PROPAO

(Regional Program of Physical Oceanography in West Africa)

(2007 - 2010)

==➔ Jeune Equipe Associée à l'IRD (JEAI) 2011-2014

Présenté par

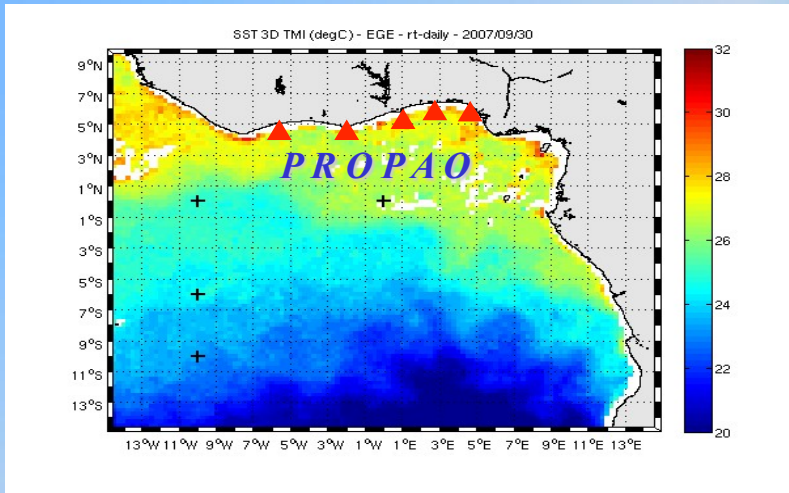
Dr. Ir. Zacharie SOHOU

Centre de Recherches Halieutiques et Océanologiques du Bénin (CRHOB)

PROPAO

Need for:

- *Capacity building in Physical Oceanography in West Africa*
- *Network of regional measurements*



Scientific outline :

- Continuity of measurements activities, research and training initiated in the frame of EGEE/AMMA (study of ocean circulation and climate in the Gulf of Guinea), in coastal countries of the northern Gulf of Guinea (Nigeria, Benin, Togo, Ghana and Cote d'Ivoire).

Regional Program of Physical Oceanography in West Africa (Gulf of Guinea; 2007-2010); PROPAO:

Program funded by French FSP-RIPIECSA through IRD and carried out by:
Benin (CRHOB), Nigeria (NIOMR), Togo (CGILE), Ghana (DOF)
Côte d'Ivoire (LAPA & CRO) and France (IRD/Legos).

Main goals :

- Continuity of measurements activities, research and training initiated in the frame of EGEE / AMMA, in coastal countries of the northern Gulf of Guinea (Nigeria, Benin, Togo, Ghana and Cote d'Ivoire).
- To set up a network of regional measurements and build a regional coastal data bank;
(*before PROPAO, measurements of SST and SSS in the Gulf of Guinea were only from Bucket System and a few Tide Gauges*)
- Monitoring and analysis of coastal upwelling regime and understand the coastal environment.

Some works carried out in West Africa (linked to PIRATA in some ways):

The PROPAO program in the Gulf of Guinea:

- 3 years (2007-2010) program funded by the French Foreign Affaires Ministry to support scientific programs dedicated to West African climate and societal impacts of climate changes.

- Regional Program of Physical Oceanography in West Africa, involving Nigeria, Benin, Togo, Ghana, Côte d'Ivoire and France (IRD/LEGOS; B.Bourlès in Cotonou/Benin from 08/2007).

- Goals:
1) to maintain an autonomous coastal network of temperature sensors ;

