Tropical Atlantic Meeting Report

(Toulouse, February 3-6, 2009)

Introduction

After a successful meeting dedicated to Tropical Atlantic studies in the frame of AMMA, TACE/CLIVAR & PIRATA international programs, and organized as part of the 2nd international AMMA conference in Karlsruhe/Germany (November 27-30, 2007), the necessity to organize regularly such meetings appeared as an evidence. Such a need mainly results from the importance to establish more exchanges and collaborations between "observations" and "numerical models" communities, only way to improve numerical simulations and predictions at seasonal time scale over the Tropical Atlantic and surrounding countries.

The present "Tropical Atlantic" meeting has been commonly decided by TACE, PIRATA and AMMA scientific committees, and has been hold on February 3-6, 2009, just after the PIRATA Scientific Steering Group / Pirata Resources Board (SSG/PRB) yearly meeting, hold on February 2, 2009 at the same location, *i.e.* at the International Conference Center of Météo-France in Toulouse (France).

List of organization committees is provided in Annex 1.

The detailed program of this meeting is provided in Annex 2.

This meeting was dedicated to Pr Fritz Schott and Dr Yves Ménard.

Report

The main priorities of this meeting were defined as to:

- Improve our knowledge on the mechanisms of the climate variability and the seasonal climate prediction over the Tropical Atlantic and surrounding countries.
- Set up design experiments to test optimal design of observing system to improve sea surface temperature predictions in the tropical Atlantic and demonstrate improved coupled prediction skill in the tropical Atlantic with enhanced observations.
- Set up coordinated forced and coupled model inter-comparison experiments to investigate the main processes involved in tropical Atlantic model biases at various time scales. Compare these runs with available observations with emphasis on the upper ocean in the eastern equatorial Atlantic.

In that way, four scientific sessions were defined (programs & observations, numerical simulations and predictability, process studies, Tropical Atlantic Variability and Meridional Overturning Cell) along with discussion sessions, dedicated to model bias, predictability, observations & process studies.

Objectives and status of the international programs TACE (http://www.clivar.org/organization/atlantic/TACE; http://www.rsmas.miami.edu/users/tace/), PIRATA (http://www.brest.ird.fr/pirata/piratafr.html ; http://www.pmel.noaa.gov/pirata/) and AMMA (http://www.amma-international.org and http://www.ird.ne/ammanet/) were presented and recalled, along with a new proposal IASCLIP (ftp://ftp.aoml.noaa.gov/phod/pub/wang/IASCLIP_S&Iplan_spr08_v2.pdf). This meeting was

also the opportunity to inform about the last AMMA International Newsletter (available on the AMMA web site: http://www.amma-international.org/IMG/pdf/International-AMMA-NewsletterJanuary2009web.pdf) and the 3rd AMMA International Conference (also available on the AMMA web page: http://www.amma-international.org). An AMMA team also prepared a document for this meeting in order to propose some key points for discussions (see Annex 3).

About 75 scientists from several countries attended (See list in annex 4) and about 55 oral and 10 posters presentations were done. Presentations (pdf), posters (pdf) and abstracts are let available for all participants (limited access) on the meeting web site (http://www.legos.obs-mip.fr/en/observations/pirata/meeting/2009/).

An important step of this meeting was the discussions in plenary and parallel sessions, focusing on the main issues proposed as priorities for this meeting. After a general discussion in plenary session during the Wednesday afternoon dedicated to the model bias, two groups were organized on Friday morning, focusing respectively on:
- Observations, processes and models inter-comparison (Chairs: Peter Brandt and Bill Johns),
- Model biases and predictability (Chairs: Laurent Terray and Alban Lazar).

About 20 people participated to each group. Very fruitful discussions and important recommendations have been summarized in the two reports bellow. These reports should be distributed throughout the concerned scientific community and supporting organisms.

Bernard Bourlès, Cotonou, February 22nd, 2009.

