# Predictability of malaria parameters in Sahel under the S4CAST Model

28th November – 1st December 2016, UPMC, Paris, France

Presented by : **Ibrahima DIOUF**

**Co-authors: Rodríguez-Fonseca B., R. Súarez., Deme A., Cisse M., NDione J-A. and Gaye A. Th.**

# Contexte

INTRODUCTION

Literature has shown that climate is an important factor on malaria development, a vector-borne disease which is public health problem, particularly in Sub-Saharan Africa.

- **We explore the malaria outbreaks predictability over Sahel from previous SSTs.**

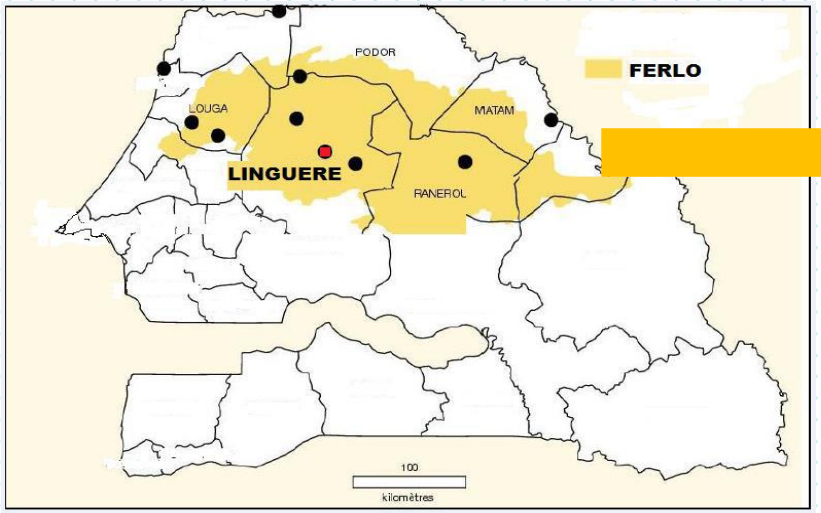
✓ The findings are highlighted by the S4CAST model. The S4CAST model based on the leading MCA covariability mode has been developed in order to evaluate and quantify the predictability of different variables in the relationship with SST.

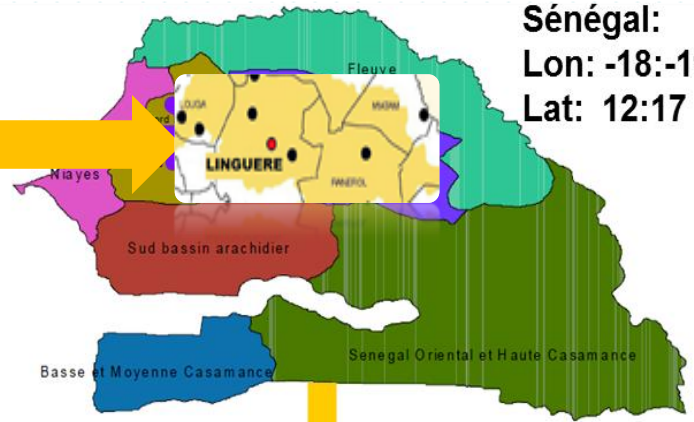
✓ The SST may be considered as a source of predictability due to its direct influence on rainfall and temperature, and also others related variables like malaria.

✓ Malaria simulations driven by meteorological data and reanalysis data sets are carried out. Simulated malaria parameters are compared with observed malaria data.

# Area of studay

INTRODUCTION




**Sénégal:**
**Lon: -18:-11**
**Lat: 12:17**

**Barkedji, station référence au Ferlo:**
**Lon: 14° 53**
**Lat: 15° 57**

The Ferlo is a sylvopastoral region, with a most sahelian climate conditions.


**Sahel:**
**Lon: -18:15**
**Lat: 9:21**

**Map showing locations of the stations used in this study. The study is extend to the Sahel region for the seasonal malaria predictability using the S4CAST model**

