


AMMA



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

What is AMMA?

1. Aims

“AMMA is a coordinated international project to improve our knowledge and understanding of the *West African monsoon* (WAM) and its variability with an emphasis on *daily-to-interannual timescales* “

International aims are:

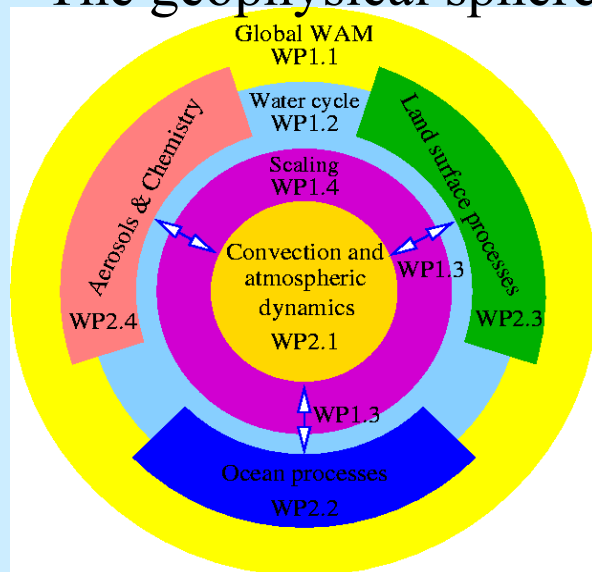
- To improve our understanding of the WAM and its influence on the physical, chemical and biological environment regionally and globally.
- To provide the underpinning science that relates climate variability to issues of health, water resources and food security and defining the relevant monitoring strategies.
- To ensure that the multidisciplinary research carried out in AMMA is effectively integrated with prediction and decision making activity.



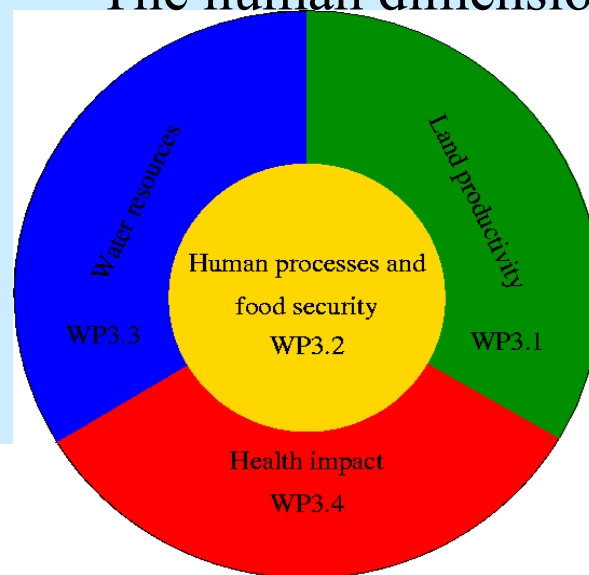
What is AMMA?

2. A multidisciplinary approach

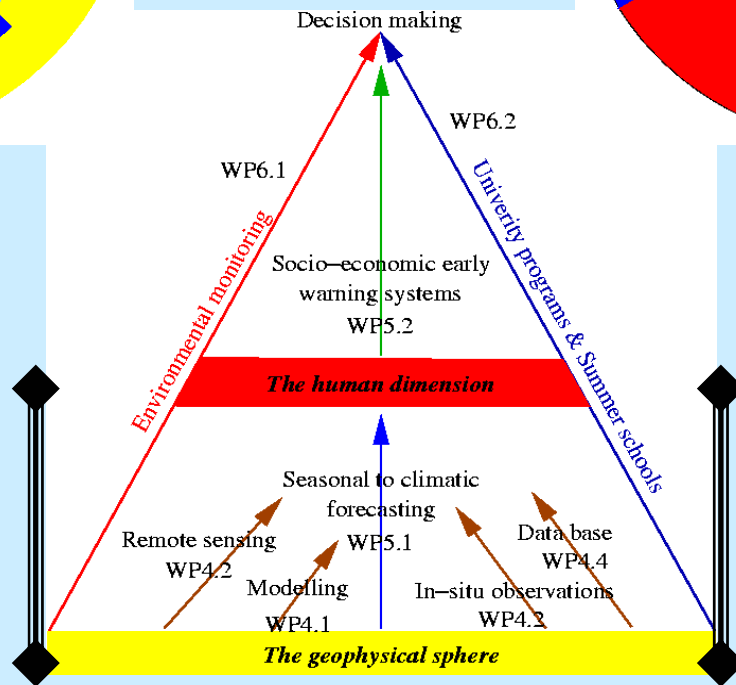
The geophysical sphere



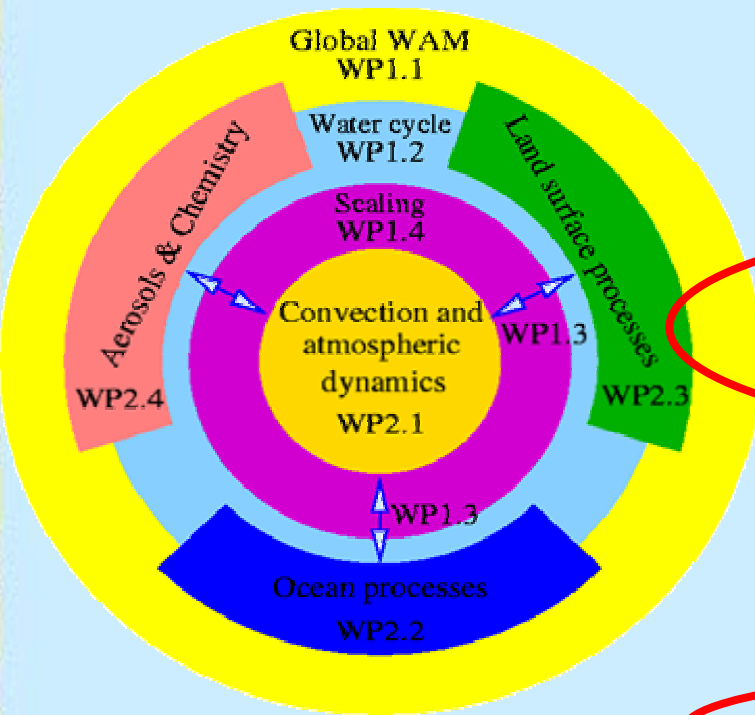
The human dimension



Tools & Methods



The geophysical sphere



Integrative science:

- West African Monsoon and the global climate
- The water cycle
- Surface atmosphere feedbacks
- Scaling issues in the West African Monsoon