Report on the Ocean Processes and Model Validation session

The following items were discussed as priorities for new research and collaborative study:

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.

2. Formation and Fate of the Equatorial Thermostad

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 thermostad 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 thermostad and appears to be intimately related to its formation. In particular, low vertical mixing at depth seems to be important to obtained 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 thermostad 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.

3. Define model output that can be compared with observational data

For the validation of assimilation models we have to define sections and time series that are able to allow an evaluation of the realism of ocean dynamics in the different models.
For MERCATOR:
The Tropical Atlantic Region is defined between 20°N and 20°S; transport sections must be implemented online. We suggest to calculate the EUC transport at 23°W between 2.5°N and 2.5°S in the density ranges sigma_theta = 24.5- 26.8 kg/m³ as well as above sigma_theta =24.5 kg/m³. Other important meridional sections, for which transport data should be separately saved are 35°W, 23°W, 10°W, 0°W, 6°E.
To test the correct working of the dynamic Bjerkness feedback, we suggest to store besides the transport time series of the EUC at the equator time series of the warm water volume in the whole tropical Atlantic (3°S-3°N above the 20°C isotherm), wind in the western tropical Atlantic (WAtl; 3°S–3°N, 40°–20°W) and SST in the eastern tropical Atlantic (Atl3; 3°S–3°N, 20°W–0°).

Identified problems with the MERCATOR assimilation are the lack of a diurnal cycle (only operational fluxes with daily averages are used) and the amplitude of TIWs and wind-generated Yanai waves. Probably due to phase differences between simulated and observed TIWs, the negative feedback between wind anomalies produced by SST anomalies of TIWs on the amplitude of TIWs can not be simulated correctly and leads to overestimated TIW amplitudes, including their effect on the upper ocean heat budget. First theoretical studies were aimed to identify the amount of data that are needed to improve the phase information of tropical waves in assimilation models.

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.

5. Impacts of Intraseasonal Waves

The role of intraseasonal waves, particulary 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.

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.

Report by P.Brandt, B.Johns & coll.

Report on the model biases session

The Tropical Atlantic community (PIRATA/TACE/AMMA researchers and engineers) met at Météo-France in Toulouse after the PIRATA SSG. A specific session was dedicated to model biases. The workshop showed that some advances have recently been made in documenting the biases in the current generation of coupled models. Recent studies on the CMIP3, DEMETER and ENSEMBLES (stream 1 and 2) datasets have suggested that the majority of current coupled models are still unable to simulate correctly the summer equatorial SST gradient in the tropical Atlantic. The SST gradient has the wrong sign in comparison with observation, with the western Atlantic being in general colder than the eastern Atlantic. Westerly wind biases in the western equatorial Atlantic during springtime seem to be responsible for a deepening of the thermocline in the eastern Atlantic. Although the wind biases decrease in summer and the total winds are favourable for upwelling, the too deep thermocline is preventing the development of the eastern cold tongue in the coupled models. A similar wind bias is also presented in AMIP-type experiments, suggesting that the origin of the bias may be from the atmosphere.

The biases also affect the hydrological cycle. In spring, the simulated ITCZ is too diffuse and displaced south of the equator with warm SST biases mainly located in the southeast tropical Atlantic. The spring SST bias pattern is different from the summer one: it shows larger biases along the African coast compared to those of the equatorial waveguide. In general, it seems coherently associated with weaker southern trades. Occurrence of the drift is extremely rapid as was shown by recent results from the ENSEMBLES stream2 dataset. Seasonal hindcasts (performed in ENSEMBLES with 5 coupled models over the 1960-2005 period) initialized from ocean and atmosphere reanalysis data already exhibit the spring temperature bias spatial pattern after just one month (month of may with the models initialized May first) with a weak amplitude. At 3-month lead time (March-April-May period with initialization in February), the SST bias is already well established in terms of both pattern and amplitude and is almost similar to the one at 5-month lead time (same period but with initialization in November). There are SST biases in the other seasons as well (in spite of smaller amplitude usually). There is a need to better understand the seasonal evolution of the biases and the associated mechanisms. The workshop also showed that current models exhibits biases in other regions such as the Atlantic Warm Pool. As this region has strong teleconnections to the tropical Pacific and to the North Atlantic and European region, it is also important to better document and understand the biases there and the relevant mechanisms. The participants also felt that the existing ocean reanalysis datasets are not sufficiently used. Synthesis products that optimally combine data and model information should become easily available to users now. There is a strong need to better organize the dissemination of these products (common format, a unique database, etc …).