# Climate and malaria relationship

**Essential parameters**

**Pathogen agent: plasmodium**

**Vector of transmission : anopheles**

**Host: human**

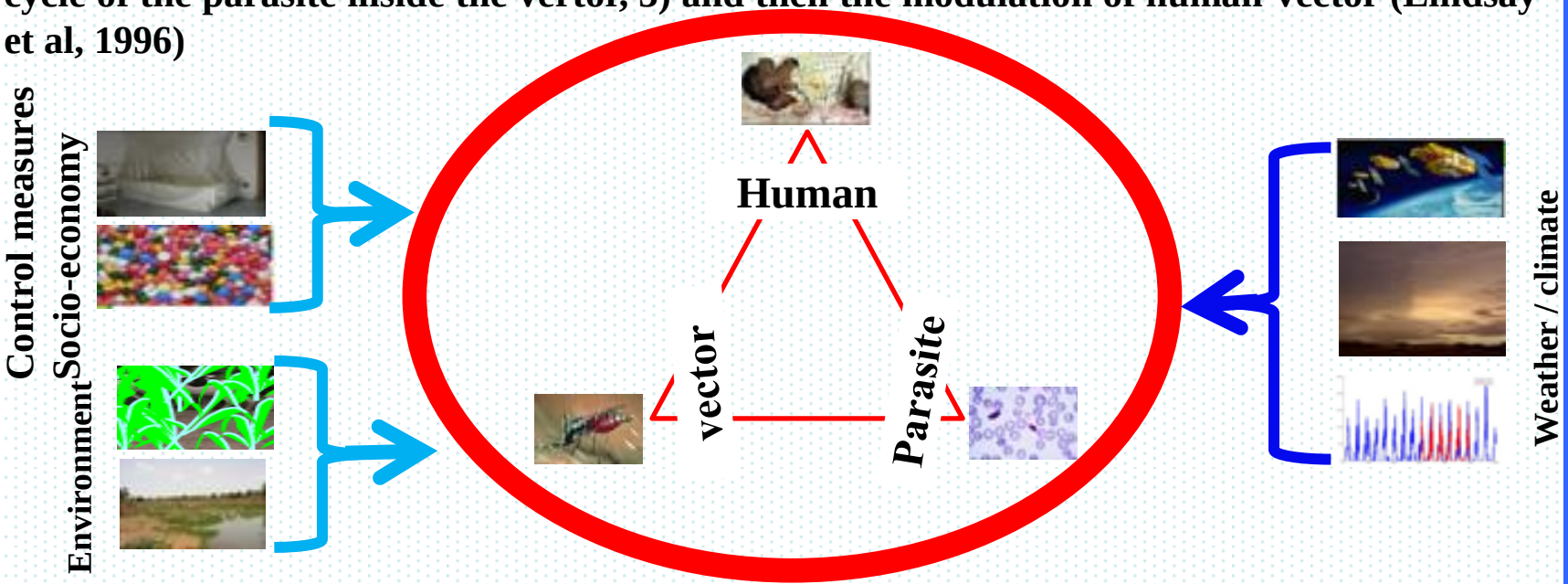
**+**

**Climatic parameters**

**Precipitations**
**Temperatures**

**Humidity**
**vent**

Climate parameters can influence malaria transmission by tree (3) transmission : 1) distribution and abondance anopheles vectors, 2) possibility and success of the sporogonic cycle of the parasite inside the vertor, 3) and then the modulation of human-vector (Lindsay et al, 1996)




Combinaision of socio-econimic, environnemental and climate factors of malaria transmission

# Data and Method

MATERIALS AND METHODS

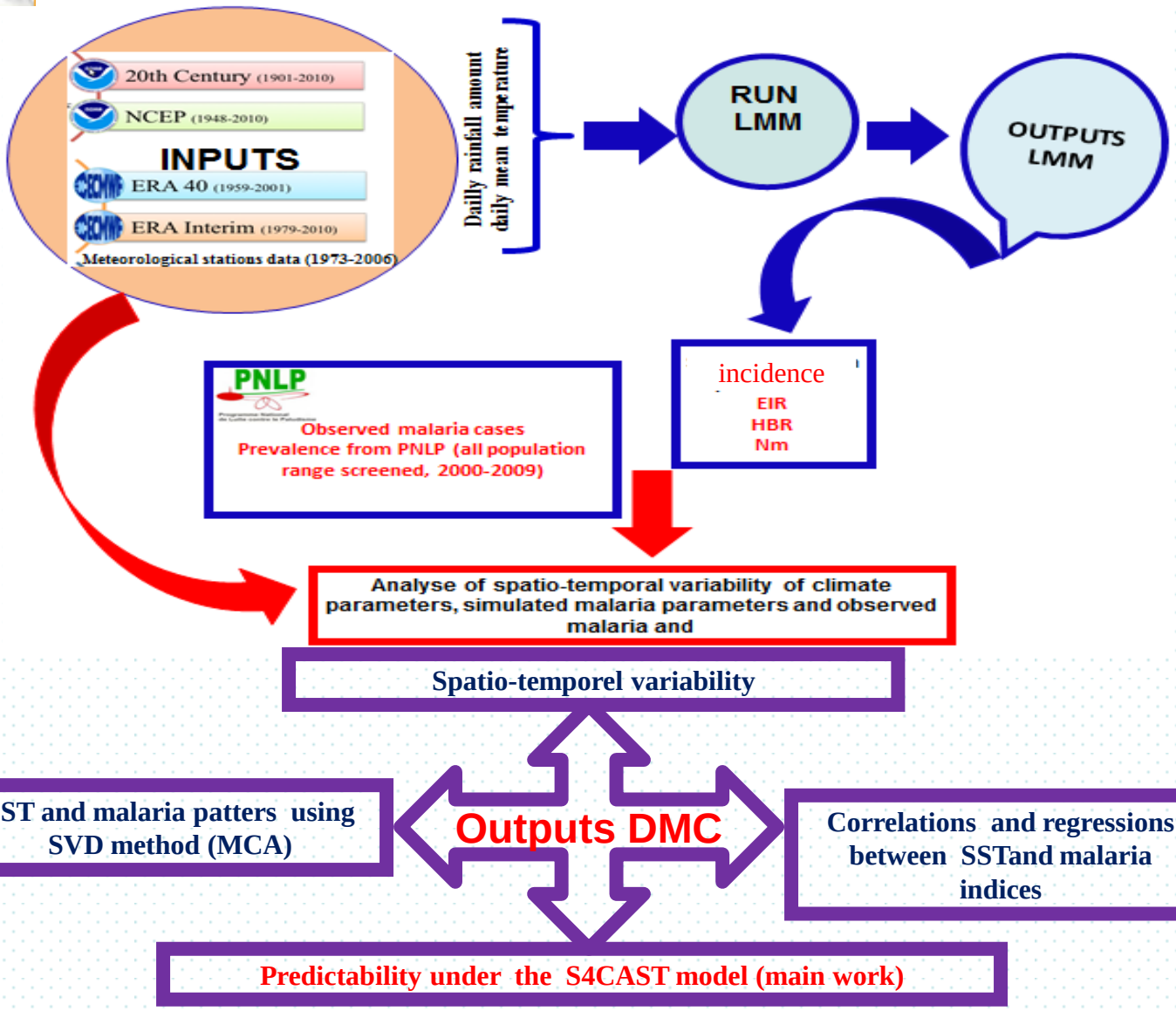
| Malaria observation | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Dataset** | **Period** | **Stations** | | | | | |
| Malaria cases and prevalence | 2000-2009 | S-Louis (Slouis) | Linguere (Ling) | Dakar (Dak) | Kaolack (Kaol) | Tambacounda (Tamba) | Ziguinchor (Zig) |
| **Observation Inputs (rainfall and temperature)** | | | | | | | |
| **Dataset** | **Period** | | | | | | |
| Meteorological data | 1973-2006 | | | | | | |

| Reanalysis inputs (rainfall and temperature) | | | |
|---|---|---|---|
| **Datasets** | **Period** | **Grid** | **Sources/references** |
| 20 Century Reanalysis Project daily averages | 1910-2009 | 2.5 x 2.5 | NOAA/Compo GP (2011) |
| NCEP | 1960-2009 | 2.5 x 2.5 | NOAA/Kalnay E, (1996) |
| ERA40 | 1958-2001 | 2.5 x 2.5 | CEPMMT/Uppala (2005) |
| ERA Interim | 1979-2013 | 1.5 x 1.5 | CEPMMT/Simmons(2007) |