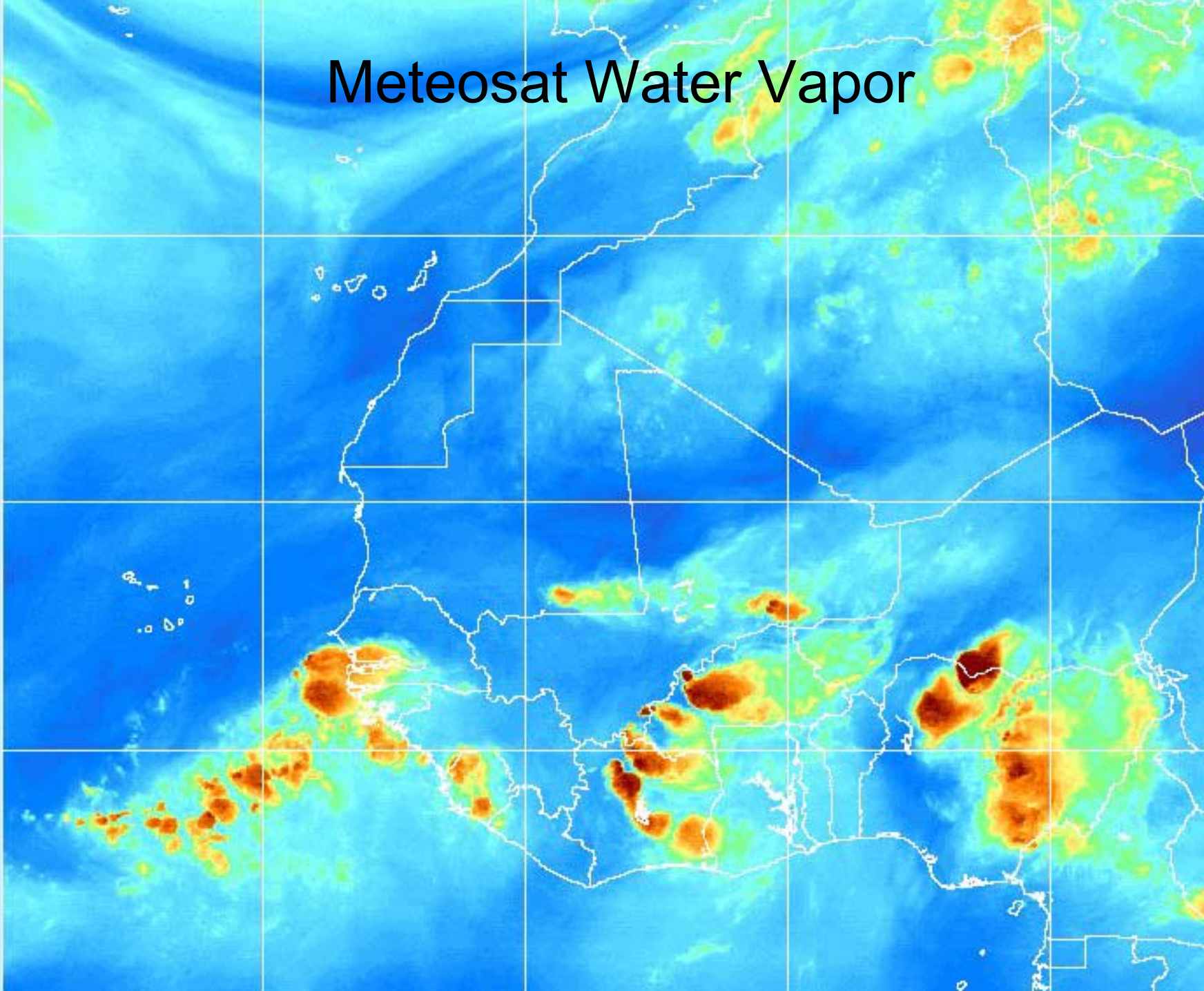
Process studies:

- Convection and atmospheric processes
- Oceanic Processes
- Physical and biological processes over land-surfaces
- Aerosol and chemical processes in the atmosphere

Process studies are only the first step towards a better understanding and prediction of the African monsoon



Meteosat Water Vapor



The largest regional precip deficit on last century

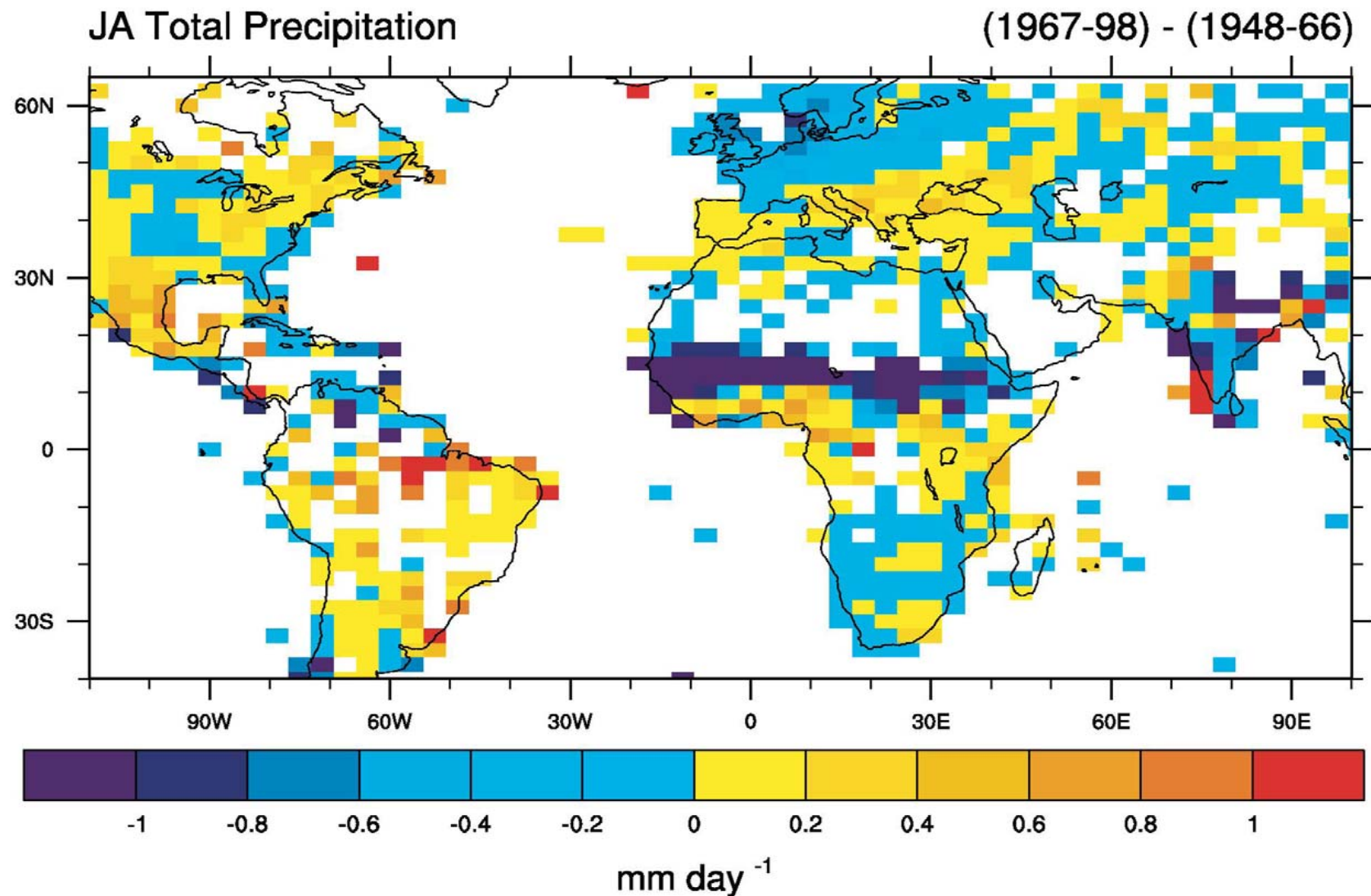
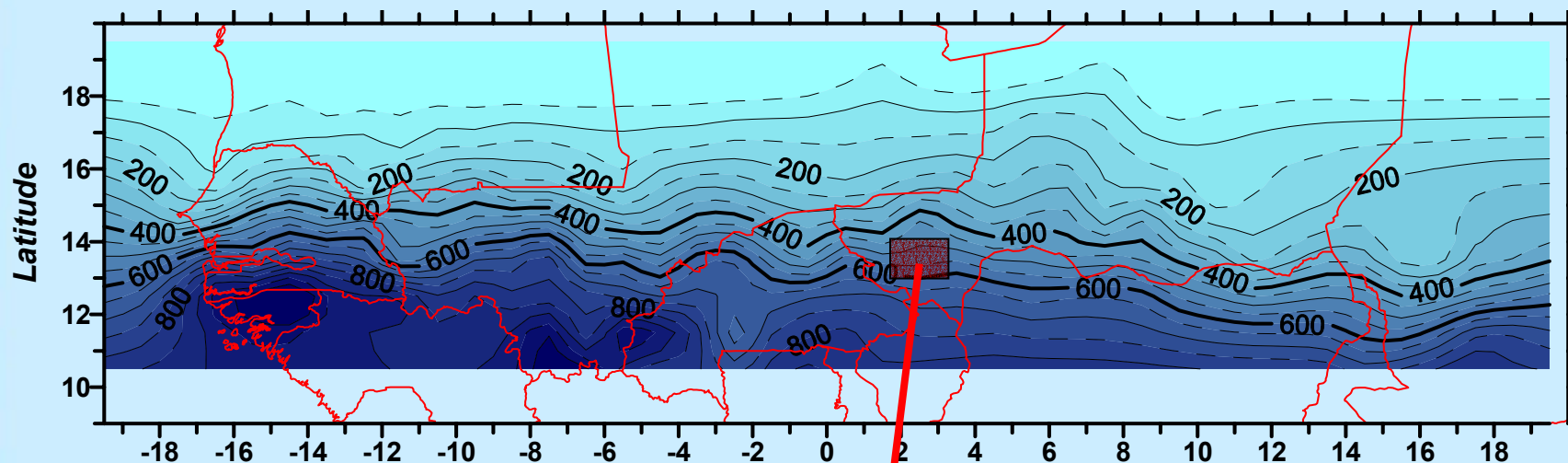