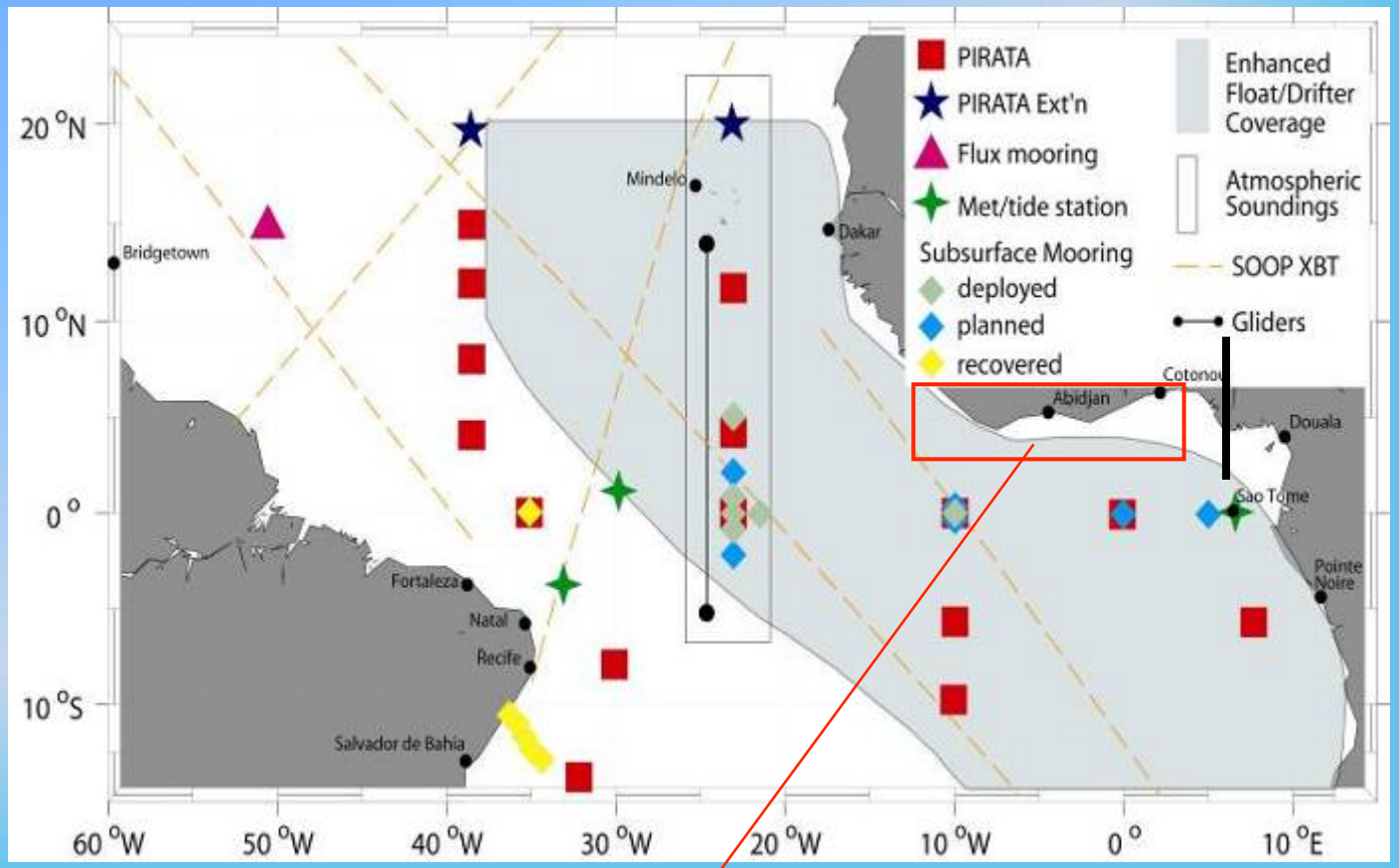
2) establish a regional data bank for studying coastal SST, upwelling, links with local & regional climate and resources, and coastal environment (erosion…);

3) Formation and capacity building: a regional Master in Physical Oceanography has been launched in 2008 at the Cotonou University.

Continued (hopefully, due to pb in Cote d'Ivoire) by the ALOC-GG program (2011-2014)
Between Benin and Côte d'Ivoire:
Goals: maintain the coastal network, reinforce and continue regional collaboration & capacity building
Through PhD thesis on priority topics (coastal upwelling, coastal erosion, resources…).

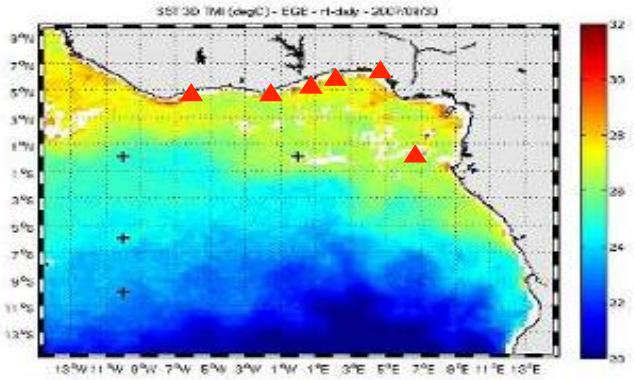
Goals :

