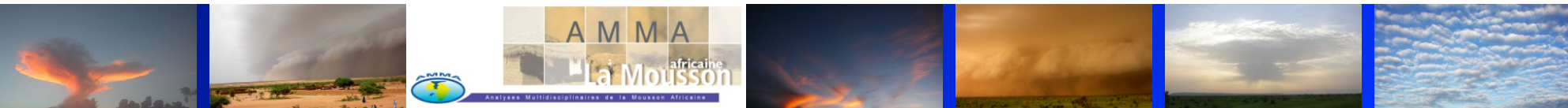


# The AMMA programme Results & new challenges from a WCRP perspective

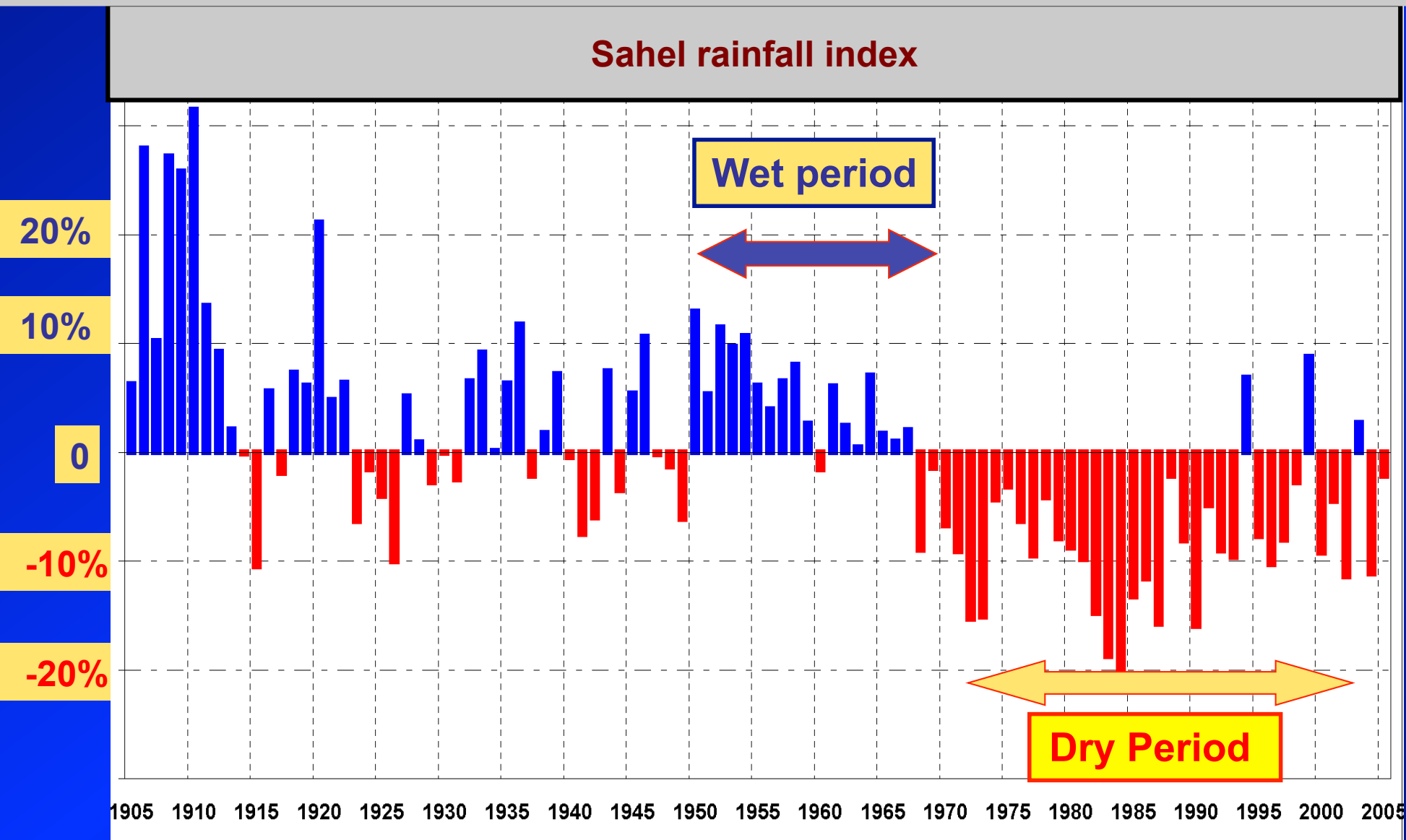


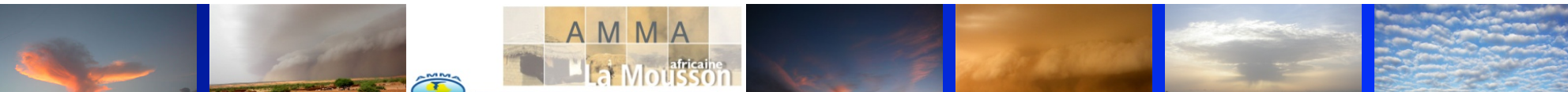
**Jean Luc Redelsperger, LPO & CNRM, France**  
**E. Afiesima, A. Diedhiou, S. Janicot, T. Lebel, D.J. Parker, C. Thorncroft**  
**(AMMA Executive Committee)**