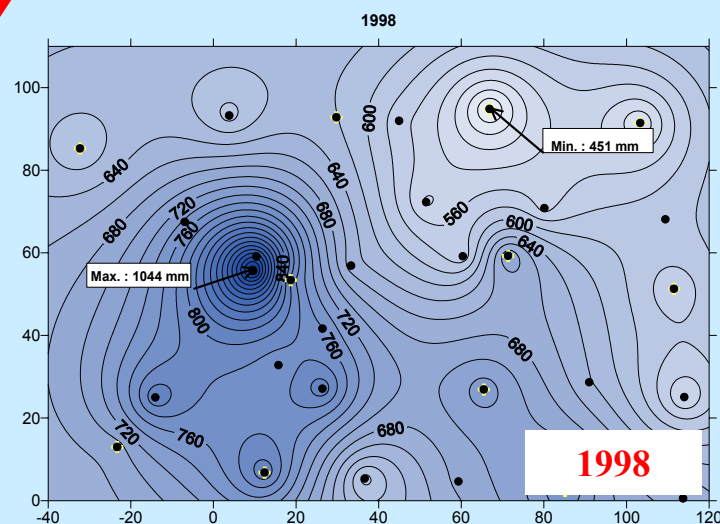
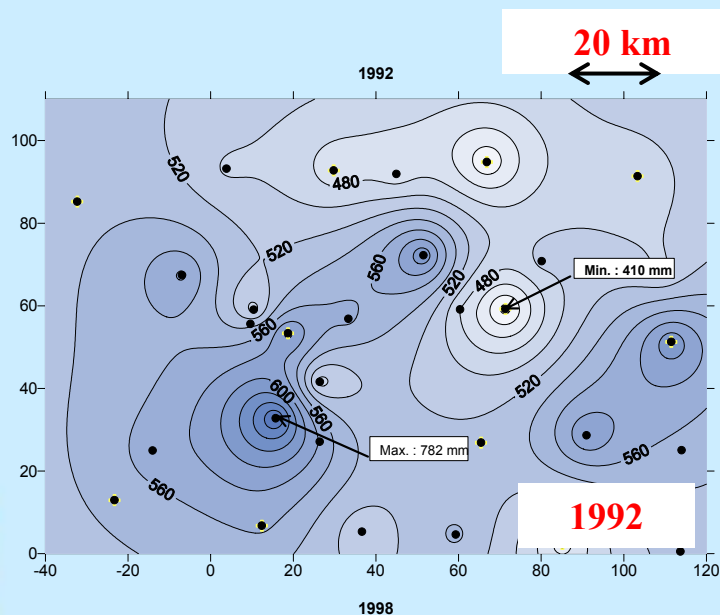
Fig. 3: The change in high summer (July-August) total precipitation (mm day⁻¹), 1967-1998 minus 1948-1966, estimated from land surface records ('g55wld0098.dat' constructed and supplied by Dr. Mike Hulme at the Climatic Research Unit, Univ. of East Anglia, Norwich, UK).

Spatial scales of observed rainfall variability

Echelle Régionale: Zone de gradient méridien



Echelle Locale: Echelle du couplage centrale pour l'hydrologie du Sahel



What is AMMA?

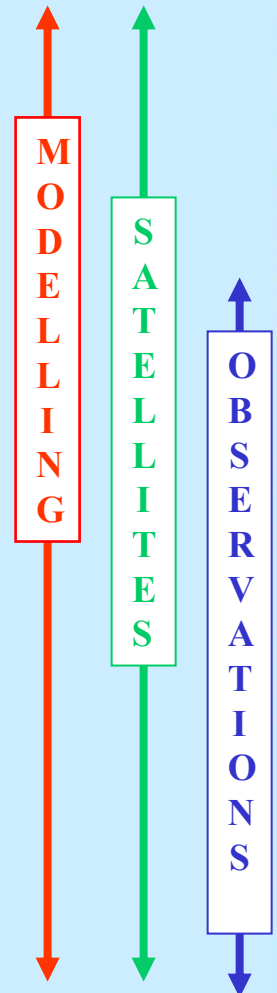
2. A multidisciplinary and multiscale approach

Global: 2-way interactions between the WAM & the rest of the globe
(e.g role of SST patterns on WAM variability; impact of WAM on tropical Atlantic, export of aerosols/chemical species). Variability from seasonal to decadal scales

Regional: Monsoon Dynamics and Scale Interactions, Continental Water Cycle, Land and Ocean Processes, Aerosols and Chemistry Variability from intraseasonal to interannual scales

Mesoscale: Mesoscale Convective Systems, Vertical transports (Aerosols, Water, chemical species), Tropical Cyclones, Catchments and Vegetation Intraseasonal variability

Sub-meso (<10km): Hydrological Cycle, Vegetation Convective rain scale=>Coupling scale with hydrology (Sahel)=>Main scale of interest for agriculture, ...



What is AMMA?

3) A coordinated international effort

➤ Scientists from more than 25 agencies/institutions in more than 20 countries in Africa, Europe and the US are now involved: Algeria, Belgium, Benin, Burkina Faso, Cameroon, Chad, Congo, Denmark, France, Germany, Ghana, Italy, Ivory Coast, Mali, Morocco, Niger, Nigeria, Senegal, Spain, Togo, UK, US



World

➤ Endorsement received from WCRP (CLIVAR & GEWEX), GCOS, IGAC...

➤ French, UK & USA funding agencies have declared support

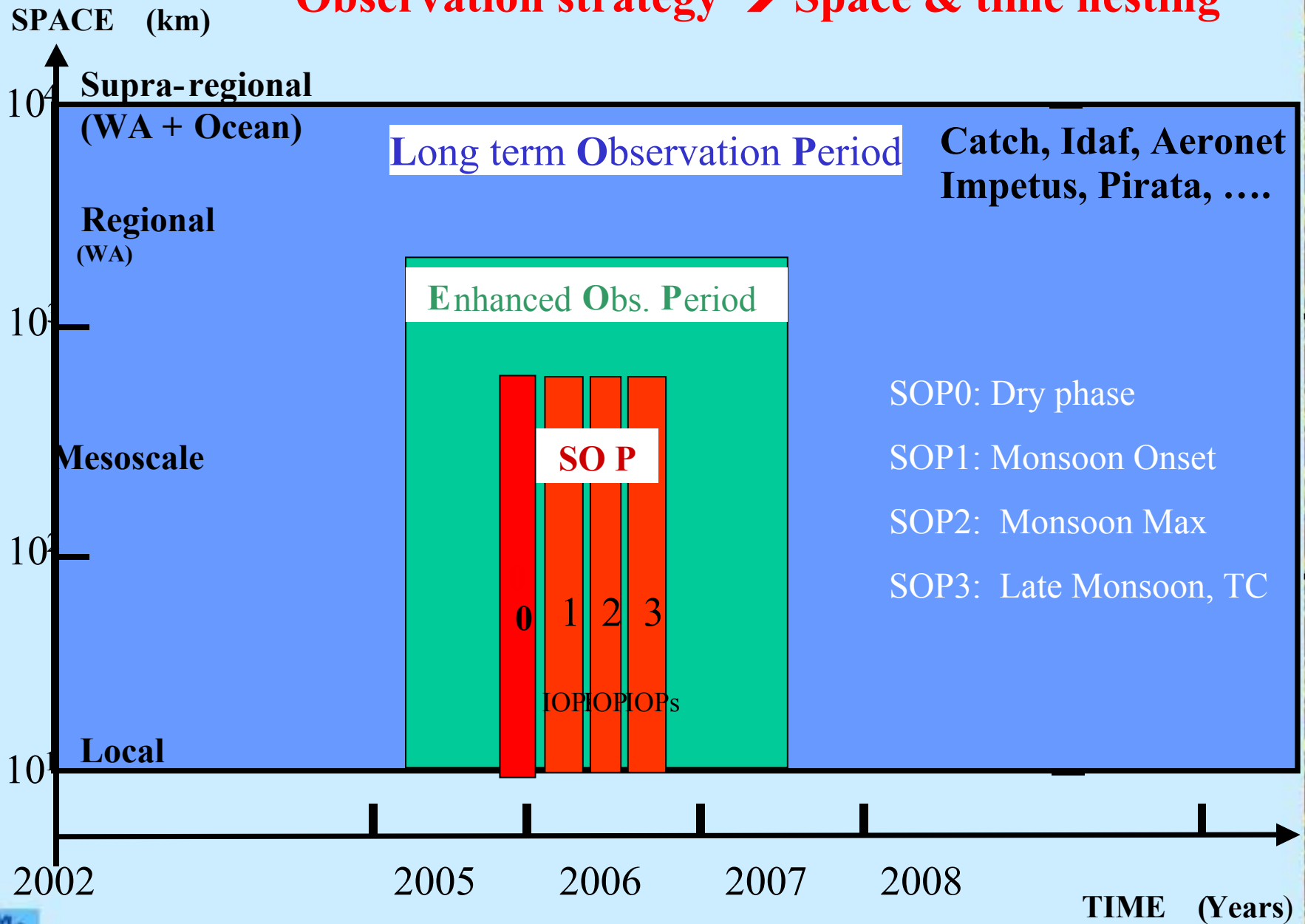
▪ France (12.5Meuros): Soundings, aircrafts, ground stations (aerosols, chemical species, water, ...), lidar, Doppler radar, ship, ..

