

Predictability and control of Meningococcal Meningitis in African Sahelo-Soudanian countries by using climate information: Case of Burkina Faso and Niger.

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INTRODUCTION

- ❖ A human bacteria with arian transmission
- ❖ 25 000 to 200 000 cases per year with 10% of deadly cases in west Africa (WHO)
- ❖ Several favourable factors to epidemics :
 - **Biological factors** (immune receptivity, virulent serogroups (W135 for instance))
 - **low socio-economical level**
 - **specific climatic and environmental conditions** (temperature, humidity, rainfall, dust ...)

Consequences

- Irritated nasopharyngeal mucosal membrane
- Facilitate the penetration of the bacteria in the blood stream

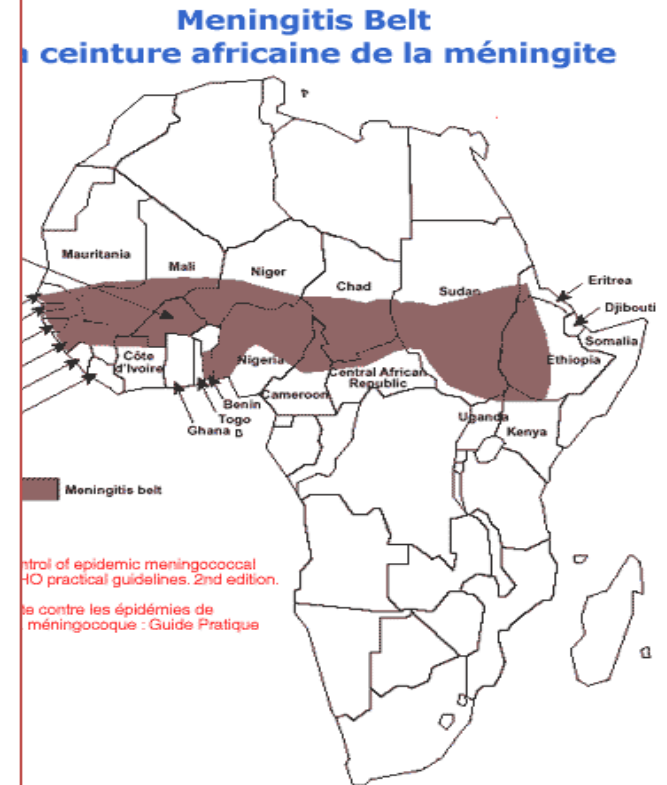
Relationships Between Meningococcal Meningitis (MCM) with Climatic factors

1. Geographical localization

- **Global disease burden is in western Africa (MCM belt)**
 - **Sahelian or dry tropical climate**
 - **Between rainfall isohyets 300mm to 1000mm**
 - **Sahelian area characterize by lack / low of vegetation many month by year**

2. Environment

- **Variation of soil greenery influence on MCM risk transmission**
 - **Deforestation, clearing of woods favorable to soils erosion.**
 - **Erosion favorable to the ventilation of aerosols and divers micro - particles (dust) that increasing MCM risk transmission and infection**



3. Climate :

- **Factors influencing the bacteria (*Neisseria meningitidis*)**
 - Weakened by **outside condition** (in extreme weather conditions)
 - Weakened by strong **dryness**
 - Weakened by **ultra-violets radiations**
 - Dead when **temperatures** higher than 37 °C
- **Factors influencing on the transmission and the outbreak of MCM**
 - Temperature**
 - Higher portage / carrying rate during dry and cool season
 - Epidemics occurring only in hot season
 - Air humidity**
 - Drying, irritation and cracking of nasopharyngeal mucosal membrane
 - Picks occurring only in dry season
 - Wind (harmattan)**
 - Picks occurring only when harmattan is blowing, characterized by dry and hot wind .
 - Lithometeores** (earth aerosol, dust, various atmospheric particles)
 - Cause multiform aggressions of nasopharyngeal mucosal membrane
 - Picks occurring only in dusty period
 - Rain (disease seasonality)**
 - Cases start increasing at beginning of the dry season (January)
 - Sharp decrease with the beginning of rains, May-June
 - Disappearance of epidemics during rainy season
 - end /shift of epidemics when came unexpected extra season rains «**God rains vaccination**»

How to fight against MCM epidemics: Health Ministries and WHO strategies

❖ Surveillance of MCM weekly cases in health districts to practise reactive vaccination at the good timing

➤ Alert threshold
5/100 000/week



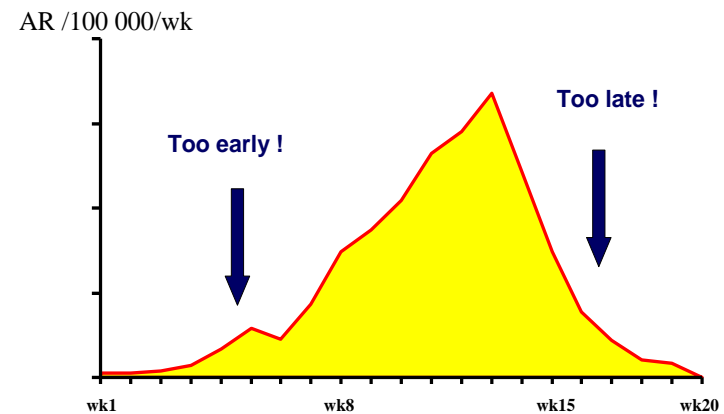
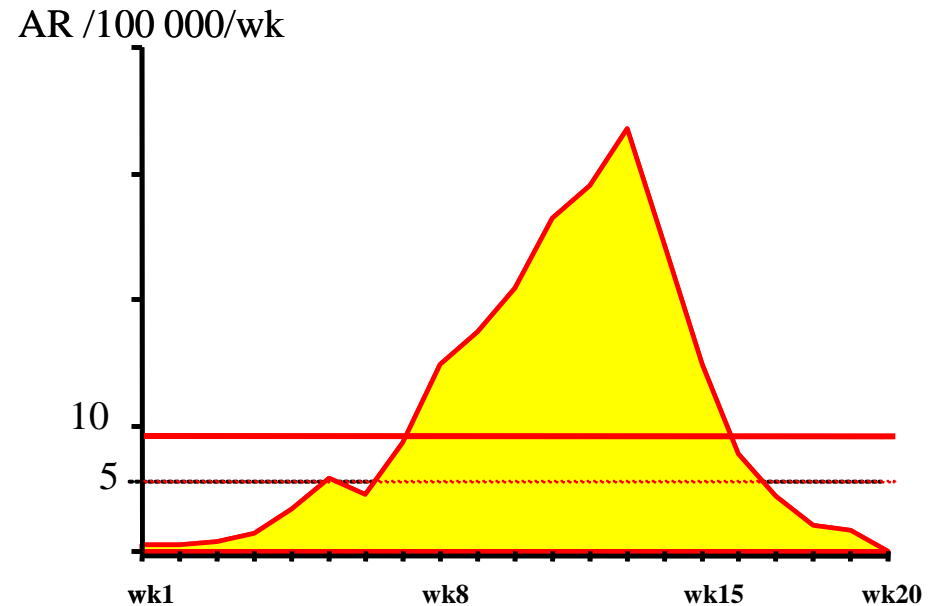
Clinical samples + lab confirmation

➤ Epidemic threshold
10/100 000/week



Immediately conduct district mass Vaccinati
Strengthen case management

The principle of the thresholds

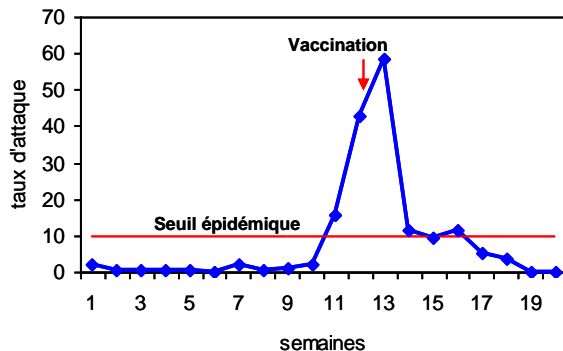


What happen and why this high lethality (about 10 – 15 %) ?!

