Quantifying Weather and Climate Impacts on Health in Developing Countries (QWeCI)

Science Talk

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Climate and health : observation and modeling malaria in Ferlo (Senegal)

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SEVENTH FRAMEWORK PROGRAMME

Outline

- Introduction
- Climate and malaria link
- Data collect and process
- Preliminary results
- Conclusion and perspectives

Framework of study: QWeCI project (*Quantifying Weather and Climate Impacts on Health in Developing Countries*), further informations in the project on www.liv.ac.uk/QWeCI

□ Context : Climate and health relationship

□ Objectives :

➢ describe the spatial and temporal characteristics of climate in Ferlo, Senegal and West Africa and analyse impacts on vector-borne diseases;

➢ assess the seasonal malaria parameters using the Liverpool Malaria Model (LMM) and its interface DMC (Diseases malaria Cradle);

➢ enable decision makers to better access to climate forecasts and application on heath in order to prevent high transmission risk.

Climate and malaria link

Essential parameters

Pathogen: plasmodium

Tranmission vector: anopheles

Target host: human

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Rainfall
Temperature

Humidity
wind

Climate parameters

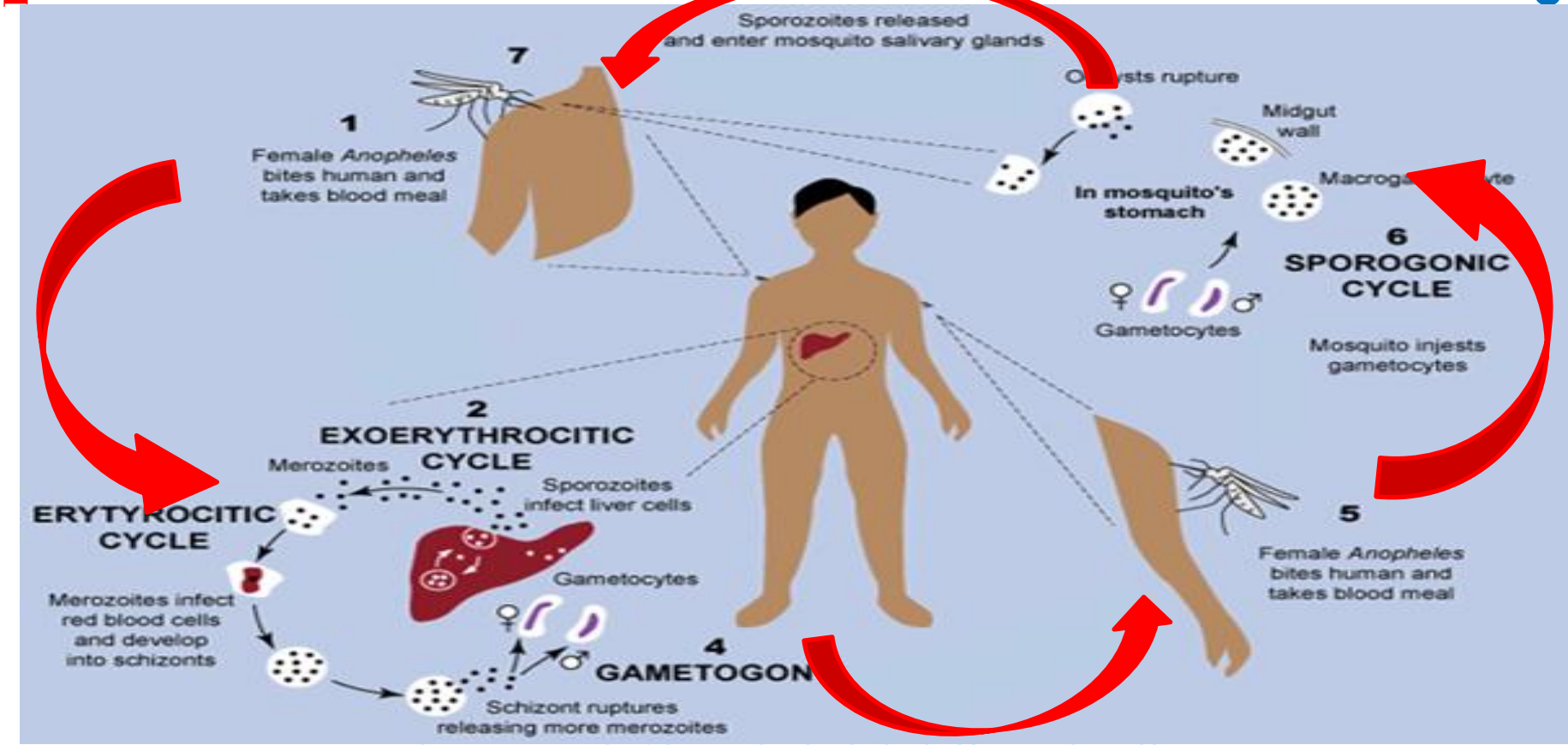
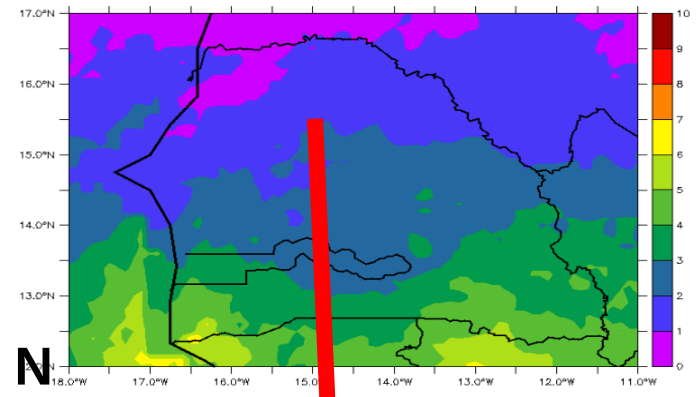


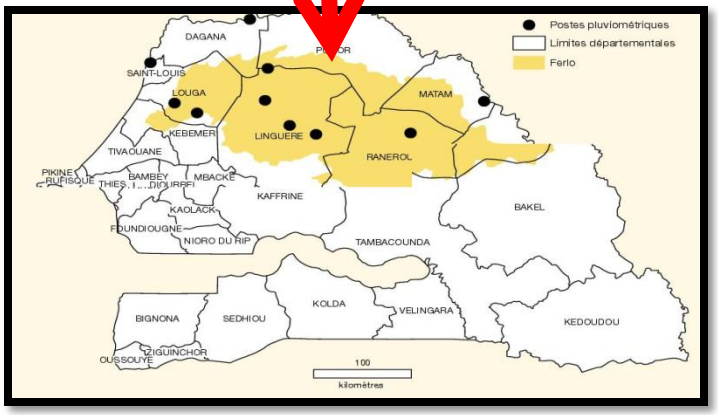
Fig 1: Process cycle of the parasite developing inside mosquito and human , Jones, 2008

Presentation of area Study

R



N



L

The study is conducted in the Ferlo area. The Ferlo is a sylvopastoral region, with a sahelian climate.