# The largest regional deficit of rainfall observed during the past century

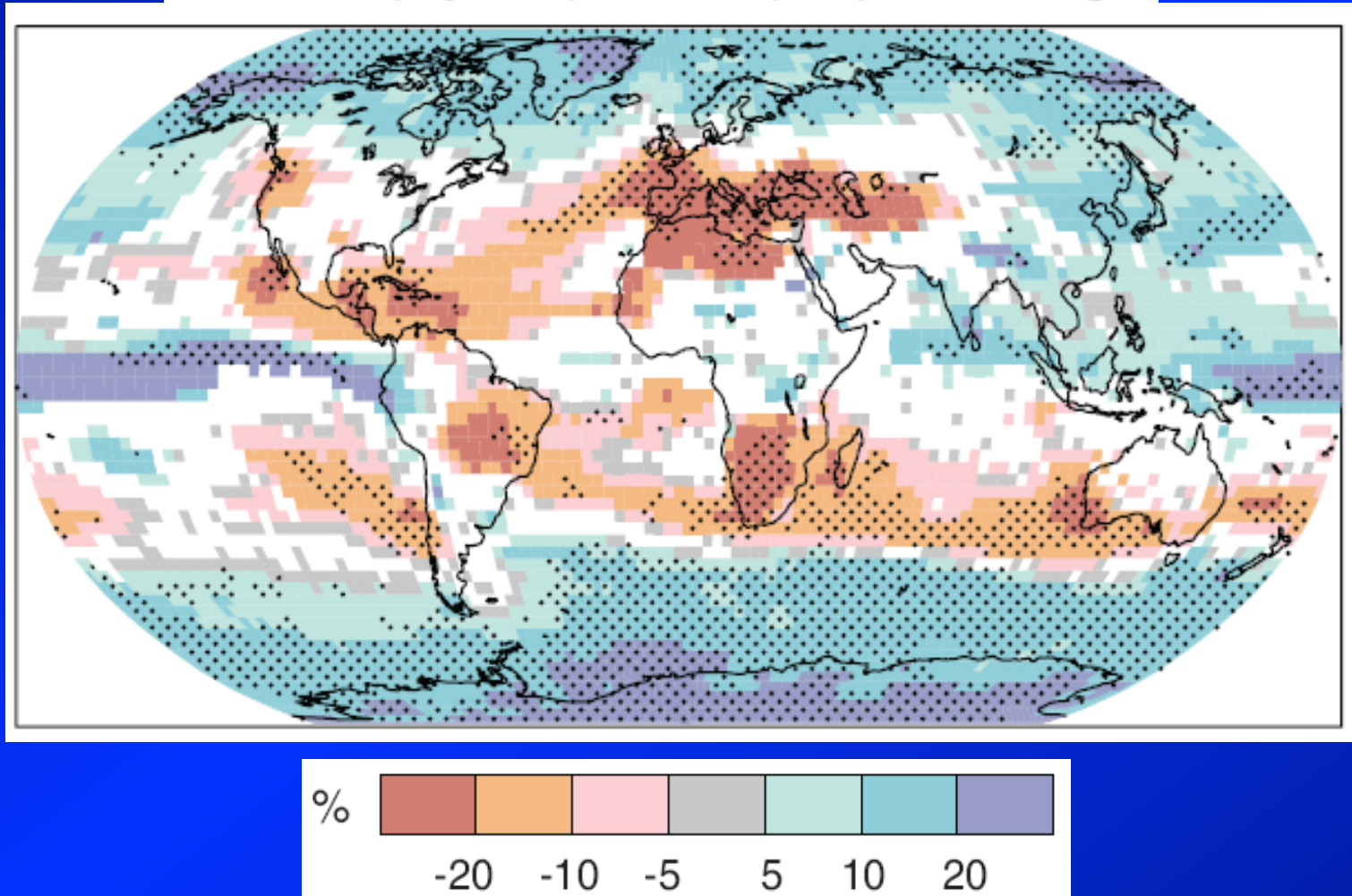
## Sahel rainfall index






## Uncertainties about the future (IPCC)

### 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}

**A M M A**



**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**



# A coordinated international program on West African monsoon, its variability and society-environment-resources-climat Interactions

## Aim 1

To improve our understanding of the WAM & its influence on environment regionally & globally

## 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 (EWS)

AMMA coordinated with **international** programmes and bodies



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**Coordination** : multidisciplinary research, different communities

**International** : ~600 people from 30 countries

**Africa** : ~250 pers ; Research and application (forecast/EWS) communities

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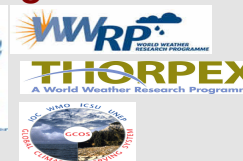
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**Training/Education**: PhD (160 incl 80 Africans) masters, summer schools, workshops  
Communication (external & internal)

**See poster W189 Session C3**

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## Field experiments

Long term multidisciplinary observation networks  
Modelling; Satellite products tailored & validated

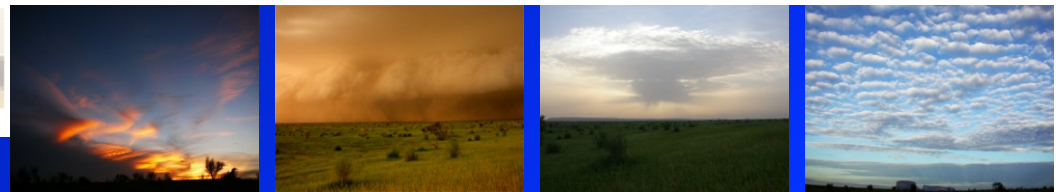
Unique **database** with mirror in Africa (obs, models, sat, library)

AMMA coordinated with **international** programmes and bodies





# Field experiments

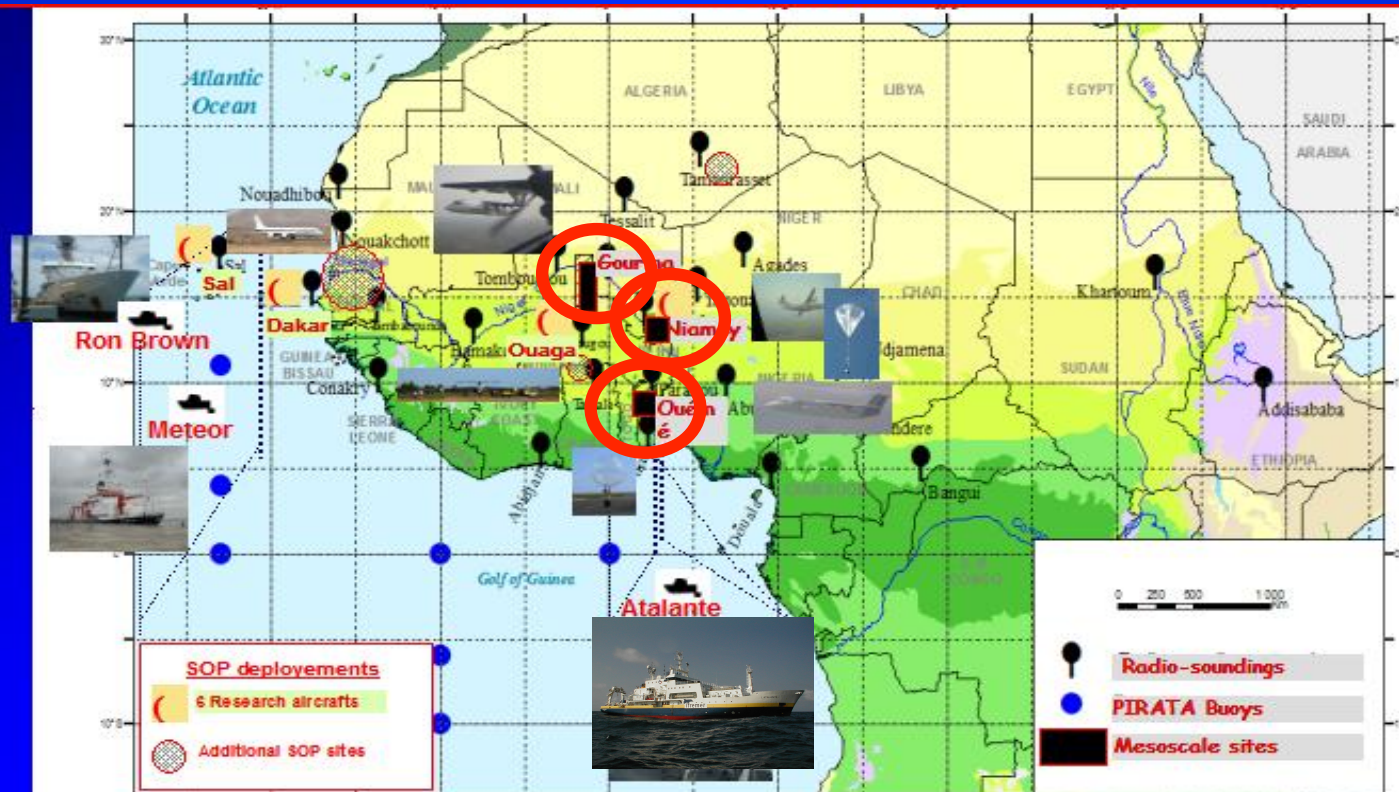


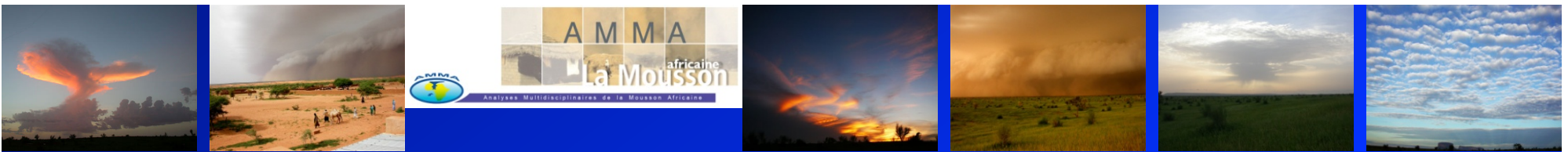
**SOP 2006:** First international experiment in Africa at regional scale