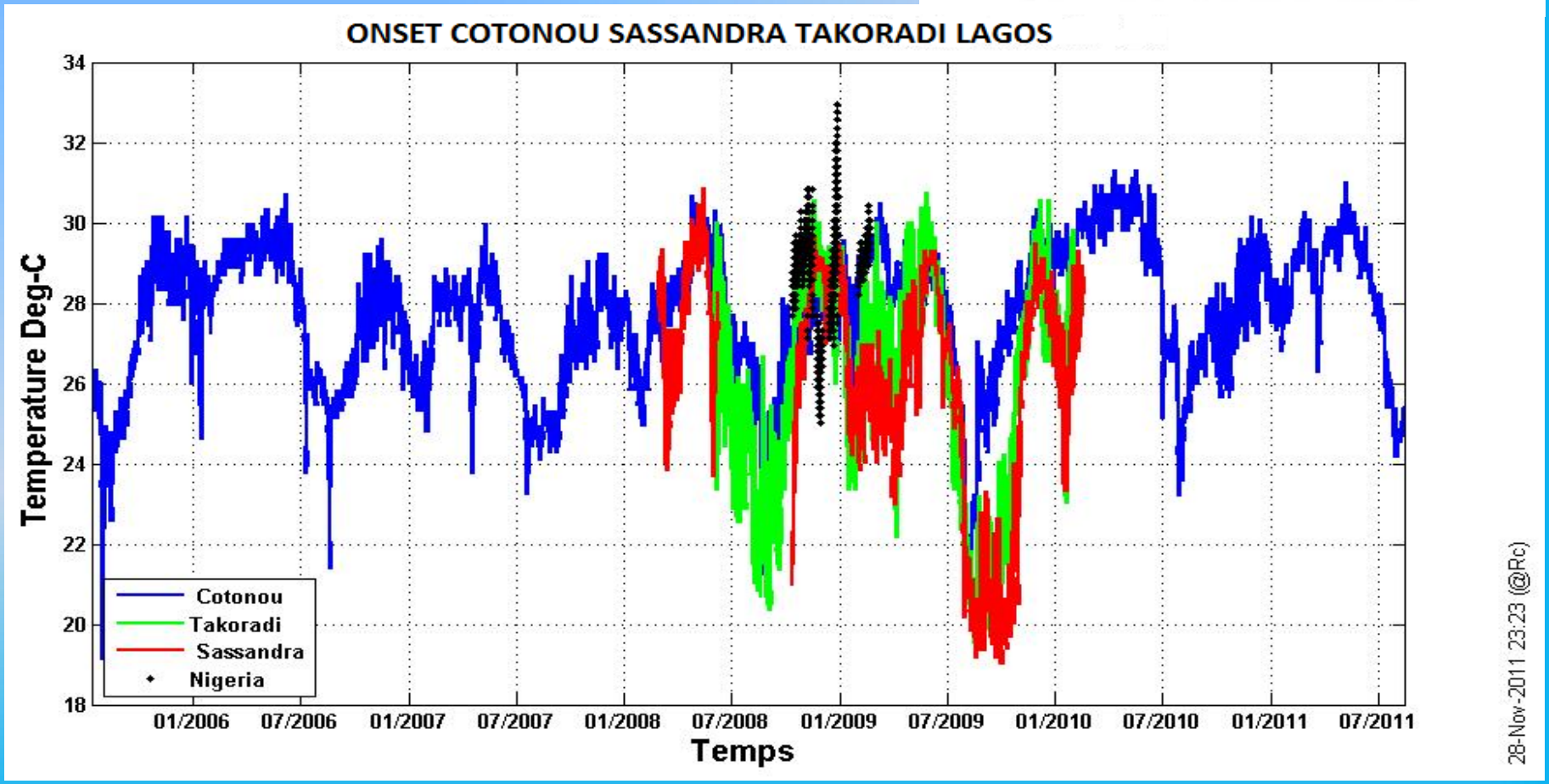
- Extend the PROPAO network eastward and westward, with SST autonomous sensors and tide gauges (problems…)
- PROPAO could become an African contribution to the TA observing network



Present PROPAO coastal network

Coastal SST: July 2005 – July 2011:
Cotonou (Benin: red), Takoradi (Ghana: green),
Sassandra (RCI: blue), Lagos (Nigeria: black)





(Mooring the Onset Captor Moored at Sassandra, Ivory Coast)

Extrem conditions

- TIDBIT ONSET model 5 version 3
- Measured temperature range: -5 °C to +37 °C.
- Precison: ±0,2°C.
- Onset captors are calibrated at Institut Français de Recherche et d'Exploitation de la Mer (IFREMER)

COOPERATION IN Local level

MCA gived some sensors to Port

Sensor description:

On WCP1 & WCP2 installed:

- 1 AWAC (1MHZ 25 m range, directional wave dt=1h and current dt=10mn)
- 1 Turbidity meter (connected to AWAC dt=10mn)
- 1 SBE (temperature and salinity dt = 10mn)
- 1 Aquadopp (used like pressure sensor dt=5sec)