Recommended ACTION ITEMS

The first three items are of the highest priority and some progress can be achieved on these issues within one year. The other items are as important but the expected time frame is longer.

1) To focus on the big problems first; when they are solved then worry for the minor ones. It was felt by most of the participants that making progress on the SST gradient bias is of the

foremost importance and that this problem should be on the top of the list for the interested modelling groups.

2) To exhaustively document the various model biases in the tropical Atlantic by analyzing a large set of models (CMIP3, AMIP, ENSEMBLES, WGSIP simulations, OMIP, ocean synthesis products). This could take the form of a white paper which will summarize the findings and results from the various multimodel analysis recently performed.

3) To clearly separate the coupled feedbacks which amplify the original bias from the underlying initial causes. It appears that the Bjerknes feedback (which is also operating in the tropical Atlantic interannual variability) is playing a dominant role in amplifying the equatorial spring biases in models. What is less clear (and seems to vary among models) is the original cause of the westerly wind spring bias. Various atmospheric causes have been suggested from analyses of AMIP type simulations: displacement of the subtropical High's, bias in continental precipitation over the Amazon and West Africa, atmospheric convection over the ocean, stratus cloud representation. There are also suggestions for an oceanic role on the wind bias origin off-equator. There is a need to better document the different causes which can lead to the equatorial westerly wind bias in the western Atlantic (using both forced and coupled models).

4) To better understand the phase relationship between the SST biases in the Benguela Niño region (where are located the largest biases during the spring season) and at the equator (largest biases during summer). Are the Benguela SST anomalies propagating to the equator? Are they amplified or damped during the propagation? Are they linked in any way to the westerly wind bias? How are the biases related to the main tropical modes of interannual variability?

5) To assess the biases influence on predictability at seasonal to decadal time scale. Recent studies suggest the role of weather noise as a potentially disrupting factor for the predictive skill in the tropical Atlantic. Other studies have pointed out the overestimation of the simulated SST-heat flux feedback (more negative in the models than in the observations) as a potential damping source of seasonal to interannual variability. These diagnostics should be applied to the most recent datasets. A large amount of work is still needed to fully exploit the seasonal predictability of climate in the tropical Atlantic region.

6) To better document and understand the remote influence on the model biases in tropical Atlantic. For example, ENSO's bias may influence on the tropical Atlantic modes as well as on its time evolution (the variation of the influence).

7) To identify and understand processes and/or parameterizations in coupled models that are responsible for generating model biases in the Atlantic Warm Pool (AWP). Many state-of-the-art climate models exhibit cold SST bias in the AWP. In boreal summer, the cold bias can reach up to -3°C and lead to precipitation bias of up to -5 mm/day (dry bias). As this region is important for hurricane genesis and intensification, there is a need to better document potential causes that lead to the cold bias using AGCMs, OGCMs and coupled GCMs. In addition, we need to investigate the possible relationships between model biases in the AWP and the equatorial Atlantic. The analysis and study of model biases in the AWP region is one of top priorities for the Phase I of the CLIVAR/VAMOS IASCLIP Program (2009-2014).

8) To use clever modelling strategies in order to make progress on the above issues.