▪ UK (3Meuros proposal)

➤ EU AMMA-IP consortium (12.7Meuros, 5 Years)



Observation strategy → Space & time nesting



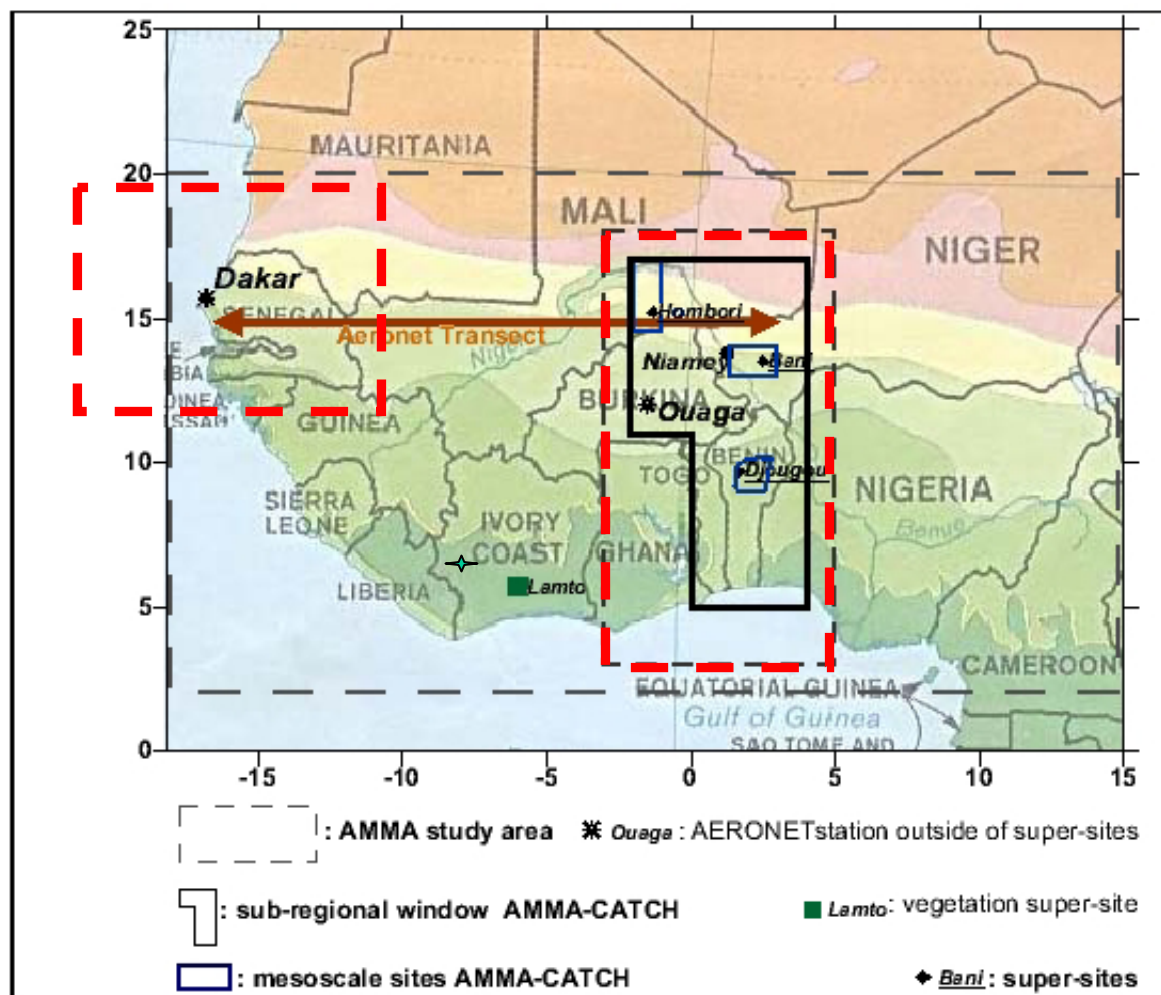
International Field Program: a strong component of AMMA

- ***The Long Term Observing Period (LOP)*** is concerned with multi-year observations of the coupled atmosphere-ocean-land system to support analysis of interannual variability of the WAM.
- ***The Enhanced Observing Period (EOP, 2005-2007)*** To document over a climatic transect the annual cycle of the surface conditions & atmosphere and to study the surface memory effects at the seasonal scale. A major focus will be on improving radiosounding coverage & establishing surface flux stations (aerosols, chemical species, water, energy) over the continent.
- ***The Special Observing Period (SOP, 2006)*** will provide a multi-scale & multi-process detailed analysis of one monsoon season.

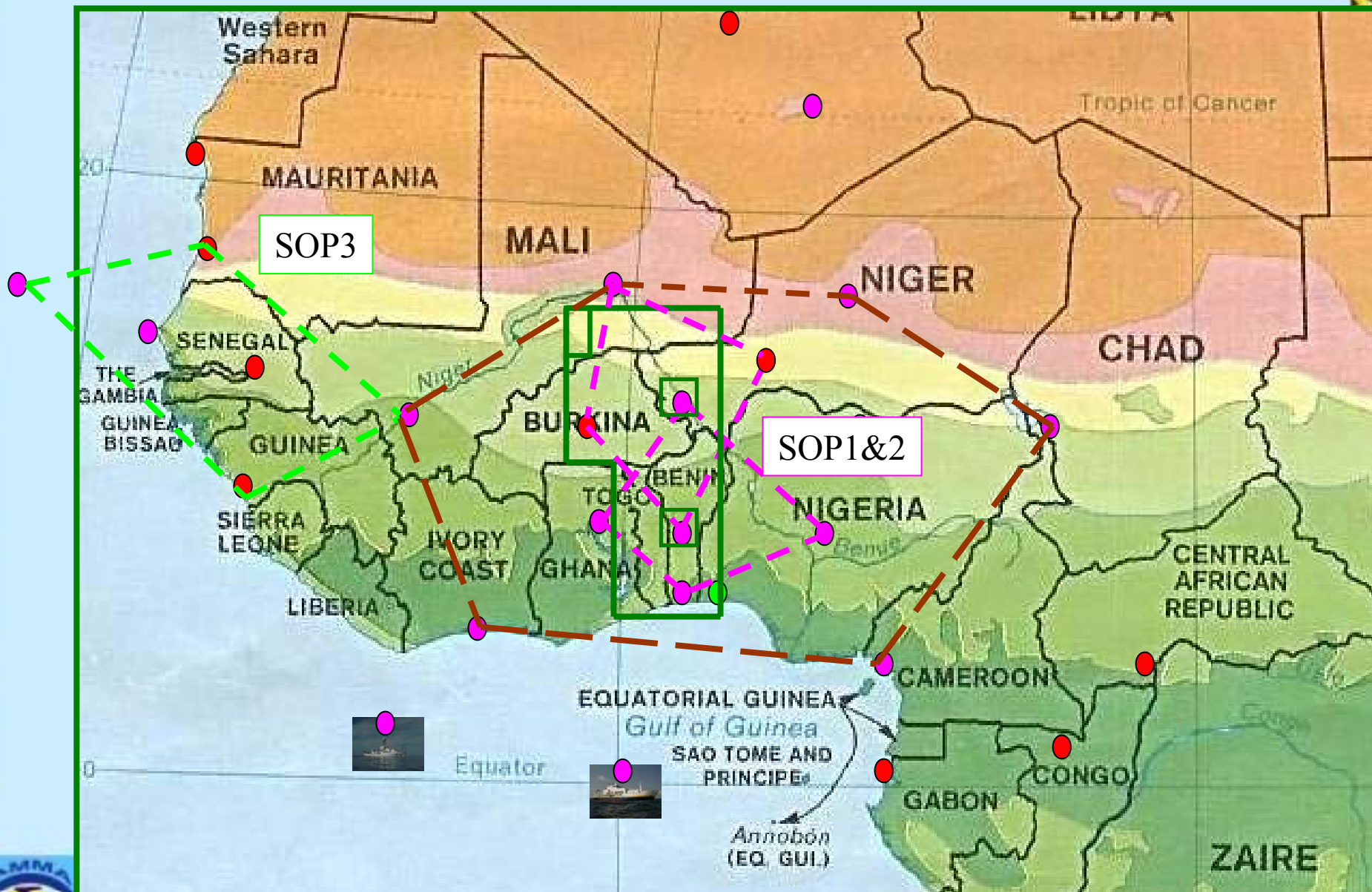
<u>SOP 0</u> Dry phase	(Jan-Feb)
<u>SOP 1</u> Monsoon Onset	(~ 1-30 June)
<u>SOP 2</u> Monsoon Maximum	(~ 15 July - 15 August)
<u>SOP 3</u> Late Monsoon	(~ 15 August - 15 September)