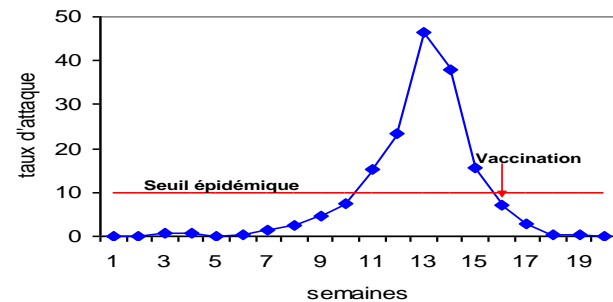
- ✓ Multiple endemic and epidemic diseases
- ✓ Limited resources
- ✓ Lack of laboratory capacities
- ✓ Most of people don't go to public health services because of poverty
- ✓ No existence of public health service in many areas
- ✓ Lack of right demography statistical data to calculate alert and epidemics threshold rate in health districts.
- ✓ People prefer traditional practitioners who are more cheaper, and come in public health district when it is very late
- ✓ Lag time for organism to react after vaccination (about 10 days)

The reactive vaccination: a frustrating strategy !!!

Ziniare 2006



Bogande 2007

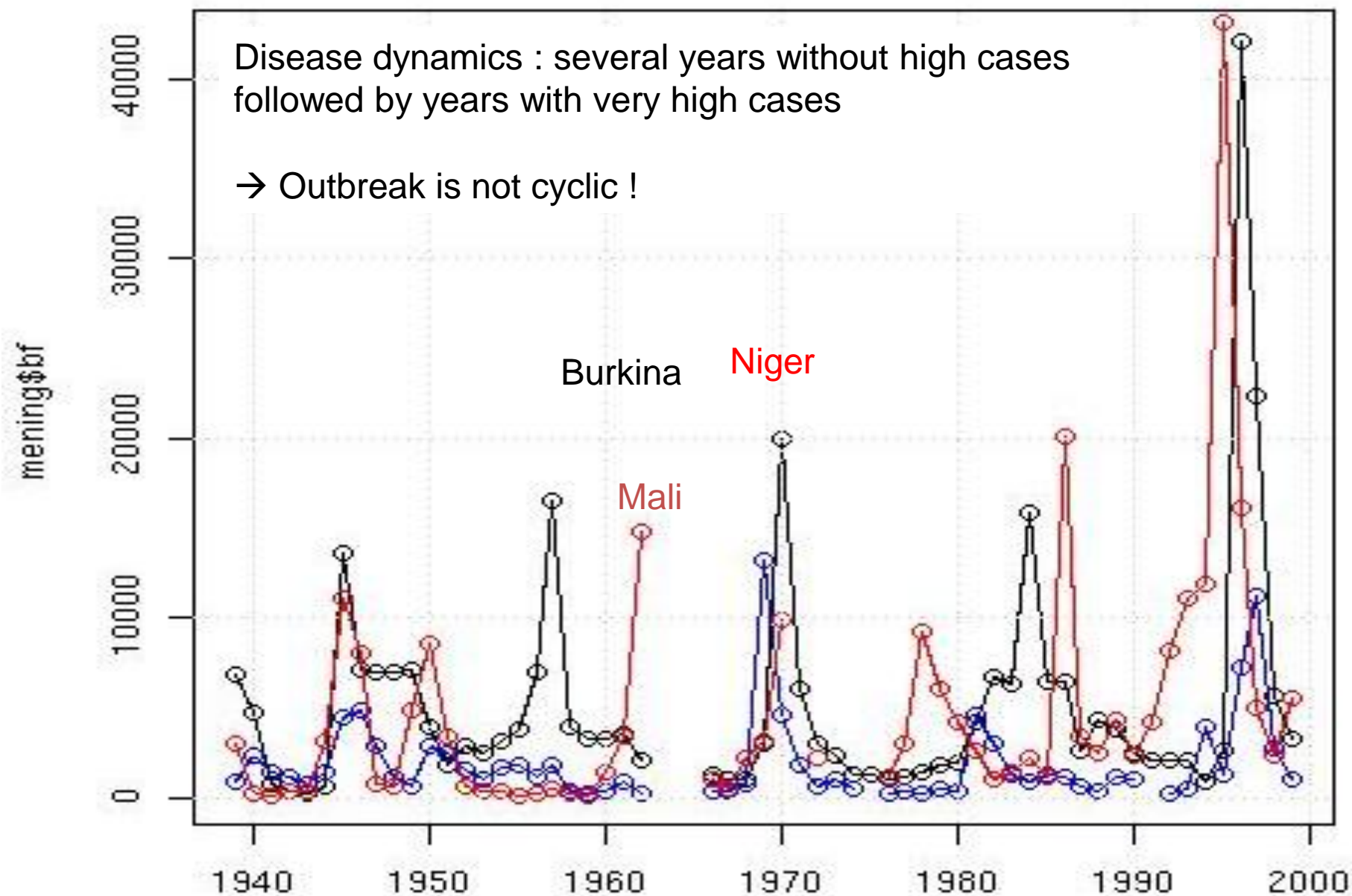


Selected countries : BURKINA FASO , NIGER

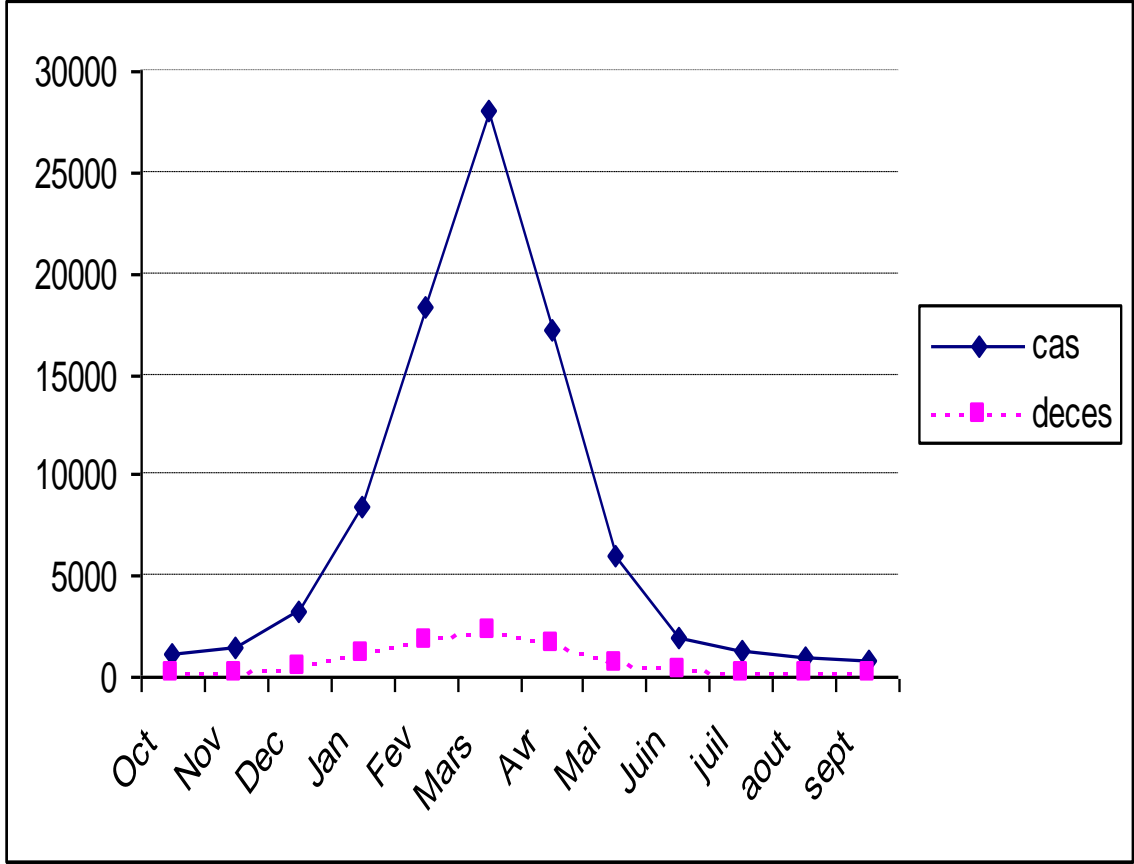


- The third cause of death in Burkina Faso, Niger and many Sahelian Countries
- Burkina has the great cases in the world, following by Niger during last decade

MCM yearly dynamics in Burkina, Mali and Niger from 1940 to 2000



MONTHLY DISTRIBUTION



OBJECTIVES

1. Determine if NCEP/NCAR Re-analyses parameters are associated with interannual variation of MCM cases.
2. Develop spatio-temporal models of MCM prediction using NCEP re-analyses
3. Test and validate these models for CSM survey and its early warning in African Sahelian Countries