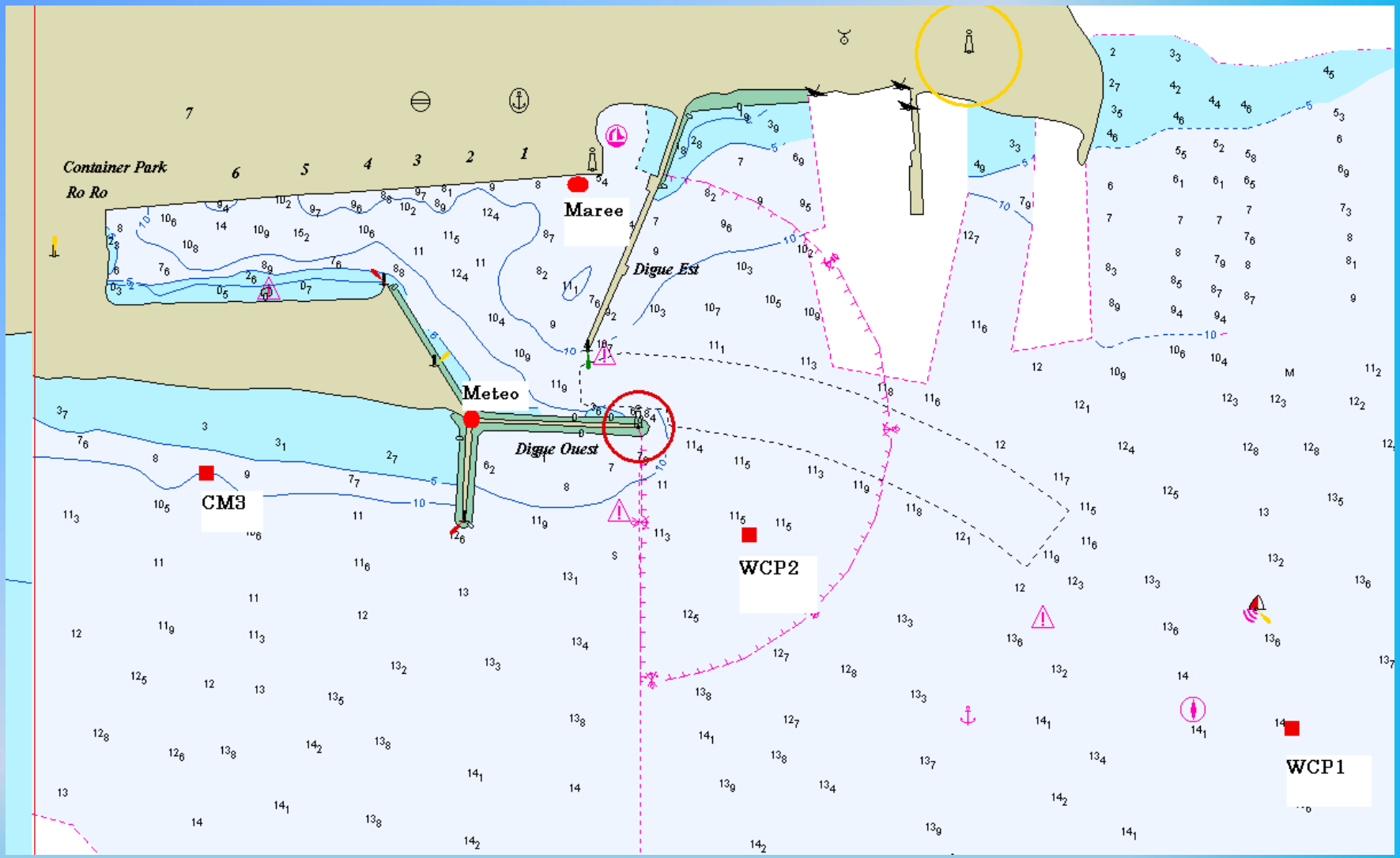
On WCP3

- 1 Aquadopp PRO (Current Profiler dt=10mn)
- In real time (data transmitted by radio with two radio modems)

1 Weather Station (temp direction, speed, rainfall, atmospheric pressure)

Wind averaged every 2 minutes, rainfall data are accumulated every 10 minutes.

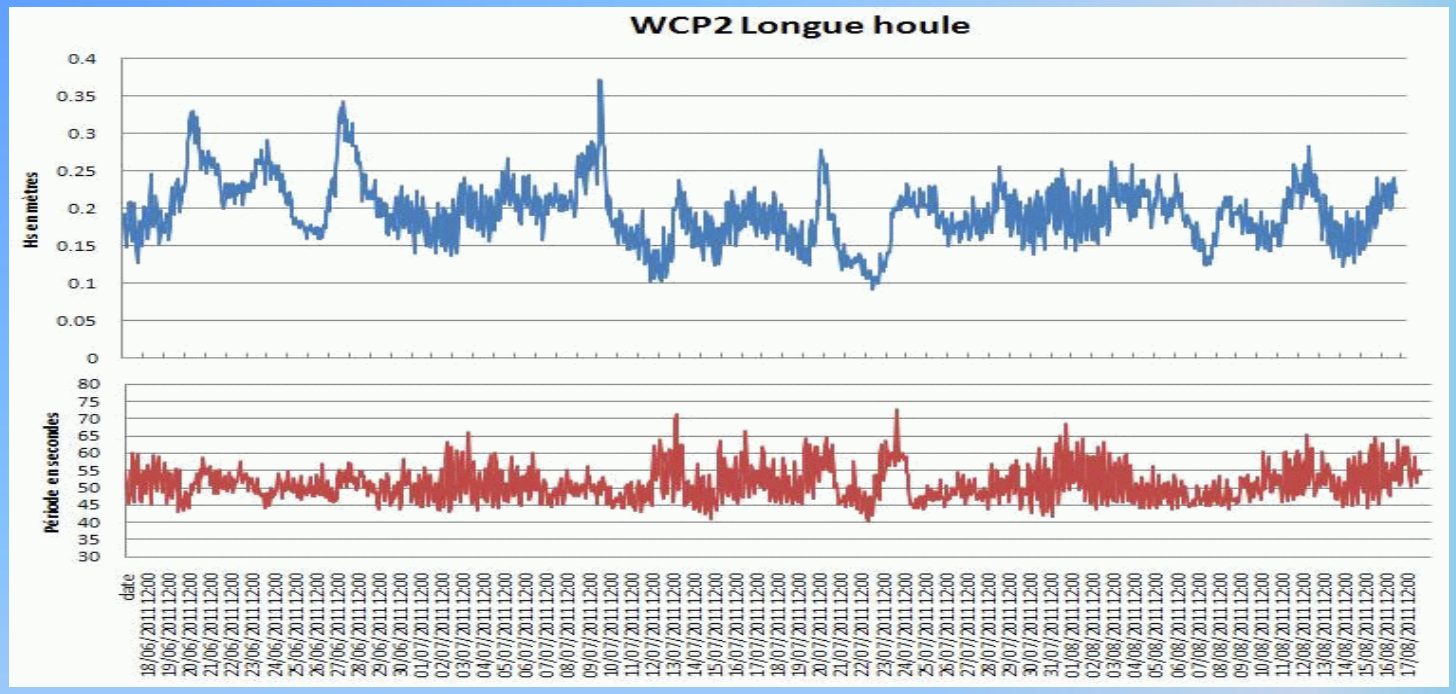
A tide gauge positioned at 75cm below zero level.