Fig 2: Area of study for regional (R), national (N) and local (L) scale

❑ Data

- ✓ climate : (daily and monthly) : rainfall, temperature (maximum and minimum), relative humidity (maximum et minimum), wind speed and direction ;
- ✓ simulated climate models : NCEP, Era-interim ;
- ✓ others observation data : CRU, TRMM (satellite data), GPCP etc.;
- ✓ clinical : malaria incidence, specific morbidity, parameters linked with vector and parasite;

❑ Processing with fortran, matlab, xmgrace, LMM interface (DMC)

Observation results on climate parameters

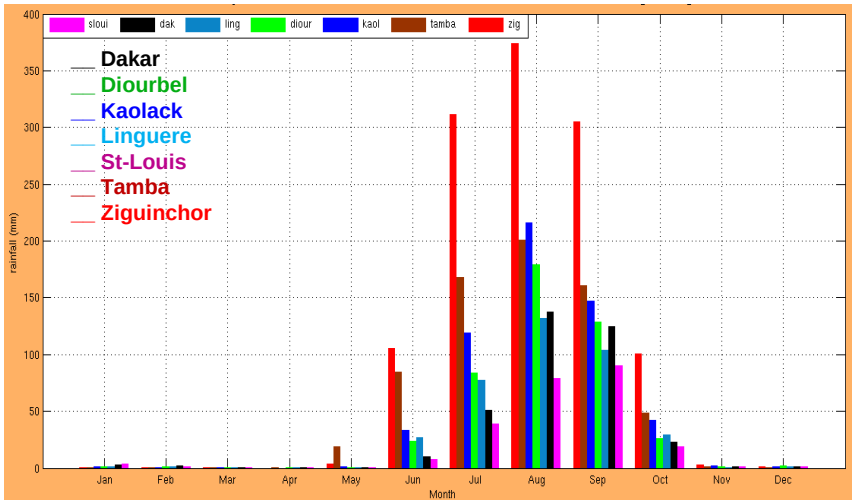


Fig 3: Annual cycle of rainfall over different regions of Senegal (1973-2006)

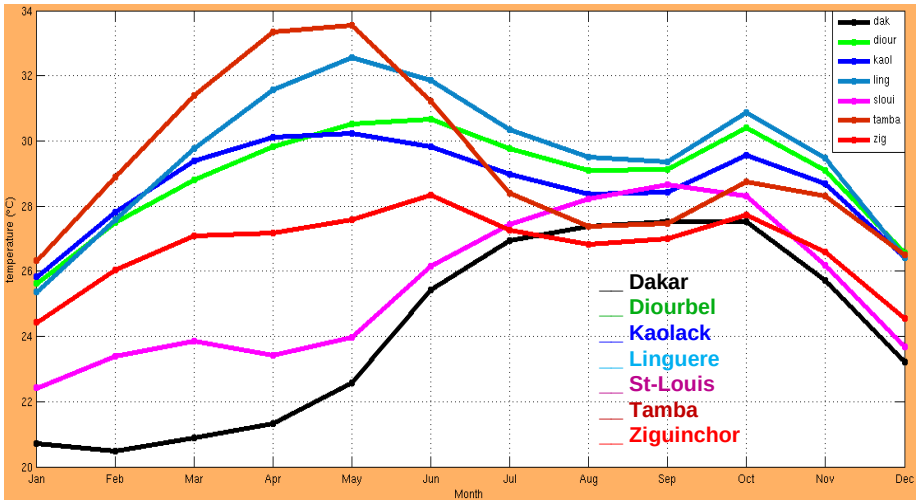


Fig 4: Annual cycle of temperature over different regions of Senegal (1973-2006)

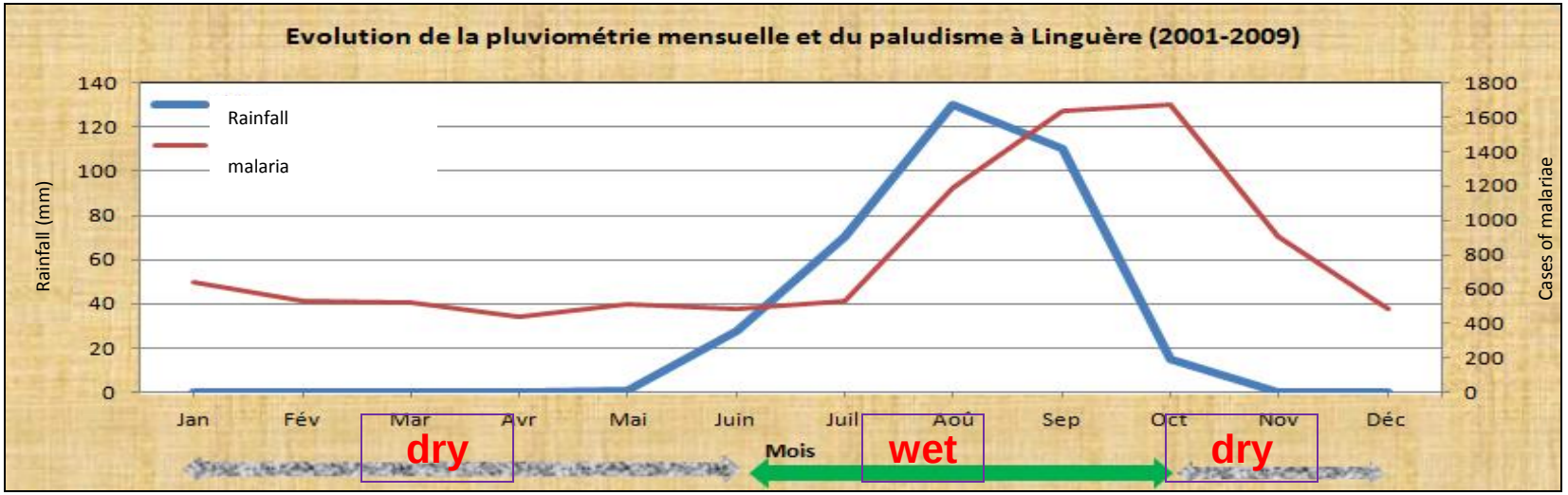


Fig 5: Seasonal rainfall variation and malaria occurrence in Linguere (2001-2009)