APPROACH METHODOLOGY

- ✓ Elaboration of correlations maps between MCM IR anomalies in Sahel and NCEP Re-analysis
- ✓ Analysis of correlations maps and extraction of climate indexes in target zones
- ✓ Computation of statistical Multi-varied Analysis (*Generalized Linear Model*)
- ✓ Elaboration of the final model to predict the MCM annual IR trend

MODELISATION MCM - REANALYSES NCEP/NCAR IN AFRICAN SAHELIAN COUNTRIES

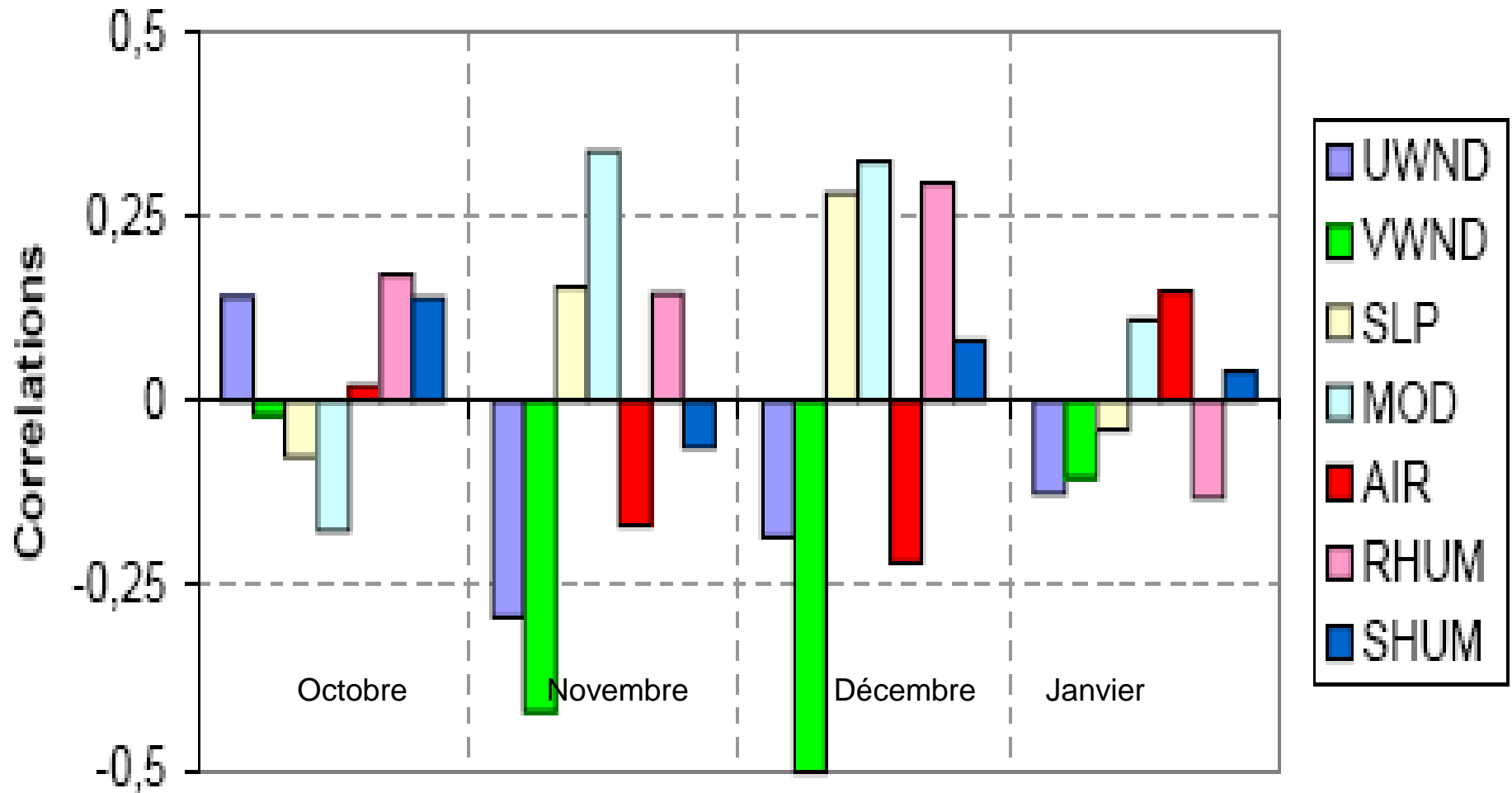
Definition: Results of assimilation (from multiple sources) of observed data which are unequally distributed in space and short-term forecasts models (6hr) for a wide and three-dimensional cover of Ground - Ocean - Atmosphere assimilation.

DATA SELECTED : MCM epidemiological data from Burkina and Niger

Data in mesh of 2,5 degrees including:

- Pressure (slp)
- Specific moisture (shum)
- Relative humidity (rum)
- The temperature of the air (air)
- The temperature on ground and sea (skt)
- The module of wind (MOD)
- The zonal component of the wind (uwnd)
- The meridian component of the wind (vwnd)

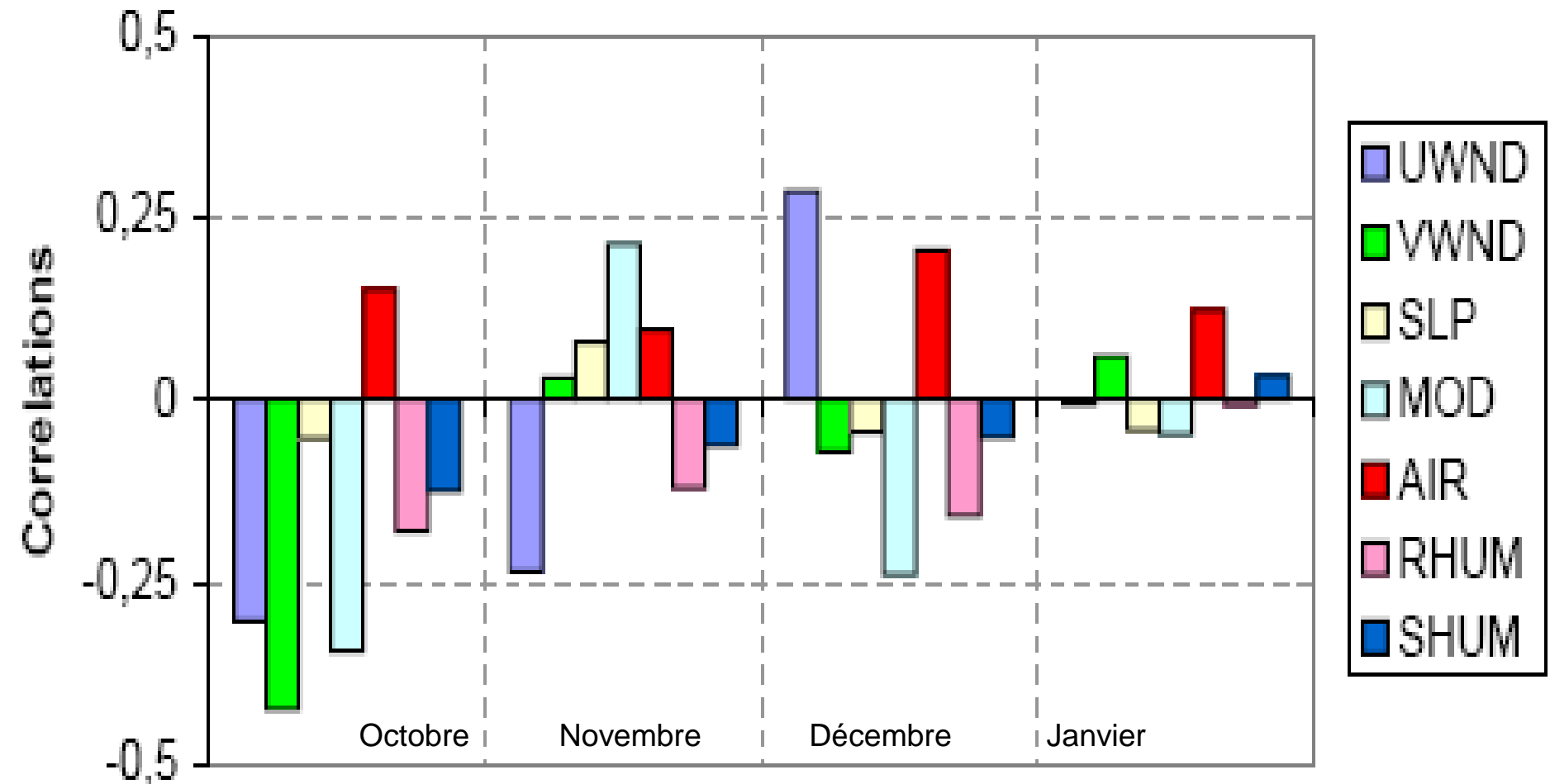
Monthly Mean NCEP reanalysis et annually log incidence data of Meningitis



✓ Significant and high correlation in November and December.