**Classification of dataset, period of study and considered stations**

# Data and Method

MATERIALS AND METHODS




**Different sources of data and the processing**

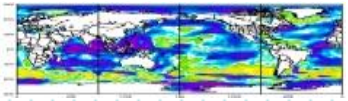
# Data and Method

**SST-malaria relations with SVD (MCA)**

**PREDICTOR: X**

nx

**ATL & PAC**
**SST (lagged)**



nt

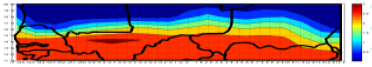
**PREDITANT: Y**

ny

**Sahel**
**EIR_son**
**HBR_son**
**Incidence_son**
**Nm_aso**

ny

nt

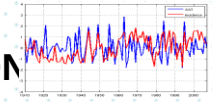


**MATRICE DE COVARIANCE**

$$C = Y^{*}X^{T}$$

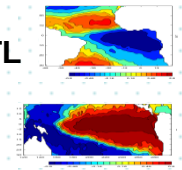
nx

**COEFICIENT D´EXPANSION**

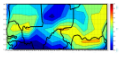


**PATTERNS SPATIAL**

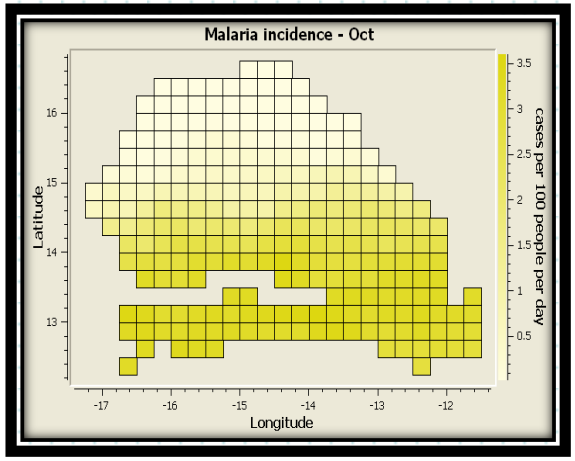
**SSTs ATL & PAC**

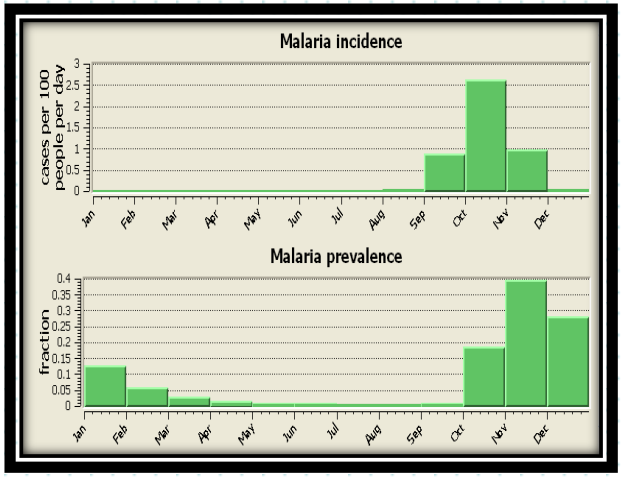


**MalariaSahel**

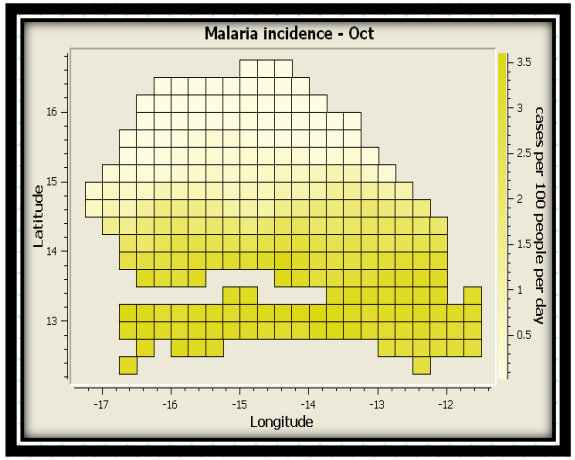


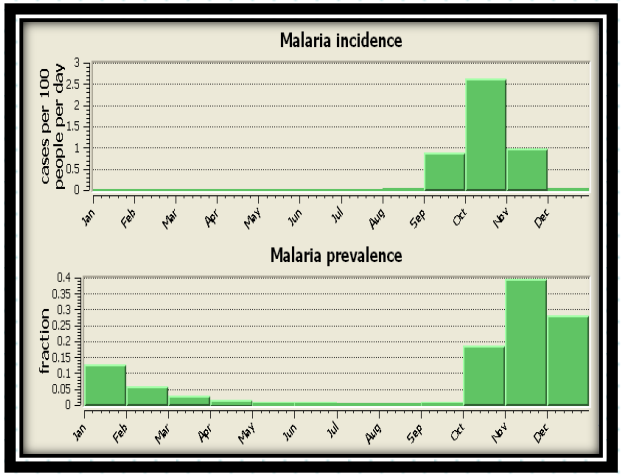
# DMC (The LMM interface)




