



African Monsoon Multidisciplinary Analysis (AMMA)

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AMMA-International Scientific Steering Committee (Executive):

Jean-Luc Redelsperger (France, Chair)

Ernest Afiesimama (Nigeria, AMMA-Africa)

Arona Diedhiou (France, AMMA-Africa)

Serge Janicot (France)

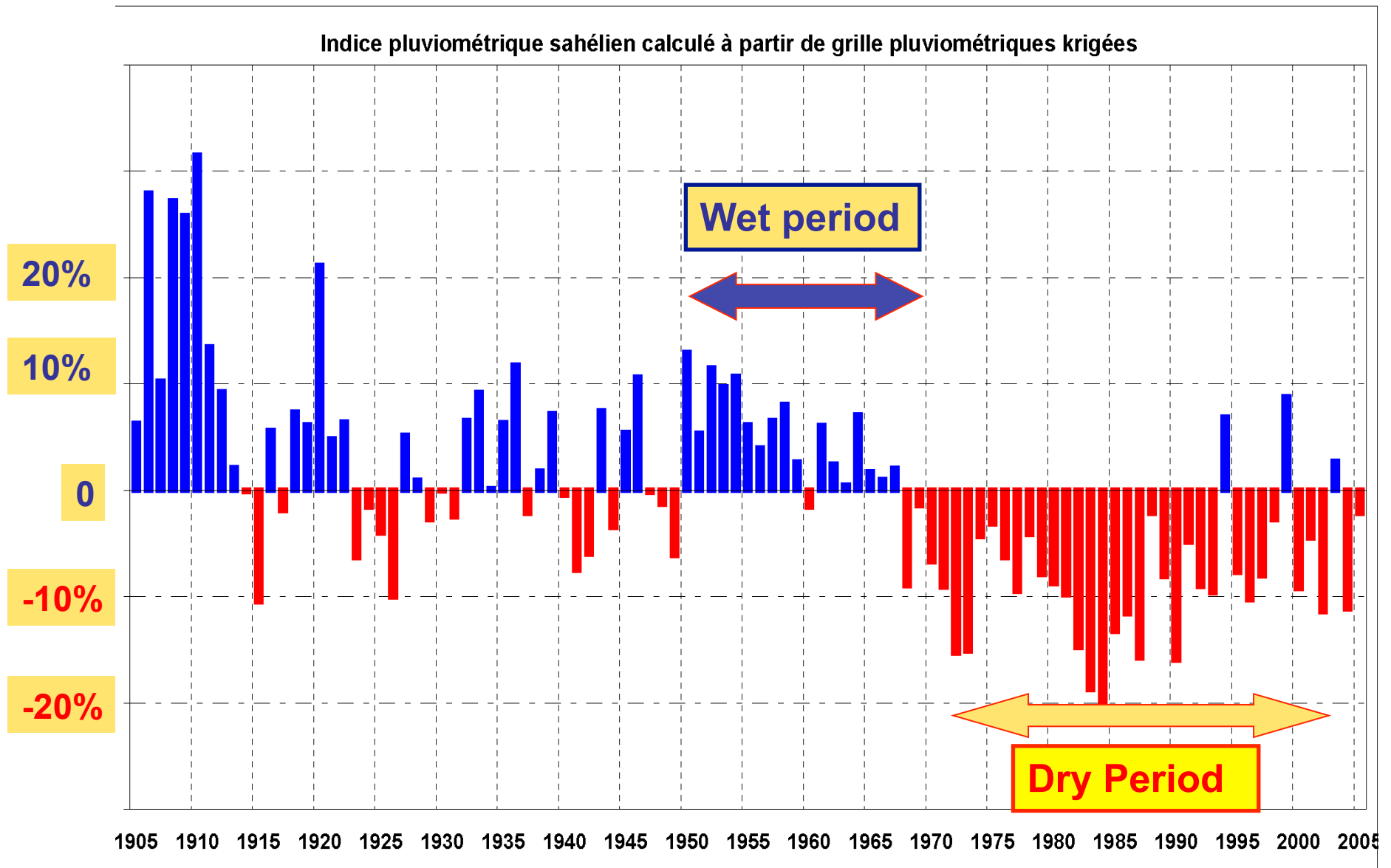
Thiery Lebel (France)

Doug Parker (UK)

Chris Thorncroft (USA)



The largest regional deficit of rainfall observed during the last century



Uncertainties about the future

Multi-model projected patterns of precipitation changes

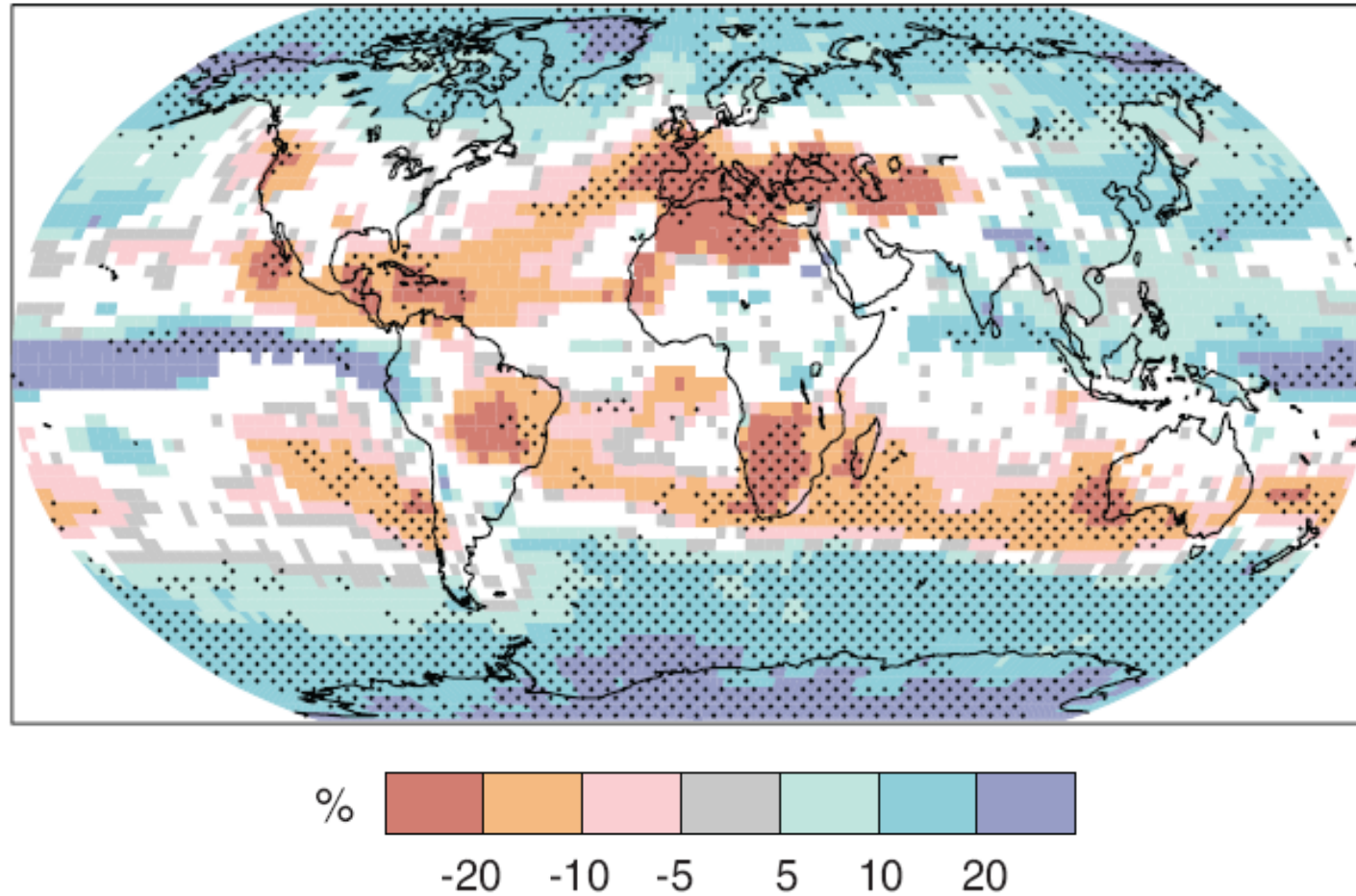


Figure 3.3. Relative changes in precipitation (in percent) for the period 2090-2099, relative to 1980-1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {WGI Figure 10.9, SPM}

Climate Variability Impacts:

Water
Agriculture
Health
Demographics
Security



This Talk

1. Overview of AMMA Phase 1 (2002-2010)
2. Capacity Building in AMMA
3. AMMA Phase 2 (2010-2020)

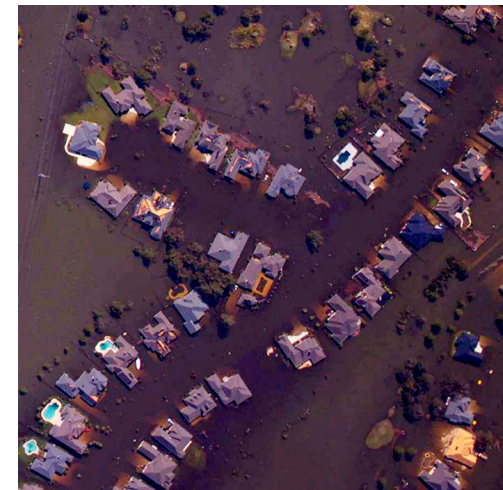
Dry spells




Flooding: Ghana 07



Flooding: New Orleans 05



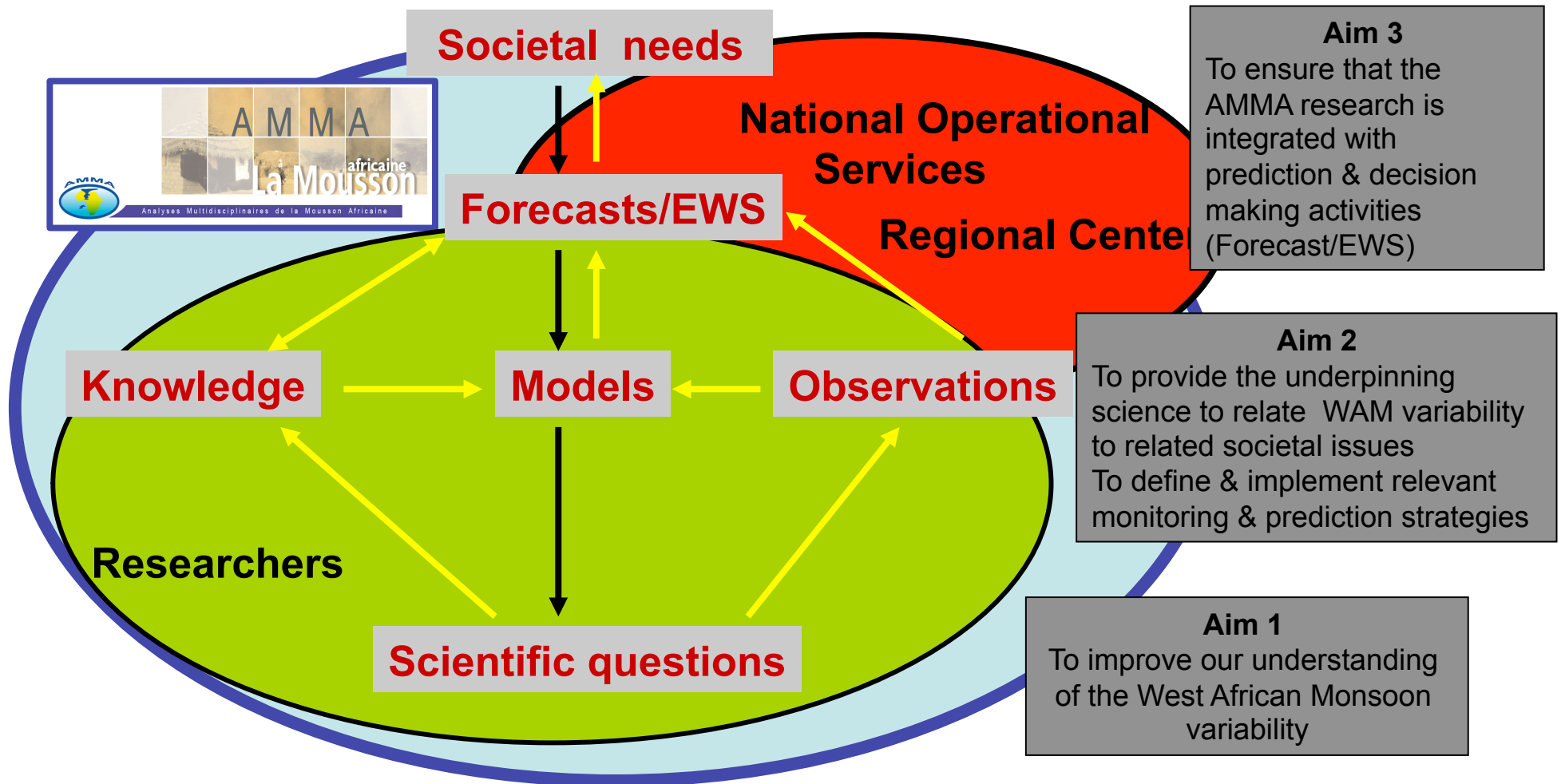
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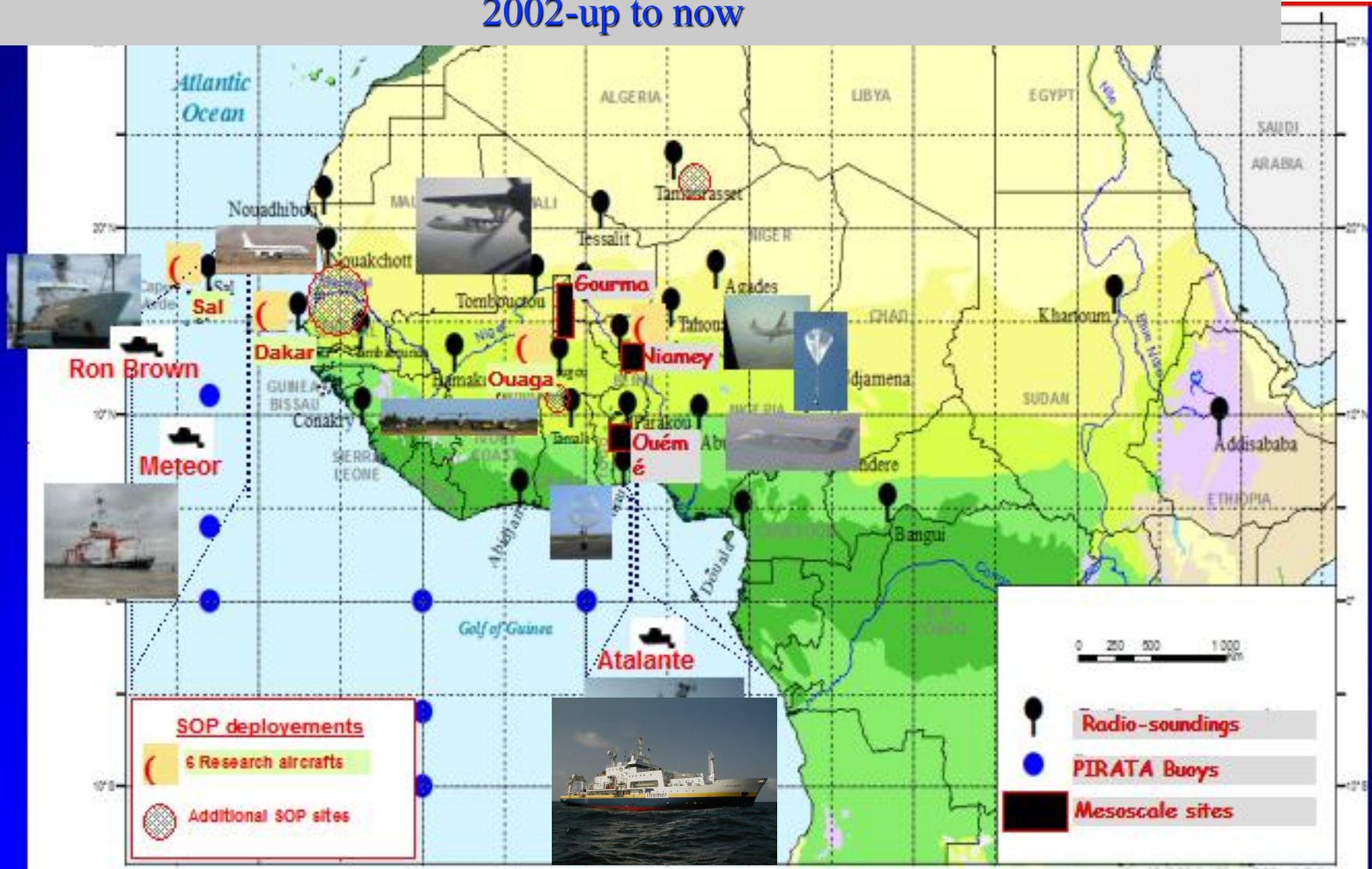
African Monsoon Multidisciplinary Analyses
Afrikanske Monsun: Multidisiplinære Analyser
Afrikaanse Moesson Multidisciplinaire Analyse
Analisi Multidisciplinare per il Monzone Africano
Afrikanischer Monsun: Multidisziplinäre Analysen
Analisis Multidisciplinar de los Monzones Africanos
Analyses Multidisciplinaires de la Mousson Africaine

AMMA: African Monsoon Multidisciplinary Analysis

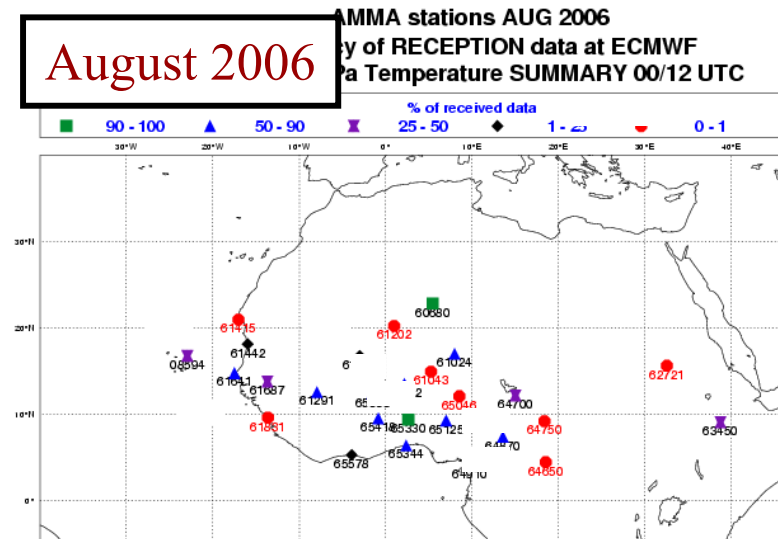
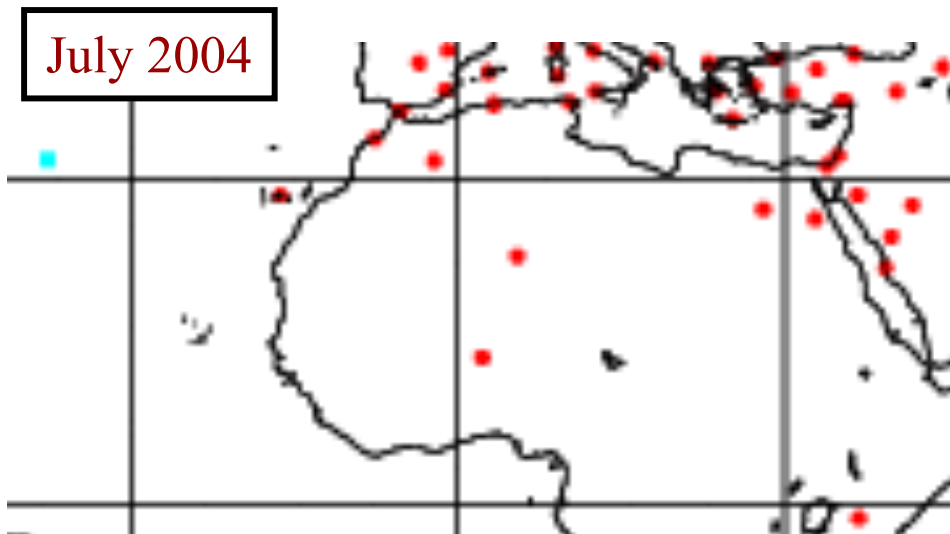
An international program on West African monsoon variability and society-environment-climate interactions