✓ Negatives Correlations with Meridional Wind Component (VWND)

Monthly Mean reanalysis NCEP and annually log incidence data of Meningitis

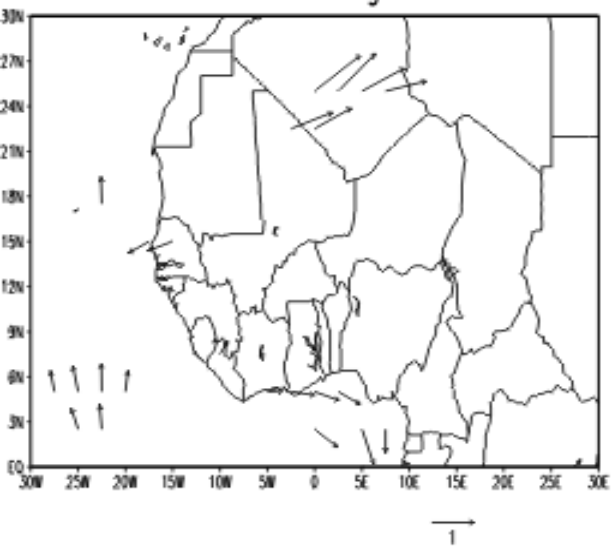


✓ Significant and high correlation in October.

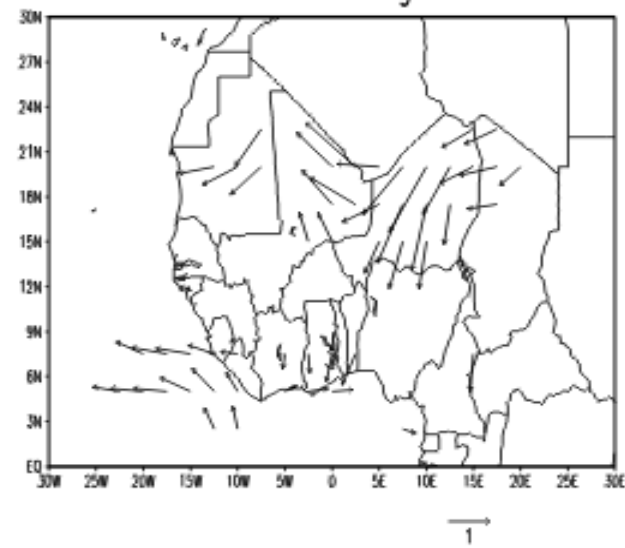
✓ Negatives Correlations with Meridional Wind Component (VWND)

Difference of monthly mean of wind surface during very high years of MCM comparing to very low years of MCS in Niger (up side) and Burkina Faso (down side) between 1966 to 2005.