First of all, as the climate drift is extremely fast (few months), the seasonal hindcast framework is well adapted to test various working hypotheses. We would like to recommend the following case studies: one could pick up two contrasting years in terms of cold tongue anomaly (for instance 2005 and 2006 for which we have quite a lot of observed data). We could then replay ensemble seasonal hindcasts with different model setups. Strategies such as spectral nudging in atmospheric models, partial coupling, and forced AGCM and OGCM sensitivity experiments could be used separately or together in order to test various hypotheses as to the origin of the wind westerly biases in spring and to identify problems linked to the representation of processes and/or feedbacks associated to the development of the Atlantic cold tongue.

Report by L.Terray, A.Lazar, P.Chang, C.Wang, and coll.

ANNEX 1: Tropical Atlantic meeting organizers and supports;

Organization committee:

Bernard Bourlès (IRD/LEGOS), Joël Poitevin (Météo-France), Guillaume Charria (IRD/LEGOS), Yves Du Penhoat (IRD/LEGOS)

Scientific committee:

Observations:
Bernard Bourlès (IRD/LEGOS), Peter Brandt (IFM-GEOMAR), Bill Johns (RSMAS), Paulo Nobre (INPE)

Numerical models and predictability:
Laurent Terray (CERFACS)

Process studies:
Guy Caniaux (Météo France), Marcus Dengler (IFM-GEOMAR), Frédéric Marin (IRD/LEGOS)

Tropical Atlantic Variability & MOC:
Ping Chang (DO/TAMU), Alban Lazar (IRD)

Supports:

This meeting has been carried out thanks to the main contributions by:
- Meteo-France (conference centre and facilities, Pirata official diner,…)
- IRD (cocktail, coffee breaks, grants,…)

Meteo-France & IRD are greatly and sincerely acknowledged by all members of the scientific committees and participants.

ANNEX 2: Detailed Tropical Atlantic meeting Program;

TROPICAL ATLANTIC MEETING
&
PIRATA-14 SSG/PRB MEETING

(February 2-6, 2009, International Conference Center, Meteo France, Toulouse, FRANCE)

a) Monday Feb. 2nd, 2009: Pirata PRB/SSG meeting:

9h00-9h30: Welcome & registration

- Welcome introduction (Joel Poitevin)

9h30-13h00: Pirata status presentations (15' each):

- M.McPhaden: Pirata status in US
- R.Lumpkin : Pirata NEE status
- P.Nobre: Pirata Brazil status
- B.Bourlès: Pirata France status
- G.Charria: Measurements at São Tomé
- J. Grelet: Updates on the French Pirata website
- M.Rouault: Pirata SEE status
- N.Lefevre: Pirata O2 "piggy back" program status
- P.Brandt: Measurements along 23W
- G.Foltz: Barrier layer thickness & SST
- Fabrice Hernandez; Mercator Ocean activities report.

13h00-14h: lunch time

14h-15h: Reports from International and national institutions

- J. Trotte (DHN)
- C. Clarke (NOAA)
- Y. du Penhoat & J. Poitevin (IRD, Meteo France)

15h-16h: International and National Status of PIRATA network and extensions

- Continuation & additional discussions
- Problems to solve and prospective

16h-18h00: closed sessions :

- PRB & SSG parallel meetings (PRB continued on Tuesday afternoon, from 16h).

18h: MoU official Signature ceremony

20h: PIRATA official diner (offered by Meteo France)

b) Tuesday Feb. 3rd, 2009: Tropical Atlantic Variability meeting day 1:

Morning: Introduction & observation programs

8h30-9h30: Welcome & Registration

09h30- 10h30: Opening ceremony:

- General welcoming by local organizers (J. Poitevin)
- General welcoming by scientific committees (B. Bourlès)
- Presentation in memory of Fritz Schott (P. Brandt)
- Presentation in memory of Yves Ménard (S. Arnault)

10h30-13h00: Status of TA international observation programs (15-20' each)

