

**Recommandations from TACE, PIRATA & AMMA
For the tropical and eastern tropical Atlantic
(observations only)**

- Date des campagnes (printemps)
 - mesures de salinité
- Mesures de courants (peut on acheter des sondeck et les ajouter en //?)
 - Fish repellent system (CIO-E Pirata evaluation)
 - manip mouillages et gliders?
 - projet TOTAL PIRATA SEE?
- Liens avec AMMA, OOPC etc etc!!!

Recalls from the last Tropical Atlantic meeting (Toulouse)

1. EUC Structure and Termination in the Gulf of Guinea

The German/US/PIRATA mooring program in the eastern equatorial Atlantic along with the French EGEE/PIRATA cruises in the Gulf of Guinea should provide an opportunity to study the EUC termination in a more comprehensive way than previously possible. Results presented at the meeting showed evidence for high-salinity tongues embedded in westward flows north (and sometimes south) off the equator during summer/fall, that indicate zonal recirculation of EUC core waters. Some of the cruises also permit investigation of poleward transport along the eastern boundary. The fate of the EUC waters, including the fraction upwelled at the equator, the part feeding into eastern coastal currents and coastal upwelling regimes, and remnants recirculating within the equatorial region, is a key question posed in TACE. Further, its seasonal dependence and interannual variation (e.g. during Atlantic Nino's) need to be determined to the extent possible. It was recommended and agreed by the meeting participants that cooperation to achieve these objectives, including comparisons with available models, would be undertaken by the scientists involved in these projects.

⇒ Continue the effort of measurements in the eastern tropical Atlantic (partly done with the French Pirata cruises) + use of Argo profilers? + models...

2. Formation and Fate of the Equatorial Thermostat

Vertical mixing at the base of the mixed layer as well as in the thermocline at the equator has been identified as one of the key processes that has to be improved in high-resolution ocean models. These models have to produce a **correct thermostat including circulation at and below the depth level of the EUC**. Failure to do so means that important currents like the SEUC will not be properly represented, since this current **occurs at the southern boundary of the thermostat and appears to be intimately related to its formation**.

In particular, low vertical mixing at depth seems to be important to obtain realistic transports of the different current branches, but might affect also SST.

Also, assimilation models (e.g. the Mercator model) shows particularly large temperature trends between 200 and 500m after initialization and the comparison between model and observations reveals substantial differences in velocity and hydrographic fields. Model validation with regard to the thermostat can be done using data from previous cruises. However there are relatively sparse measurements available in the far eastern equatorial Atlantic. This could also be a problem for studying the seasonal termination of the EUC, as there are almost no measurements during the boreal winter season.

⇒ ***Attempt to organize cruises in winter-spring***

(Could be partly done by shifting earlier the french Pirata cruises).

⇒ ***Extend southward the easternmost sections.***

4. Vertical Velocity

Vertical motion produced by the model seems to be dependent on model resolution. A better understanding of the sources of vertical motion is required. Vertical motions should be analyzed in the different models, mainly on seasonal time scales. Observations of different tracers like e.g. Helium and Beryllium, might help to clarify possible model errors with respect to vertical motions. It was also suggested to include additional moorings at 10°W to observe zonal divergences of the flow. It must be shown that the accuracy of these measurements are helpful to validate numerical models with respect to their differences in the vertical velocities, as the accuracy of the measurements might not be great enough. Study of previous such attempts in the Pacific was recommended to determine the available accuracy from this technique.

⇒ *About Helium etc. see paper by Rhein et al.*

⇒ *More MSS measurements? (refer to Marcus Dengler works)*

⇒ *ADCP at 10°W. Maintain moorings*

+ attempt an dedicated experiment (4-5 moorings)?

+ dedicated cruise?