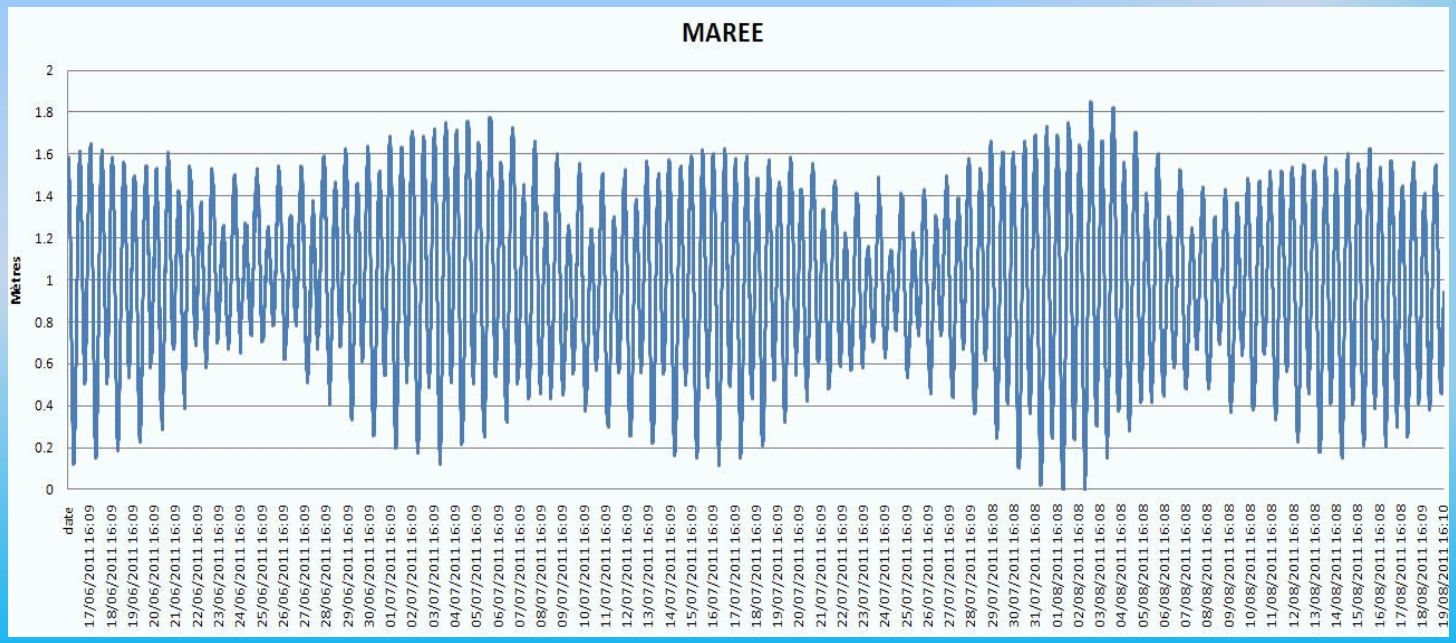
Sensor Localisation in Cotonou Port

Sensor after retrived from water

- **Sensor AWAC** for current profil & directionnel wave
- **Sensor Aquadopp**, for current & non directionnel wave.
- **Sensor SBE37 Seabird**, une sonde CTD (salinity temperature & pressure.



Wave height with the period



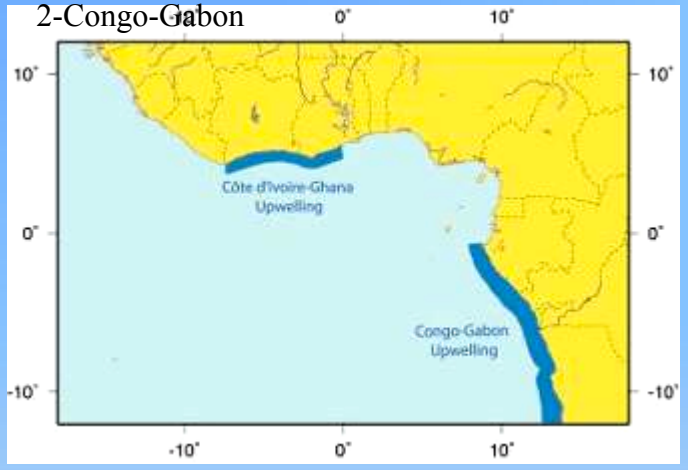
Tide Trends

Main scientific context: The coastal upwelling in the GG

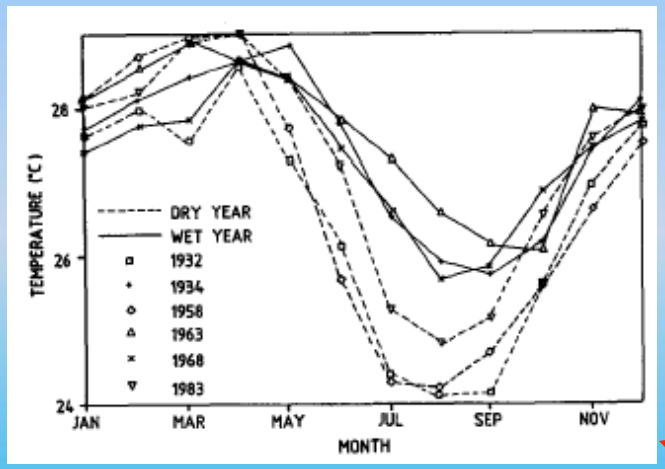
TWO MAIN COATAL UPWELLING REGIONS:

1-Côte d'Ivoire-Ghana

2-Congo-Gabon



(Source: courtesy of Claude Roy, IRD)



Coastal sea surface temperature during particular « wet » and « dry » years in Ghana (Opuko-Ankomah et Cordery, 1994).