Cliquer en un point pour afficher les séries chronologiques correspondantes



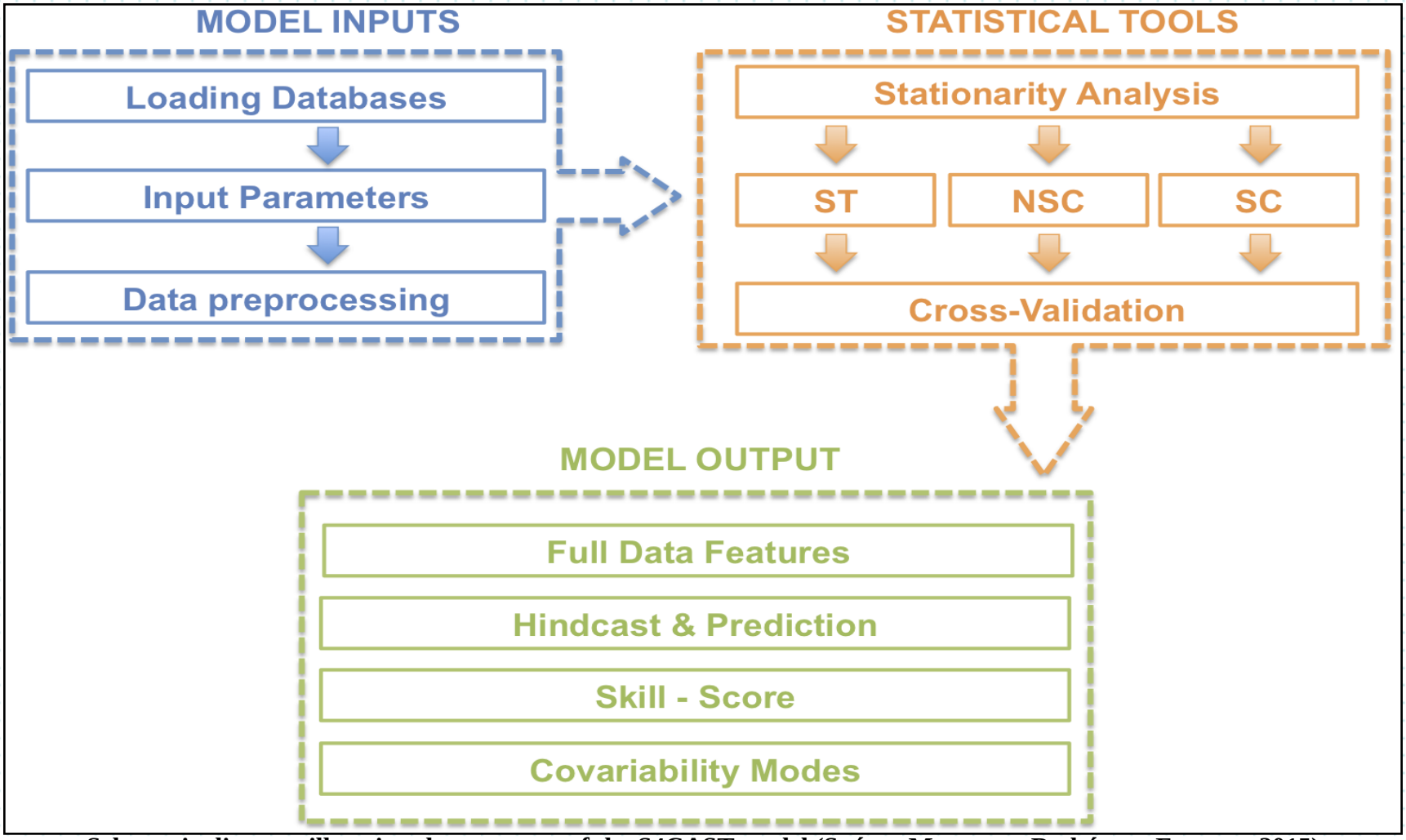




Click on a month of the time series to see the corresponding spatial distribution

**Spatio-temporelles Simulations OF MALARIA INCIDENCE IN Senegal using the DMC (LMM interface)**

# S4CAST MODEL (Version V2.0)

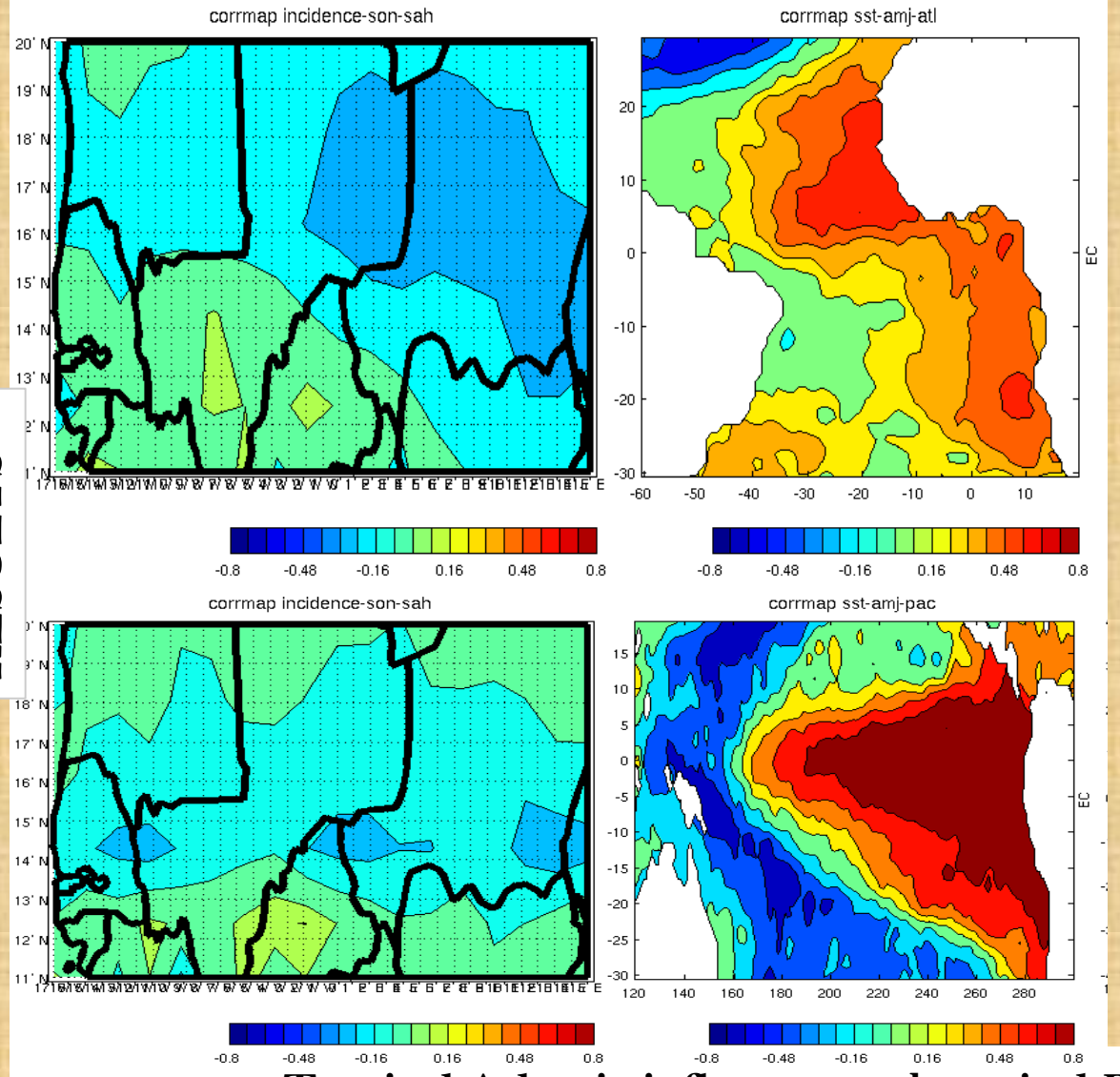
**Developed in the framework of a cooperation project between UCAD & UCM to study predictability of AO precipitations**