→ A unique data set documenting simultaneously the sea-air-continent system over a full seasonal cycle & over an eco-climatic transect

**EOP 2005-2007:** Unprecedented monitoring of water, energy, aerosol cycles over land, ocean & atmosphere at the regional and mesoscale, coordinated with socio-economic observations

**LOP 2002 – 2009:** A long term monitoring program of key continental and oceanic regions





## Multidisciplinary observatories on agriculture, vegetation, livestock, hydrology, pollution & climate

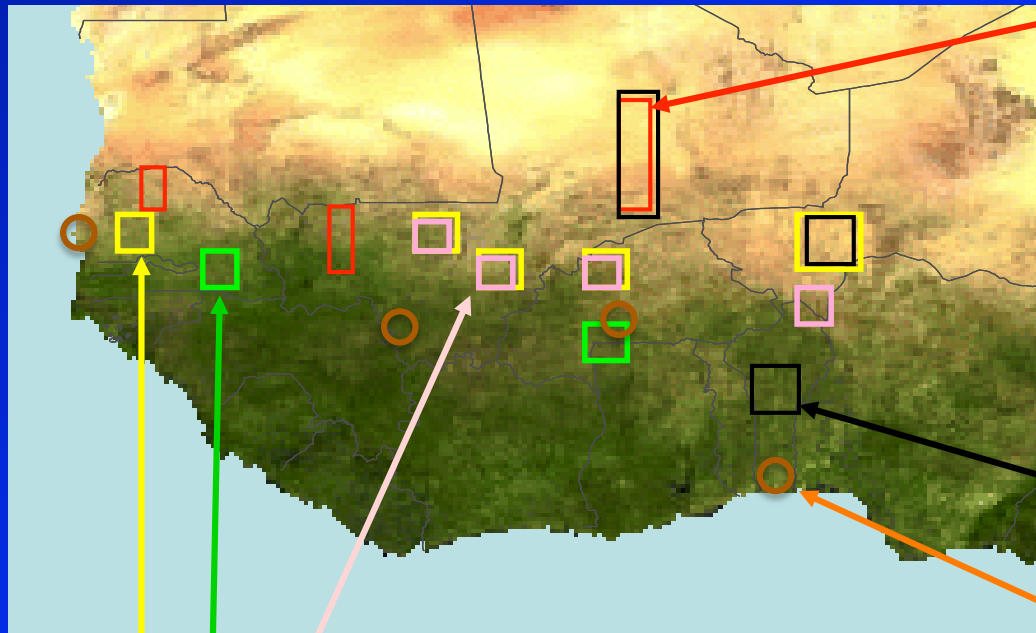
### Rangeland surveys:

-3 North-South transects  
(from 100mm to 1000mm per year)

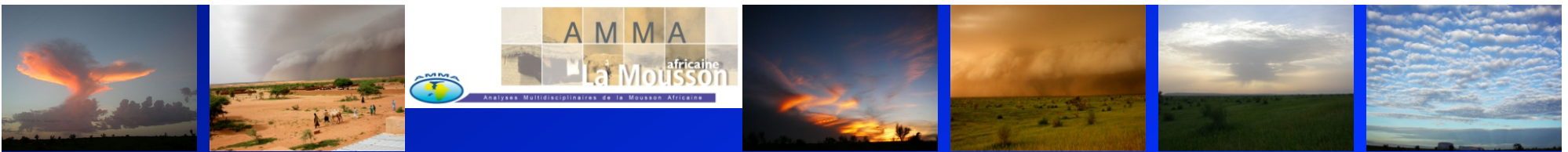
-More than 50 sites on various soils, vegetation types and pastoral pressure status

### Hydrology

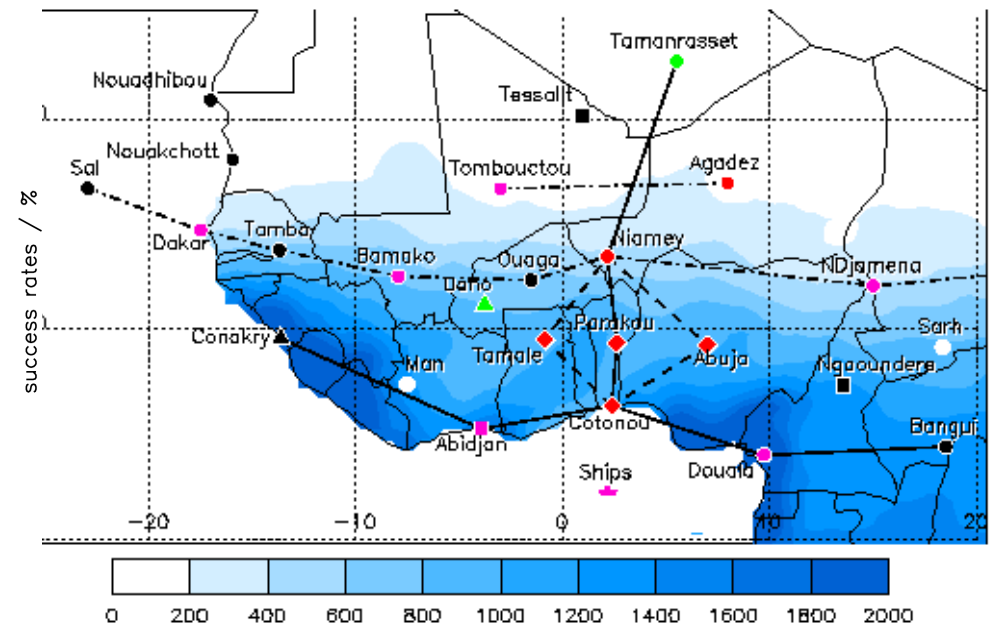
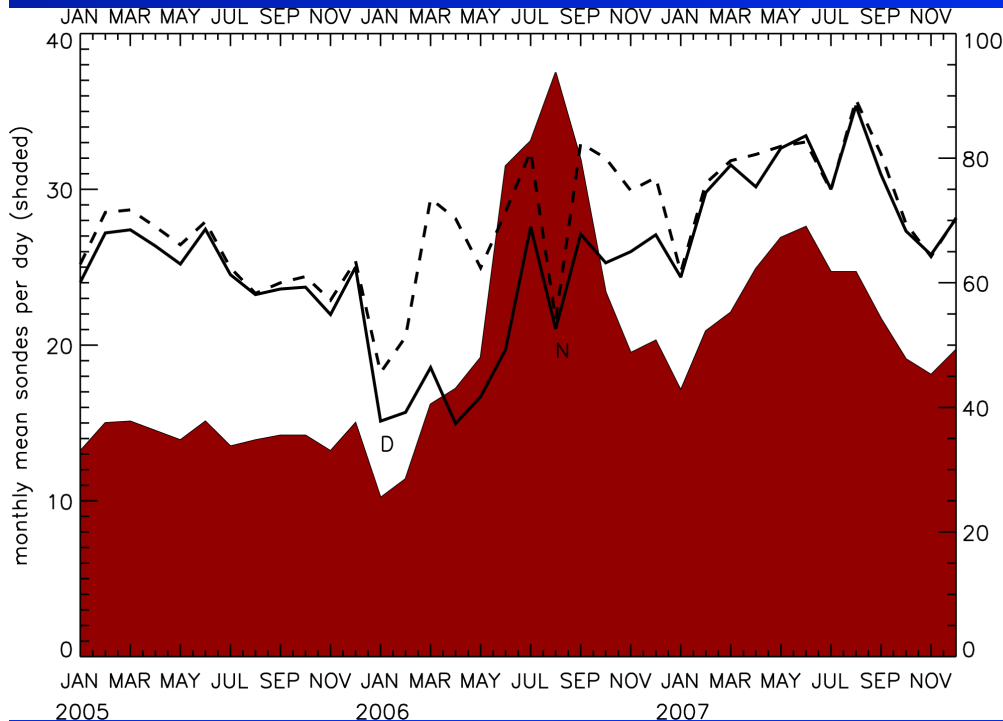
Urban pollution  
Started at end of AMMA phase 1