-Two upwelling seasons:

-Main upwelling season from June to September;

-Minor upwelling season from January to March.

=> **Alternative mechanisms have been suggested** (for the Côte d'Ivoire-Ghana upwelling):

-Current induced upwelling *(no; may contribute)*

-Cape effect *(no; may contribute to maxima)*

- Regional wind (not main cause…)

-Remote forcing by trapped Kelvin waves

(yes; strong evidence of their impacts…)

-etc.

- Ecological implication: Wind mixing and nutrient input seem decoupled (non-Ekman type upwelling?)

- Strong interannual variability

- Potential regional climate impact?

=> monitoring & dedicated studies…

Other motivations: coastal erosion & environment

Kpogan, Togo, *3m de recul d'août à nov. 2005*

Cotonou, Bénin, *PK 10, Hôtel PLM, 29 oct. 2005*

Causes :

- littoral management (ports, dams…) => weakening of the sediment flux
- augmentation of the wind amplitude (=> of waves) ? *(not proven !)*
- sea level changes

⇒ Wind historical data analysis

⇒ Analyze of waves energy and transport conditions

⇒ Analyze of the different potential processes and their relative importance!

Regional MASTER 2 of Physical Oceanography and Applications (MROPA) (1)

How it works:

- Co-diplomation/habilitation between University Abomey Calavi (Cotonou) and University Paul Sabatier (Toulouse)
- International level (Unesco, Chaire of Mathematical Physics and Applications)
- 10 researchers/teachers / year (courses & assistance for training periods in research) *(Legos/UPS-Toulouse, Us IMAGO-Brest, Locean-Paris, Total)*
- Research training period of 5 months (generally supervisor at distance, local assistance)
- When possible, formation at sea during Pirata cruises (done in 2009, planed in 2011)

Courses:

- 1) Computing, fluid mechanics, statistics, waves theory
- 2) Introduction to Physical oceanography/climate, teledetection, ocean dynamics,

Chemistry and biochemistry, offshore, advanced dynamics, sedimentation, numerical modelisation, Statistics applied to climatology.

1st results:

2008-2009: 11 students: 5 Bénin, 2 Togo, 3 Nigeria; 7 passed (3 mentions Bien).
5 students in PhD thesis in October 2011 (time delay to get grants/position!),
(2 in Grenoble, 2 in Cotonou, 1 between Toulouse & Cotonou: Salinity in the tropical Atlantic)

2009-2010: 10 students : 3 Bénin, 2 Togo, 2 Cameroun, 2 Nigeria, 1 Ghana, 1 Côte d'Ivoire
9 passed (2 mentions Bien). 1 students in PhD thesis in Cotonou (ressources)
1 grant to UFCP/RECIFE (thanks to FACEPE) on a Pirata Tace topic! (one grant pending).

2010-2011: 9 students: 2 Cameroun, 3 Togo, 2 Bénin, 1 Ghana, 1 Sénégal
1 Thesis with University of Bordeaux and University de Legon (Ghana), 1 IFREMER/TOTAL in Brest, 1 at UFCP/Recife, Brasil, 1at Mac Gill University (Canada)

Regional MASTER 2 of Physical Oceanography and applications (MROPA) (2)

This MASTER is the ONLY one (to our knowledge) totally dedicated to oceanography in Africa.

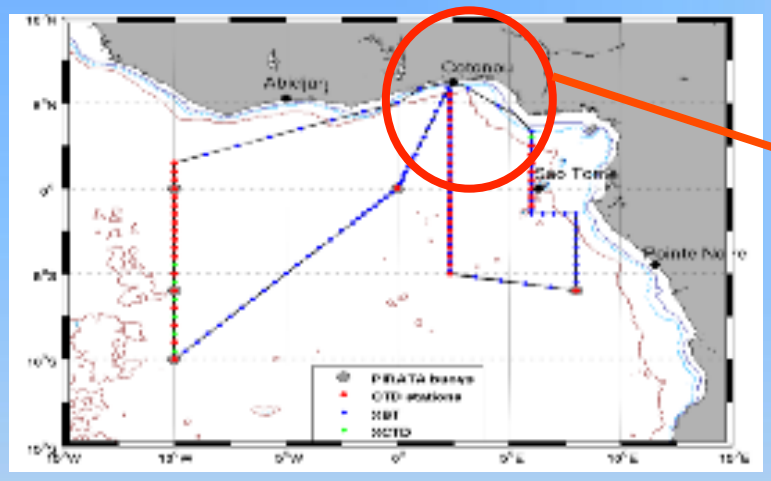
It responds to a strong demand of African partners.