Seasonal and spatial variability of rainfall over Senegal

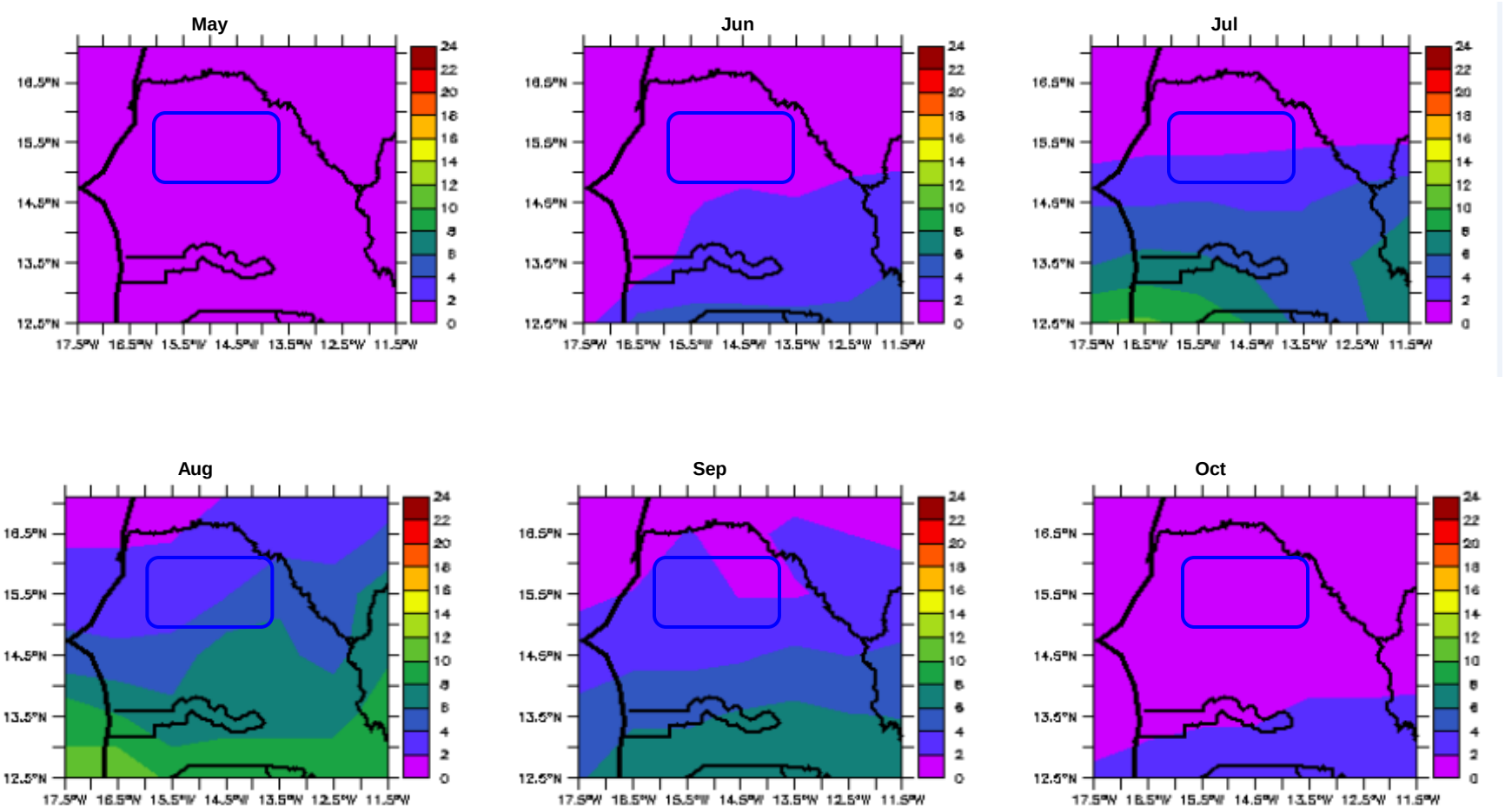


Fig 6: Spatial and temporal variability of precipitations (mm/day) over Senegal from May to October with GPCC data 1901-2012; *the box in blue shows the Ferlo area*

