N-20°S). In a third experiment, we assimilated only PIRATA data, while in a fourth assimilation system excludes PIRATA data. We want to address on which processes and at what scales the assimilation of profiles of temperature and salinity of PIRATA mooring have an impact. Do they also improve the ocean interior below the depth of PIRATA profiles? Assimilation of PIRATA data leads to better equatorial dynamic constraints. The multivariate assimilation in the tropics of temperature and salinity profiles and sea level anomalies allows to constrain the equatorial dynamics and the mesoscale features, and to rectify the mass fields. Compared to altimeter-only assimilation run, it leads to a more realistic thermocline with a warming of the surface layer and a cooling below the thermocline. The improvements are visible in the mixed layer and below down to 300meters. When a lack of PIRATA occurred (if a sensor at a depth does not transmit), the impact is immediate but is more sensitive mainly between 200 and 400 meters. We also discuss the changes in the current system, mainly on the strength of the equatorial undercurrent and on the current system of the western boundary, the North Brasilan Current, regions where we usually found strong error growths.

URL: http://www.mercator-ocean.fr

OS33C-06 1450h

The Variability of Sea Level in the North Atlantic and North Pacific in 1993-2002 Observed With Satellite Altimetry.

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To compare the variability of sea level in the North Atlantic and North Pacific over nine years of the combined Topex/Poseidon and ERS-1/2 altimetry data (from October 1992 to February 2002) are studied. The study is focused on the northern areas with low kinetic energy. The sea level anomaly signal is represented as a composition of inter-annual, annual and mesoscale (mainly eddies) components. In spite of different spatial scales of the oceans, the pattern of sea level change appeared to be similar. In both oceans the inter-annual change in the subpolar gyre was found to be in anti-phase to the subtropical gyre. The impact of the North Atlantic Oscillation and El Nino Southern Oscillation events on the inter-annual variations are also considered. The magnitude and relative contribution of the inter-annual, annual and mesoscale signals are estimated.

OS34A CC: 524 C Wednesday 1530h

Scientific Results From the PIRATA Program (1997-2004) II

Presiding: **E Campos,** University of Sao Paulo**; J A Carton,** University of Maryland

OS34A-01 1530h

A Real-Time Diagnostic Analysis of the PIRATA Observations

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