Agriculture surveys:  
3 crop types & many varieties  
9 sites (from 450mm to 900mm per year)  
2 to 10 villages per site



## AMMA Radiosoundings: A major achievement 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

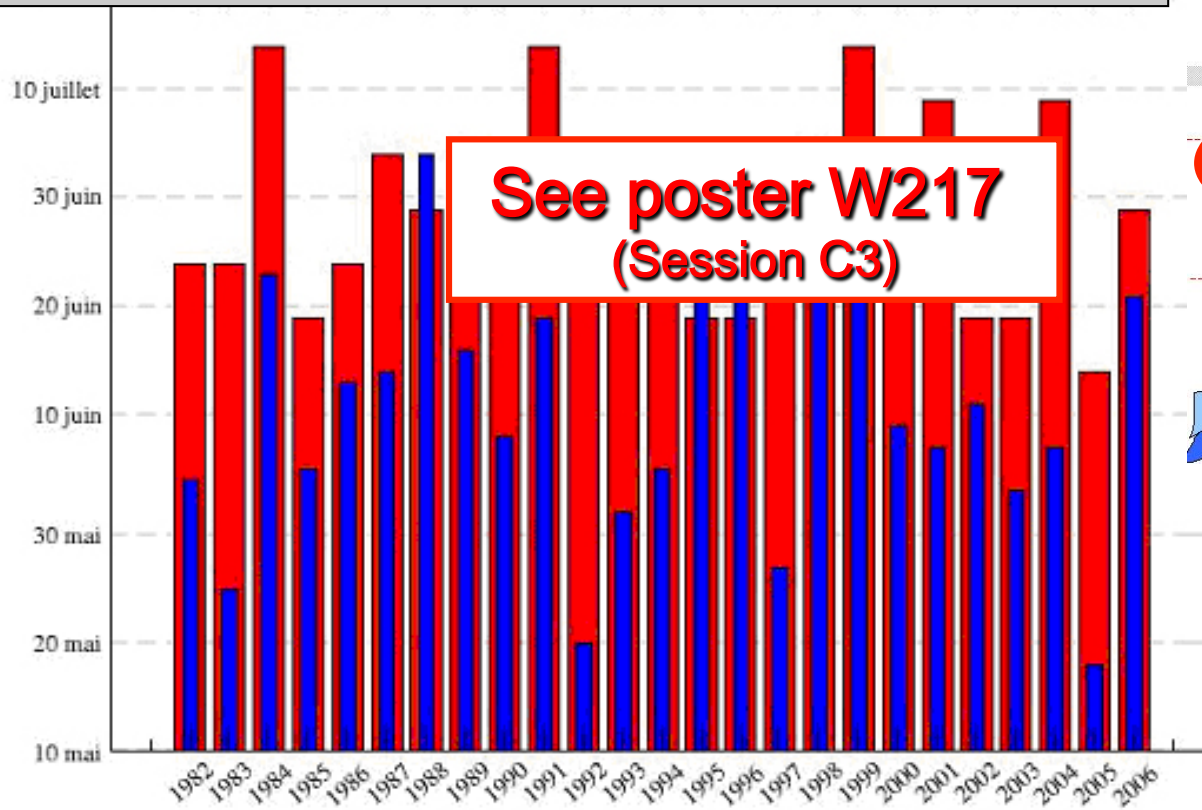
Figure from Parker et al , BAMS 2008



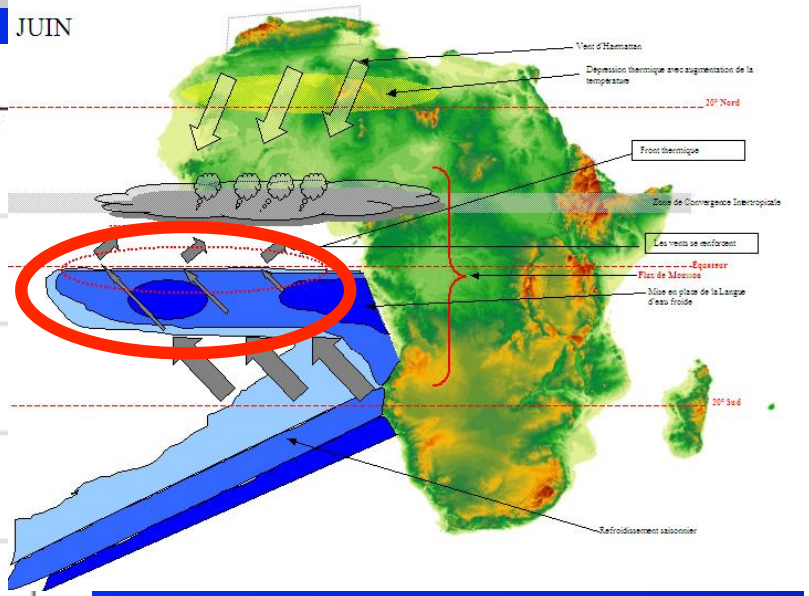
# Cold tongue, Monsoon onset, Agriculture