First ocean-atmosphere-land regional campaigns of observations in Africa: 2002-up to now



Restoring the West African radiosonde network necessary to make forecasts & to monitor climate



- Greatest density of atmospheric soundings ever launched with 21 active stations
- 200 radiosonde operators and technicians working on the network + students and researchers from Africa, the Americas and Europe

AMMA: Established an International Community

Coordination : Multiisciplinary, Different communities
International : ~600 people from 30 countries

Africa : ~250 pers ; **Research and Application (Forecast/EWS) communities**

Training/Education: PhD (160 incl **80 Africans!!**) Masters, Summer Schools, Workshops
Communication (external & internal)

AMMA coordinated with international programmes and bodies



Research field experiments / Database & library

Observation networks; Modelling; Satellite Products tailored & validated

2. Capacity Building in AMMA

Right from the beginning of AMMA in 2002 capacity building was recognized to be crucial – both for the success of AMMA but also for the future of Climate Variability and Impacts Research in the region.

It remains a high priority for AMMA.

It remains a challenge to fund.



Capacity Building and Training in AMMA: Results from Phase 1

- (i) A coordinated African community
- (ii) Doctoral Studies
- (iii) Workshops and Summer Schools
- (iv) Database



(i) A Coordinated African Community: Some History

February 2002 at Niamey, AMMANET was created during the first AMMA-International meeting. AMMANET was a network of scientists supported by the National Meteorological and Hydrological Services (NMHSs), African universities and the regional centres (ACMAD, AGRHYMET, ASECNA) with a coordination committee (CSAM) and national focal points.

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November 2003 in Cotonou, African scientists were mandated to prepare the African Scientific Plan. This initiative, one year after the creation of AMMANET was motivated by a real need of the different members of the network to get involved actively in the implementation of the AMMA in Africa and to be fully engaged in AMMA, working in close collaboration with the other parts of the program (France, Europe, UK, USA).

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November 2004 at Niamey, with the financial support of IRD and the logistical support of ACMAD, the CSAM held its first meeting with the objectives to produce in one week a consistent set of 5 volumes based on the inputs from the thematic leaders and produced the first version of the African Involvement Plan (PIAF). By this time, AMMANET became AMMA-Africa.

(i) A Coordinated African Community: AMMA-Africa Science Plan

The PIAF was based on more than one hundred detailed inputs received from African universities, research institutions and NMHSs. The difference between this plan and other European and American components of AMMA are:

Emphasis was on

- (1) Impacts and applications,
- (2) Demonstration projects and
- (3) Training and Capacity Building that include problems and needs of African universities and NMHSs.

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By 2005, the PIAF has involved 36 African institutions with 89 research projects of duration going from 3 to 5 years at local and regional scales. In terms of human resources, near 200 researchers, 40 scientists and technicians and 72 students (Master and PhD) have benefited from this initiative. Also, By the end of 2005, 5 centres (ACMAD, AGHRYMET, ASECNA, 2IE(EIER), CERMES) were funded in the frame of `the consortium of the AMMA European project (Consortium AMMA-EU) for the implementation of AMMA-EU contract.

(i) A Coordinated African Community: Major Achievements

- (a) Participation of AMMA-Africa to the field campaign. The « Field Schools » over the research observatories (ORE) in Mali, Niger, and Benin and during the SOP, in Burkina Faso, Guinea Conakry and Senegal has involved around 20 engineers, technicians from the NMHSs**

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- (b) Europe/AMMA-TTC: Support to 17 African national research institutions and operational services for the period 2007-2009 and for impact studies.**

- (c) FSP RIPIECSA: 56 African institutions involved in interdisciplinary research on interactions between climate, ecosystems and societies;
25 projects funded by RIPIECSA,
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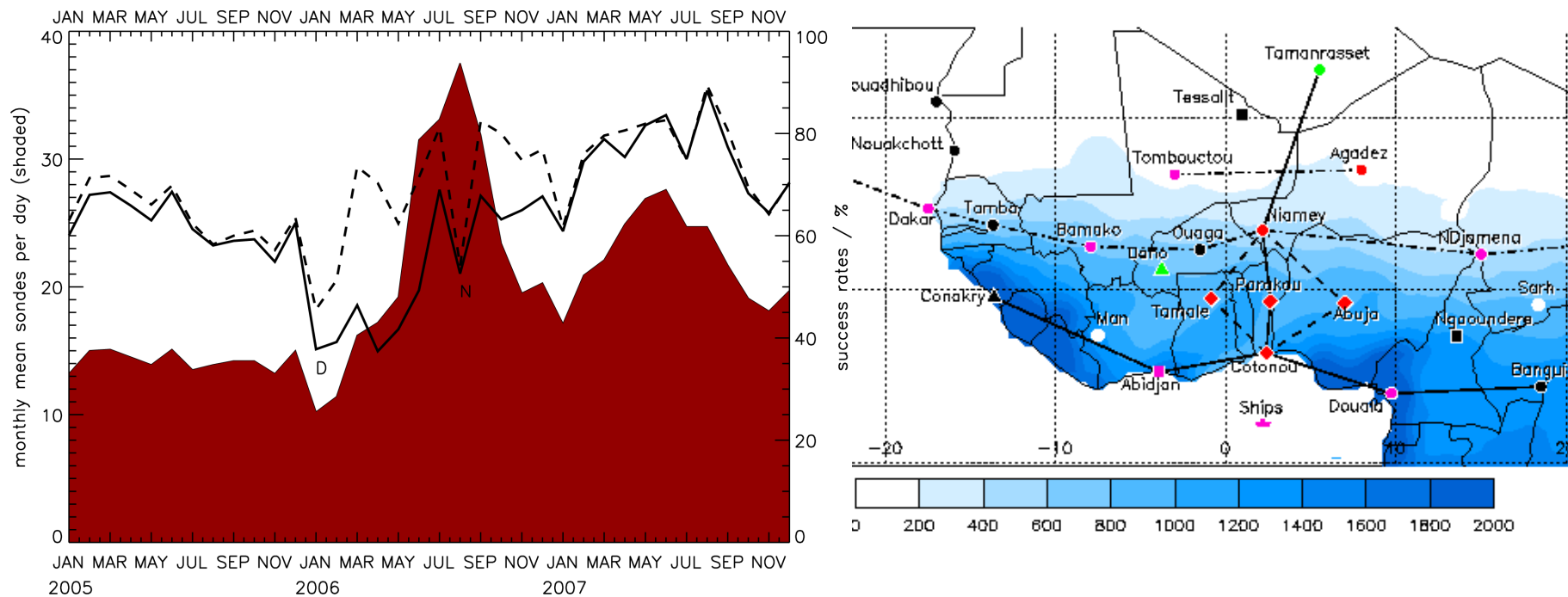
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- (e) Increased network of observing stations of the West African Monsoon System (see next slides)**

AMMA Radiosoundings: A Major Achievement of AMMA



AMMA Radiosoundings: A Major Achievement of AMMA

- The AMMA radiosonde budget was about 2.5 MEu.
- Operational agencies in the region launched the great majority of these sondes. Around 50% of these were the routine operational commitment, which has continued by and large.
- A significant fraction of the data were not communicated to the GTS.