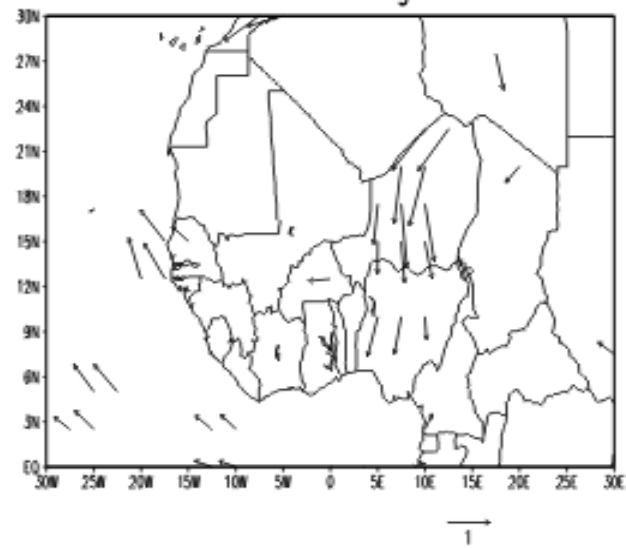
October Niger



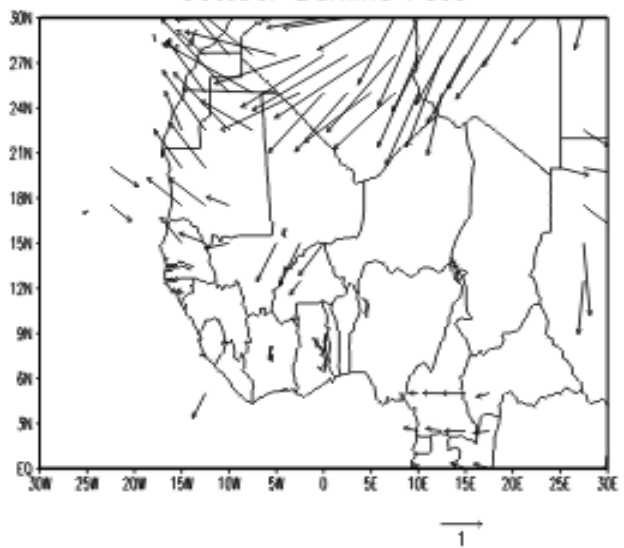
November Niger



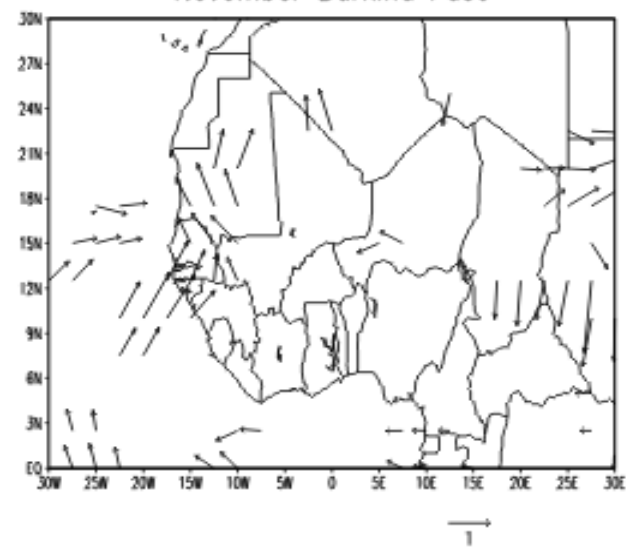
December Niger



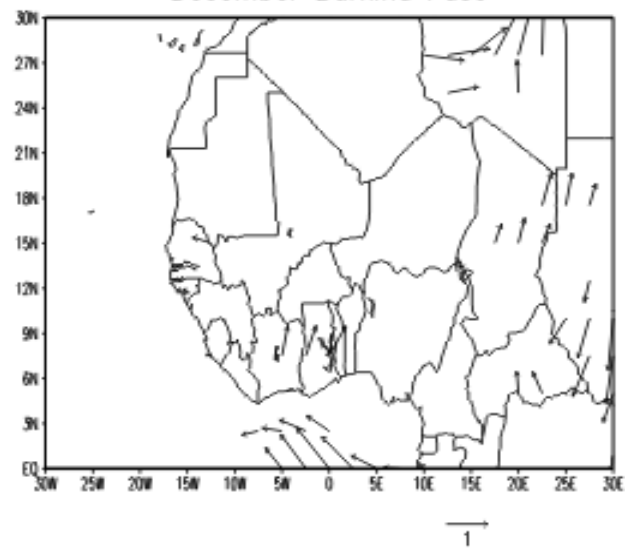
October Burkina Faso



November Burkina Faso

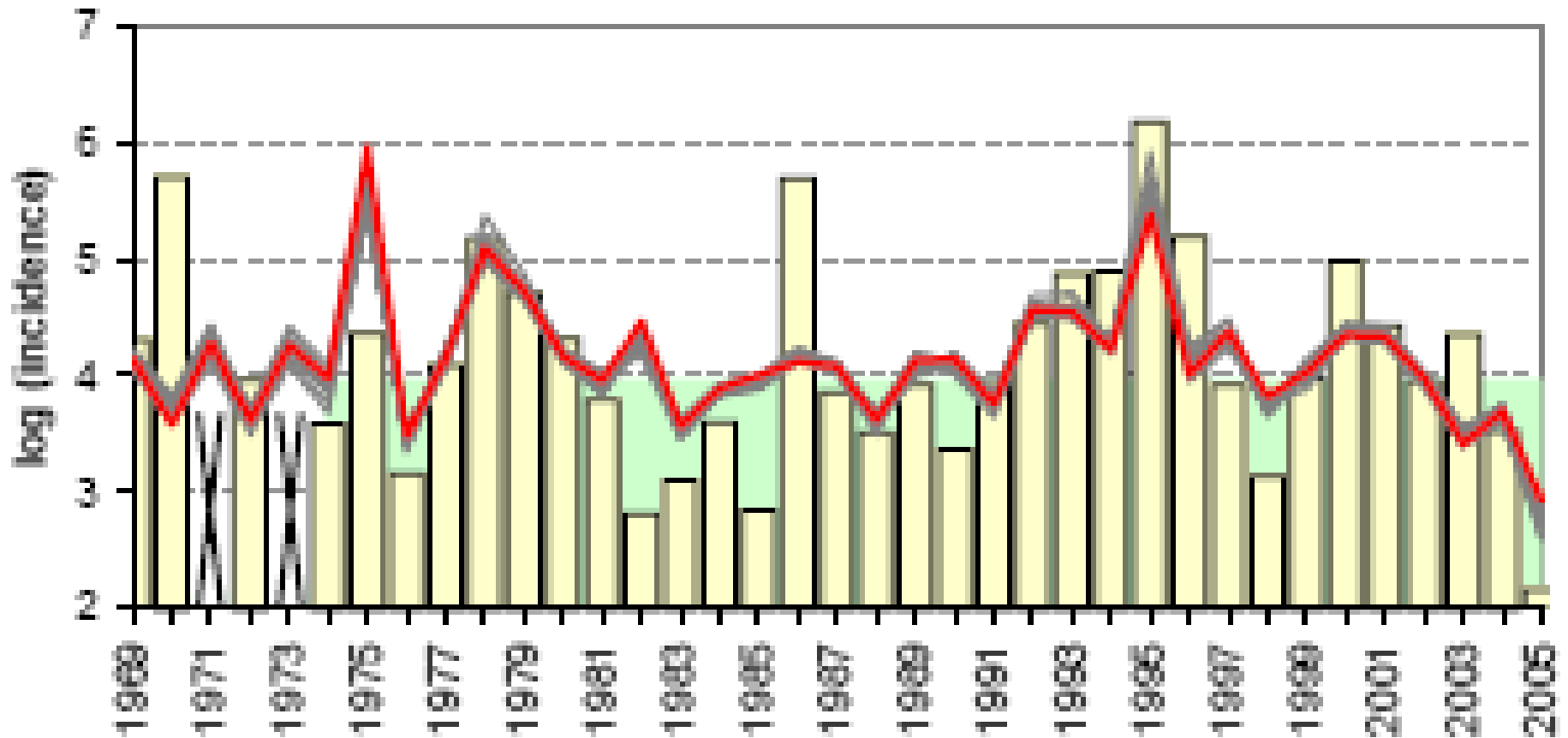


December Burkina Faso



Prediction of MCM epidemics occurrences in NIGER (1969 to 2005)

An interesting prediction of meningitis occurrence in Niger ($R=0.62$; R_c (Skill) = 0.50)

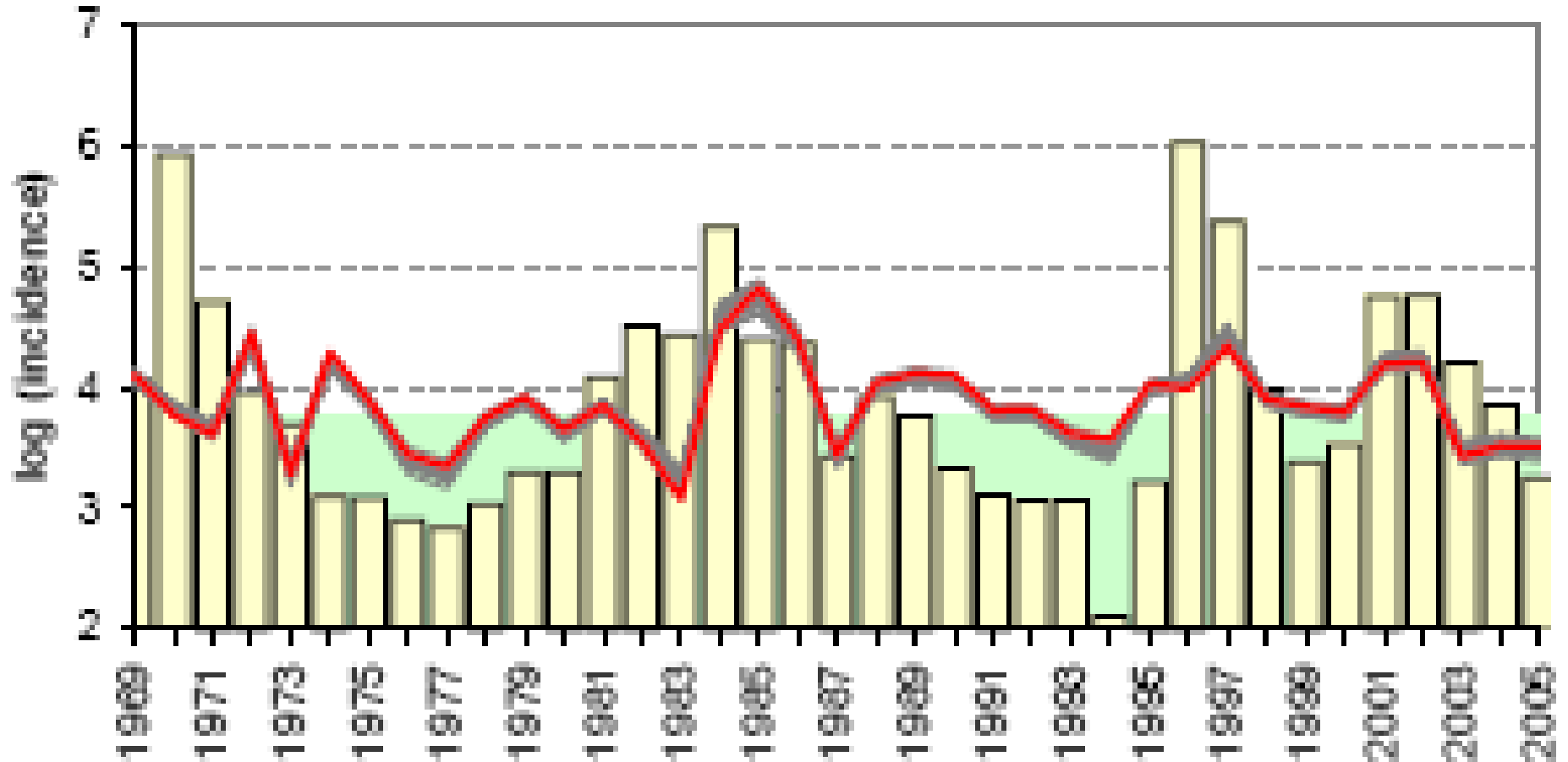


Histogramme : Ln of MCM observed MCM (incidences from 1968 to 2005).

Red Ligne : Predictions of Ln of MCM incidences occurrences from 1968 to 2005 after cross validation.