Red : Date of first rainfall over Sahel

Blue: Date of cold water formation in Gulf of Guinea



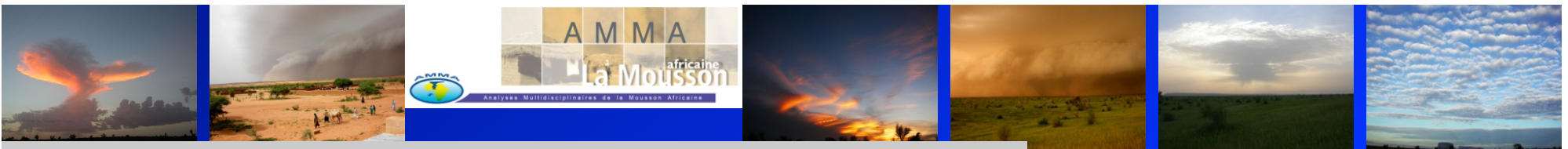
**See poster W217  
(Session C3)**



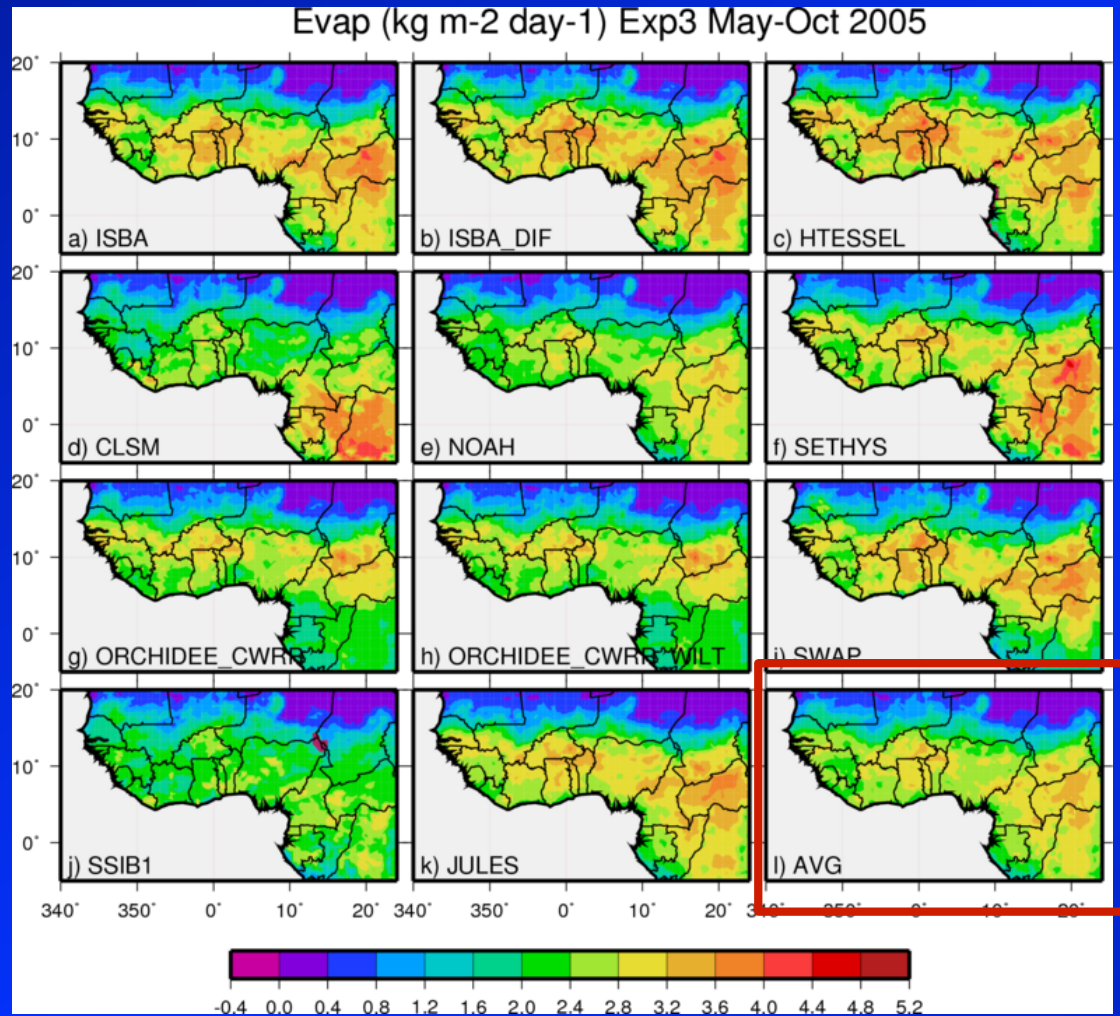
Equatorial region of gradients of surface flux (Ocean towards Atmosphere)

→ To forecast the beginning of the rainy season (monsoon onset)  
→ To better advice for first seeding in Sahel





# AMMA Land Model Intercomparison (ALMIP)

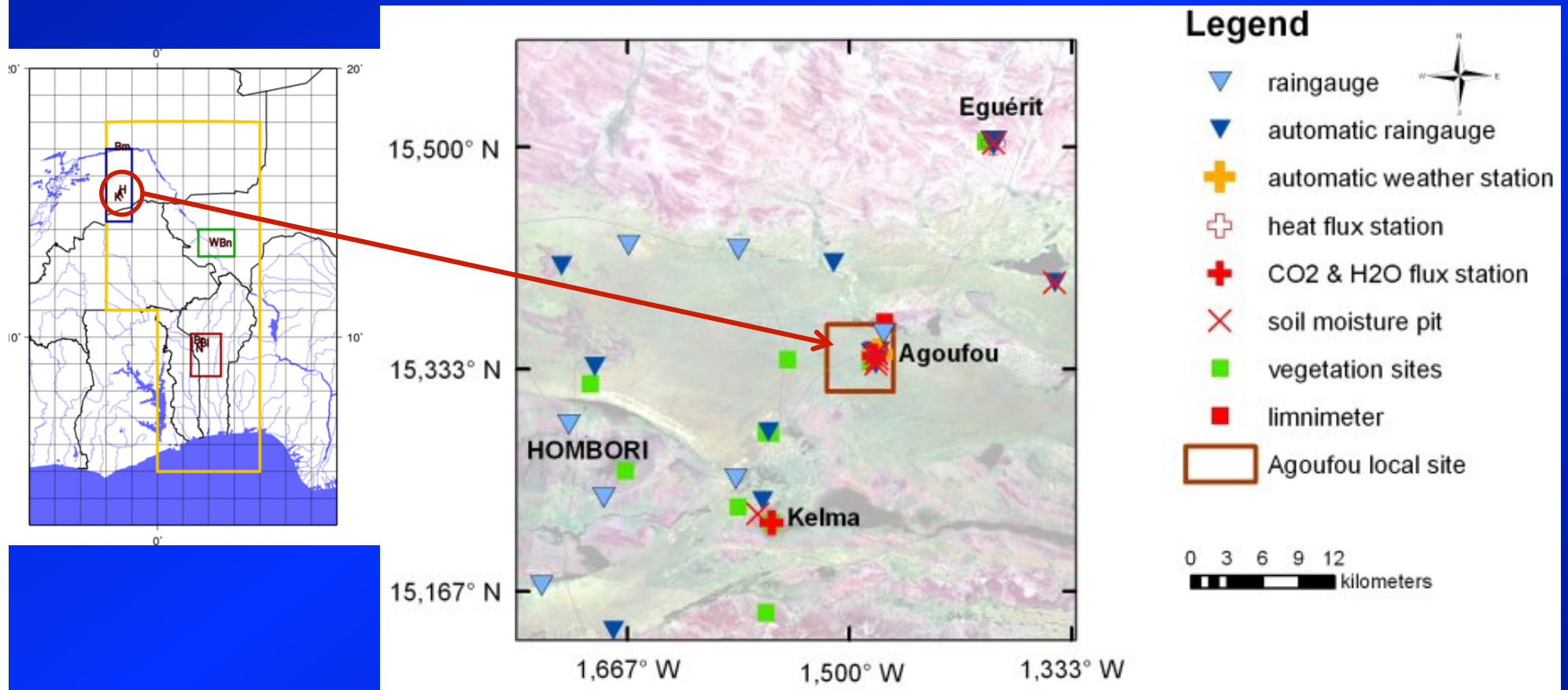


**Evaporation (JJAS)**  
 Precipitation exerts strongest control in northern part of domain, in southern portion more differences owing to intra-model physics differences