Outcome Example: Forecast for civil security (Aviation, Floods, etc)

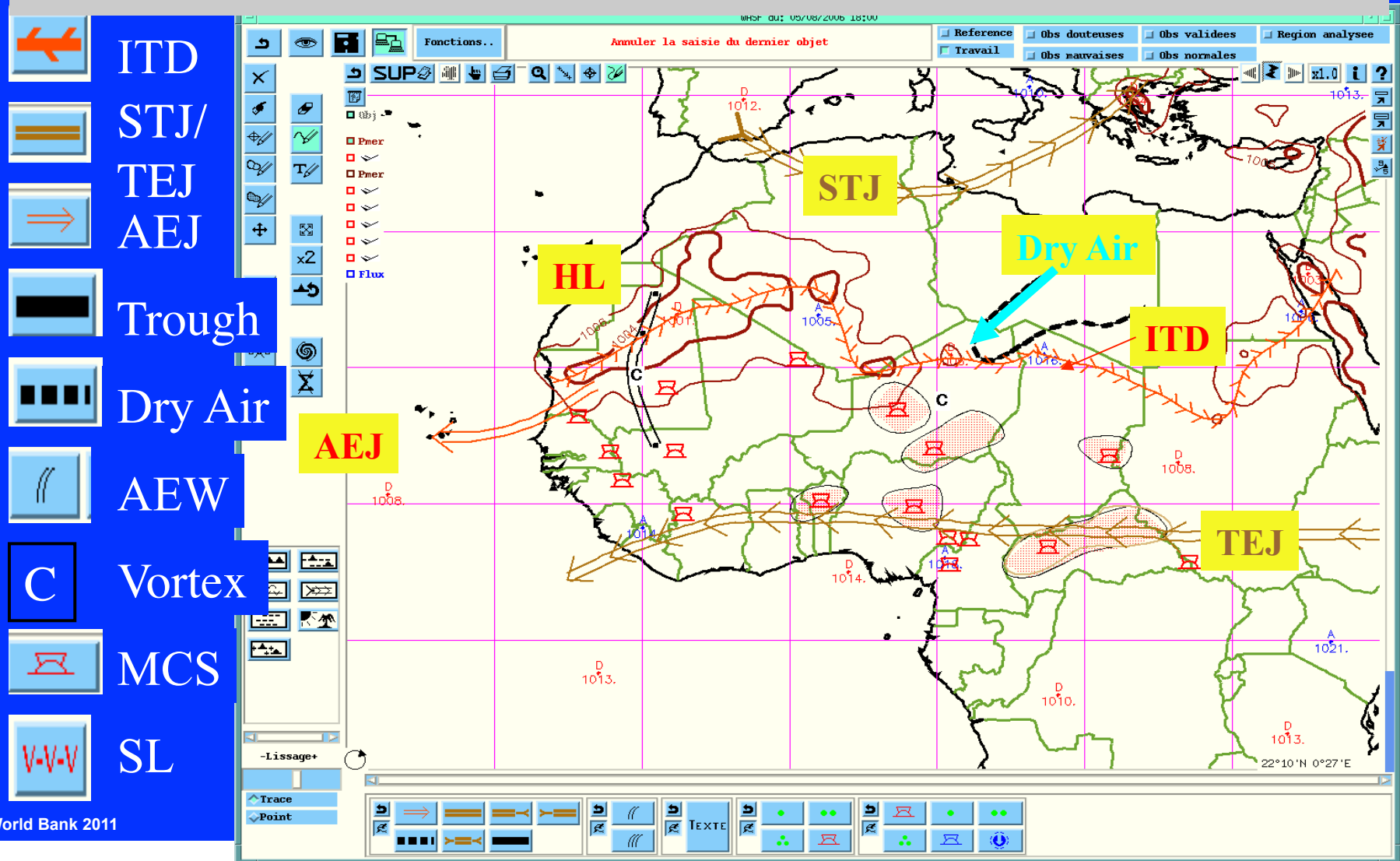
New forecasting methods in Africa
Knowledge transfer Researchers ↔ Forecasters



AMMA, ACMAD, Météo-France, OMM, Services Météo Nationaux Africains

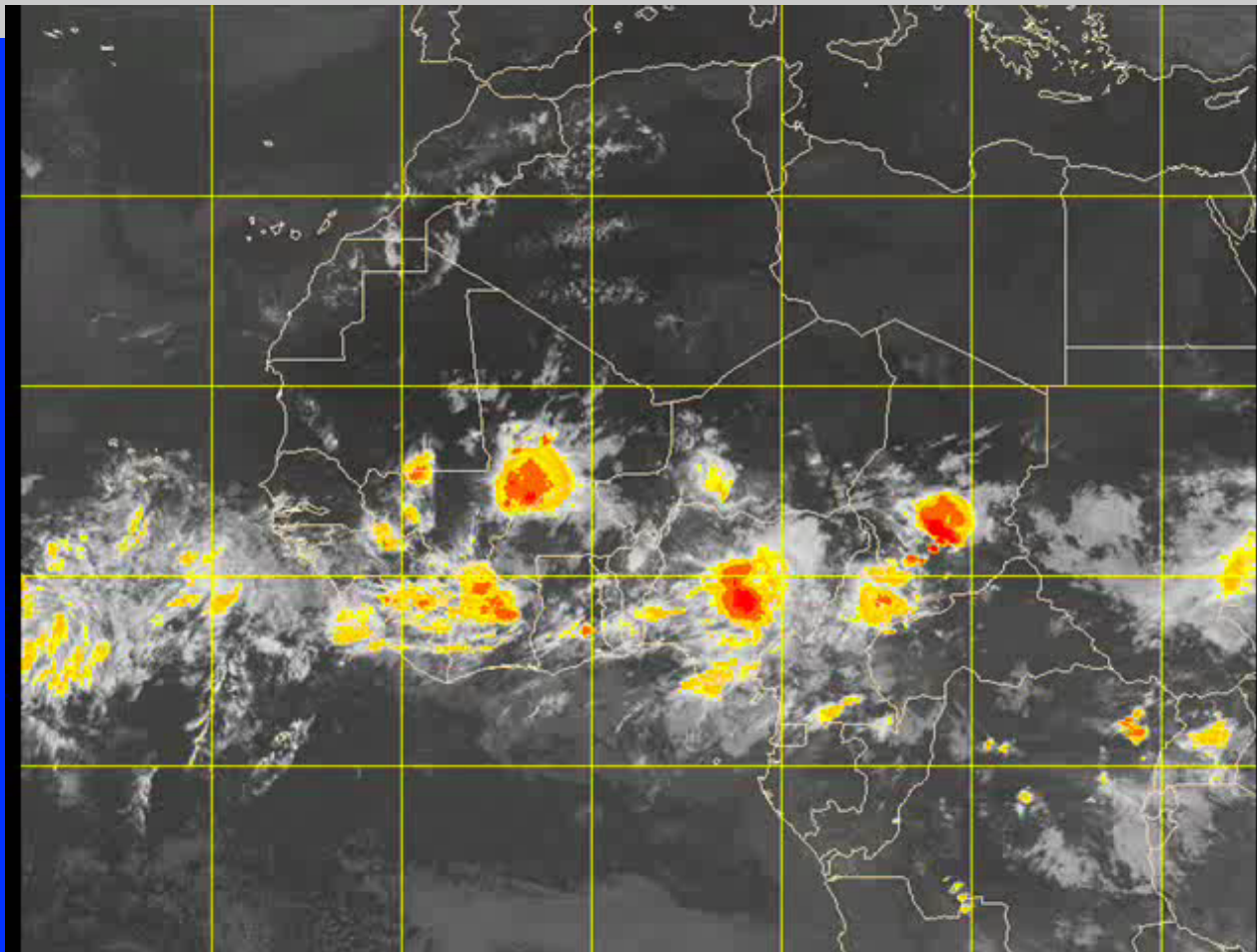
Outcome Example: Forecast for civil security (Aviation, Floods, etc)

Creation of a synthetic map for weather analysis and forecast



Outcome Example: Forecast for civil security (Aviation, Floods, etc)

Following storms in real time: development, intensity, travelling, ...



Outcome Example: Forecasters' Handbook for West Africa

- Forecasting for the midlatitude countries meets the needs of its main customers (aviation and shipping, power generation, etc.) with excellent 1-to-3 day forecasts.
- In Africa, the advances enjoyed in forecasts for other parts of the world have not been achieved, and the forecasts are not well exploited by the primary customers (agriculture, planners, aviation, ...)
- Good forecasting practice for Africa exists in the continent, and in other countries (e.g. USA, EU) but is not documented nor well communicated.
- There is a vicious circle in which observations are not supplied from Africa to the US/ EU forecasting centres, because the African organisations do not regard the products supplied in return by those centres as high quality / valuable.

Outcome Example: Forecasters' Handbook for West Africa

- The forecasters' handbook aims to:
 - Document existing best-practice for the region;
 - Import and test new ideas from other parts of the world;
 - Exploit new scientific results from AMMA (e.g. use of land-surface remote sensing for daily to intraseasonal forecasting).
- The project has formal WMO / WWRP / THORPEX-Africa support; ACMAD is leading the management.
- We hope to publish this as a commercial book (this option is preferred by the African participants).
- Target timescale for completion: 2012-13.

(ii) Doctoral Studies

Around 80 African students are performing doctoral studies and 39 students have already defended their PhD thesis within the framework of AMMA

RIPIECSA project supported 35 African students at the Masters level, 26 students on AMMA doctoral studies, and 54 technicians and engineers from national services.

Challenge: Need to “support” Africans returning to Africa.

(iii) Workshops and Summer Schools

AMMA workshops and summer schools have been organized bringing together students, researchers and forecasters from Africa and around the world to participate in lectures in Tropical Meteorology and Climate with a special focus on the West African Region:

- France,-AMMA Summer School on African Monsoon, September 1-12 2003 Lannemezan
- AMMA Professional training workshop for forecasters, June 2005, Niamey, Niger
- AMMA Training workshop for agricultural modeling, December 2005, Thiès, Senegal
- AMMA Radio-sounding training in various places 2006
- AMMA Summer School ,1st Ewiem Nimdie International Summer School in Tropical Meteorology and Climate, co-funded by the British Council, 2008, 2010 Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana
- AMMA Summer School, Climate Change and Water Resources, November 9-20 2009
- Université Cheikh Anta Diop, Dakar, Senegal.

This series of workshops and schools should continue in the long-term, funded by different national and international sources.

Education in Meteorology and Climate in West Africa

- New degree programmes in Meteorology and Climate Science have been established at KNUST, Kumasi, Ghana.
- The degrees were designed using best practice from Europe and across Africa, with assistance from Nairobi, Botswana, Pretoria and Akure (Nigeria).
- These have been launched with two flagship, bi-annual Summer-Schools (2008, 2010)
- The degrees are taught and attended by African scientists, and are financially independent. The summer-schools provide periodic exposure to, and engagement with the international community. African / non-African participation of staff and students is about 50:50.
- The Summer Schools require some (~ \$30k) external funding for the costs of non-Ghanaian African students, **uncertain whether there will be a 3rd in 2012.**

Ewiem Nimdie Summer School July 2008





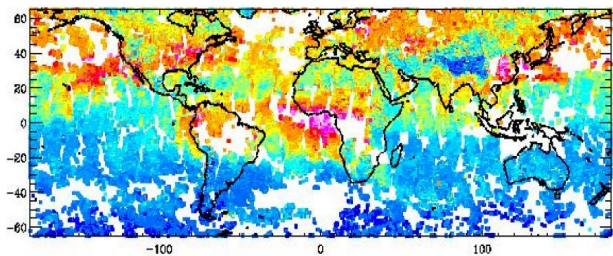


(iv) Database

The AMMA database has been mirrored in Africa at AGHRYMET Regional Centre in Niamey and has operational there since January 2009.