Prediction of MCM epidemics occurrences in BURKINA (1969 to 2005)

An significative prediction of MCM occurrence in Burkina ($R = 0.42$; $R_c = 0.33$)



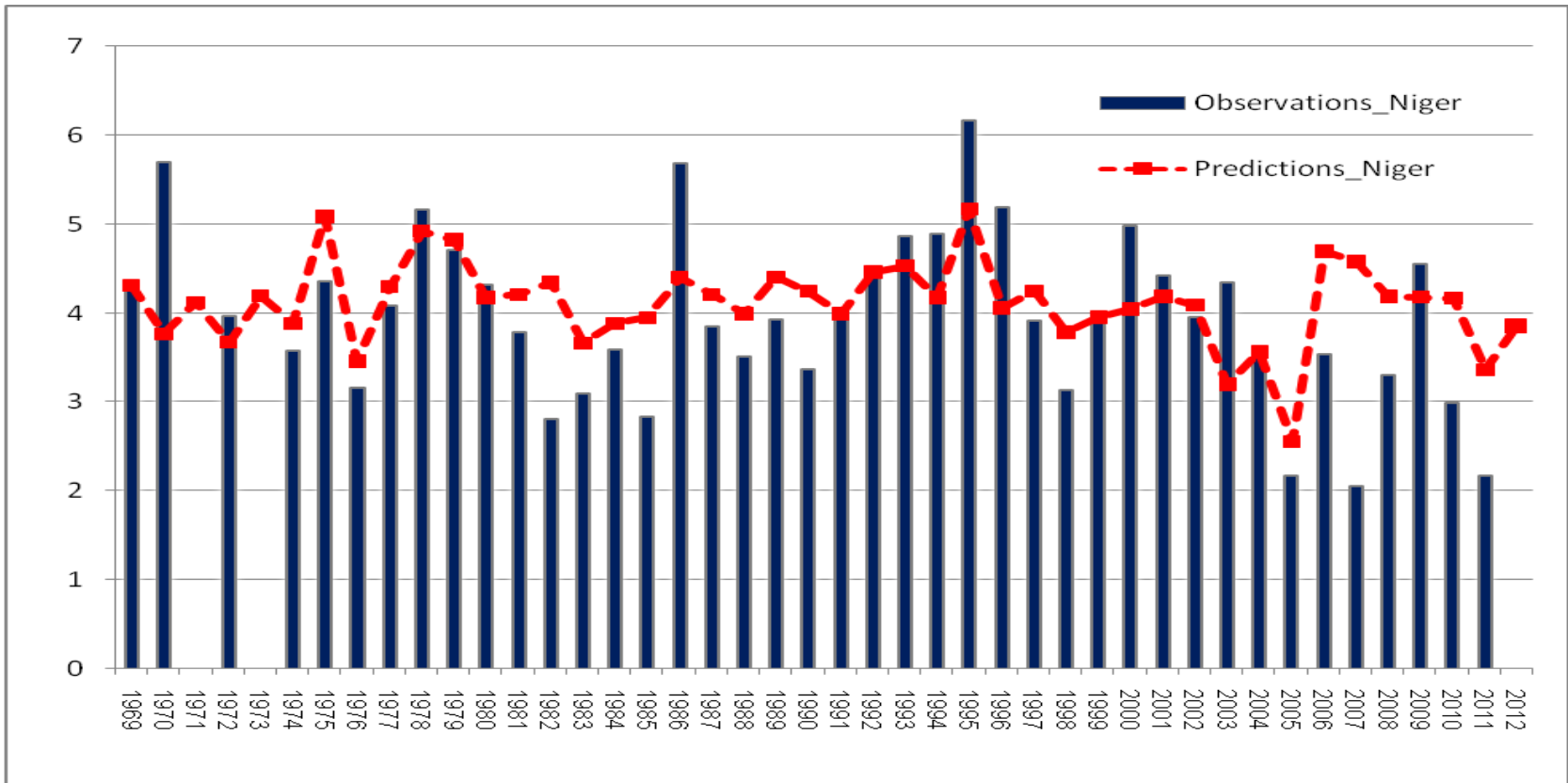
Histogramme : Ln of MCM observed (MCM incidences from 1968 to 2005).

Red Ligne : Predictions of Ln of MCM incidences occurrences from 1968 to 2005 after cross validation.

Prediction on Meningitis epidemic trends in Niger in 2012

For meningitis the coming season in Niger the morbidity trend will be :

- around the normal (mean between yearly high and low case)
- Amplitude will be high than last year observed cases



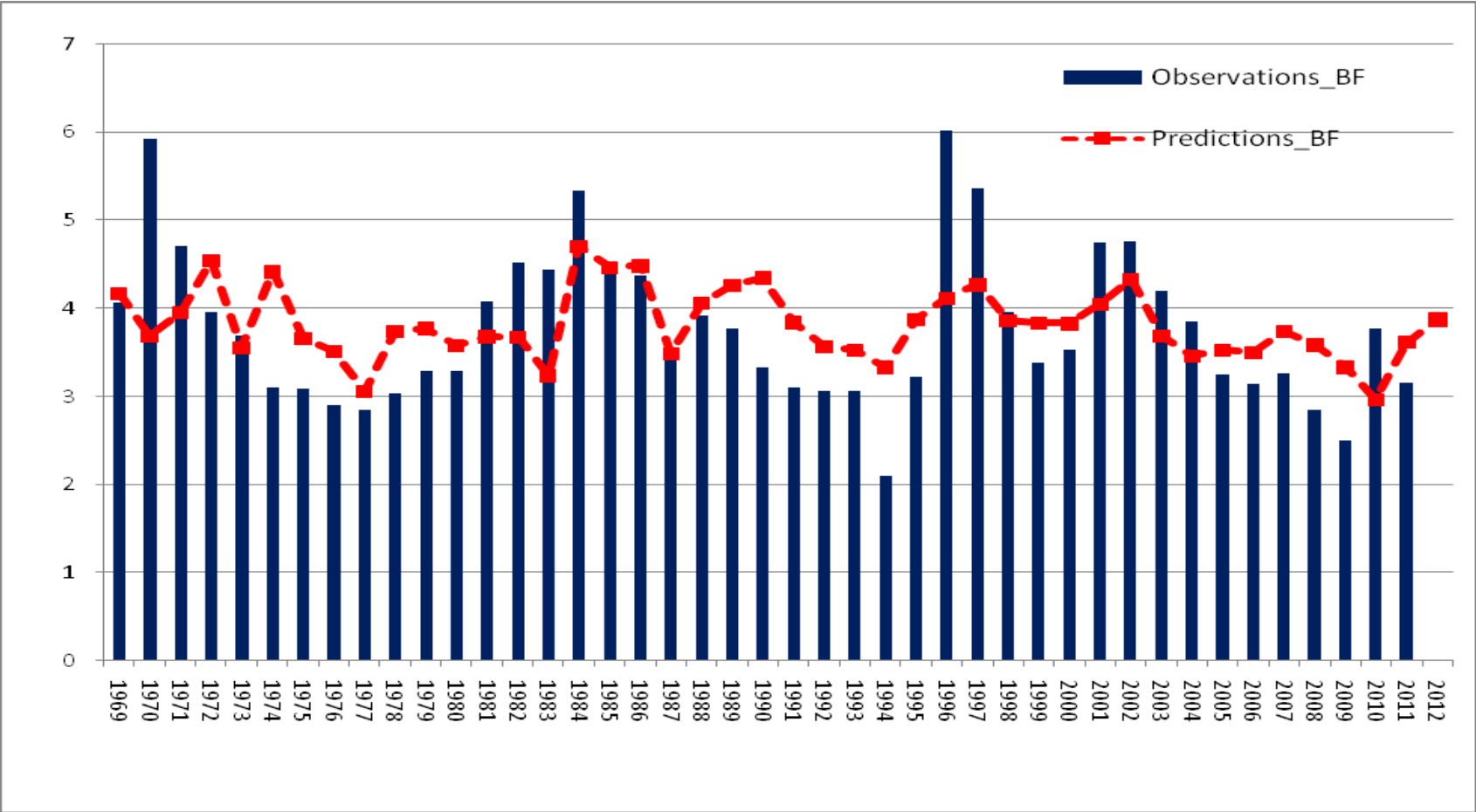
Blue Histogram : Ln of meningitis observed from 1968 to 2010.