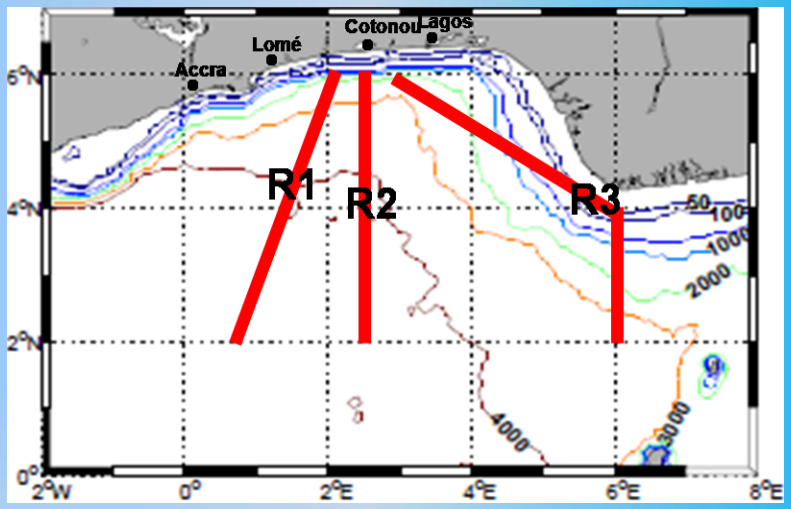
It is a « source » for potential efficient African PhD students on topics related to climate science, everywhere (France, Brazil, USA, India, Africa….)

Collaborations to be established (or reinforced) with regional universities AND other Universities in Africa, ie CapeTown (South Africa) BUT also with other countries (Brazil, US, Germany…).

One of the ways to involve Africa in international Science & Observations networks, (Africa is one of the region that should be the more impacted by climate change…) and also in their own country development (coastal and ressources management, coastal erosion monitoring, energy from ocean, ports…).

2nd ex: Analysis of hydrologic conditions and currents in Gulf of Guinea from *in situ* observations *(2005-2007 : 6 Egee / Pirata cruises)*

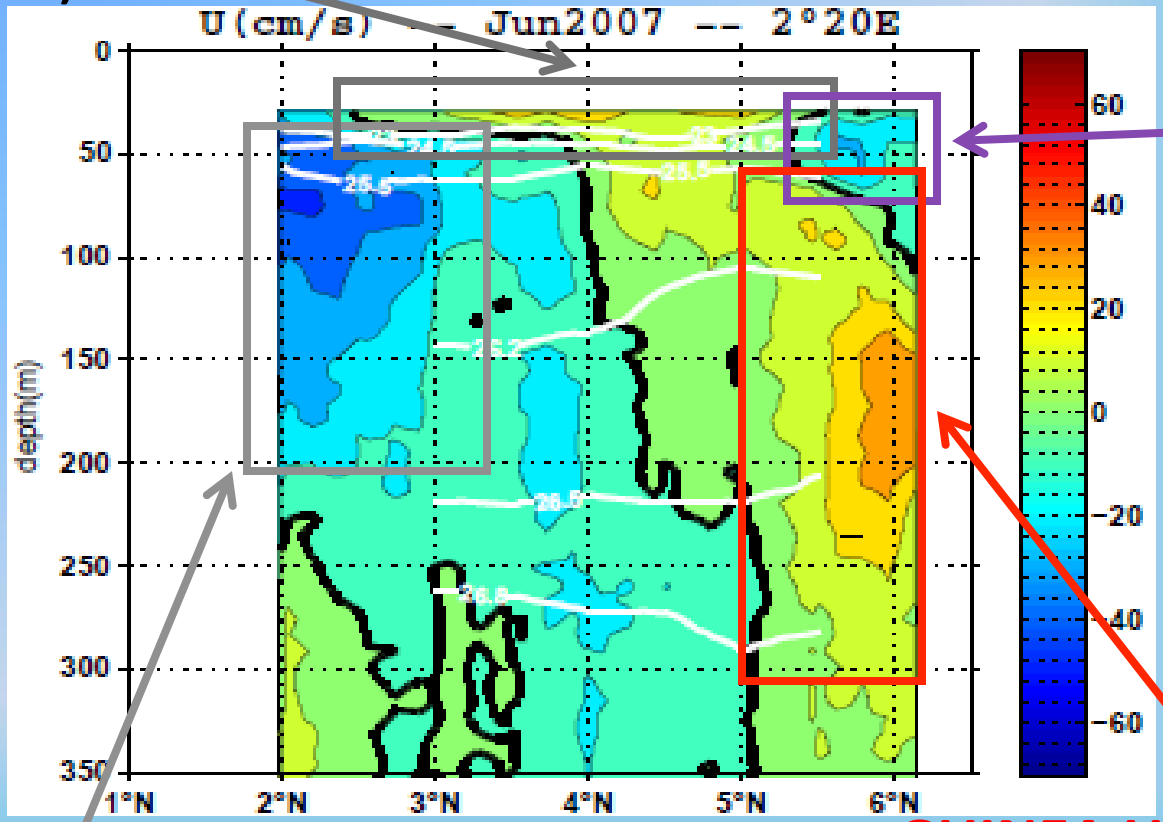




CURRENTS MEASUREMENTS (Master2 works)

Guinea Current(GC)

