Report on Tropical Atlantic workshop, 7-9th of June 2004, De Bilt The Netherlands.

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Introduction

ECMWF's seasonal forecast system predicted a large chance of a shift in the position of the Atlantic Ocean's Intertropical Convergence Zone (ITCZ) for the boreal summer of 2004. However, the accuracy of this prediction is questionable because of the lack of skill of seasonal predictions with dynamical models in the tropical Atlantic. Major errors in the coupled ocean/atmosphere models are the main reasons for the lack of skill and provide compelling arguments for additional research on tropical Atlantic circulation. In June 2004, about 25 specialists on tropical Atlantic circulation met at KNMI in de Bilt (The Netherlands) to discuss recent advances in observing and modelling the tropical Atlantic and to coordinate future plans. These plans include the Tropical Atlantic Climate Experiment (TACE) that focuses on improving the understanding of SST-ITCZ interactions in the eastern Tropical Atlantic region, the African Multidisciplinary Monsoon Analysis (AMMA) that focuses on the African Monsoon and it's offshore components, and the Atlantic Marine ITCZ (AMI) project.

Summary of the presentations

In the first part of the meeting much attention was directed at the western tropical Atlantic. New hydrographic data shows mounting evidence for large cross-equatorial and cross-gyre transport of Southern Hemisphere surface and thermocline waters in North Brazil current eddies and subsurface eddies. Saline water masses from the South Atlantic are observed at the passages of the Caribbean. After crossing the equator, much of the North Brazil Current transport also feeds the Equatorial Undercurrent, which carries primarily water originating from the Southern Hemisphere. Transport from the North Equatorial Current has been shown to feed both the North Equatorial Countercurrent and the North Equatorial Undercurrent. It was shown that altimeter data and new high-resolution ocean model data confirm this picture of western tropical Atlantic circulation.

The Deep Western Boundary Current and deep equatorial jets dominate deep circulation in the tropical Atlantic. The jets are probably generated by inertial instability. Surprisingly, both in the deep jets and in the Deep Western Boundary Current strong variability is found. In the Deep Western Boundary Current large anticyclonic eddies have been observed along the Brazilian coast.

Satellite data show that the Bjerknes feed back mechanism that relates wind stress to thermocline depth is operating on the equator. Also, these data show intraseasonal variability signals that are not well understood yet. Slow variations in salinity in the ventilated layers are observed in hydrographic data and are probably caused by changes in ventilation rates. However, from ocean models of the Atlantic it is still unclear whether variability in atmospheric forcing and associated variations in subtropical cells can generate sizeable variability on the equator. Atmospheric connections between remote regions and the tropical Atlantic are indicated by data and need to be studied further. Coupled models show large biases, but careful tuning of mixed layer parameterizations improves the simulation of tropical Atlantic climate. Also, discrepancies in shallow atmospheric convection are found among models and reanalysis sets. Discrepancies in mixed layer climatologies are found as well. Due to the large biases, the skill of the predictions in the tropical Atlantic region is low, while there is large potential predictability of rainfall on the African and South American continent (i.e. if SST is prescribed in the models). Multi-model ensembles overcome some, but certainly not all, problems with the lack of forecast skill. Finally, climate change affects the tropical Atlantic region as well and changes in Sahel rainfall were shown in a coupled model study.

The last day of the workshop was reserved for planning and discussion on future observations and modelling. Current programs and plans for the coming years were presented: the CLIVAR – TACE initiative, the European Union funded AMMA program, the EGEE and PIRATA programs, the US CLIVAR – AMI initiative and the plans of the hydrographic work by University of Bremen, NOAA/AOML and IFM/Geomar.

Discussion sessions and recommendations

The discussion sessions were directed at formulating objectives for the CLIVAR – TACE initiative and coordinating these objectives with the other programs such as AMMA and AMI. There was consensus that the eastern tropical Atlantic is important for climate variability in the tropical Atlantic region. There is a clear connection between eastern tropical Atlantic SST and ITCZ position and strength, while the processes that regulate SST are not well understood. This absence of understanding argues for additional research effort in this region. The central goal of this research would be:

Improve understanding of the interaction between the ITCZ and upwelling zones (Benguella region, Guinea dome, eastern cold tongue) and the implications for predictability.