Red Ligne: Prediction of Ln of meningitis from 1968 to 2012

Prediction on Meningitis epidemic trends in Burkina Faso in 2012

For meningitis the coming season in Burkina Faso the morbidity trend will be :

- around the normal (mean between yearly high and low case)
- Amplitude will be high than last year observed cases

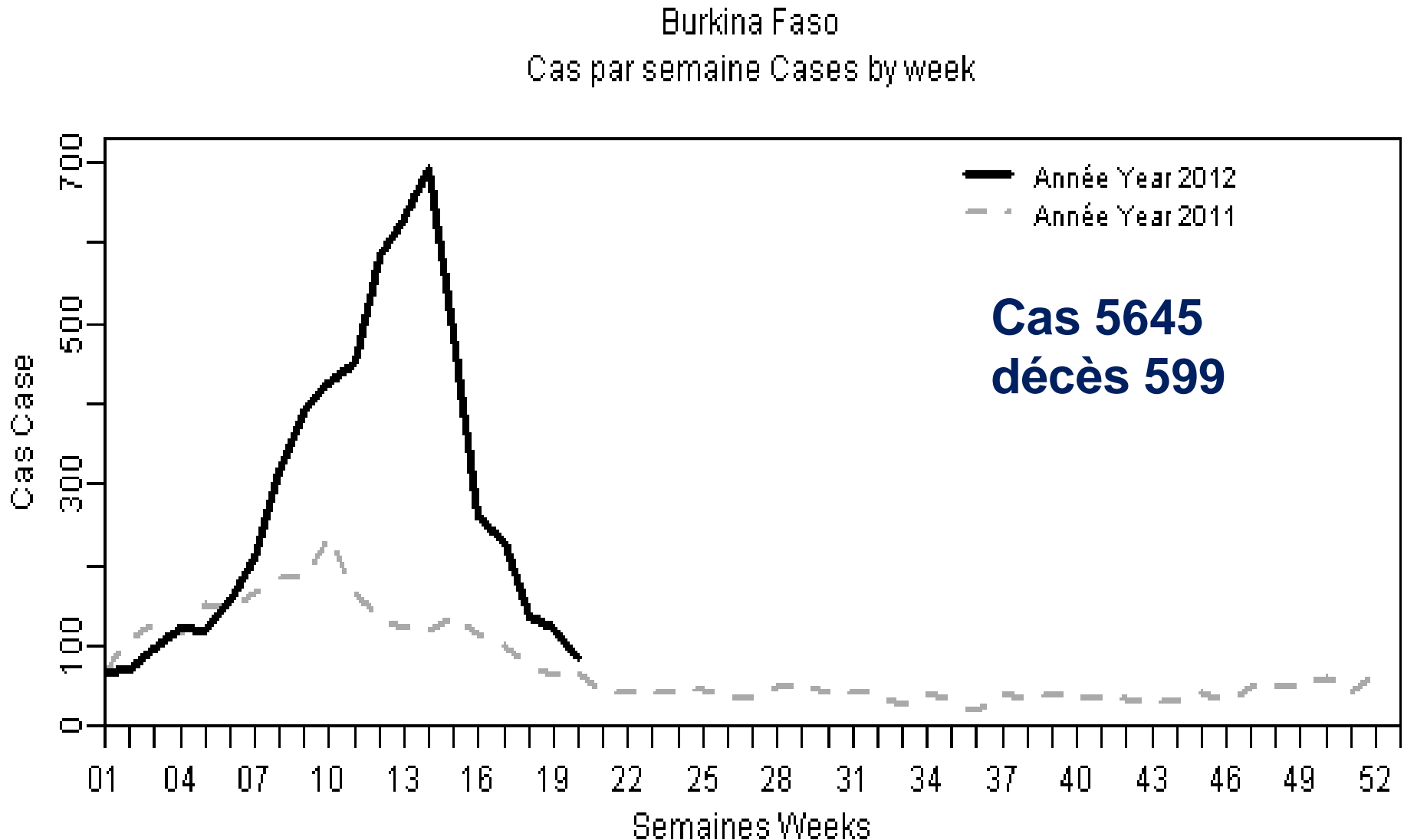


Blue Histogram : Ln of meningitis observed from 1968 to 2010.

Red Ligne : Prediction of Ln of meningitis from 1968 to 2012

BURKINA EPIDEMIOLOGICAL SITUATION IN 2012

(FROM WEEK 01 – 20) (REFERENCE : WHO-Afro)



**Thanks for your
attention.**



**Questions and
comments?**

Analysis of spatio-temporal and prediction of meningitis in Burkina Faso by using climate factors