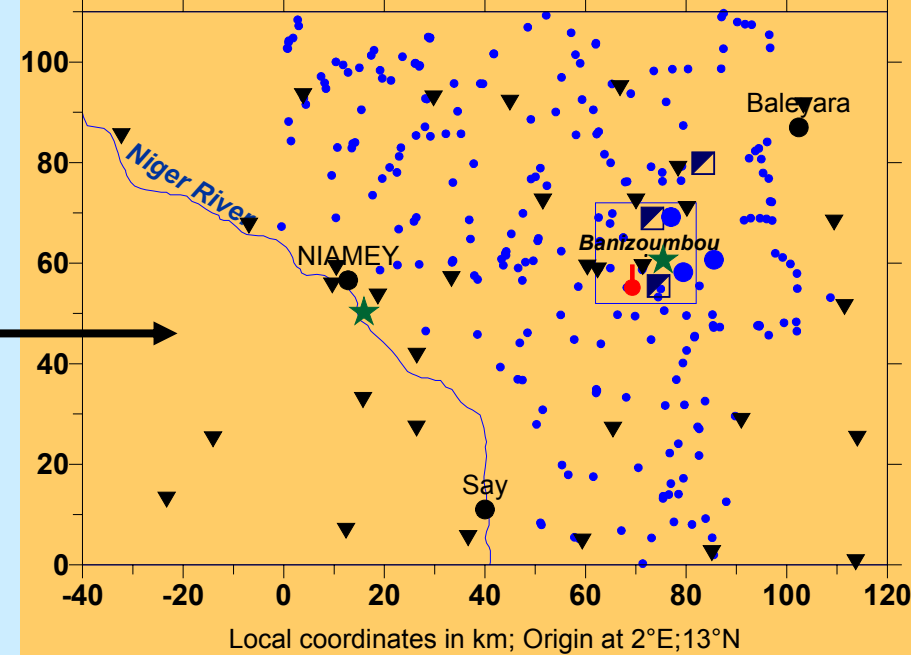
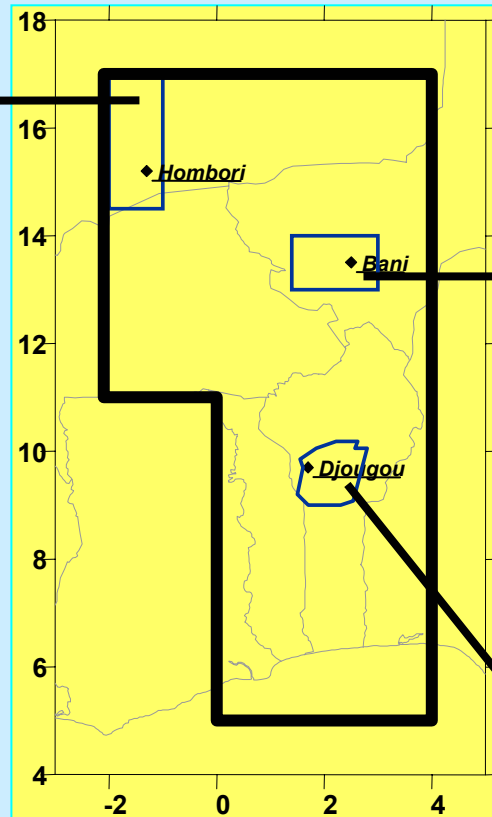
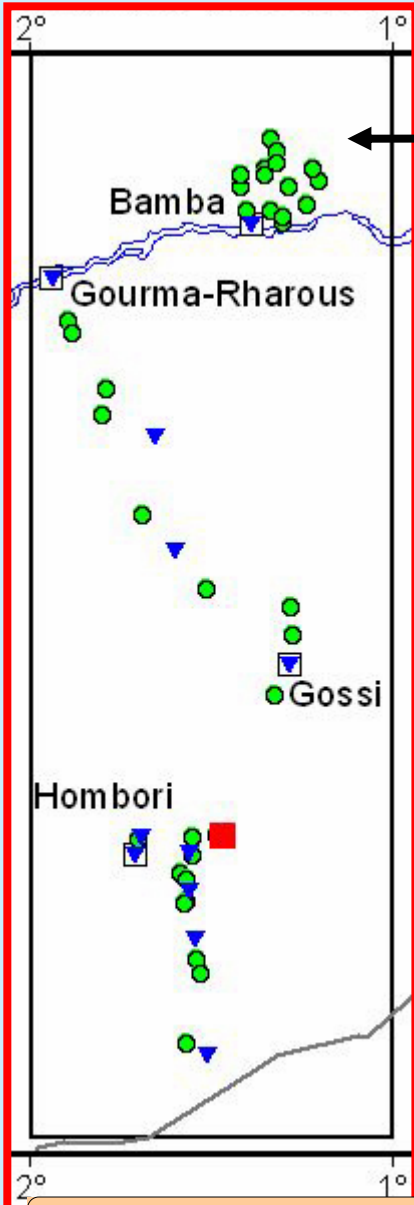


The Core AMMA Region

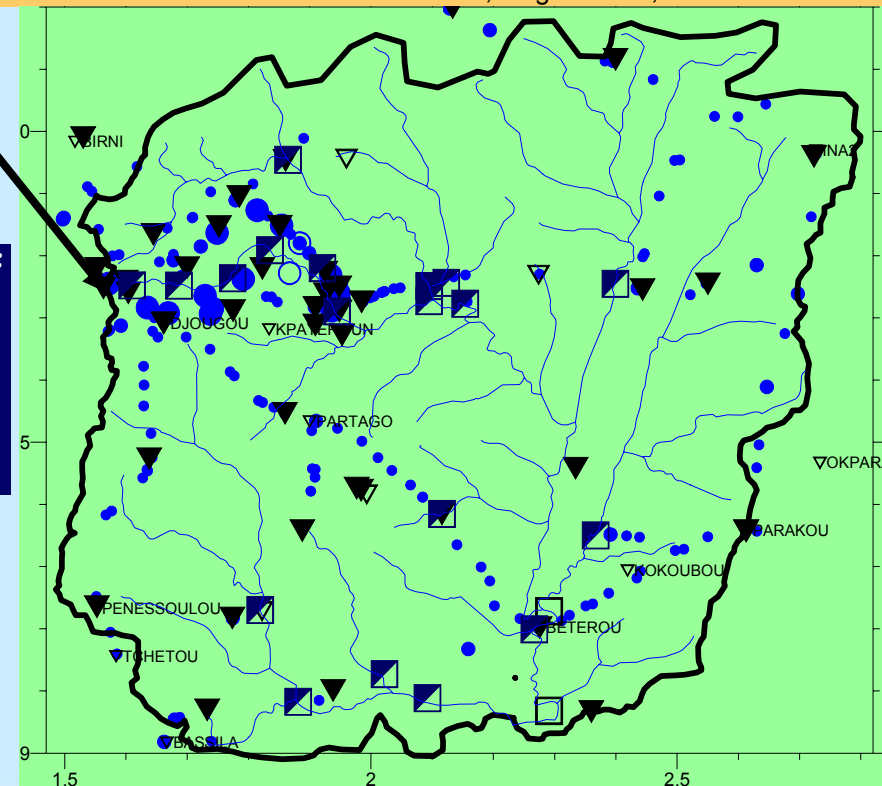


Improved Radiosounding Network





3 mesoscale sfc networks (diff climate regimes): To monitor the water & vegetation cycle
+ Intensive measurements on super-sites