The discussions set out with this central goal and recommendations for observations and modelling were made. Figure 1 shows the observations needed for TACE (constructed by W. Johns, RSMAS). Several of these observations have already been proposed for AMMA for deployment in 2006 (e.g., additional PIRATA moorings and surface drifting buoys). Figure 1 summarizes the recommendations based on discussions of observational needs. This encompasses an enhanced observation period of 1 – 5 years in the eastern tropical Atlantic that aims to:

- Determine mixed layer heat budget and subsurface heat content
- Determine surface and subsurface current structure and their role in modulating the heat budget and thermocline properties
- Determine shallow and deep atmospheric circulation in the marine ITCZ complex

The recommended oceanic observations focus on a line along 23W, which is the same line where atmospheric observations are proposed for the AMMA and AMI projects. Moorings along this line and in the upwelling regions in the Southern Hemisphere are proposed as well as glider sections with oxygen sensors to determine upwelling. Also, enhanced deployment of ARGO floats and surface drifters in the region is recommended. The plans will be coordinated with the cruises in the same region planned in the French EGEE project.

The focus on mixed layer heat budget and subsurface heat content in the upwelling zones was welcomed by the modellers at the meeting. In the upwelling regions the models fail to simulate accurately upper layer conditions and validation of the simulated mixed layer and subsurface heat budget by observations is thought to be essential for progress. The modelling studies that are needed aim to:

- Improve SST forecast in the tropical Atlantic region (seasonal to interannual)
- Determine response of tropical Atlantic region to global warming

It was recommended that the main focus of ocean model improvement needs to be on diapycnal oceanic mixing and mixed layer physics. Atmospheric modelers need to focus on stratus clouds/radiation feed backs and shallow and deep convection. Specific projects that were proposed include a systematic investigation of the impact of ocean model resolution and of the impact of ocean/atmosphere coupling on the simulation of sea surface temperature in the tropical Atlantic region. Also, studies on potential predictability with atmospheric models and studies on the effect of dust were recommended.

The workshop made clear that the emphasis of future work will be on the eastern tropical Atlantic. With a wealth of data available from the western tropical Atlantic it now is the appropriate time for synthesis activities on the western tropical Atlantic. R. Molinari (NOAA/AOML) will coordinate these activities.

The stimulating annual tropical Atlantic meetings will be continued. P. Rizzoli (MIT) will organize a follow up, tentatively scheduled for October 2005 in Venice. The program, a list of participants, and most presentations of the meeting at KNMI can be found online at: http://www.knmi.nl/samenw/tameet/tameet.html

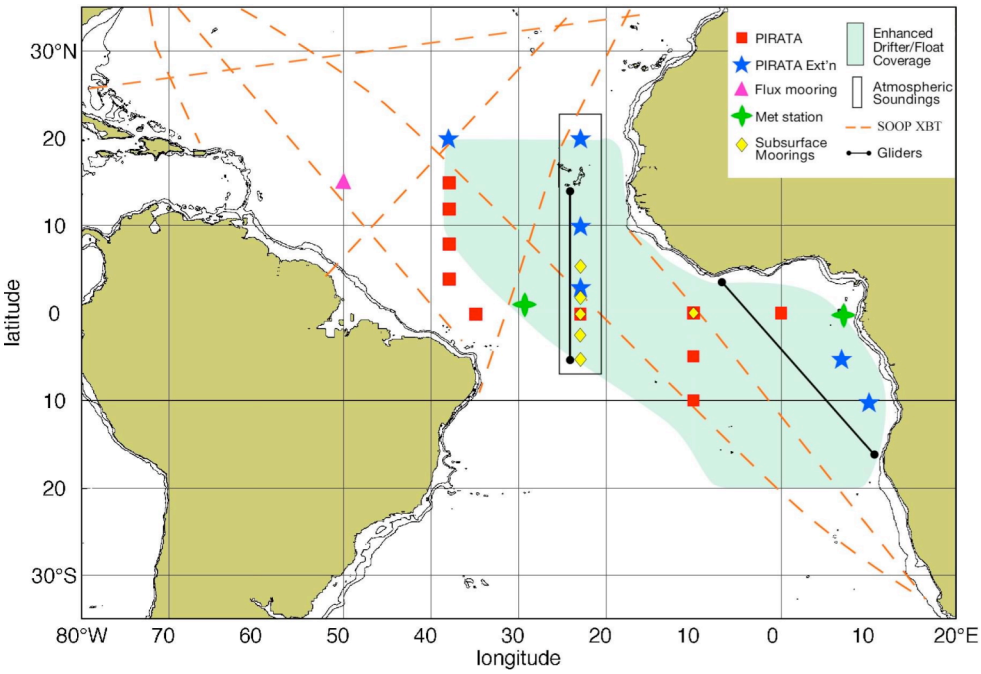

Figure 1: Scheme showing proposed observations during the 1-5 year enhanced observation period of CLIVAR-TACE (courtesy of W. Johns, RSMAS)