5. Impacts of Intraseasonal Waves

The role of intraseasonal waves, particularly TIWs, in the heat budget, remains an unresolved question and a source of significant disagreement among modeling studies. **It is thought that TIWs warm and wind-generated Yanai waves in the Gulf of Guinea cool the SST. However, a dedicated observational study testing these hypotheses is lacking.** A dedicated TIW process study is recommended for 2011 possibly including upwelling moorings as suggest above to **determine vertical motions.** Meridional and zonal divergences are also needed for the evaluation of mixed layer heat budget. **Changes in the heat budget will be observed with ship and glider sections (already planned by IFM-GEOMAR) during onset and height of equatorial upwelling. Drifting thermistor chains would also be a valuable tool for this study.**
It is recommended to also include longwave radiation sensors at the PIRATA buoys at least at 10°W, 0°N.

=> *longwave radiation sensors at the PIRATA buoys at least at 10°W, 0°N.*

⇒ *Cruises in late spring with gliders etc...*

could be attempted in 2011 with IFM-GEOMAR & French Pirata cruise

6. Salinity measurements and the Barrier Layer problem

Conductivity measurements with higher vertical resolution (same as temperature measurements) at the PIRATA buoys are important to address the Barrier layer problem. In general, the surface freshening seems to be a problem in (assimilation) models. It is believed that precipitation/evaporation from NCEP or ECMWF must be corrected to obtain a realistic hydrological cycle. Other possible measurements that would be helpful in addressing the hydrological cycle are surface salinity measurements with drifting buoys. However, due to biofouling these measurements are only valid for a few month of operation. **With the SMOS satellite there is a chance of improving surface salinity information in the tropical Atlantic. However, up to now there are no dedicate SMOS validation campaigns in the tropical Atlantic planned. Further, there are not enough data to address the river discharges in the tropical Atlantic region in particular with regard to the interannual variability.**

⇒ ***Dedicated SMOS cruises????***

What can we do during the annual cruises

already scheduled in the framework of PIRATA?

⇒ ***Additional conductivity sensors at some PIRATA sites.***

⇒ ***SVP-C deployments + use of ARGO profilers data.***

Recommendations from AMMA-ocean (France & EU)

(B.Bourlès, G.Caniaux & P.Brandt)

Weather system scale (less than 10 days).

The wind bursts occurring over the tropical Atlantic dynamics deserve **additional investigation**, e.g. their origin and occurrence, their impact on the ocean and air-sea exchanges and their potential use as predictive events for the conditions encountered in the Gulf of Guinea. For example, most process studies initiated in the frame of AMMA/EGEE indicate that **other observations are needed concerning the atmospheric circulation related to the Santa-Helena anticyclone and the influence of south hemispheric southeasterlies strengthening on the response of the ocean.** This seems to be a key question for preconditioning and influencing the cold tongue **emplacement and for its potential influence on the WAM.** The Santa-Helena anticyclone remains one of the less well studied features of the coupled system **at the beginning of the WAM.**

⇒ ***Access to the measurements on South Atlantic Islands***

⇒ ***ATLAS buoys farther in the south (Pb vessel etc...)???*** (recurrent issue)

Intra-seasonal scale (between 10 and 90 days).

Although much progress was obtained in the understanding of the Intraseasonal variability in the ocean, including Tropical Instability Waves (TIWs), wind-generated Yanai waves and Kelvin waves, and the fact that it is assumed that TIWs warm and wind-generated Yanai waves in the Gulf of Guinea effectively cool the SST, there are many open questions that deserve to be addressed, as: i) the direct influence of intraseasonal waves on the meridional SST gradient in the eastern tropical Atlantic and thus on the atmospheric convection, ii) the wind changes associated with the meridional SST gradient that might be effective in pushing atmospheric convection northward, iii) the role of the intraseasonal Kelvin waves in preconditioning diapycnal mixing processes during the onset phase of the cold tongue, iv) the deep thermoclines in the far east due to springtime propagation of downwelling Kelvin waves that might prevent diapycnal mixing processes, v) the role of TIWs in the mixed layer heat budget, and vi) the reasons for the strong disagreement among modelling studies, and vii) the processes at work in the region at the junction between the equatorial upwelling and the Angola-Congo upwelling.