Automatic

▼ Rain ● Aquifère ▣ River

Manual

▽ Rain ● Aquifère □ River ● Vegetation

SOP-1 (\approx 1 - 30 June 2006) « Monsoon Onset »

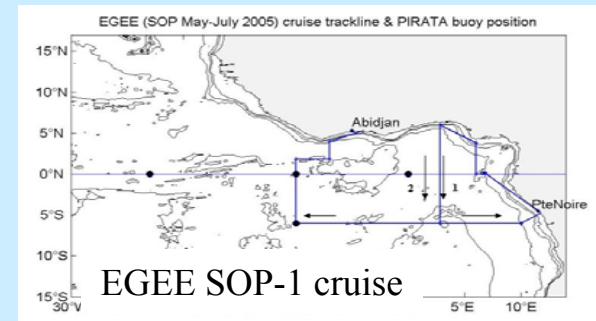
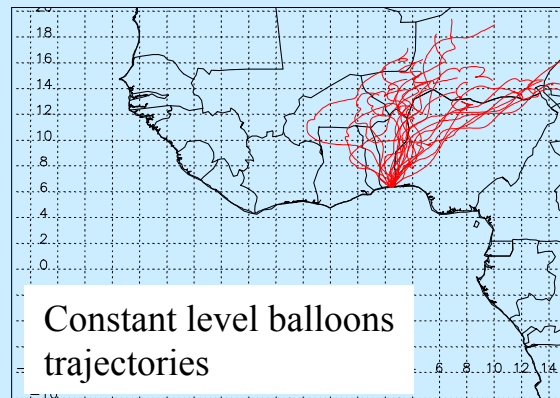
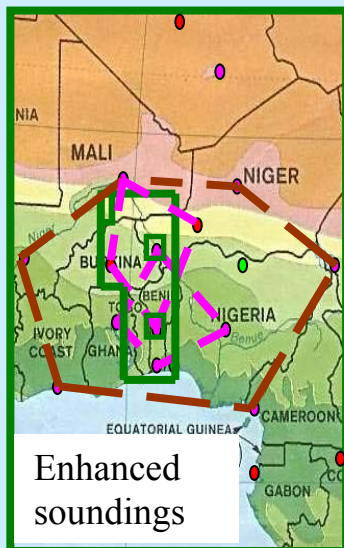
Scientific objectives :

- ☐ To investigate the structure & evolution of the atmospheric boundary layer over the continent before, during & after the arrival of the monsoon ,
- ☐ To study the interaction with the drier easterly winds above & to the north, & the evolution of the African Easterly Jet ,
- ☐ To identify the fundamental relationships between evolving properties of the ocean & land surfaces, the planetary boundary layer, & the monsoon system ,
- ☐ To quantify the water & energy budget at synoptic and meso- scale.



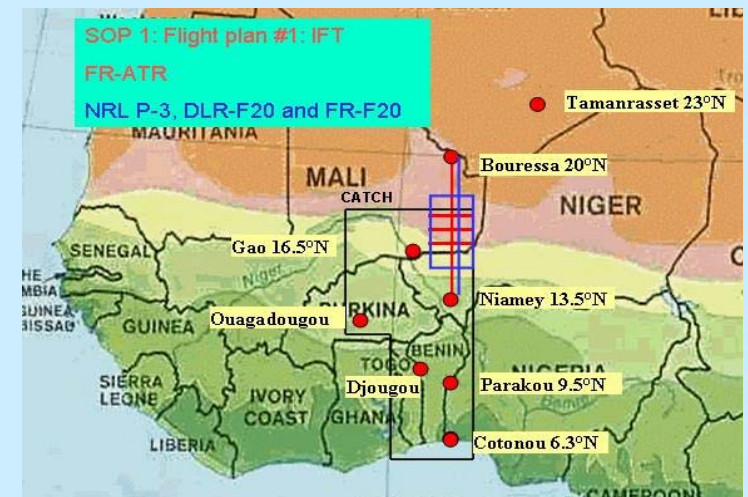
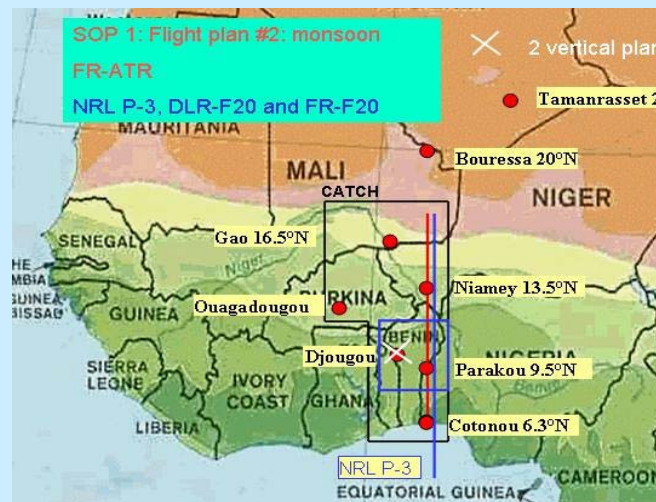
SOP-1: Main additional surface-based equipments :

- High resolution radiosounding network
- Lidar, Micro-lidars, Microwave radiometer, Doppler/polar radars, ..
- Surface stations from the coast to the Sahara (Meteo, Fluxes, Radiation, Aerosol, Trace gases, GPS...)
- Constant level balloons launched near the gulf of Guinea
- French & USA cruises in the Gulf of Guinea

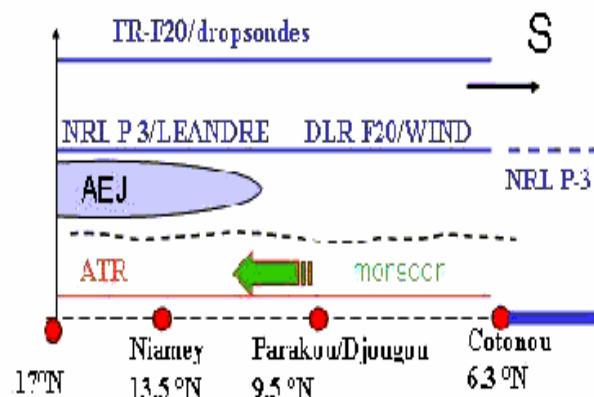


SOP1: Instrumented aircrafts (based in Niamey, Niger) :

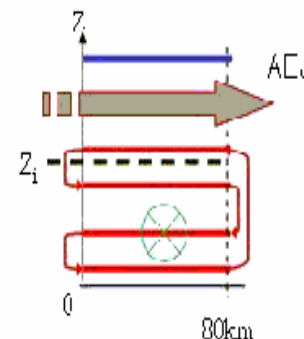
- **French ATR-42** : flight-level turbulence & flux measurements
- **German Falcon-20** : WIND Doppler lidar & dropsondes
- **US NRL-P3 or (NOAA-P3, French Falcon-20): Doppler radar & LEANDRE-2 WV lidar**