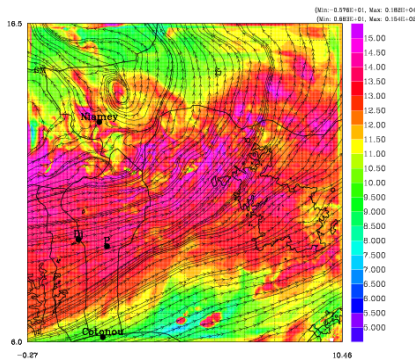
Users can now access metadata and request data through one or the other of two equivalent gateways: <http://database.amma-international.org> or <http://amma.agrhymet.ne>.

Satellite data

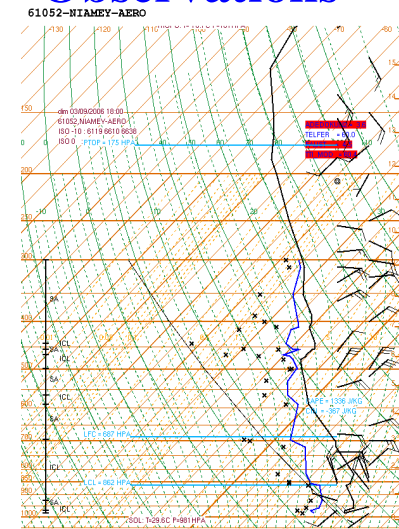


Streamlines and Vapor content (g/kg) on 850hPa + relief-800m

Model data



AMMA Observations



- * AMMA Articles
- * Qualitative Data (e.g. questionnaires, socio-economic)

3. AMMA Phase 2 (2010-2020)

Recall the Aims:

Aim 1

To improve our understanding of the West African Monsoon variability

Aim 2

To provide the underpinning science to relate WAM variability to related societal issues
To define & implement relevant monitoring & prediction strategies

Aim 3

To ensure that the AMMA research is integrated with prediction & decision making activities (Forecast/EWS)

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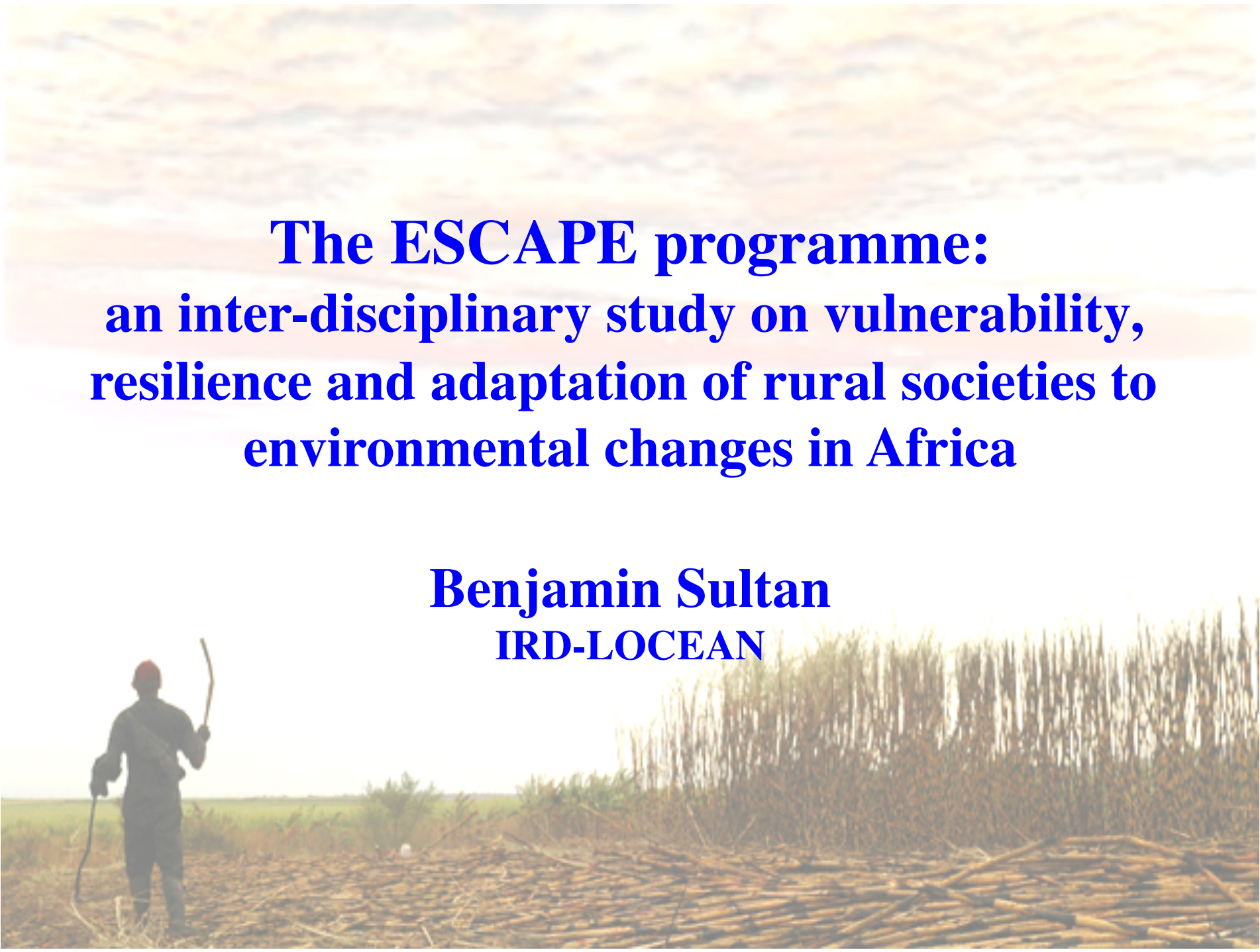
Will receive greater emphasis
In phase 2

3. AMMA Phase 2 (2010-2020)

Updated International Science Plan completed December 2010
www.amma-international.org/IMG/pdf/ISP2_v2.pdf

Research Themes:

- (i) Interactions, Society, Climate
- (ii) Weather, Seasonal and Climate Predictability and Prediction
- (iii) Monsoon System

A person wearing a red cap and dark clothing is harvesting sugarcane in a field. The person is holding a machete and is standing in a field of harvested sugarcane stalks. The background shows a large field of standing sugarcane stalks under a bright, hazy sky, suggesting a sunset or sunrise. The overall scene is rural and agricultural.

**The ESCAPE programme:
an inter-disciplinary study on vulnerability,
resilience and adaptation of rural societies to
environmental changes in Africa**

**Benjamin Sultan
IRD-LOCEAN**

Sub-Saharan Africa is the most food-insecure region today...