One priority is also to maintain (or to support the maintenance) the current observations through currentmeter moorings at 10°W-Equator, implemented in the framework of AMMA and now maintained thanks to PIRATA-France. Such observations are of prior importance to test recent theory of the existence of an equatorial balance between the zonal current vertical shears and the isopycnal doming along the equator.

multi-annual scale (inter-annual, decadal, and climate change).

There are still open questions like e.g. what are the key SST anomaly pattern that influence the WAM on seasonal to decadal time scales and particularly what is the role of ocean dynamics potentially leading to predictability. The starting point of TACE was the strong SST bias in the tropical Atlantic in coupled climate models. This problem, which does not allow to establish correctly climate feedbacks like the Bjerkness feedback, is still not solved. The mean zonal SST gradient during boreal summer in recent model studies (CMIP3, DEMETER, ENSEMBLES) has still the wrong sign compared with observations. Additionally there is a westerly wind bias in the western equatorial Atlantic during boreal spring, which is responsible for the thermocline deepening in the cold tongue region. The SST-heat flux feedback seems to be overestimated in climate models resulting in a potential damping of seasonal to interannual variability. In general, the SST bias in climate models should have highest priority to be solved through improved parameterizations. **Key observations are needed to identify most clearly problems in climate models.**

Moreover, a larger question is the respective position and coupling between the three following large scale features: the Santa-Helena Anticyclone, the Atlantic cold tongue, and the Azores Anticyclone/Saharian heat low that lead to the natural interannual - multidecadal variability of the WAM.

Also, the effect of salinity changes on buoyancy surface fluxes remains open. In general the surface freshening is a problem in models and in assimilation. It is believed that precipitation/evaporation from NCEP/ECMWF must be corrected to obtain realistic hydrological cycle. With the upcoming SMOS satellite there is a chance of improving surface salinity information in the tropical Atlantic.

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« Notable gaps exist in the southern part of the central and eastern tropical Atlantic basin. In the framework of PIRATA, a proposal has been endorsed for a South-Eastern Extension -PIRATA SEE- that has been tested during a one-year experiment at one location off Congo in 2006-2007. Such a proposal is presently in stand by for funding support problem but should be strongly supported and endorsed. Also, the CLIVAR AIP strongly recommended in 2006 a PIRATA extension toward the southern ocean, around 23°W-10°S mostly motivated by improvement of the climate and weather prediction. However PIRATA has to deal with vessel time availability... that is a major issue.”

Observations dedicated to process studies.

Processes responsible, and their relative importance, for the upwelling along the southern African coast in the north of the Gulf of Guinea are still not precisely known (local wind, remote wind forcing and equatorial/coastal Kelvin waves, Guinea current variability,...). Potential impacts of this upwelling on regional climate and WAM onset are still an issue of concern and the analysis of its variability, from seasonal to interannual scales, could provide important inputs in the frame of climate change. This particular upwelling was too poorly studied during AMMA.

An oceanic experiment should be dedicated, at the time of the upwelling onset (ie during the preconditioning phase of the cold tongue), to the survey of the ocean-atmosphere coupling, the setup of the meridional temperature and radiative flux gradients, on both sides of the equatorial thermal front. Such an experiment could be carried out during a specific Pirata cruise between 23°W and 0°E.

The estimate of the vertical velocity is a crucial point to validate numerical models with respect to their differences in the vertical motions in the eastern equatorial Atlantic. Specific in situ experiments should be encouraged through i) the definition and implementation of a currentmeter mooring arrays (4) around 10°W-Eq, ii) a particular cruise around this area (with “grid-like” trajectory).

Once the PIRATA SEE implemented, such a particular experiment is to be encouraged in the Congo-Gabon upwelling area in order to estimate the thermal balance and the advections at a very local scale. This could be achieved through cruises making an hydrological survey (a “grid-like” trajectory) over a specific zone (for instance including an Atlas buoy).

*About 8 day experiment with
0-500m CTD/LADCP profiles every
1/4° in latitude/longitude around the buoy*