Others observation results on intra and inter-annual rainfall

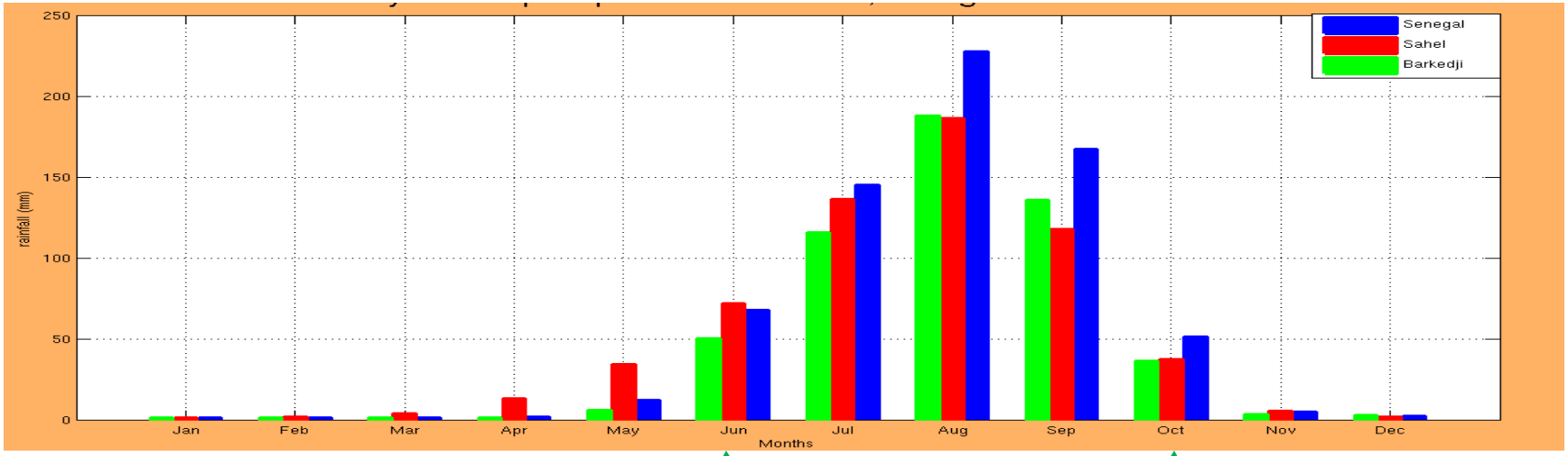


Fig 7: Annual cycle of rainfall averaged over Sahel, Senegal and Ferlo area

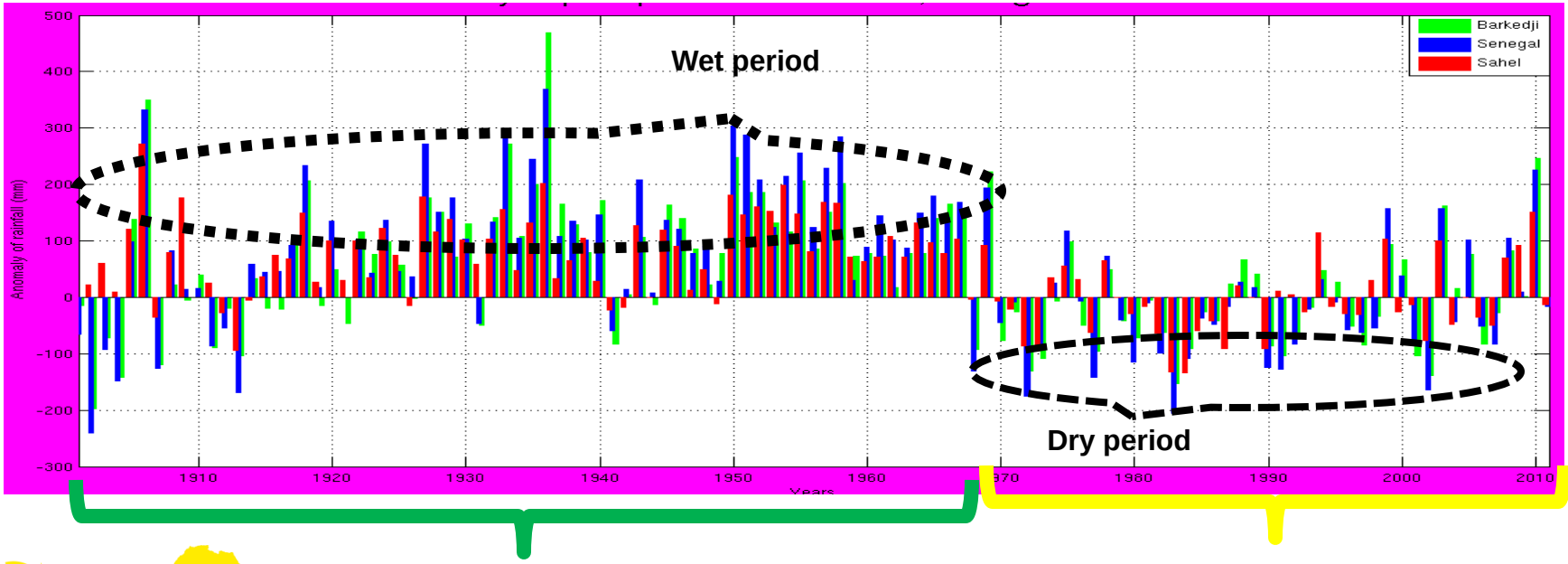


Fig 8: Interannual cycle of rainfall averaged over Sahel, Senegal and Ferlo area

Observation results on malaria over Senegal regions

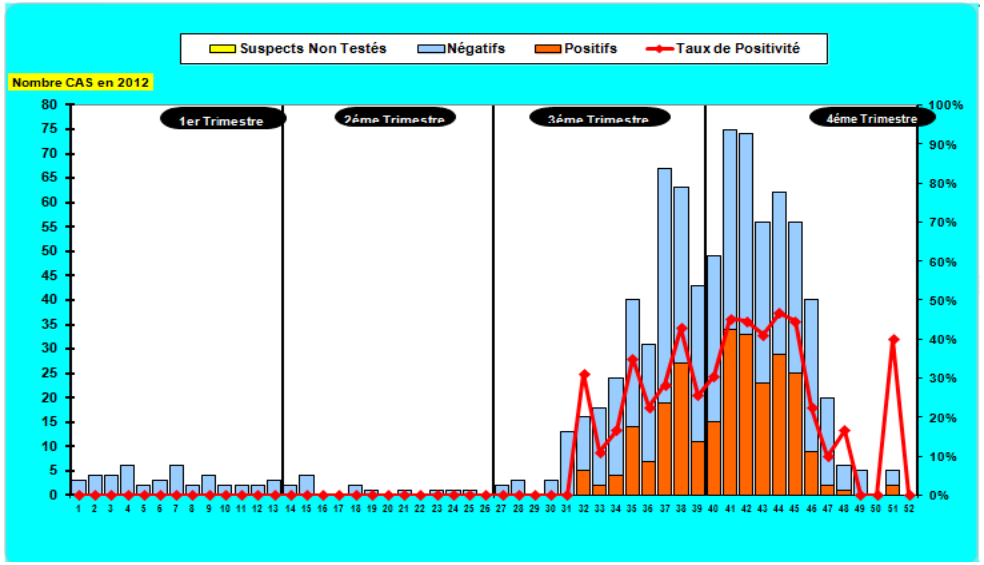


Fig 9: Sentinel site of Linguere: Weekly cases of malaria collected in Barkedji post in 2012

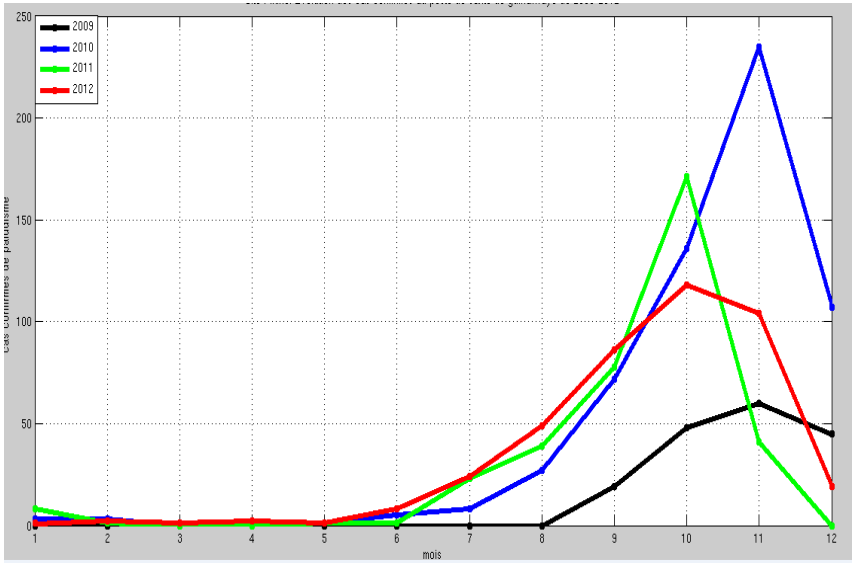


Fig 10: Sentinel site of Pikine (Dakar banlieue): monthly cases of malaria transmission in Guinawray post (2009-2012)

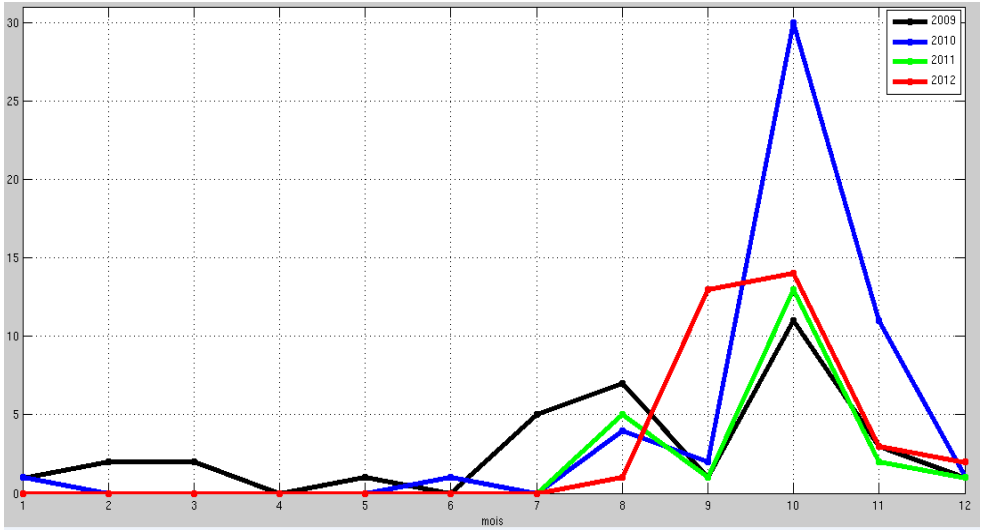


Fig 11: Sentinel site of Linguere : monthly cases of malaria transmission in Barkedji post (2009-2012)

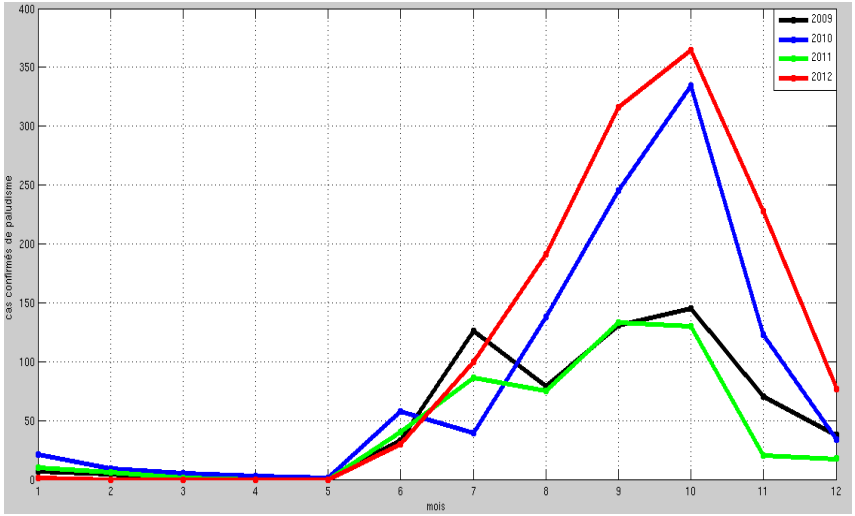


Fig 12: Sentinel site of Bakel (Tambacounda region in Eastern Senegal): monthly cases of malaria transmission in Gabou post (2009-2012)

Simulation results (spatial variability of LTS)