Figure from Boone, A. et al , BAMS 2009

# Annual cycle of sensible heat flux (Mean 2005-2007)

60 X 60 km<sup>2</sup> : 3 AMMA-CATCH stations (Mali)

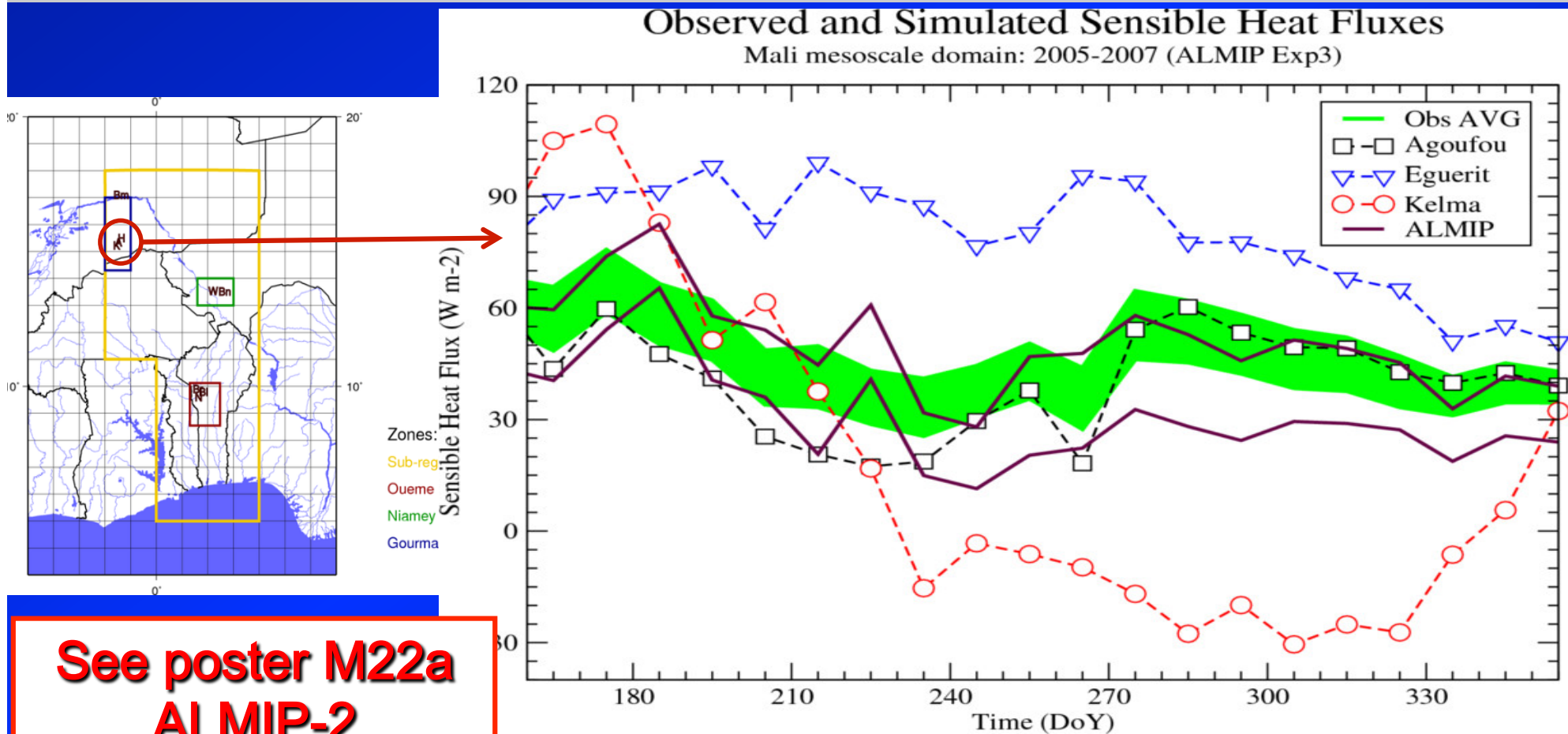




# Annual cycle of sensible heat flux (Mean 2005-2007)

60 X 60 km<sup>2</sup> : 3 AMMA-CATCH stations (Mali)

Aggregated (green area : spread) ; ALMIP LSM average +/- standard deviation (purple)

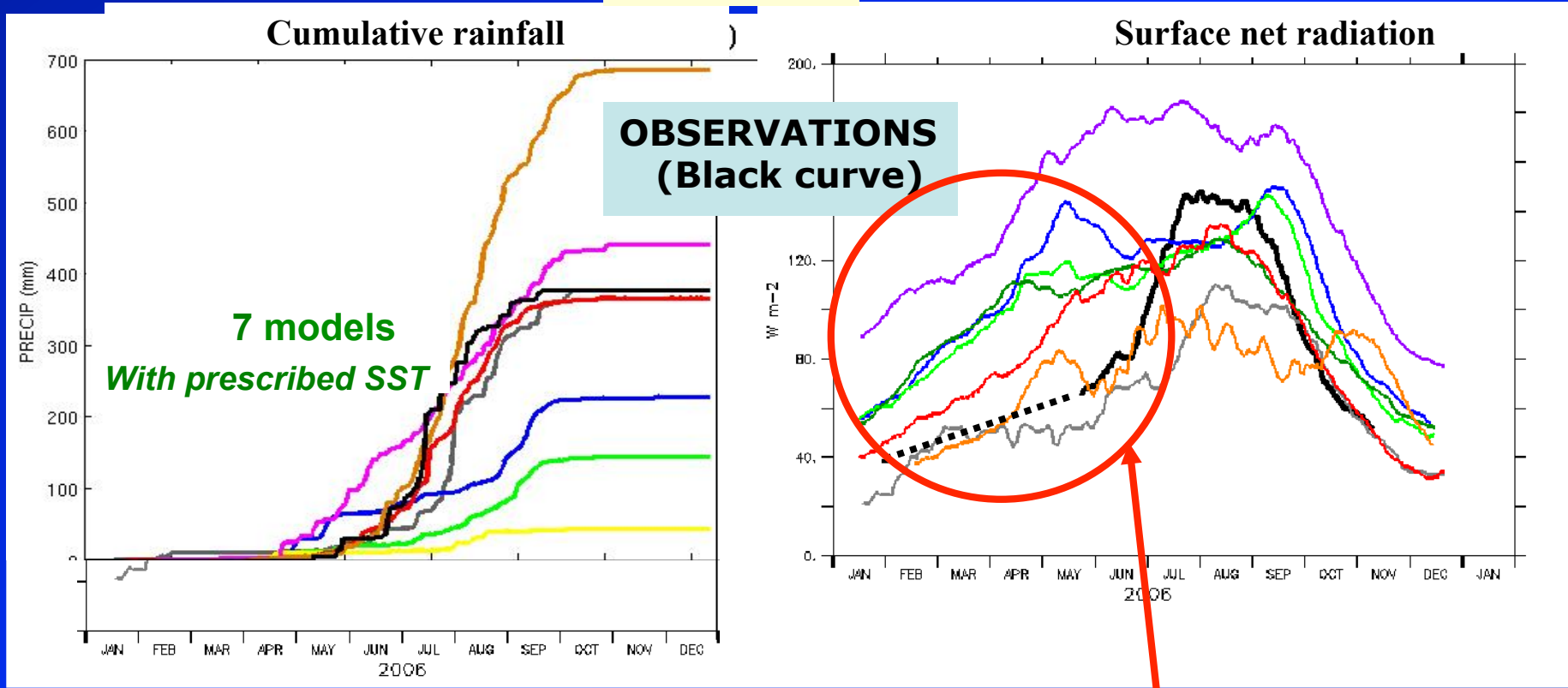


**See poster M22a  
ALMIP-2**

Figure from Boone, A. et al , BAMS 2009 ;  
Observations from Timouk et al J Hydrol 2009