**Schematic diagram illustring the structure of the S4CAST model (Suárez-Moreno et Rodríguez-Fonseca, 2015)**

# RELATIONS BETWEEN SST AND SEASONAL MALARIA INCIDENCE IN SAHEL

RESULTS



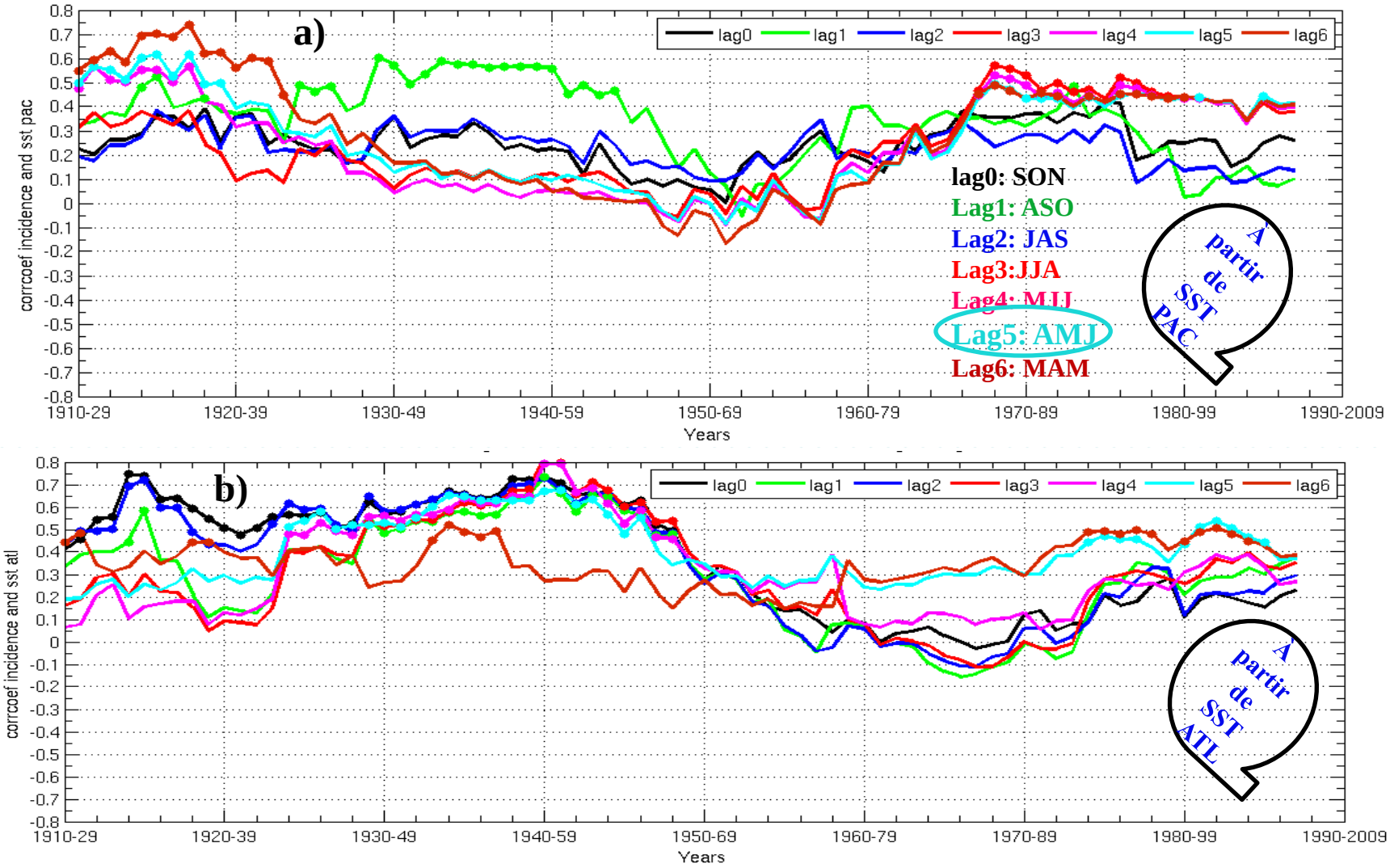

lag0: SON
Lag1: ASO
Lag2: JAS
Lag3:JJA
Lag4: MJJ
Lag5: AMJ

- For the Atlantic, a warming in the tropical region is linked with less incidence over the north-estern part of Sahel and high incidence over its south-western part.