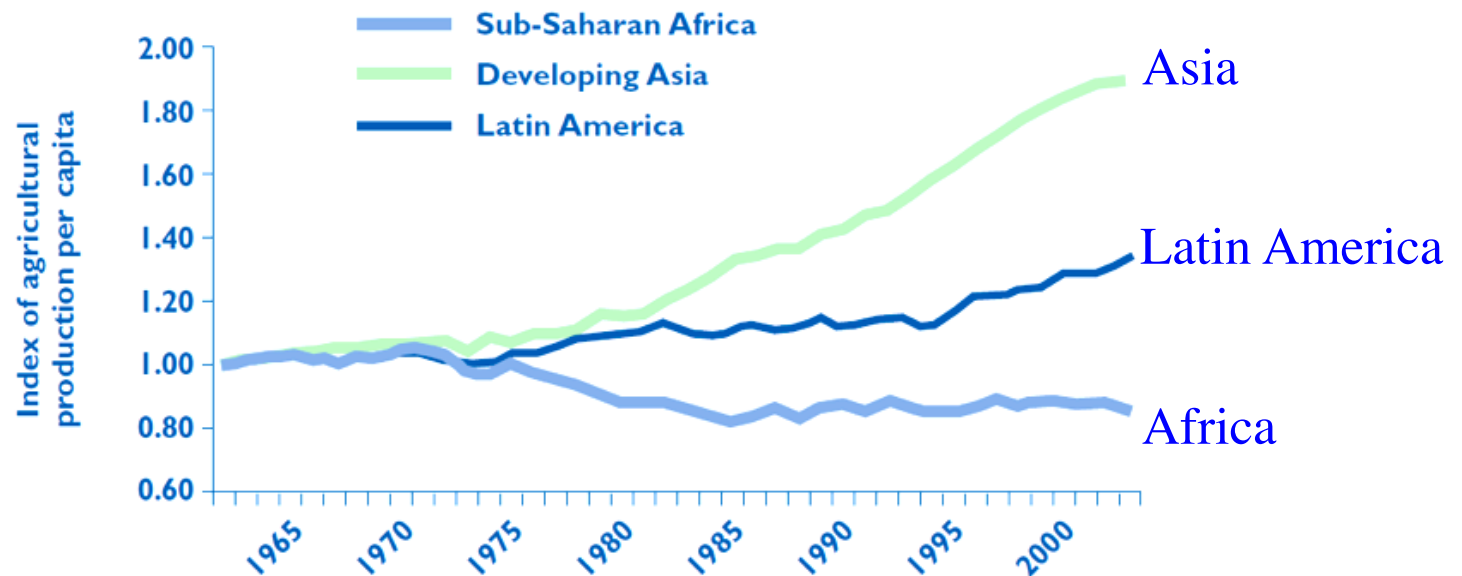


1/3 of the population is facing widespread hunger and chronic malnutrition

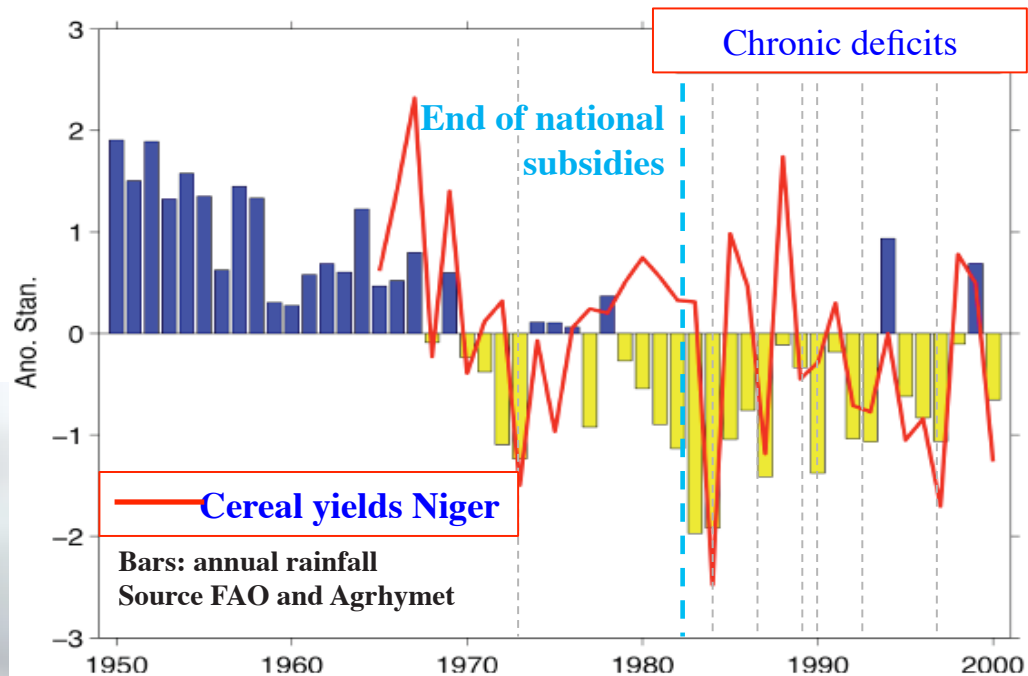
Rural households whose livelihood is heavily dependant on traditional rainfed agriculture are highly vulnerable

Despite an increased food production in the last decades, the agricultural sector is facing the difficult challenge of feeding a rapidly rising population

Trends in agricultural production (Haggblade et al. 2004).



Climate variability: a constraint to intensification



The drought in the Sahel (but also economic factors) has severely impeded agriculture intensification and has kept potential production low.

+ Uncertainties in future climate

Anticipating climate variations and their impacts on agricultural systems is a challenge for food security in Sub-Saharan Africa

Two pre-requisites to beneficial use of climate information (forecasts, projections):

- i. Focus on relevant climate variables for users
- ii. Existence of viable decision options sensitive to climate information

What are the users' needs ?



The most salient rainfall parameters farmers in Burkina Faso want in a forecast (in order of declining priority):

- Onset and end of the rainy season
- Rainfall distribution within the rainy season
- Total amount of rainfall

Ingram et al. (2002 ; Burkina Faso)

To deliver a relevant service climate forecast should consider the critical times for farming activities (i.e. planting) and for plant growth (i.e. grain-filling period)

Klopper et al. (2006 ; South Africa)

At the moment, only the total amount of rainfall is forecast in West Africa



escape

Changements environnementaux
et sociaux en Afrique
passé, présent et futur

Environmental and Social
Changes in Africa
past, present and future



AGENCE NATIONALE DE LA RECHERCHE
ANR



*48 months (February 2011 –
January 2015)*

Two main objectives:

- **Assess the vulnerability of rural societies in West Africa to climate and environmental changes**
- **Explore adaptation pathways to reduce this vulnerability**



Health Impacts – WP « Meningitis »

Resp. Nadège Martiny



Desert dust, Climate and meningitis outbreaks in the Sahel

Inventory :

(i) A group in extension (ETP2008 : 1.5, ETP2010-2011: 5, ETP2012 : 7) (ii) 21 participants among which more international partners, especially in Africa, and WHO

Goals :

- (i) Identify and hierarchize the role of climate (wind, t°, humidity) and dust variables
- (ii) Forecast these variables at adapted spatial scales to evaluate the risks for populations

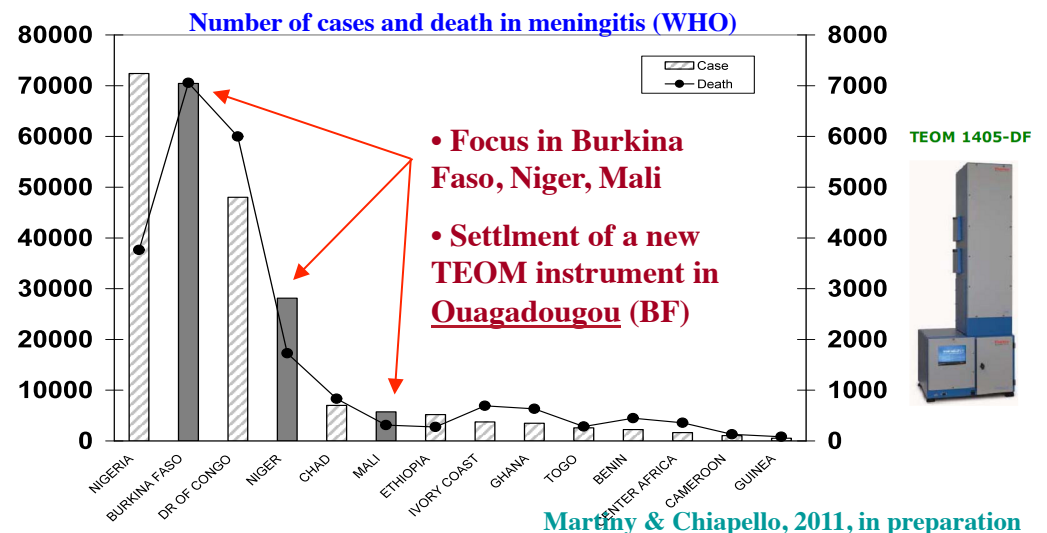
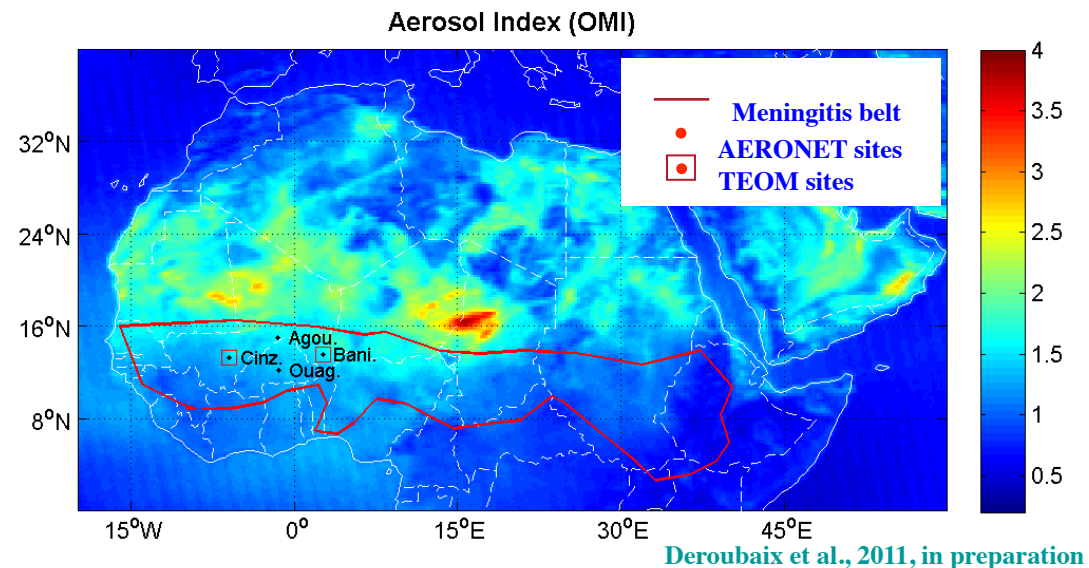
Data & Methods

Remote sensing : TOMS (~1°), OMI (~0.25°) and Aeronet/NASA

Models : CHIMERE-Dust and Regional Climate Models

Fields : Settlement of a new TEOM at the end of 2011

New data sets : West African military archive on « climate & meningitis » since 1900





Health Impacts – WP « Meningitis »