- J.L.Redelsperger: AMMA: status and perspectives
- B. Johns: TACE Equatorial Undercurrent Study: US plans and status
- C. Wang et al.: The Intra-Americas Seas Climate Processes (IASCLIP): A New CLIVAR/VAMOS Program from 2009-2014
- B.Bourlès: Observations in the GG: an overview (PIRATA, EGEE, PROPAO…)
- M. Dengler: Observational programs at 23°W and in the northeastern tropical OMZ: Status and plans
- H. Viola: Data Buoy Cooperation Panel Update and Developments

Afternon: Scientific session "Observations in the Tropical Atlantic"

14h-18h00 (20' each with discussions: Chair: P.Brandt & B.Johns):

- B. Woodward, M. Guigue, and C. Ortega: Implementing Argos-3 PMTs in Ocean platforms
- A. Aman, A. E. Kouadio, E. Toualy, P. Woodworth, B. Bourlès and P. Assamoi: Regional oceanography and Climate monitoring in West Africa
- M. Rouault and M. Mehari: Ocean land atmosphere interaction in the Tropical south East Atlantic
- N. Lefèvre, A. Guillot, L. Beaumont and T. Danguy: Sea surface observations of the fugacity of CO2 from PIRATA moorings
- P. Brandt, V. Hormann, J. Fischer, L. Stramma, M. Visbeck and A. Funk: Circulation and oxygen distribution in the central tropical Atlantic south of Cape Verde
- V. Hormann and P. Brandt: Upper equatorial Atlantic variability during 2002 and 2005 associated with equatorial Kelvin waves
- N. Kolodziejczyk, Y. Gouriou, F. Marin and B. Bourlès: Equatorial undercurrent termination in the Gulf of Guinea
- D. Urbano, P. Nobre, R. de Almeida, E. Giarolla and M. Malagutti: The EUC structure and high frequency variability
- G. Charria, F. Marin, Y. du Penhoat, B. Bourlès, L. Testut, N. Rousseau, P. Téchiné and L. Roblou: Interannual variability of sea level anomalies in the Gulf of Guinea close to the São Tomé Island
- A. Subramaniam and E. Key: Using in-situ and ocean color satellite data to trace the Congo River plume

Poster session:
- S. Arnault, Y. Tanguy and P. Lattes: ARGO floats and the ARAMIS project in the Tropical Atlantic
- A. P. de Oliveira, J. Soares and J. Servain: Preliminary results from the FLUTUA project: Micrometeorology in situ measurements at St Peter & St Paul archipelago (01°N-29°W)
- J. L. Pelegrí, J. Beth, E. Calvo, M. Emelianov, A. García-Olivares, J. Gourrion, F. Machín, C. Marrrasé, B. Mourre, V. Nieves, J. Piera, C. Pelejero, J. Salat, J. Salvador, A. Turiel and Á. Viudez : Oceanographic cruise along 8N in spring 2010

19h: Meeting cocktail (offered by IRD)

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c) Wednesday Feb. 4th, 2009: Tropical Atlantic Variability meeting day 2:

<u>Morning: Numerical simulation and predictability session:</u> comparisons of model results (ocean, atmosphere, coupled) and problems in the tropical Atlantic. Attribution of model biases.

9h-13h00 (20' each with discussions: Chair: Laurent Terray):