- For the Pacific, a warming is related to less incidence in Sahel but a little more incidence in the South.

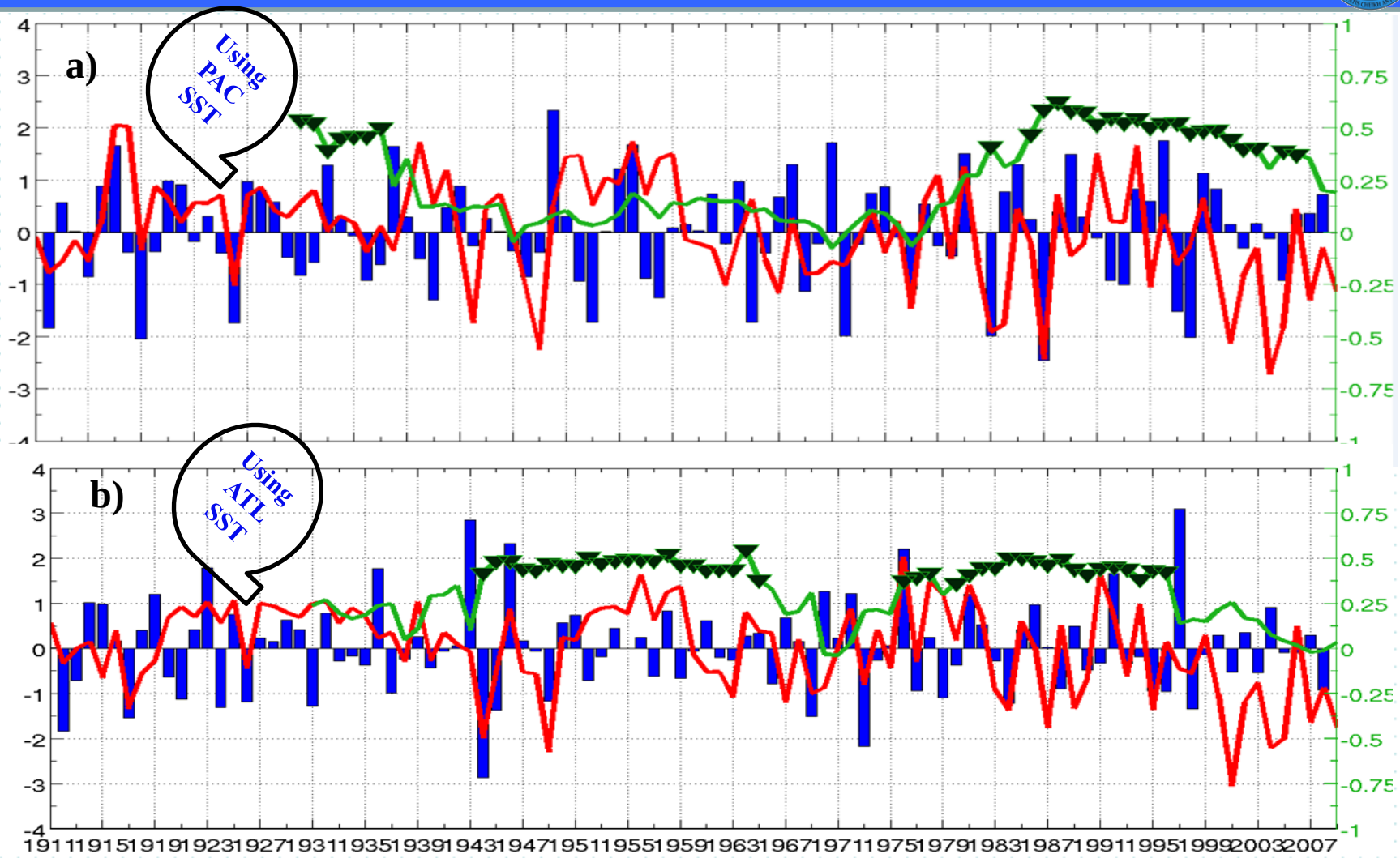
**Tropical Atlantic influence and tropical Pacific influence.**