# Surface rain & Energy budget: Observations & AMIP Simulations

Sahel 15°N

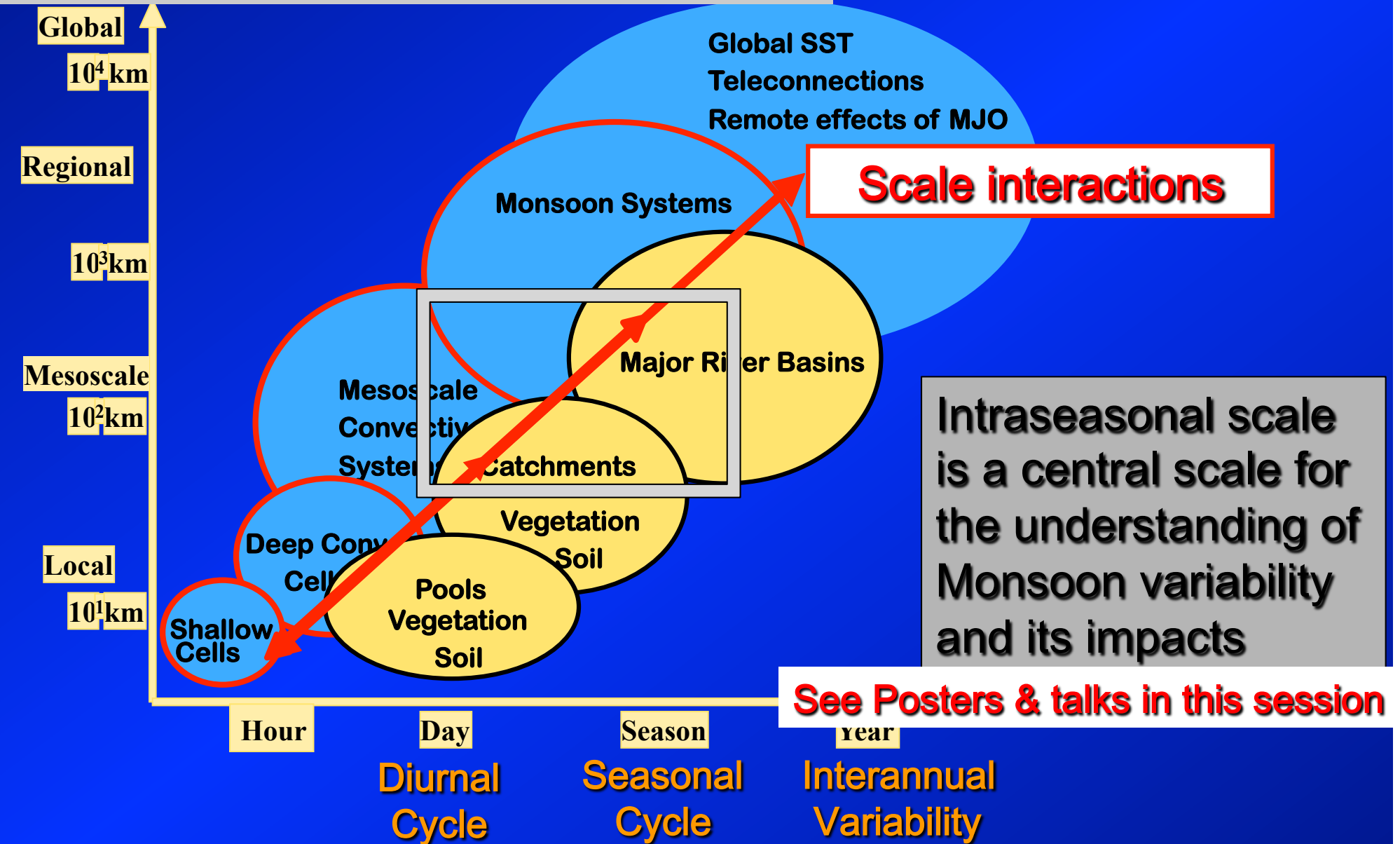


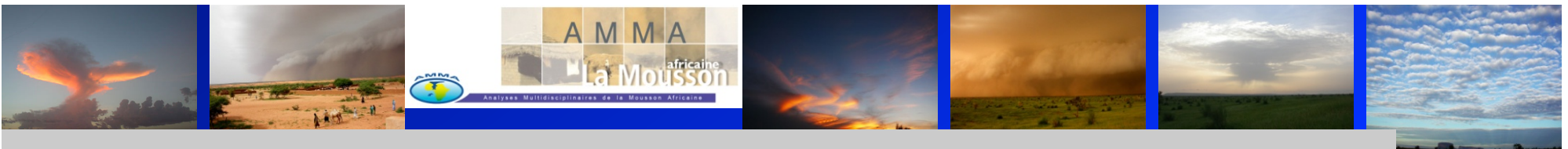
**Major problems in models, even before the monsoon onset & the rain**  
**Multiple possible reasons : Surface representation but also aerosols & clouds**

Figure from Traore PhD 2010



# Intraseasonal scale & Scale interactions





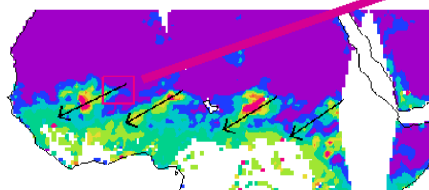
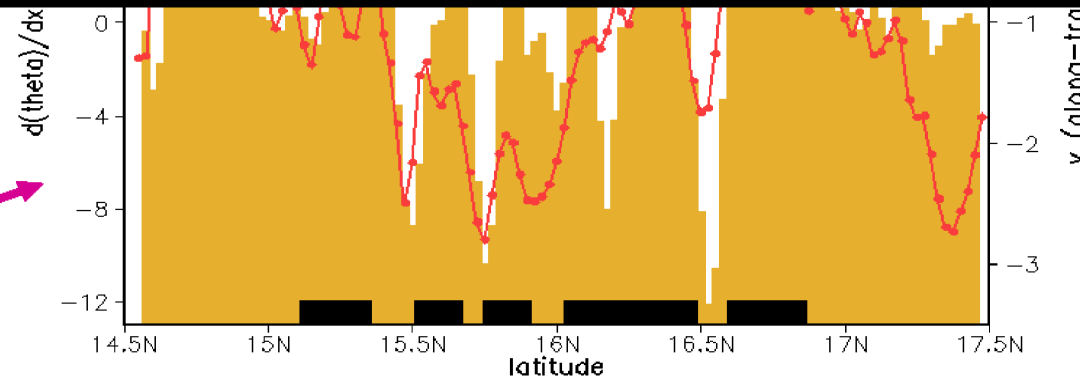
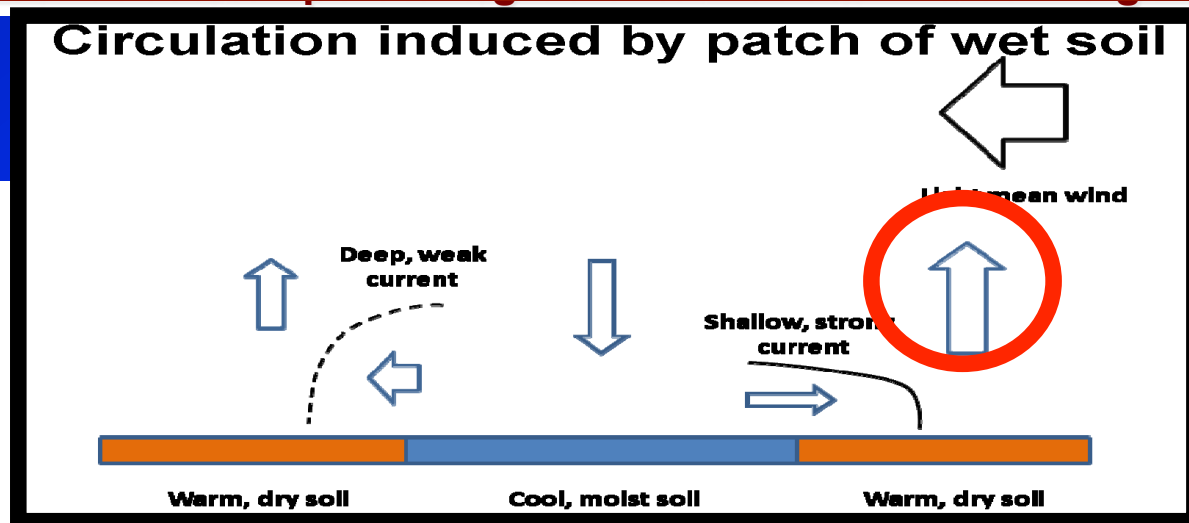
## Atmospheric boundary layer feedback to soil moisture anomalies

Wind & surface temperature spectrally coherent down to  $\lambda \sim 20\text{km}$