⇔4 ZONAL CURRENTS MEASURED

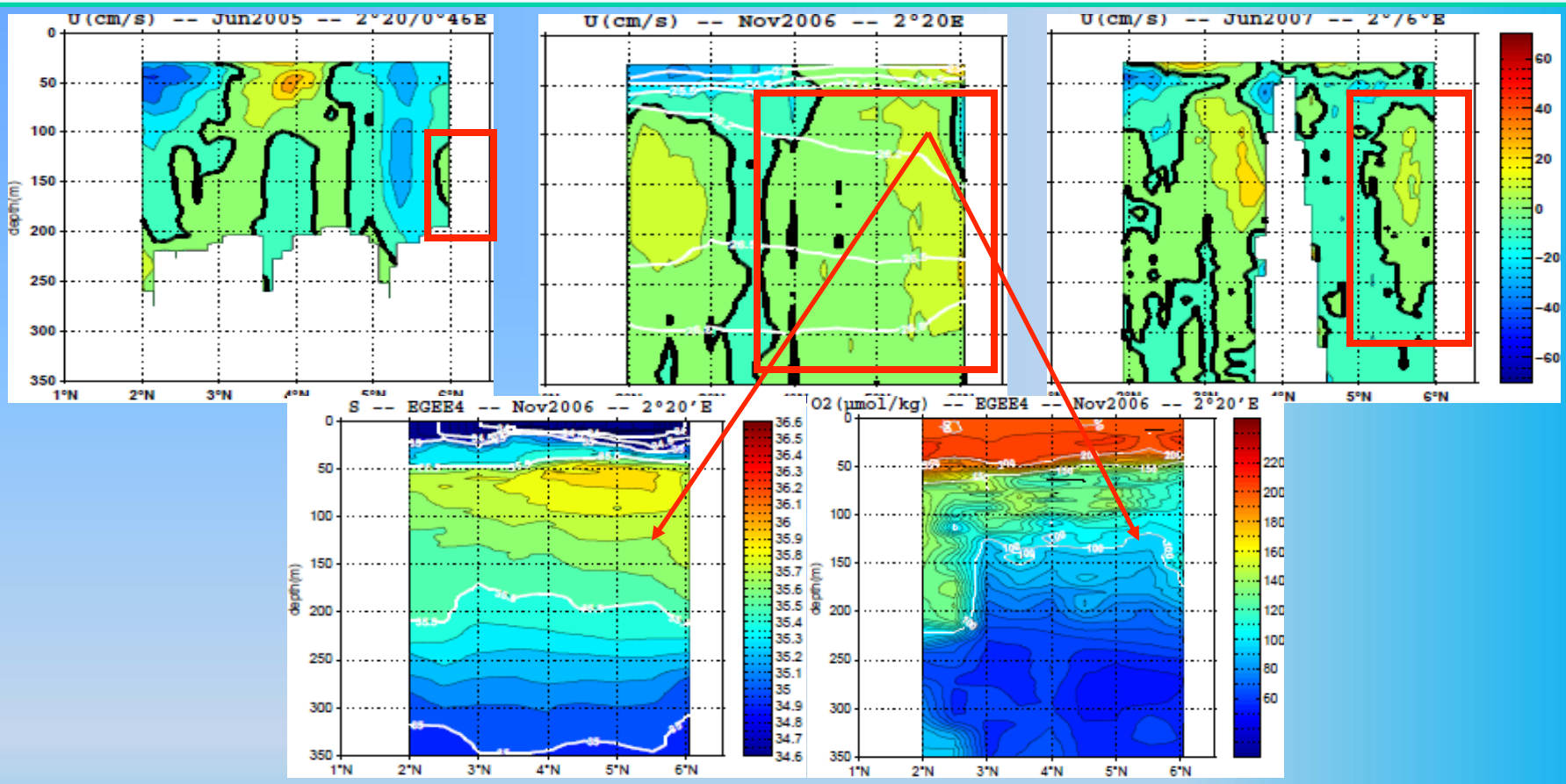


Guinea Counter Current (GCC) (name adopted because of its opposite direction relatively to GC)

deep branch of South Equatorial Current (nSEC)

GUINEA UNDERCURRENT (GUC) (name adopted because flow under GC)

ORIGIN OF GUC (Master2 works)



⇔GUC is observed along R1, R2 and R3 during EGEE period and characterized by a relative maximum of salinity(~34,8) and dissolved oxygen (120µmol/kg)

⇔ GUC origin hypothesis :

- Local recirculation?
- North Equatorial UnderCurrent(NEUC) extension?

PERSPECTIVES

The PROPAO efforts are continuing in the framework the ALOC-GG JEAI program (2011-2014), carried out in coordination between Benin and Côte d'Ivoire:

Goals: maintain the coastal network, reinforce and continue regional collaboration & capacity building Through PhD thesis on priority topics (coastal upwelling, coastal erosion, resources…).

- Maintenance & potential coastal network extensions (east/west)
- Develop and maintain over the long term a network of coastal autonomous measurements along the northern coast of the Gulf of Guinea (mainly sea surface temperature, meteorological measurements);
- Establish and maintain a databank of regional oceanic and atmospheric measurements (sea temperature, salinity, currents, weather and wind-);
- Carry out joint research priority for the sub-region, linked to the variability of climate and ocean conditions along the northern coast of the Gulf of Guinea (upwelling, currents, resources, erosion);
- Encourage training and formation in Oceanography in regional universities, and research in partner laboratories.

MANY THANKS