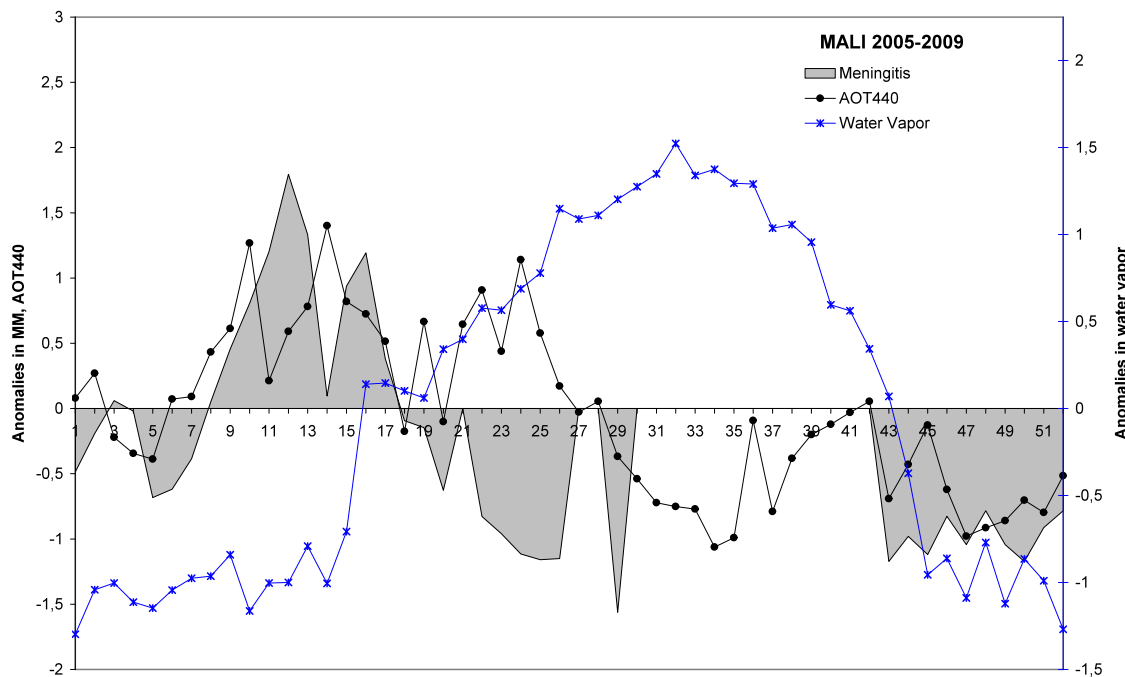
Resp. Nadège Martiny



HYP. Low humidity and dust events fragilize the mucous membranes (especially pharynx), which enables the *Neisseria Meningitidis* bacteria to pass in blood (Mueller & Gessner, 2010)

Main Recent Results :

- (i) In January-February, the combination of a low humidity and the occurrence of important dust events play a major role in the meningitis outbreaks
- (ii) The mean time-lag between the dust events and the increase in number of cases is 1 to 2 weeks, which corresponds to the incubation time of the disease
- (iii) The increase in humidity at the beginning of the rainy season (May-June) stops the epidemics



Martiny & Chiapello, 2011, in preparation

Perspectives :

- (i) Refine these relationships at fine spatial scales by using TEOM data sets, measurements of aerosol concentrations at the surface
A clear need of in-situ data → heavy and expensive operation (on the way... planned in 2011)
- (ii) Model the key variables in the actual and the future in order to forecast the risks for meningitis
Again, a clear need of in-situ data to « calibrate » the models in the actual
- (iii) Better understand the aerosol-climate-meningitis processes
A clear need of measuring what people really inhaled → fastidious and expensive experiment (on the way... planned in 2013)

Environment-Malaria Interactions

Problem

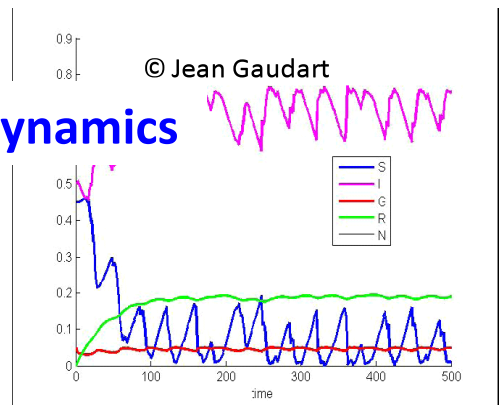
2009: >~225 million cases of clinical malaria and 781,000 malaria-related deaths, mainly in sub-Saharan Africa

Climatic changes and Environmental variability



High heterogeneity of transmission dynamics

Failure of control programs



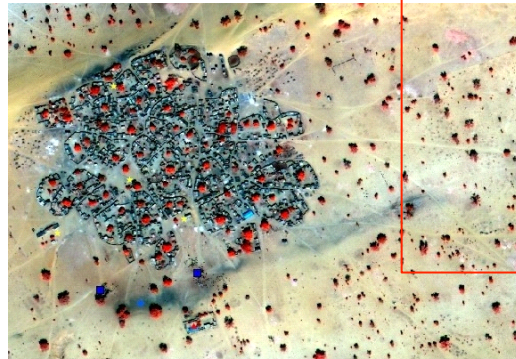
Question:

How to develop sustainable intervention strategies?

Aim:

Understanding the transmission key-factors and interactions between climate, environment (including land use), society, vector, and parasite populations,

Tool:



Field studies

Remote sensing studies

Entomology (Vector behavior and resistance)

Clinical epidemiology (incidence rates, mortality)

Parasite variability, drug resistance, vaccine

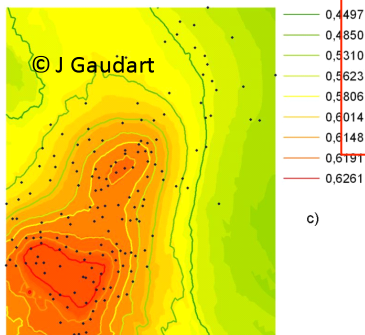
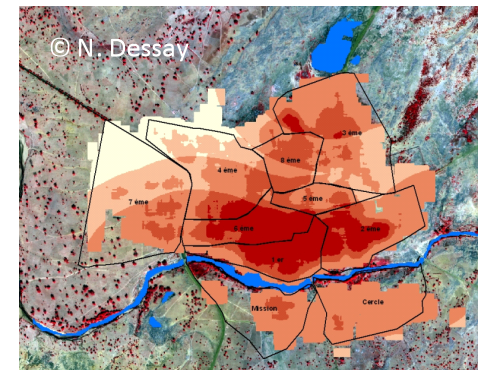
Demography, Economic factors

Land use, urbanization

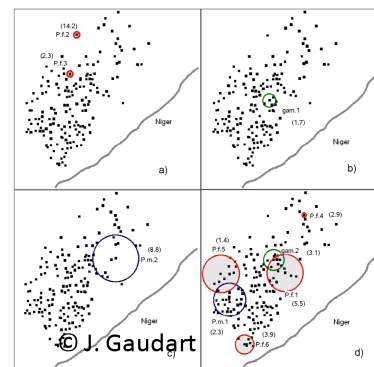
Environment, Meteorology, Hydrology

Results:

Risk Mapping



Targeted control measures



Integrated Focus on West African cities

(Cotonou, Bamako, Dakar, Yaoundé)

Emissions, Air quality and Health : Impacts of aerosols and gases



France : C. Liousse, C. Galy-Lacaux, E. Assamoi, B. T. Doumbia, R. Rosset, P. Castéra, E. Gardrat,

C. Zouiten, G. Uzu, C. Jambert, I. Annesi-Maesano, A. Didier, S. Audry, H. Cachier, B. Guillaume, N. Marchand, A. Ehgere, A. Baeza, S. Val, I. George, J.P. Lacaux

Ivory Coast : V. Yoboué, A. Konaré.

Benin : A. Akpo

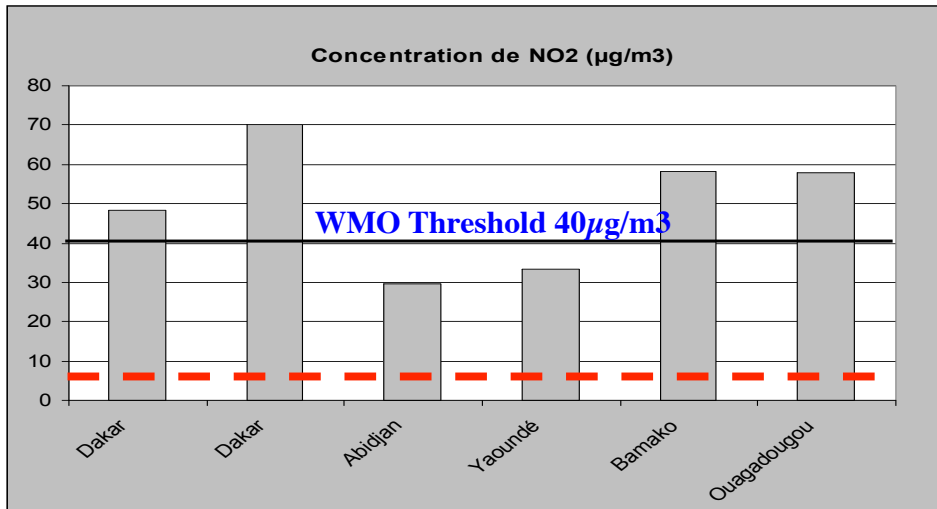
Cameroun : L. Sigha, M. Ouafu.

Mali : B. Diop, O. Koita

Sénégal : A. Ndiaye, A. Diouf, P. Gueye.

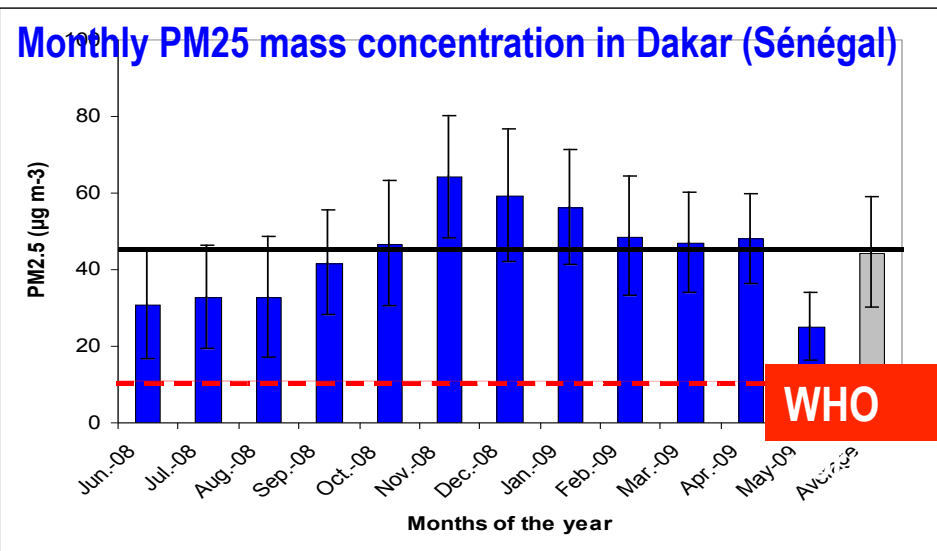
Nigeria : E. Afiesimama

Air quality in Africa : an area not really investigated, however...