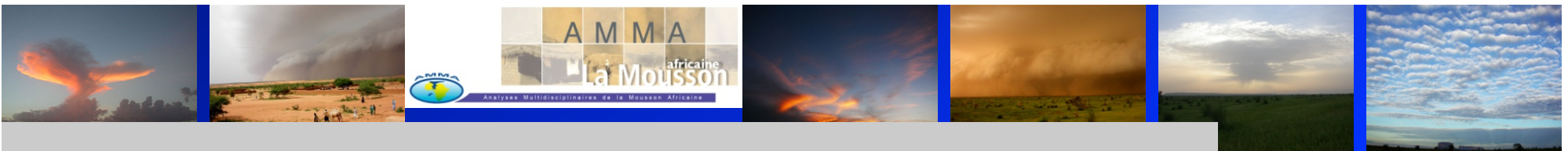
PBL & surface temperature spectrally coherent down to  $\lambda \sim 20\text{km}$

Surface-induced temperature gradients induce wind convergence

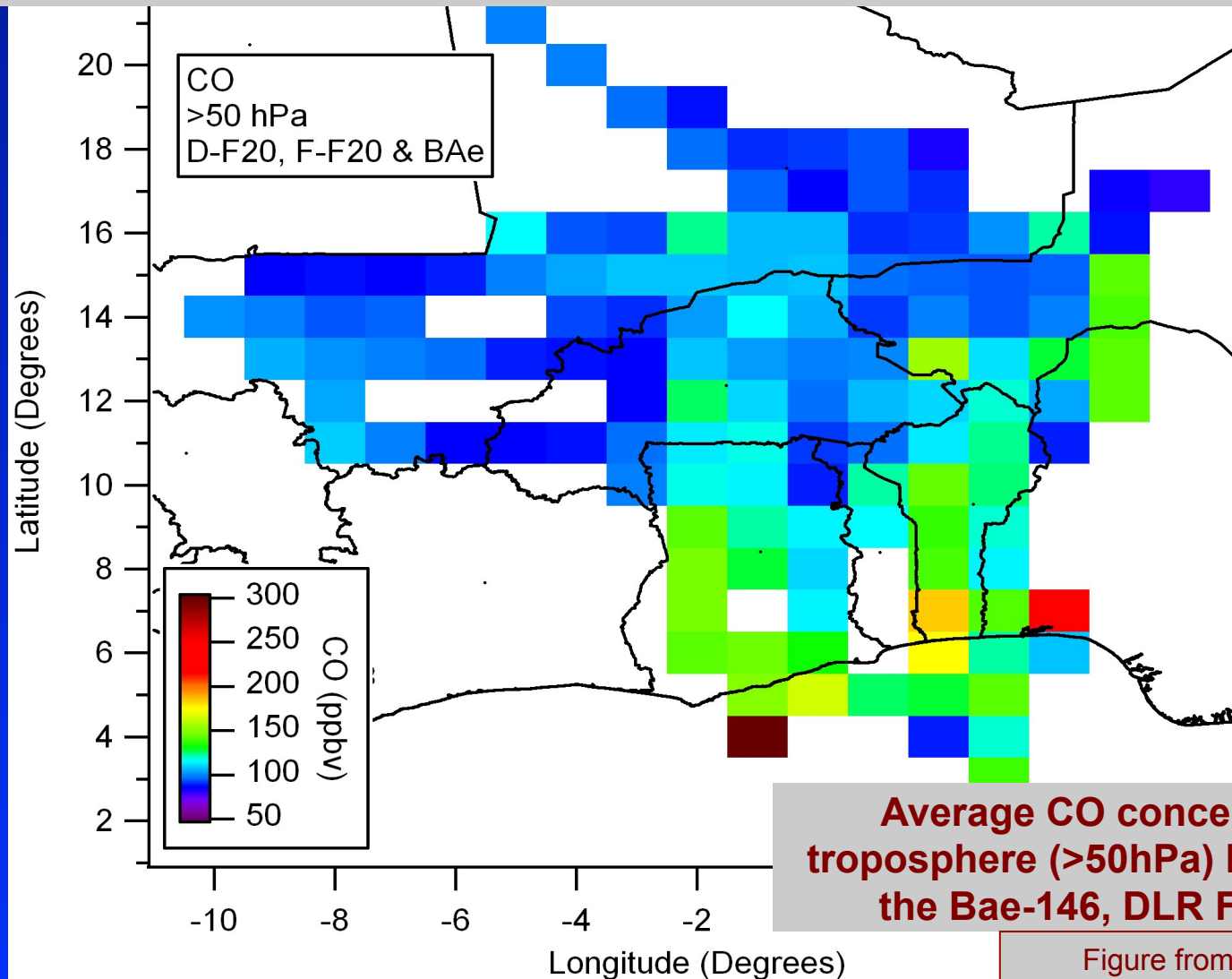
### Circulation induced by patch of wet soil



Figures from Taylor, A. et al , 2007, 2011



# First picture of the West Africa atmospheric composition



**Average CO concentrations through out troposphere (>50hPa) based on 1-min data from the Bae-146, DLR Falcon, French Falcon**

Figure from Reeves et al, 2010

# AMMA Phase 1 (2002-2009)

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## Aim 3

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More emphasis

Process knowledge

Multi-scale & multi-disciplinary with emphasis on geophysics part

Building the scientific ground basis & a community to work on societal-climate issues

Less emphasis

First tests to improve NWP products & EWS



# AMMA Phase 2 (2010-2020)

## Aim 1

To improve our understanding of the WAM & its influence on environment regionally & globally

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-to relate WAM variability to related societal issues  
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## Aim 3

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Same emphasis

Same emphasis

International Science Plan 2 (2010-2020) (<http://www.amma-international.org>)

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

Observations, Capacity Building & training, Coordination and scientific diffusion

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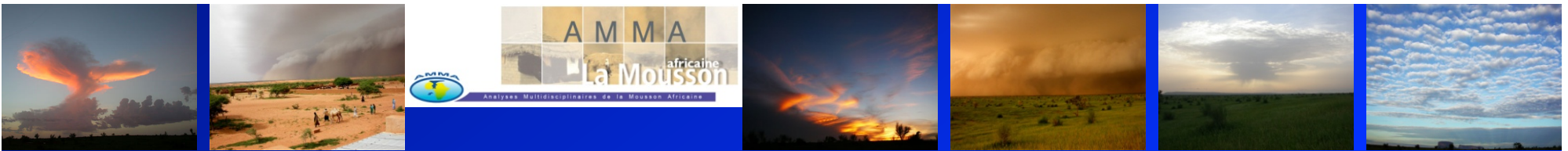
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(iii) Monsoon System  
Observations, Capacity Building & training, Coordination and scientific diffusion

From processes of WAM system (Phase 1) towards the system of processes

Scale Integration (up/down) & Pluri-disciplinary  
→ Interactions Societies-Environment-Climate

Pull-through of knowledge to improve prediction of weather & climate variability and its impacts (New/Improved Climate & Weather Models; EWS ; tailored products)

Relevant monitoring for Application & Research in regard societal-climate issues



## Final thoughts

### AMMA successful in its first phase:

- Improved understanding of the WAM (600 peer review papers)
- Establishment international community in partnership with Africans
- Implemented important capacity building activities
- First international experiment in Africa at regional scale & long term observational network
- A unique data set documenting simultaneously the sea-air-continent system over a full seasonal cycle & over an eco- climatic transect

### AMMA Phase 2 facing to major challenges:

- Pull-through of knowledge to improve prediction of weather and climate variability and associated societal impacts
- Maintain monitoring observation network
- Maintain strong coordination to provide
  - Benefits from the go-to community for issues related to climate variability & climate change in the West African region
  - Bridges between science and applications for the benefit of society
  - Partnership between numerous isolated projects sharing AMMA aims & benefiting from AMMA (community, knowledge, database, ...)
  - Promote and strengthen AMMA-African leadership
- Benefit the whole of Africa from AMMA lessons and knowledge

**4th AMMA conference in France (2-6 th July 2012)**  
**<http://www.amma-international.org>**