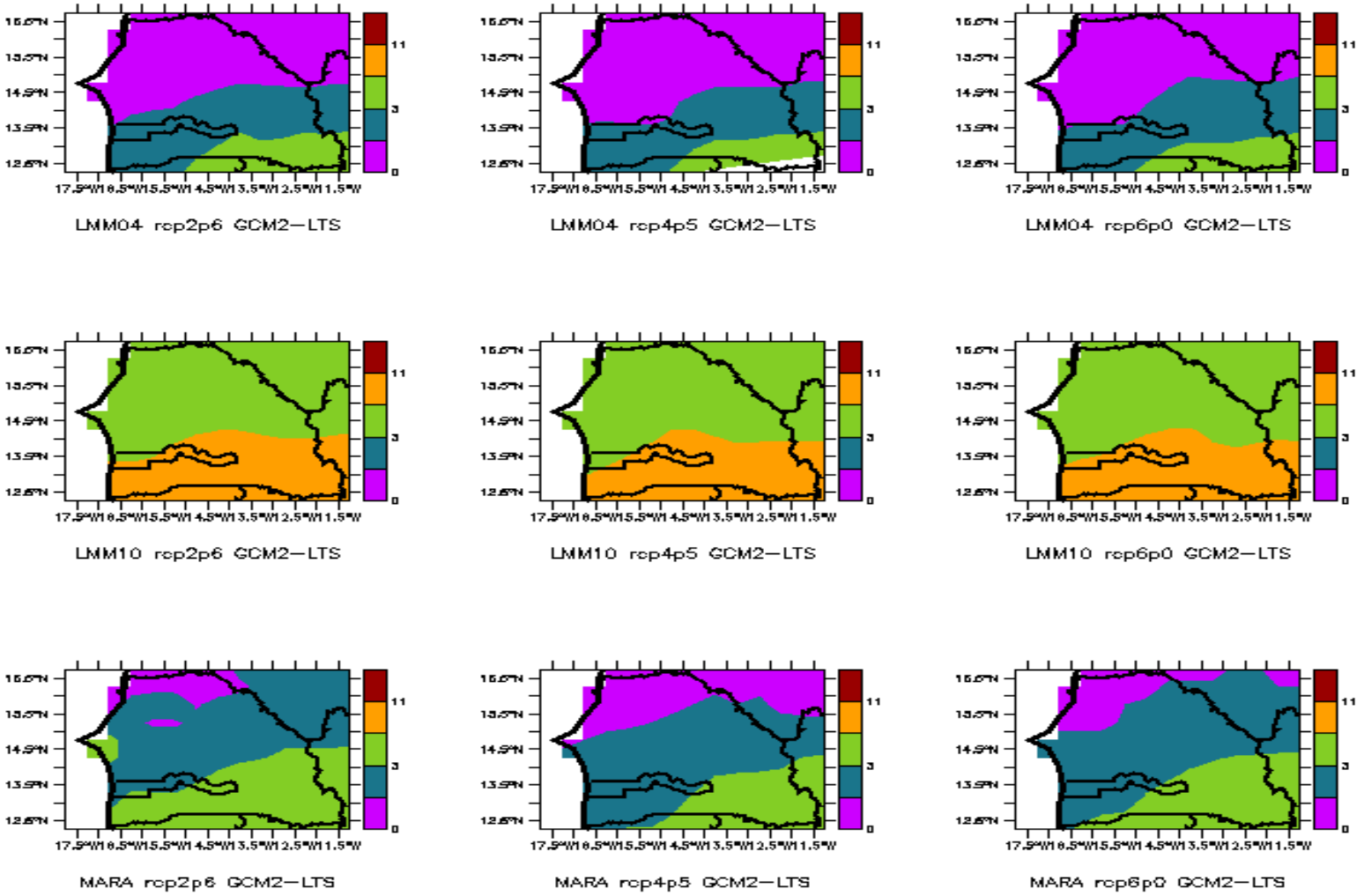


Fig 13: Length of malaria transmission season over Senegal simulated for the period 2006-2035 by LMM and MARA coupled with GCM models

LMM simulation results over Senegal regions

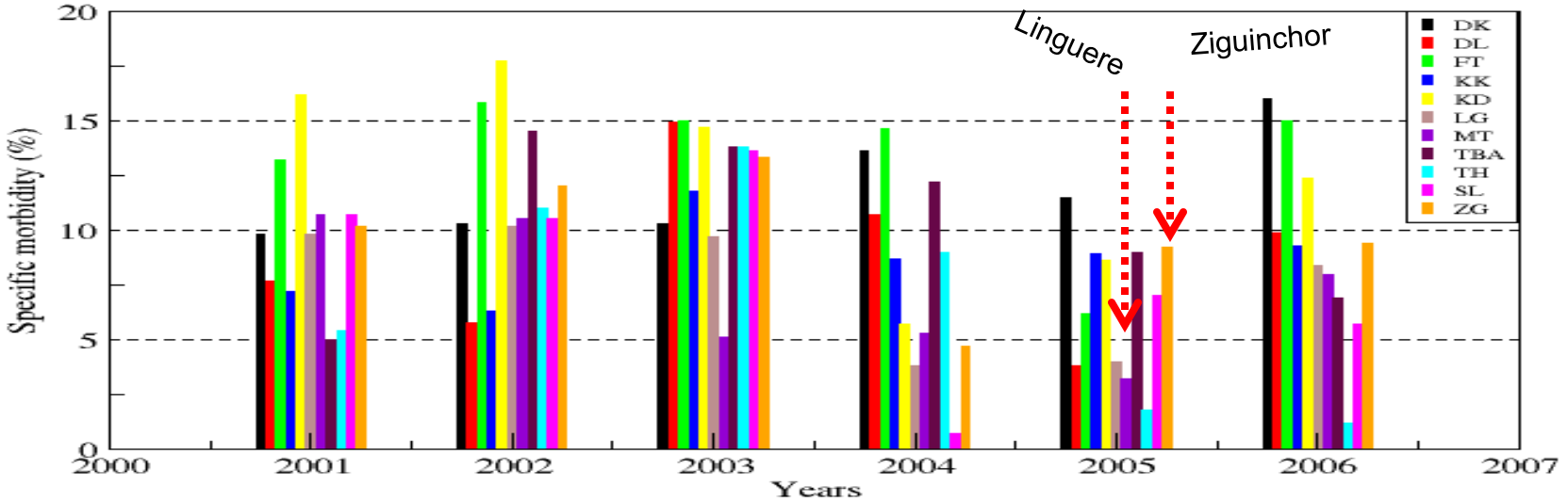
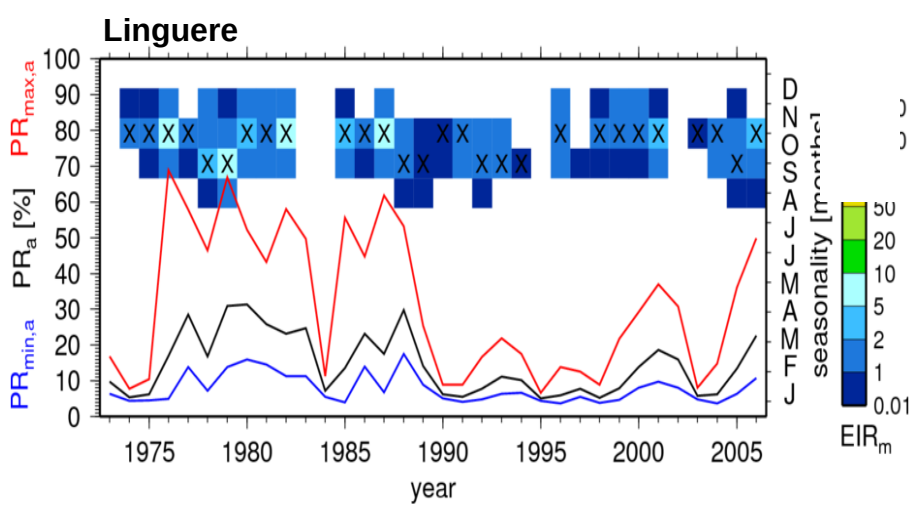


Figure 14: Comparison of specific morbidity of malaria Observed by Senegal regions fromm 2000 to 2006