# RELATIONS BETWEEN SST AND SEASONAL MALARIA INCIDENCE IN SAHEL



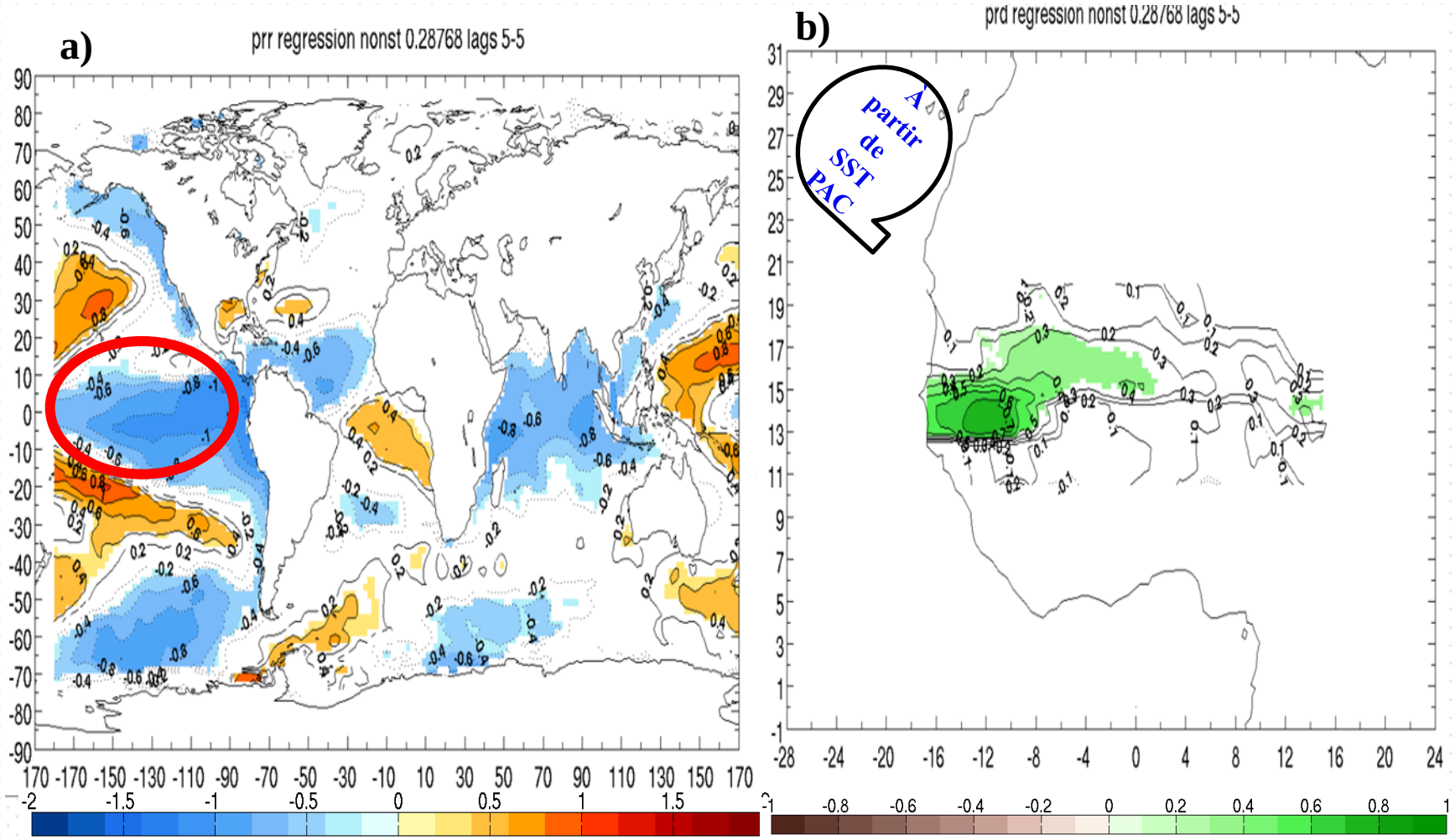

**20-year running correlation between malaria incidence SON index in Sahel and SST index over Pacific (a) and Atlantic b) from lag 0 to lag 5.**

# RELATIONS BETWEEN SST AND SEASONAL MALARIA INCIDENCE IN SAHEL




**21 years moving window correlation (Green line) between the expansion coefficients U (SST, blue bars) and V (incidence, red line) from the leading mode of co-variability between the two anomalous fields. Shaded triangles indicates significant correlation under a Montecarlo Test at 90%.**