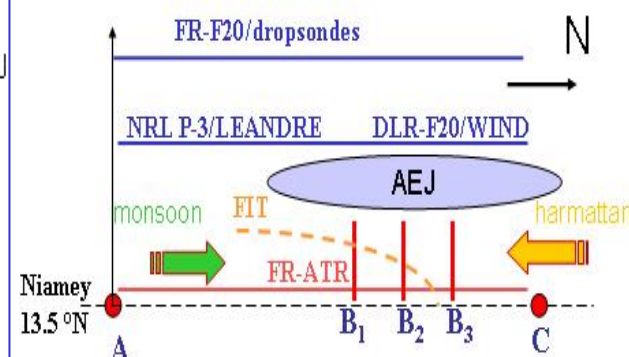
SOP 1: Flight plan #2: monsoon



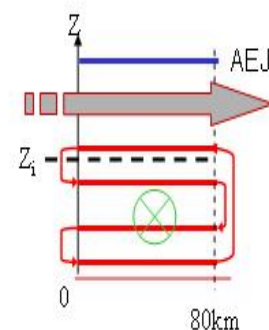
Vertical plans in Djougou



SOP 1: Flight plan #1: IFT



Vertical plans B1, B2 and B3



SOP-2 (\approx 1 July-15 Aug 2006) « Monsoon Maximum »

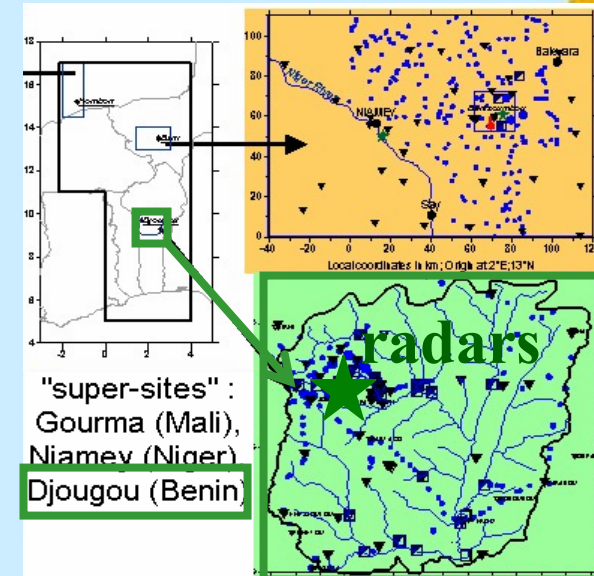
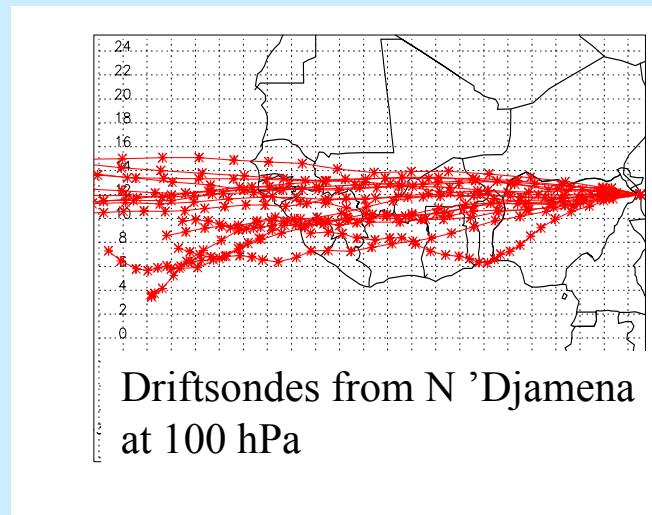
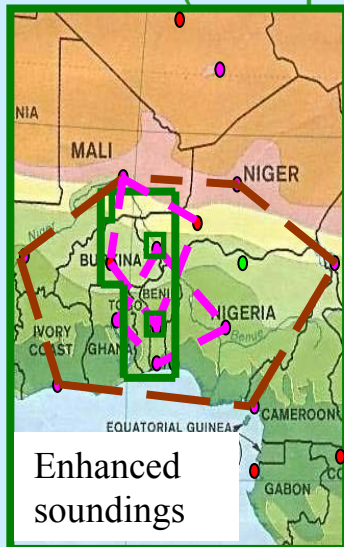
Scientific objectives :

- ☐ To investigate the structure, propagation & evolution of MCS ,
- ☐ To understand the 2-way interactions with the synoptic environment (monsoon flow in BL, AEJ, AEWs, TEJ, dry intrusions, ...)
- ☐ To quantify the heat & moisture budget, & precipitation efficiency ,
- ☐ To document the role of convective horizontal & vertical fluxes in atmospheric chemistry & aerosol distributions



SOP-2: Main additional surface-based equipments

- Enhanced RS networks (« Quadrilaterals »), O₃ soundings
- Lidar, Micro-lidars, Microwave radiometer, ...
- Surface stations (Meteo, Fluxes, Radiation, Aerosol, Trace gases, GPS, ..)
- *Driftsondes launched at N'Djamena (Chad)*
- **Djougou (Benin) :**
 - X- and C- Doppler polarimetric radars (X-Port + Ronsard) + *bistatic receiver (DLR), UHF-VHF wind profiler*
 - Lightning detection network
- **Niamey (Niger) :**
 - S-POL (NSF proposal)
 - Few ISSs (NSF proposal)

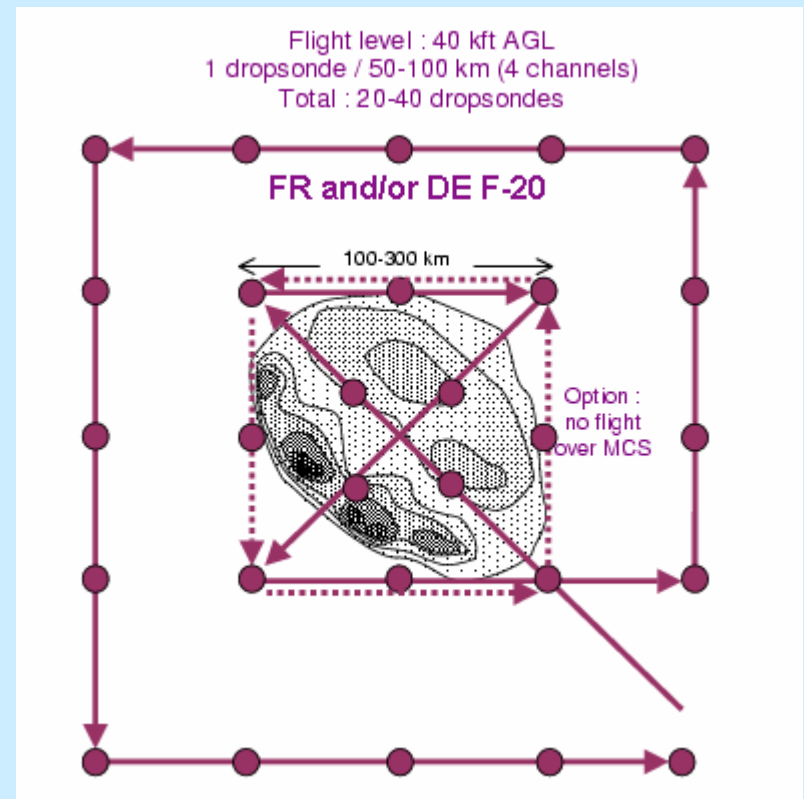
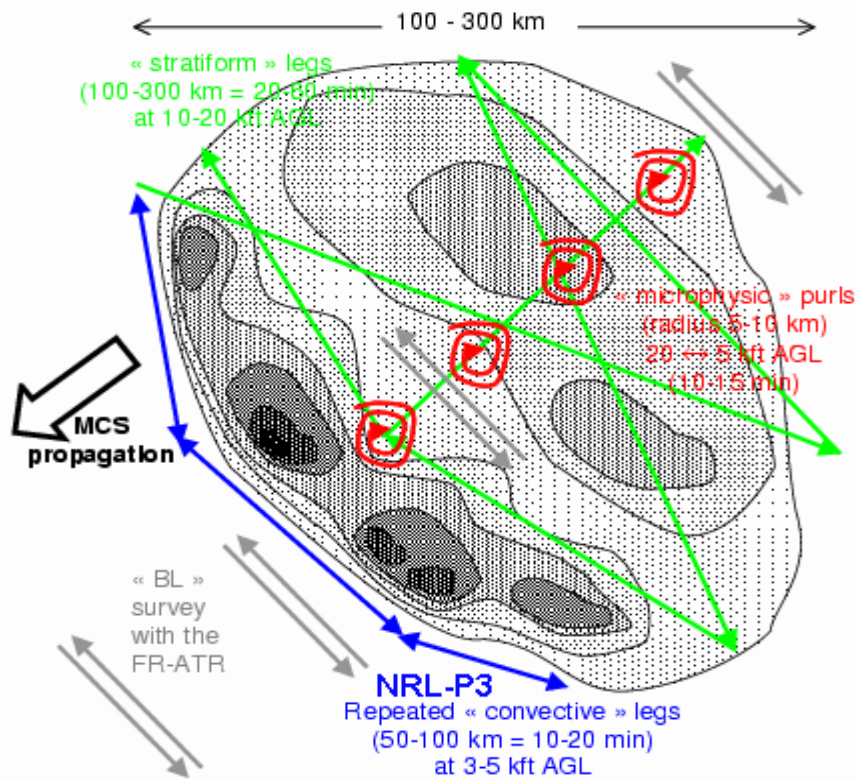