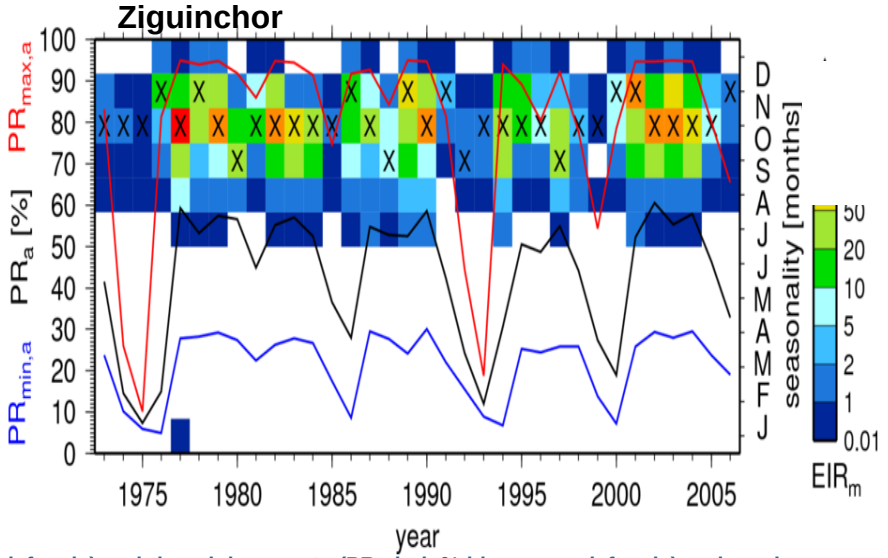


Fig 15: Interannual variability of the average rate of asexual parasites (PRa in% black curve, left axis) and the minimum rate (PRmin in% blue curve, left axis) and maximum (PRmax in% red curve, left axis) of asexual parasites. Seasonal characteristics of malaria (right axis): Monthly entomological inoculation rate (color palette). The months of maximum transmission are marked with an "X". Comparison between Linguere (Ferlo) and Ziguinchor (Southern part)

LMM simulation results over Senegal regions

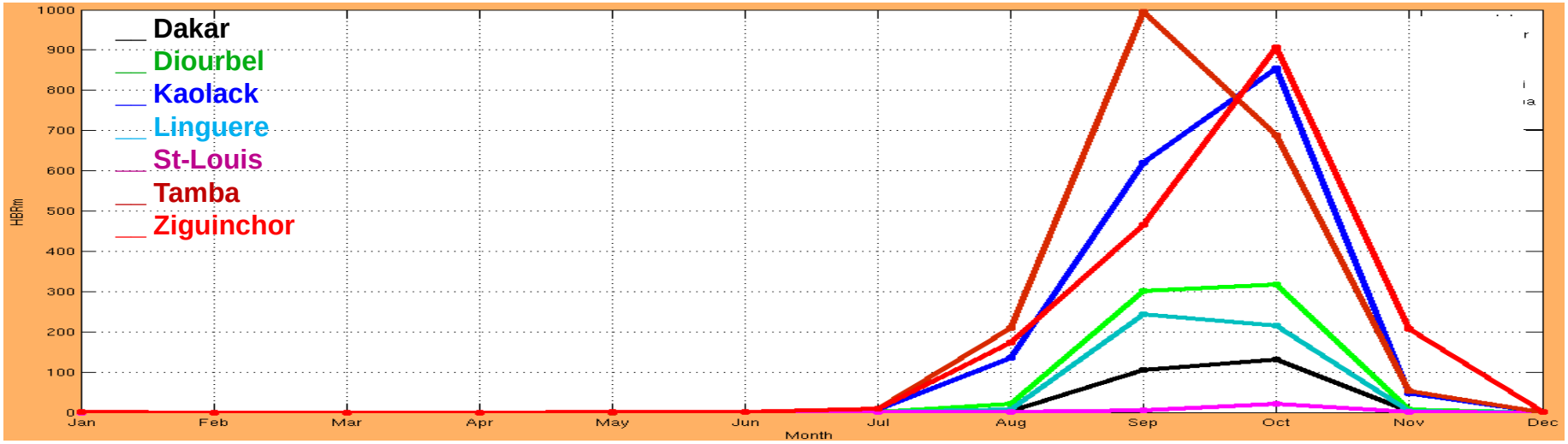


Fig 16: Monthly number of mosquitoes bites per human between 1973-2006 over Senegal regions

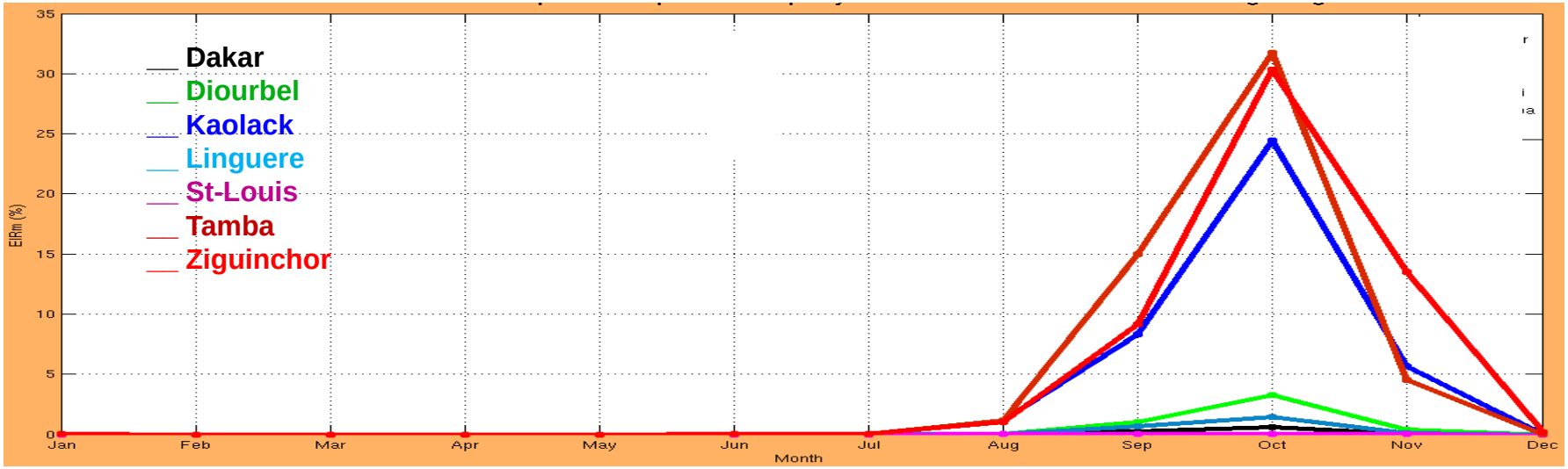
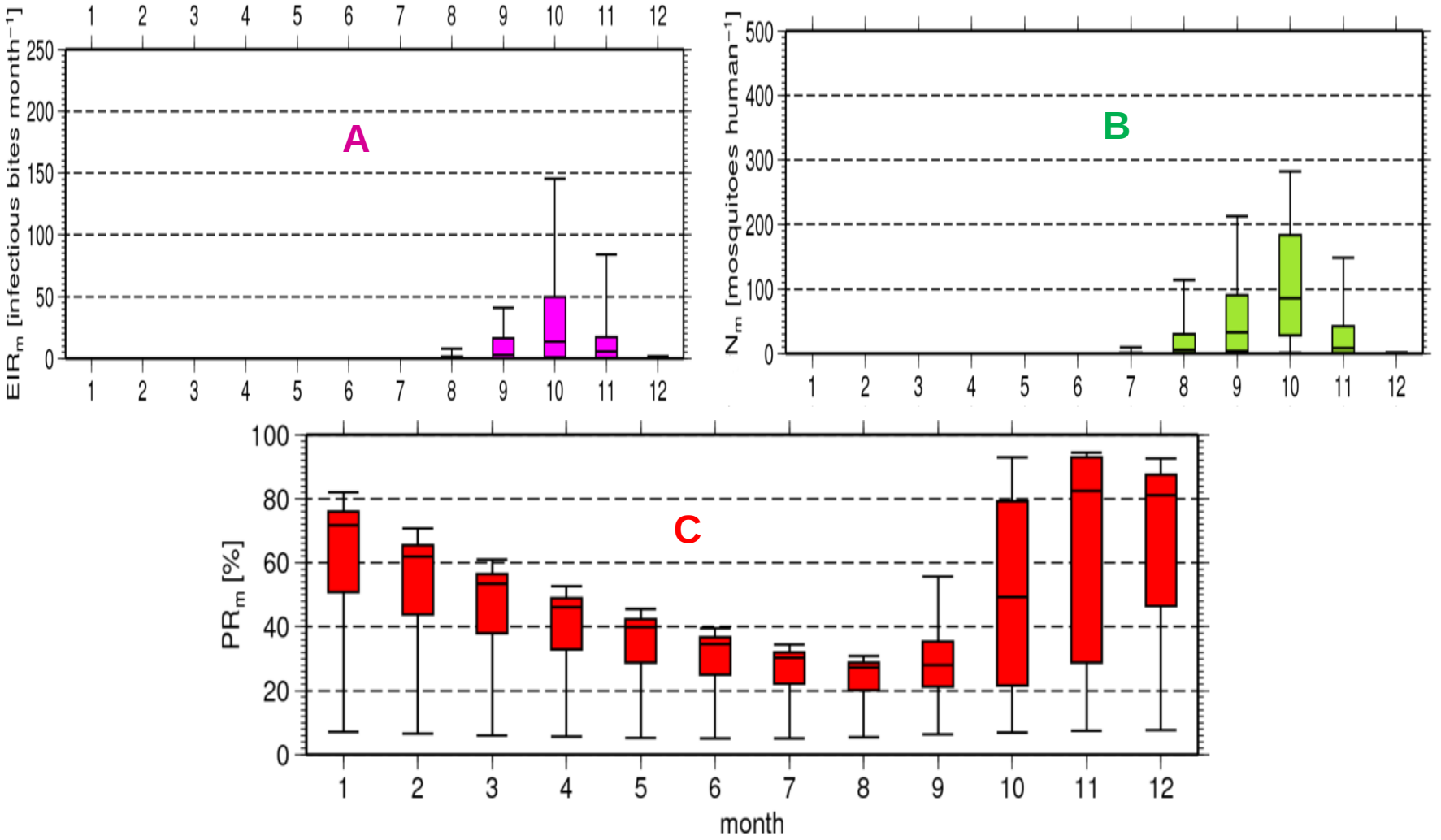