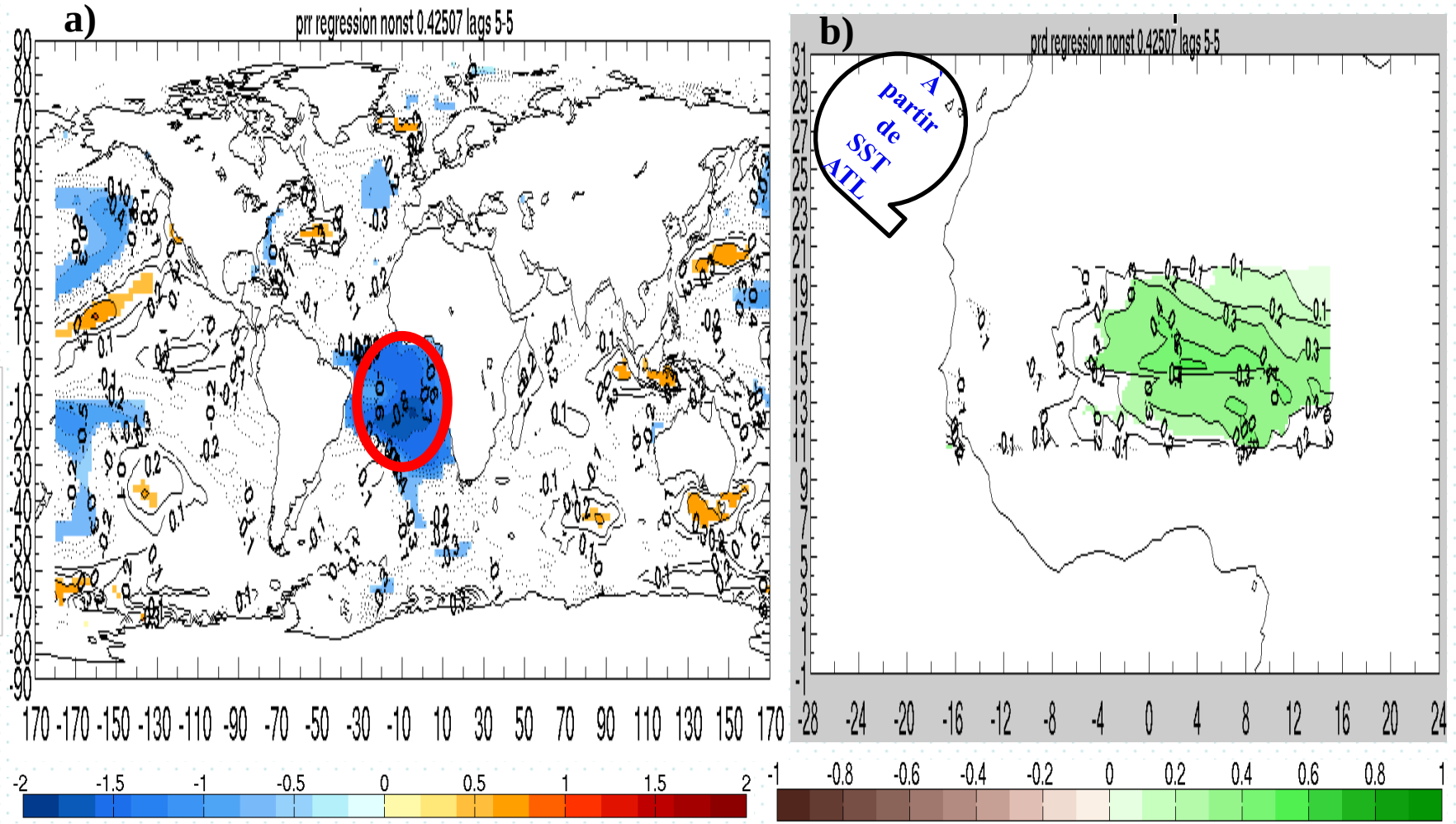
RESULTS




**SST regression map for the leading mode of co-variability for the non-stationarity periods and lag 5, and 15b) malaria incidence regression map for the leading mode of co-variability for the non-stationarity periods and lag 5**

# RELATIONS BETWEEN SST AND SEASONAL MALARIA INCIDENCE IN SAHEL

RESULTS



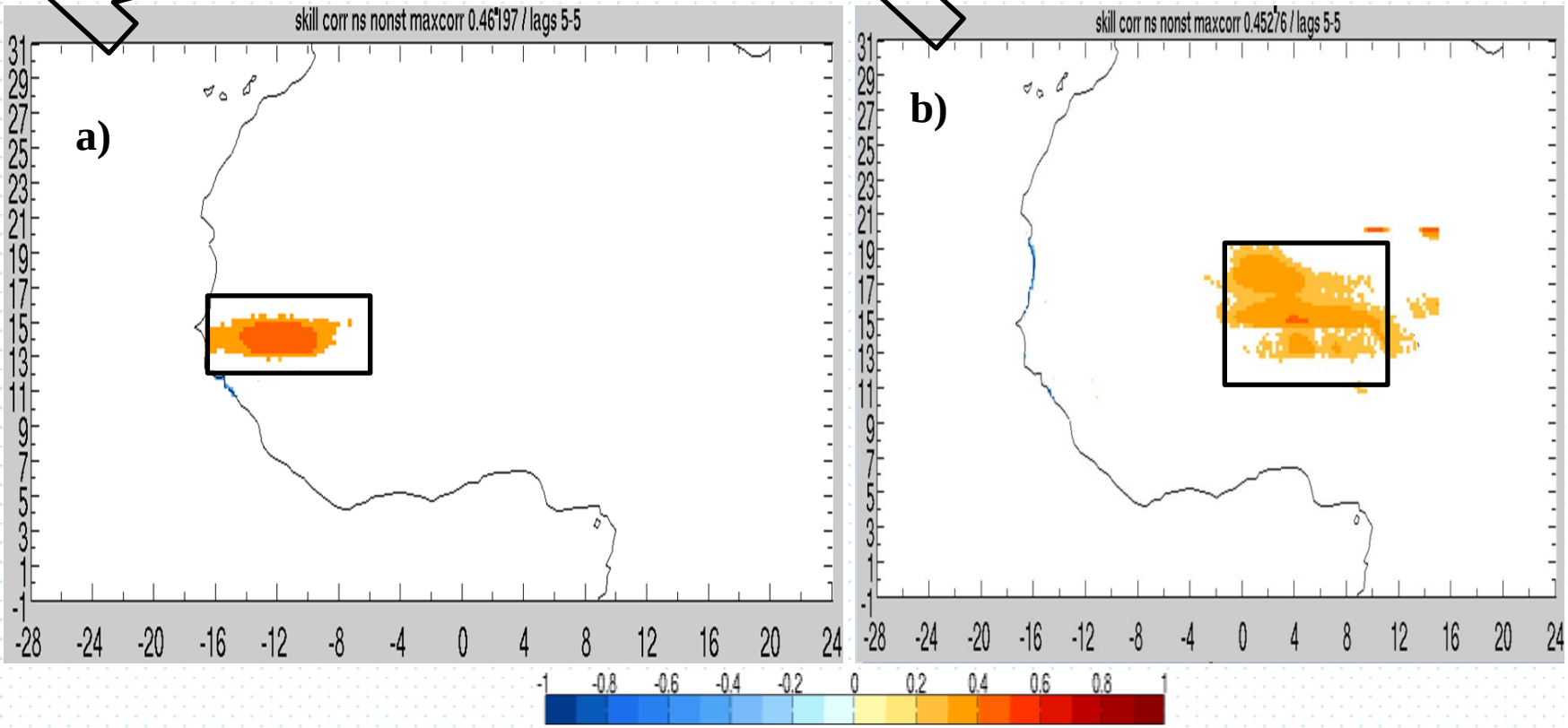

**SST regression map for the leading mode of co-variability for the non-stationarity periods and lag 5, and 15b) malaria incidence regression map for the leading mode of co-variability for the non-stationarity periods and lag 5**

# RELATIONS BETWEEN SST AND SEASONAL MALARIA INCIDENCE IN SAHEL

RESULTS

À partir de SST PAC

À partir de SST ATL




**Spatial validation of the hindcast in terms of the significant correlation between observed and modelled malaria incidence**

# Conclusions and Perspectives

CONCLUSIONS

- Less malaria transmission over Sahel seems to be related to a warming over the Pacific, that would be a coherent result with what shown on SSTs Pacific and Sahelian rainfall. The contribution of the Atlantic basin is also interesting to be taken account.

- A deep analysis of the indirect influence of ocean conditions on malaria is needed for applicability of the S4CAST on malaria using it´s recent version.

- The S4CAST model is presented as a tool to enhance and complement existing dynamical prediction models.

- Results could provide a good support tool for decision-makers in the framework of malaria prevention

# THANK YOU FOR YOUR ATTENTION