- S. Wahl, M. Latif and W. Park: Predictability in the Tropical Atlantic in the Kiel Climate Model
- M. Barreiro and A. Tippmann: Atlantic modulation of El Nino influence on summertime rainfall over southeastern South America
- J. Luebbecke, C. Boening and N. Keenlyside: On the connection between Benguela Ninos and Equatorial Atlantic Ninos
- C. Wang, S.-K. Lee, C. R. Mechoso and D. B. Enfield: Inter-Hemispheric Influence of the Tropical Atlantic Warm Pool on the Southeast Pacific
- B. Rodriguez-Fonseca, I. Polo, J. Garcia-Serrano, T. Losada, E. Mohino, C. R. Mechoso and F. Kucharski: On the recent Atlantic Niño influence on Pacific ENSO events
- J. Garcia-Serrano, B. Rodriguez-Fonseca, T. Losada and I. Polo: Horseshoe-tripole transition and the North Atlantic Oscillation.
- A. Laurian, A. Lazar and G. Reverdin: Variability of spiciness anomalies and decadal predictability: a GCM analysis
- H. Ding, N. S. Keenlyside and M. Latif : Seasonal cycle in the upper Equatorial Atlantic Ocean
- M. Wade, G. Caniaux, Y. DuPenhoat, M. Dengler, H. Giordani and R. Hummels: A one dimensional modelling study of the diurnal cycle in the tropical Atlantic at the PIRATA buoys during the EGEE-3 campaign
- E. Mohino, B. Rodríguez-Fonseca, T. Losada and S. Janicot: SST-forced signals on West African rainfall from AGCM simulations: changes in the co-variability modes.

<u>Afternoon : Numerical simulation and predictability session (continuation) & General discussion session: model bias problems, …:</u>

14h-15h (Chair : Laurent Terray):

-P.Nobre, M.Malagutti, D. Urbano, and R. Almeida, Coupled Ocean-Atmosphere model biases over the equatorial Atlantic as estimated from PIRATA data and OGCM simulations

- P. Chang: Reducing Weather Noise Influence on Seasonal Climate Forecast in Tropical Atlantic
- F. Hernandez: Intercomparison of GODAE operational systems (HYCOM, FOAM, MERCATOR) in the Tropical Atlantic
- C. Ubelmann, J. Verron, J.-M. Brankart and P. Brasseur: Observation system simulation experiments in the Tropical Atlantic.

15h-18h (Chair : L.Terray): Discussion session on model bias problems
Introduction presentations by:
- B. Johns: TACE Goals/Objectives & modeling/synthesis strategy
- L.Terray (with input from Ingo Richter, Shang-Ping Xie, Cyril Caminade, Mathieu Joly, Paco Doblas-Reyes, Lola Corre, Aurore Voldoire): Tropical Atlantic Biases in current Coupled General Circulation Models: A BIG problem

Poster session:
- M. Araujo, J. Servain, M. Silva, C. Lentini, M. Cintra and W. Arruda: Project TransAt – Preliminary validation analysis of the Mercator products
- T. Losada, B. Rodríguez-Fonseca, S. Janicot, S. Gervois, F. Chauvin and P. Ruti: Tropical atmospheric response to the Atlantic Niño

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d) Thursday Feb. 5th, 2009: Tropical Atlantic Variability meeting day 2:

<u>Morning: Process studies:</u> use of measurements (ocean & atmospheric fluxes) & models for improving some parameterizations in the numerical models.

9h-13h00 (20' each with discussions: Chair: Guy Caniaux, Marcus Dengler):

- G. R. Foltz and M. J. McPhaden: Impact of barrier layer thickness on SST in the central tropical North Atlantic
- Y. Tanguy, S. Arnault and P. Lattes: Isothermal, mixed and barrier layers in the tropical Atlantic ocean during the ARAMIS experiment
- M. Araujo, C. Limongi, J. Servain, M. Silva and C.A.D. Lentini: Salinity-induced mixed and barrier layers in the Southwestern tropical Atlantic Ocean off the Northeast of Brazil
- O. Duteil, A. Lazar, Y. Dandonneau and I. Wainer: Chlorophyll impact on tropical SST and thermal stratification
- D. Kühnel, M. Rhein, J. Sültenfuß and S. Hüttl-Kabus: Equatorial upwelling rates inferred from helium isotope and QuikSCAT wind-stress data
- M. Dengler and R. Hummels: Diapycnal mixing and turbulent heat flux in the central and eastern tropical Atlantic
- J. Mignot, A. Lazar and M. Lacarra: Towards a better understanding of BLs and temperature inversions formation in tropical areas
- F. Marin and G. Athié de Velasco: Meridional structure of Tropical Instability Waves in the equatorial Ocean
- G. de Coëtlogon, S. Janicot and A. Lazar: Intraseasonal variability of the ocean - atmosphere coupling in the Gulf of Guinea during boreal spring and summer

Poster session:
- Y. K. Kouadio, J. Servain, L. A.T. Machado and Sergio Sombra: Observed and simulated relationship between
- D. Veleda, M. Araujo, R. Montagne: Intraseasonal variability in the North Brazil Undercurrent forced by remote winds

Afternoon: Process studies (continuation): use of measurements (ocean & atmospheric fluxes) & models for improving some parameterizations in the numerical models.