Fig 17: Monthly number of infectious mosquitoes bites per human between 1973-2006 over Senegal regions

LMM simulation results over Senegal regions



Fg 18: Diagram boxes of entomological inoculation rate (A), mosquito number (B) and asexual parasite rate (C) in Ziguinchor (average 1973-2006)

LMM simulation results over Senegal regions (comparison of the LMM version)

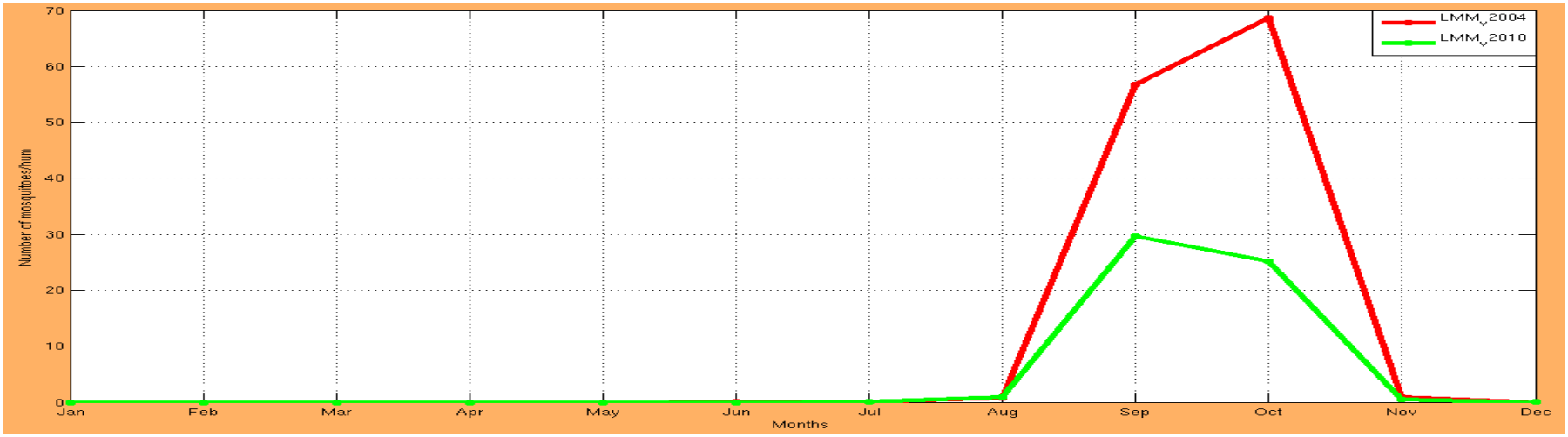


Fig 17: Monthly mosquito number for 1973-2009 period: comparison of the two versions of LMM simulations

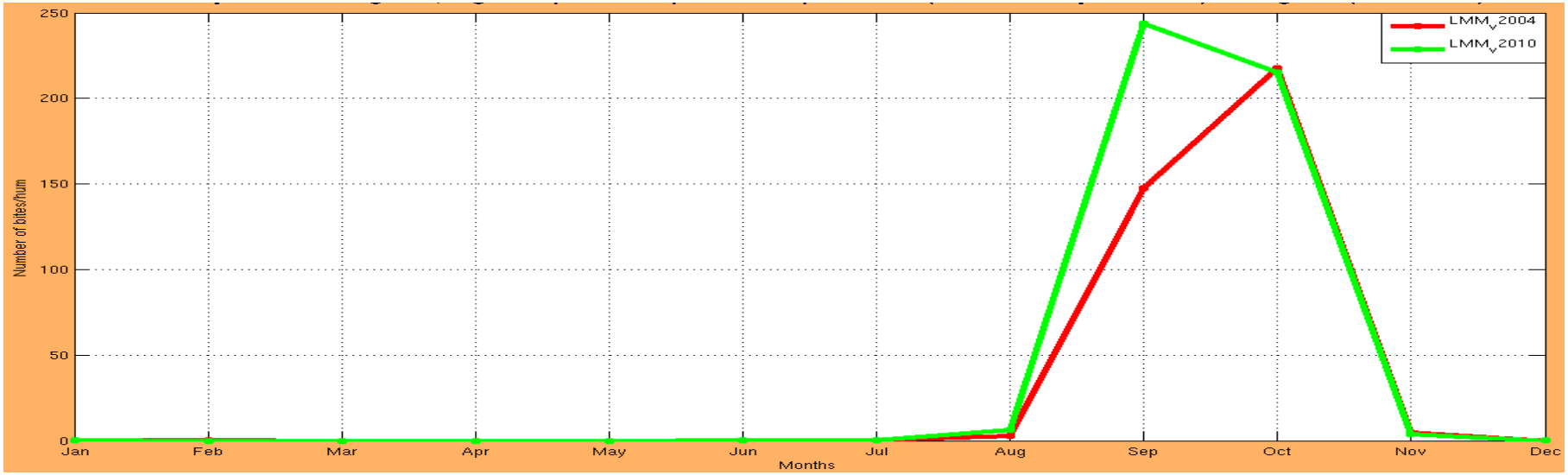


Fig 19 Monthly mousquito bite per human for 1973-2009 period: comparison of the two versions of LMM simulations

possible malaria predictability from SSTs: Coincident or causal?