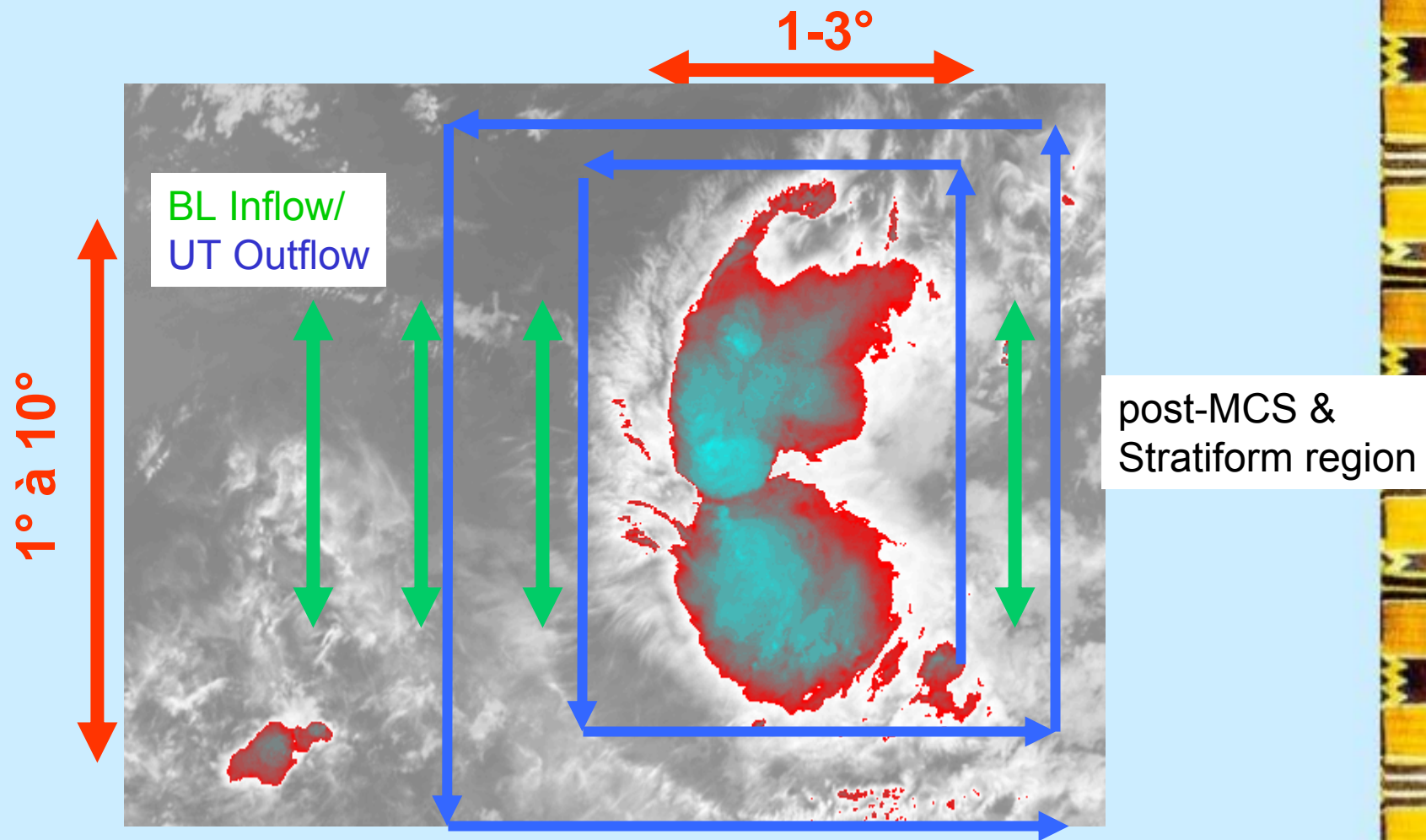
SOP2: Instrumented aircraft (based in Niamey) :

FR ATR-42 & F-20 ; UK BAe-146 ; DE F-20

US P3 NRL or/ & NOAA P3

MCS, Environment (incl PBL), Chemistry & Aerosols





MSG-1, 14 July 2003, 02:00-08:45 UTC, IR10.8



STEP 1:
before the MCS
passage - background cond.
Lat. & Vert. gradient

STEP 2:
After the MCS
passage - perturbed cond.
Lat. & Vert. gradient

F/F20:
chem. & dropsondes

UK/BAe-146:
chem.

North

South

North

South

ATR42: flux measurements

ATR42: flux measurements



SOP-3 (\approx 15 Aug - 15 Sep 2006) « **Late Monsoon** »

Scientific objectives :

- ☐ To investigate the evolution of MCS as they leave the WA continent & reach the Eastern Tropical Atlantic (\rightarrow Tropical cyclogenesis)
- ☐ To quantify the long range westward transport of aerosol and trace gases
- ☐ To document the microphysics of persistent MCS debris (high altitude anvil clouds) and their radiative impact



Enhanced radiosounding network : “Western quadrilateral” :

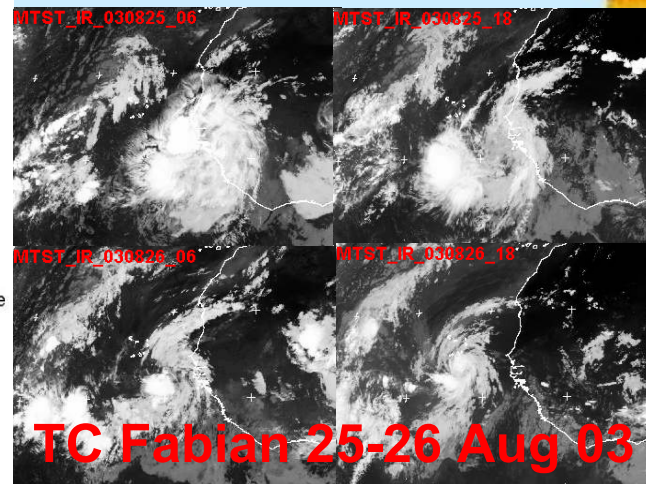
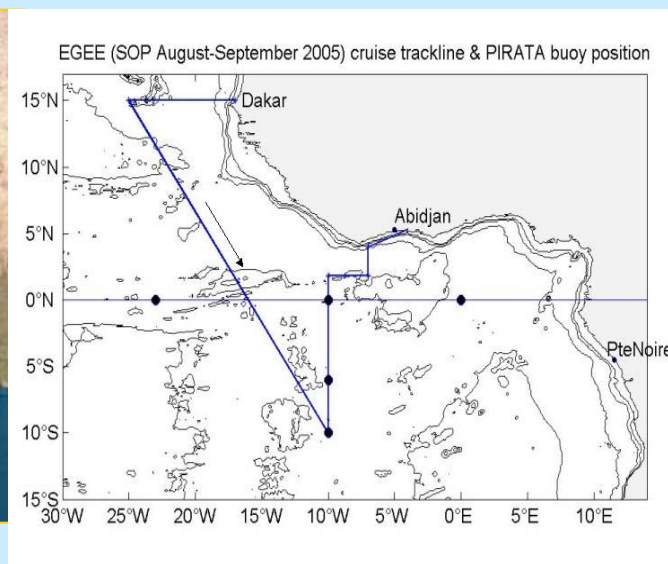
EGEE cruise in the Eastern Tropical Atlantic (+ *RV Ron Brown*)

Instrumented aircrafts (based in Dakar, Senegal) :


FR F-20 ; ? UK BAe-146 ? ; ? DE F-20 ? ; *US NRL-P3 or ???*

Driftsondes ?

US experiments in the eastern / central / western tropical Atlantic



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