14h-15h (20' each with discussions: Chair: Guy Caniaux, Marcus Dengler):

- R. De Almeida, P. Nobre and D. Urbano: Bjerkness feedback seen through PIRATA eye
- S. Faye, B. Sow and A. Lazar: Simulation of the senegalo-mauritanian upwelling: How are the winds actually driving SST variability and water mass renewal?
- A.C. Peter and A.Lazar: Thermal impact of intra-seasonal coastal waves in African upwellings

Tropical Atlantic Variability and Meridional Overturning Cell session: what do we know? What remains to be documented? Needed observations and dedicated simulations.

15h-18h (20' each with discussions: Chair: Ping Chang, Alban Lazar):

- P. Chang, R. Zhang, W. Hazeleger and others: AMOC and African Monsoon
- I. Wainer, J. Servain and G. Clauzet: Is the decadal variability in the tropical Atlantic a precursor to the NAO?
- K. Kirchner, M. Rhein, S. Hüttl-Kabus and C. Böning: On the spreading of South Atlantic Water into the northern hemisphere
- D. Beserra Lucena, J. Servain and M. Francisco Gomes Filho: Impact evaluation over the northeast Brazil rainy season of the extreme climatic events in the Pacific and Atlantic Oceans.
- G. R. Foltz and M. J. McPhaden: Trends in Saharan dust and tropical Atlantic climate during 1980-2006
- I. Polo, A. Lazar, B. Rodríguez-Fonseca and A. C. Peter: Wind forcings of tropical intraseasonal Kelvin waves
- I. Muhammed, G. Quartly and P. Challenor: Variability of horizontal temperature induced by Tropical Instability Waves in the Atlantic
- D. Zhang and M. McPhaden: Multidecadal Variability of the North Brazil Current and its Connection to the AMOC

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e) Friday Feb. 6th, 2009: Tropical Atlantic Variability meeting day 4:

Morning:

9h-11h: Parallel sessions

- Session 1: Model intercomparisons, observations & process studies (Chair: P.Brandt & B.Johns)

- Session 2: Model bias & predictability (Chair: L. Terray & A.Lazar)

11h-12h30: Plenary session, parallel session's reports, discussions & meeting closure (B.Bourlès & J.Poitevin).

ANNEX 3: AMMA inputs

African Monsoon Multidisciplinary Analyses
Afrikanske Monsun : Multidisiplinære Analyser
Afrikaanse Moesson Multidisciplinaire Analysen
Analisi Multidisciplinare per il Monsone Africano
Afrikanischer Monsun : Multidisziplinäre Analysen
Analisis Multidiciplinar de los Monzones Africanos

AMMA contribution to Atlantic Tropical Variability meeting (Toulouse, Feb 2009)

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The West African Monsoon is a favourable geophysical system where to address issues concerning the role of ocean-land-atmosphere interactions at different spatial and temporal scales. The understanding acquired by AMMA over the last few years, and the exploitation of the AMMA field campaign could bring to light relevant issues related to the Tropical Atlantic Variability. Here, we would like to suggest four key issues to be co-investigated with the TACE and PIRATA scientists:

1. GCMs show **large systematic error over Tropical Atlantic both in climate scenario and in seasonal forecasts**. Typically, most of the IPCC-AR4 XX century simulations and of the ENSEMBLES seasonal forecasts exhibit a summer warm bias over the Tropical Atlantic, underlying an erroneous representation of the processes and feedbacks which concur to the development of the Atlantic cold tongue. This systematic bias, in conjunction with a **wrong representation of the ENSO teleconnection,** weakens the reliability of seasonal to climate predictions over the region. Recent published papers have also shown that the equatorial Atlantic SST variability has significant impacts not only on the WAM, but also on the ENSO dynamics as well as on oceanic dynamics in the Indian basin and on the Indian monsoon through teleconnections based on atmospheric equatorial wave dynamics. So the summer warm bias over the tropical Atlantic could impact badly a large part of the Tropic. It is important to note that the annual cycle of the WAM arises through coupled atmosphere-land-ocean processes. These coupled processes are fundamentally important for the WAM and tropical Atlantic climates.
   New inter-comparisons, analysis and sensitivity simulations could be designed in collaboration with TACE and PIRATA scientists in order to further understand the regional mechanisms and remote teleconnections not well represented by state-of-the-art regional and global models. ENSEMBLES database could be also used for analysis and intercomparison purposes on coupled modes of variability between the SST and rainfall but also between SST and dynamics. More information about the availability of seasonal-to-decadal ENSEMBLES data can be found on:
   http://www.ecmwf.int/research/EU_projects/ENSEMBLES/
   Furthermore, some results from the ENSEMBLES seasonal hindcasts for the tropical Atlantic can be found on:
   http://www.ecmwf.int/research/EU_projects/ENSEMBLES/results/stream2_seasonal.html

2. Several recent papers have shown the strong **link between the West African Monsoon (WAM) and the Atlantic Multidecadal Variability (AMV).** It has also been shown that AMV is closely linked to the Atlantic Thermohaline Circulation (ATC). A key-question for the future West African climate along the next decades is to be able **to differentiate the impact of the natural AMV from the GHG induced long-term trend impact, the impact of GHG increase on the ATC,** and the possible impact of other oceanic decadal scale variability (Indian and Pacific basins) on the WAM.

3. **African Easterly Waves** (AEWs) are the primary synoptic-scale disturbances affecting tropical northern Africa climate during the rainy summer season, and are connected to the occurrence of Atlantic hurricanes and of rainfall events over Africa. **Air-sea interaction could play a significant role in modifying the AEWs when they cross the African boundaries and move into the Atlantic Ocean.** The design of new numerical simulations and the analysis of the AMMA field campaign data could provide new insights of the ocean contribution to the process.

4. **AMMA-MIP, a Model Intercomparison Project developed in the frame of AMMA, and the WAMME** (West African Monsoon Modeling and Evaluation, US) are sharing a light exercise of intercomparison and evaluation of both global and regional atmospheric models, focused on the study of the seasonal and intraseasonal variations of the climate and rainfall over Sahel. Taking advantage of the relative zonal symmetry of the West African climate, one major target of the exercise is the documentation of a meridional cross section made of zonally averaged (10W-10E) outputs. West African monsoon flow is mainly driven by the meridional gradient of the boundary layer temperature which develops across the Gulf of Guinea and the Western African continent. So, the AMMA-MIP framework, in conjunction we the available 2006 new data and reanalysis, could be a useful tool for a better understanding of the intra-seasonal to seasonal feedbacks between the eastern Tropical Atlantic ocean and the African monsoon.

5. **Aerosols,** both natural and man-made, as well as floods and droughts are the two most urgent societal problems confronting monsoon regions around the world. As a matter of fact, North Africa is the world's major source of mineral dust aerosols, which affect not only the climate of the West Africa monsoon regions but possibly weather and climate of the Middle East, Europe and the east coast of North America. T**he model inaccuracy in simulating the dust-radiation atmosphere feedback could cause strong errors in surface ocean conditions, which in turn determine part of the African monsoon flow variability**. The AMMA field campaign and the aerosol/chemistry model experience.

ANNEX 4: List of attending scientists

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