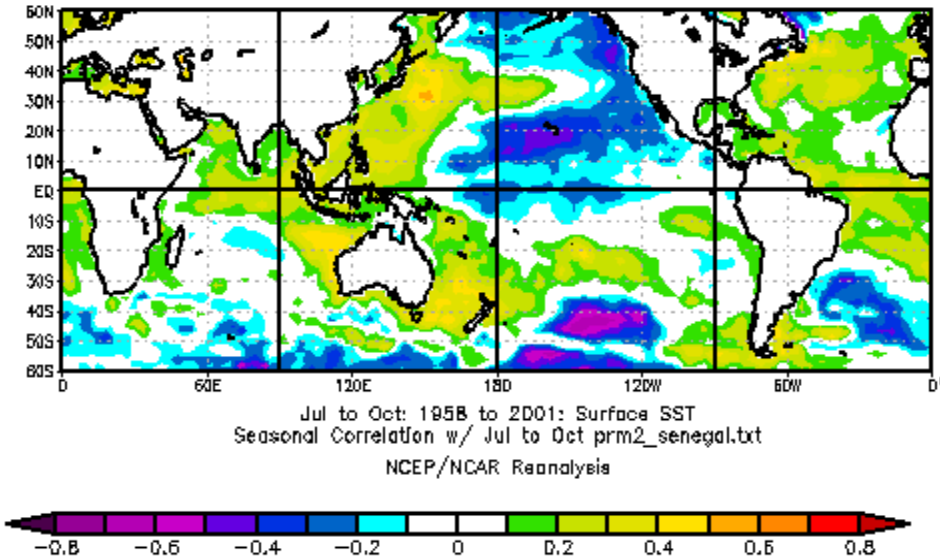


Fig 19: Correlation asexual parasites (PR)JASO with seasonal SST

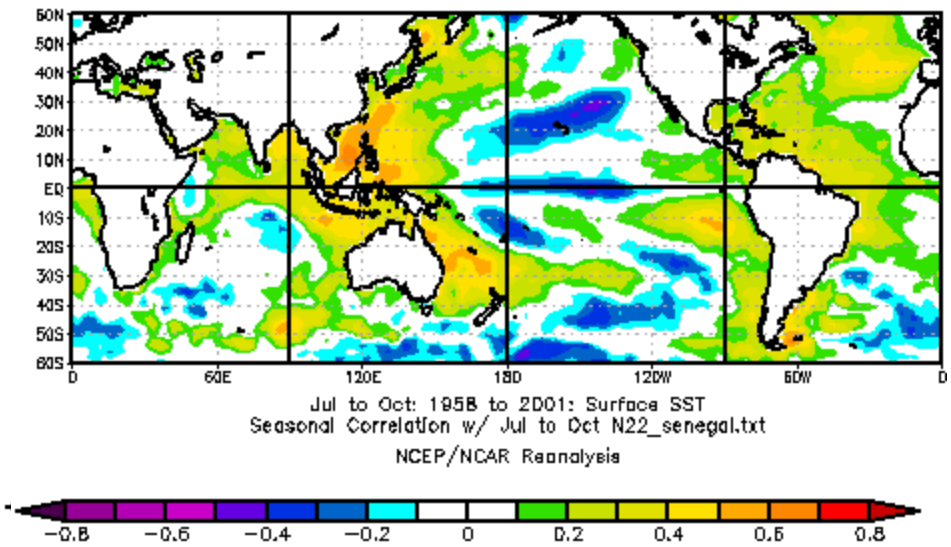


Fig 20: Correlation number of mosquitoes (Nm)JASO with seasonal SST

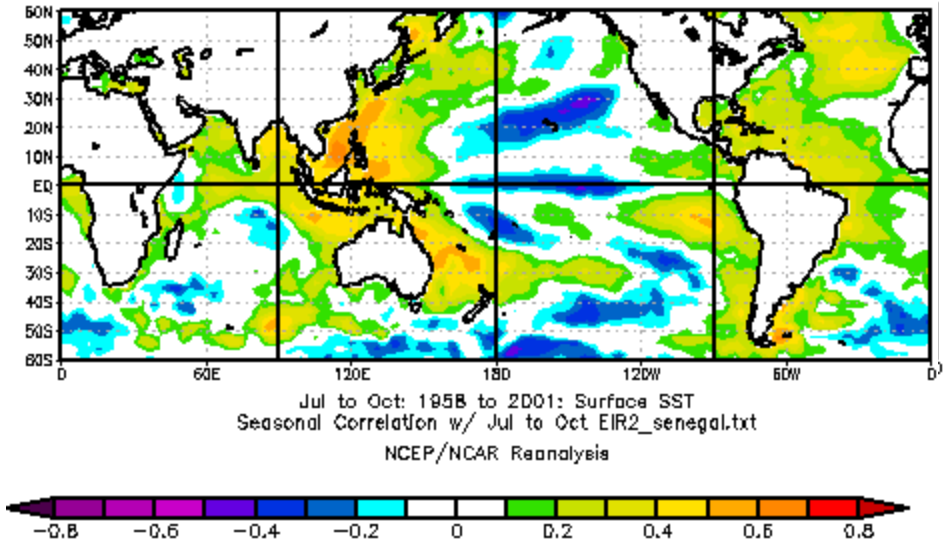


Fig 20: Correlation number of mosqutoes bites (EIR) JASO with seasonal SST

Conclusion and perspectives

❑Observations on malaria outbreaks show:

➢ **rainfall in Ferlo and Senegal in general are characterized by a strong seasonality with maximum frequency in august, and strong inter-annual variability as all West African and Sahelian regions**

➢**seasonal epidemiology of malaria over all Senegal regions but high transmission founded over the southerner and eastern wetter sentinel sites;**

➢**causal or coincident malaria development with climate parameters during or soon following rainy season.**

➢**a lag of one to two months of malaria peak compared to rainfall peak.**

❑The LMM simulations in agreement with the observations:

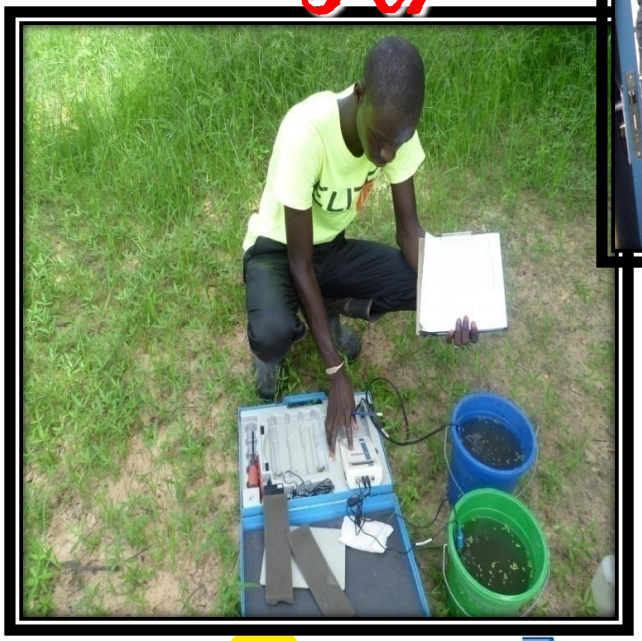
➢**favorable conditions with high value of malaria parameters are found over wetter regions as it is expected depending environmental and climate characteristics.**

❖ **Examining malaria parameters using sea surface oscillation preceding Senegal and Sahelian rainy season in order to couply *LMM* with *S⁴CAST* "SST based on Statistical Season for Cast" model for West Africa in development in Universidad Complutense de Madrid.**

Gracias

Por

su



colaboración