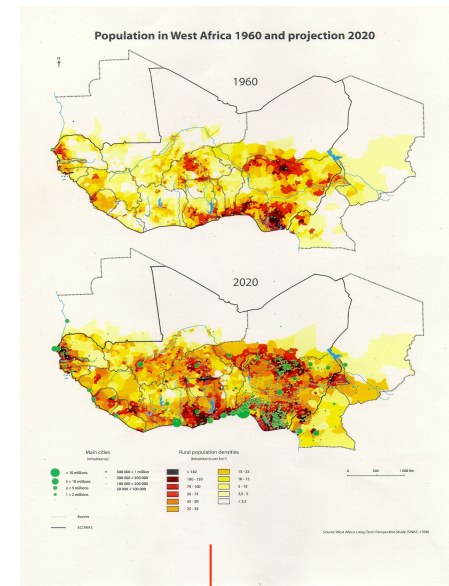


Liousse and Galy, 2010

Concentrations much higher than WHO norms



Doumbia et al., 2011



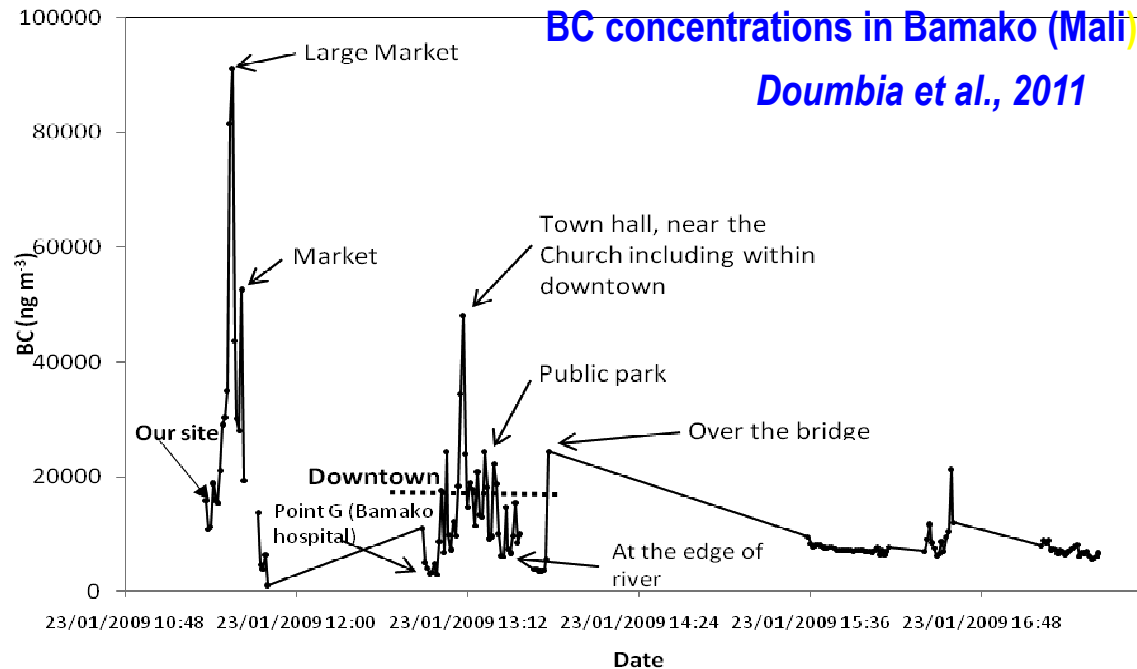
1960

Population

2020

Moreover, pollution expected to increase!

To measure exposure concentrations :



Mobile experiments show that concentrations are highly variable within an african city

**Exposure calculation is needed with personal sampler
(first estimates are on going)**





A real multidisciplinary collaboration is set up between african and european colleagues including physicochemists, toxicologists and epidemiologists.

NEED :

Integrated modeling platform in construction (e.g. dose modeling)

Long-term measurements on pollution (including organic speciation) and health including biological (in vitre tests) and epidemiological studies (population group follow up with blood tests, inquiries..) => focus on different typical african emission source (traffic, domestic sources, flaring ..) in Cotonou, Yaoundé ...

Emissions : flaring emissions need to be documented

Socio-economical aspects (emissions, costs)

A new project : AIIDA (Aerosol Impact on Inflammatory respiratory Diseases in Africa)

- to help decision makers (link emission scenarios/diseases/costs)

- to be linked to climate change studies for emission regulation choice

AIIDA details : project : not yet funded

600 keuros/48 months

Partners :

Laboratoire d'Aérodologie (OMP), GET (OMP), RMCX (Paris), EPAR (Paris)

University of Bamako, Mali.

Centre de recherche en hydrologie, Yaoundé, Cameroon.

University of Cotonou, Bénin.

North-West University, Potchefstroom, South Africa

University of Lagos (Nigeria) (emissions)

University of Cocody (Abidjan, Ivory Coast)(emissions, modeling)

Sites in Africa :

Urban sites : Bamako (Mali), Cotonou (Benin), Yaoundé (Cameroon), Vaal triangle (South Africa)

Background IDAF sites (Katibougou, Djougou, Zoetele, Skukuza)

AMMA-Africa Proposed Projects for Phase 2

Summary of Projects

1. Management of flood risks
2. Management of water for sustainable agriculture in the context of climatic change.
3. Impact of climate change on water resources in the main river basins of West and Central Africa
4. Management of river runoff and soil fertility in rain-fed agriculture in the context of climate variability and change
5. Dynamics and adaptation of agrarian systems to climate variability.
6. Prevention of food crises in West and Central Africa
7. Assessment of Coastal and Marine Ecosystem: Vulnerability and Biodiversity
8. Public Policies in the context of socio-economical impacts of climate change
9. Socio-economic dynamics and perceptions of climate change and adaptation strategies
10. Improved weather/climate prediction and atmospheric composition information for applications
11. Access to observational data for climate related studies
12. Seasonal forecast and Health: Case study on Malaria and Meningitis
13. Cross-cutting capacity building in societal, ecosystems and climate systems

3. AMMA Phase 2: 2010-2020

Updated International Science Plan completed December 2010

Capacity Building and Training:

Observing, monitoring and information systems capacities

Capacities for hydrology, environment, oceanography and meteorology database management and data processing in Western and Central Africa

Fellowships and strengthening resource mobilization in support of research and applications on climate change and adaptation in Africa

Communication, information dissemination and institutional endorsement

AMMA-Africa beyond 2010

About 90 scientists and Administrators from Africa and Europe attended a meeting in February 2009 at Ouagadougou to chart a way forward beyond 2010.

The following Resolutions were reached:

- **That AMMA Africa continues and builds on what has been achieved from Phase 1**
- **That society-based issues should be addressed, particularly on adaptation and mitigation of climate variability and change impacts.**
- **To transfer knowledge, methodology, tools to researchers working on other regions in Africa**
- **That capacity building for African scientists should continue, to meet the challenges of climate variability and change**
- **That there should be strong institutional endorsement (e.g. African Union, CEDEAO)**

Courtesy of Ernest Afiesimama (co-chair AMMA-Africa)

Fundamental Issues to be addressed

- Society:** What are social questions from issues of climate, ecosystems and human livelihood in the context of climate change and variability?
- Ecosystems:** What are crucial questions on evolution of ecosystems from the aspect of climate and the human dimension?
- Climate:** What are mechanisms and factors of climate variability and change that may be required to answer questions raised from the other two components above and also, to understand evolution of natural resources, ecosystems as well as their impacts on our well being?

Fundamental Issues to be addressed

Capacity Building and Training:

- **NMHSs observations network**
- **Database management**
- **Institutional capacity building**
- **Improve computing facilities for modeling**
- **Training at regional scale for Bachelors, Master and PhD**
- **Ongoing training**
- **Summer schools**
- **Mobile facilities for teachers and students (Exchange programs)**
- **Communication and dissemination techniques and tools (Stakeholders and End-users)**
- **Lobbying and advocacy of network groups (policy makers, parliamentarians, journalist...)**
- **Interactions with other scientist networks...**

Courtesy of Ernest Afiesimama (co-chair AMMA-Africa)

Final Thoughts

•AMMA will continue:

- To mobilize, reinforce & coordinate the African & international communities working on the West African monsoon and its societal impacts.
- To combine Observations, Forecasts, Capacity building, Knowledge transfer to better anticipate and mitigate the human (and natural) impacts of weather and climate variability

•Challenges to consolidate AMMA-Africa

-To strengthen

- *visibility and support regionally & in each country**
- *collaboration between research & application communities**
- *integration of African PhDs in research & application (NHMS/EWS) centers**

-To maintain & improve observation network

- to forecast & monitor weather and climate variabilities and its impacts**

Final Thoughts

AMMA has been very successful in its first phase:

Improved understanding of the WAM in particular

Establishment of observational network

Built an international community in partnership with Africans

Implemented important and crucial capacity building activities

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AMMA-Community provides opportunities:

- Linkages between science and applications for the benefit of society

The go-to community for issues related to climate variability and climate change in the West African region.

AMMA-African leadership should be promoted and strengthened

Lessons learned – to benefit the whole of Africa.

Provision of modest resources can reap substantial benefits