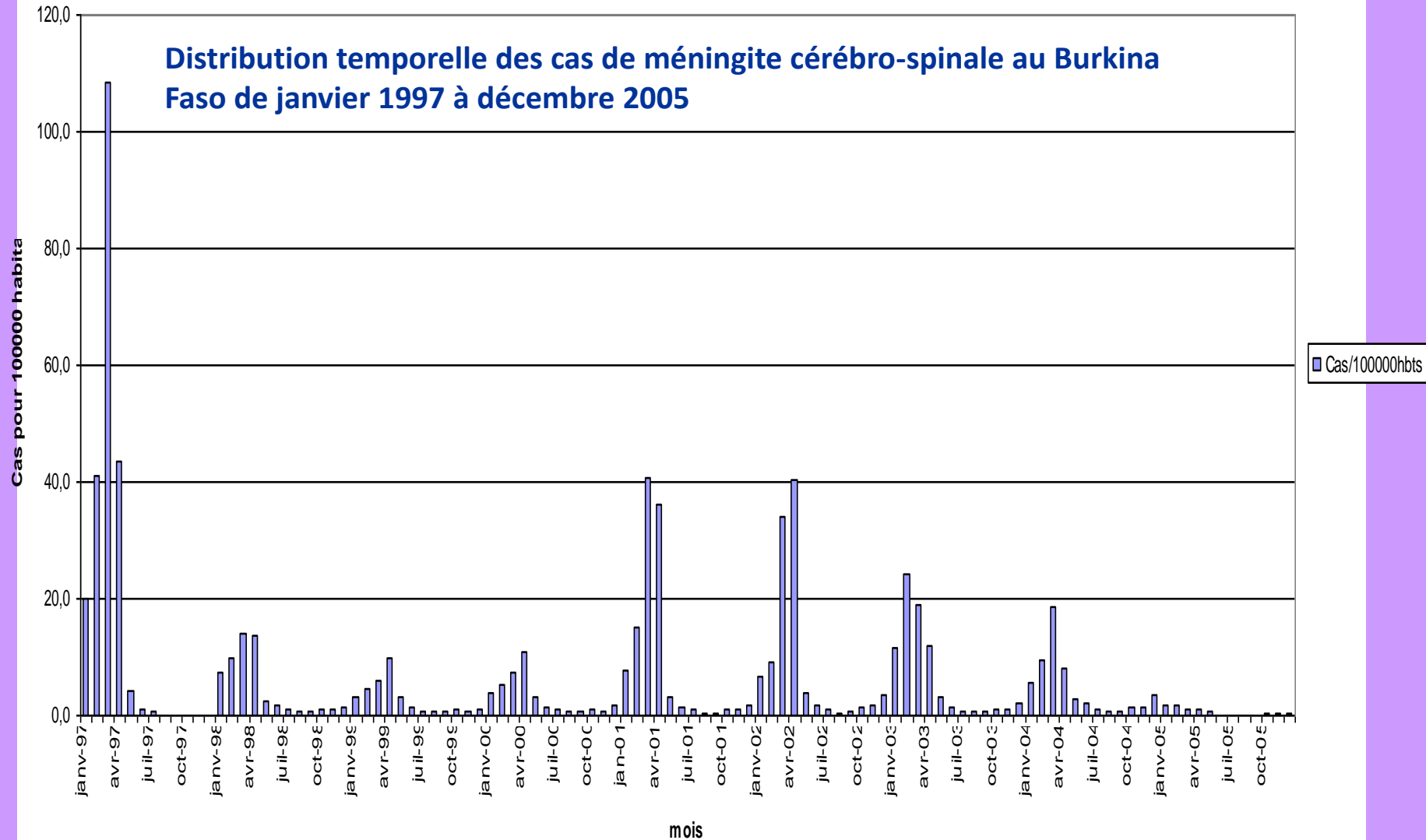
Map of Burkina health district



Source : Direction des études et de la Planification Ministère de la Santé

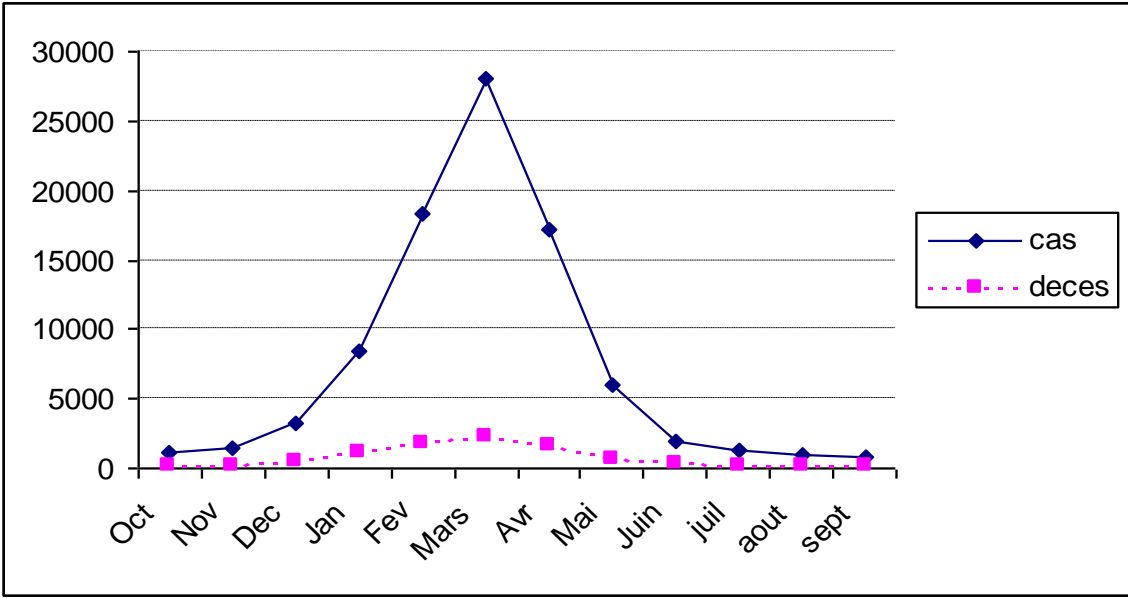
Analyse spatio-temporelle et prévision des épidémies de MCS au Burkina Faso suivant les facteurs climatiques

Distributions mensuelles des cas de MCS au Burkina (sur l'ensemble des districts étudiés)



MONTHLY DISTRIBUTION

Monthly morbidity and mortality distribution of Meningitis in Burkina Faso from 1961 to 1984

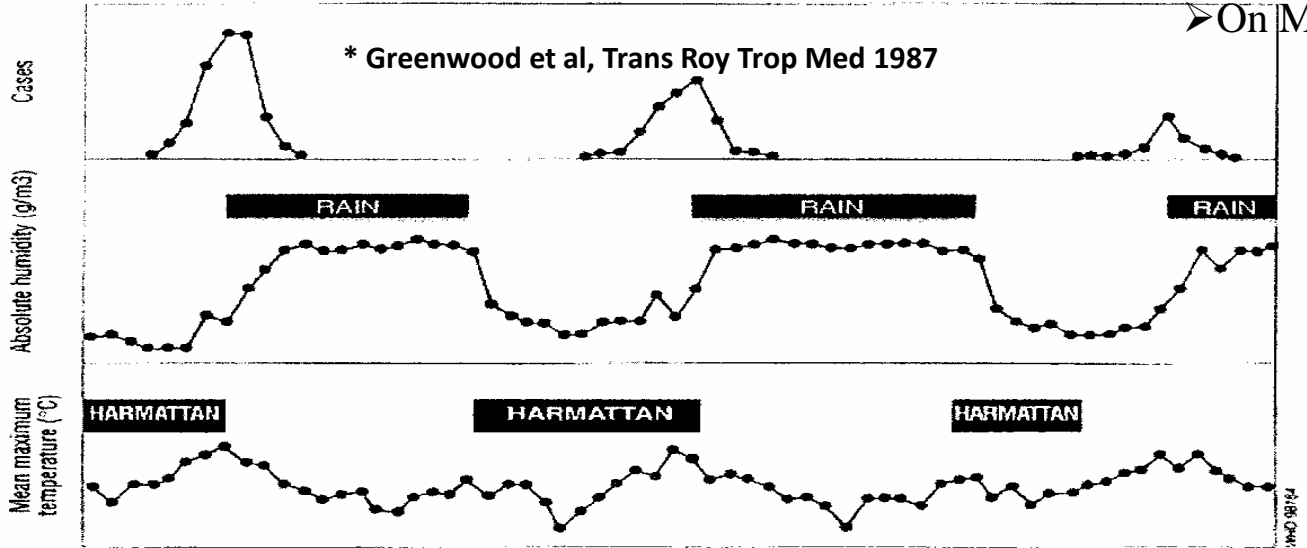


◆ Meningitis predominant from January to May ie in warm and dry season: **HARMATTAN**

◆ Low cases during wet and rainy season

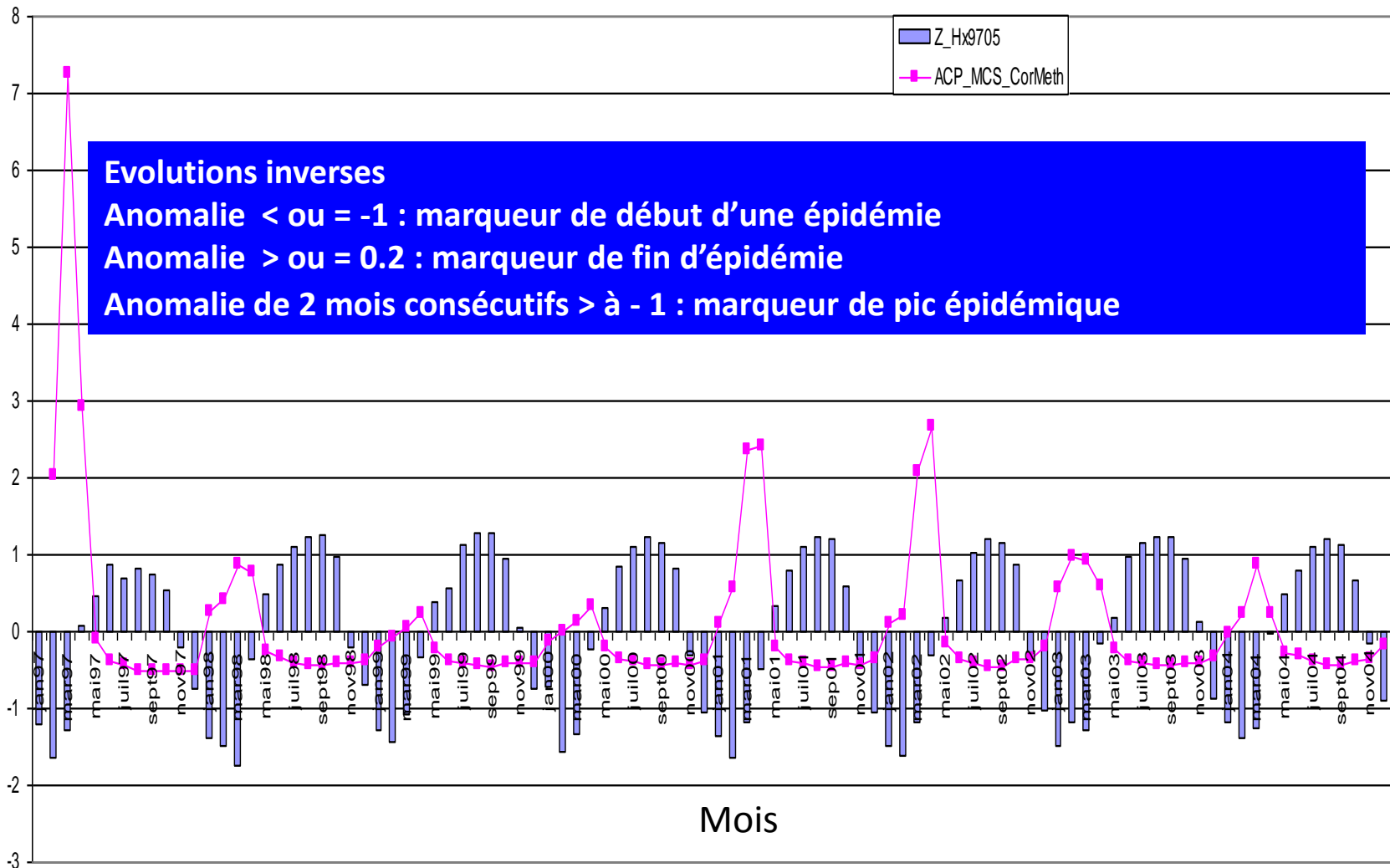
◆ last 30 years of monthly data, we have these following monthly epidemic peaks :

- on February (5 times)
- on March (15 times)
- on April (5 times)
- on January (3 times)
- On May (2 times)

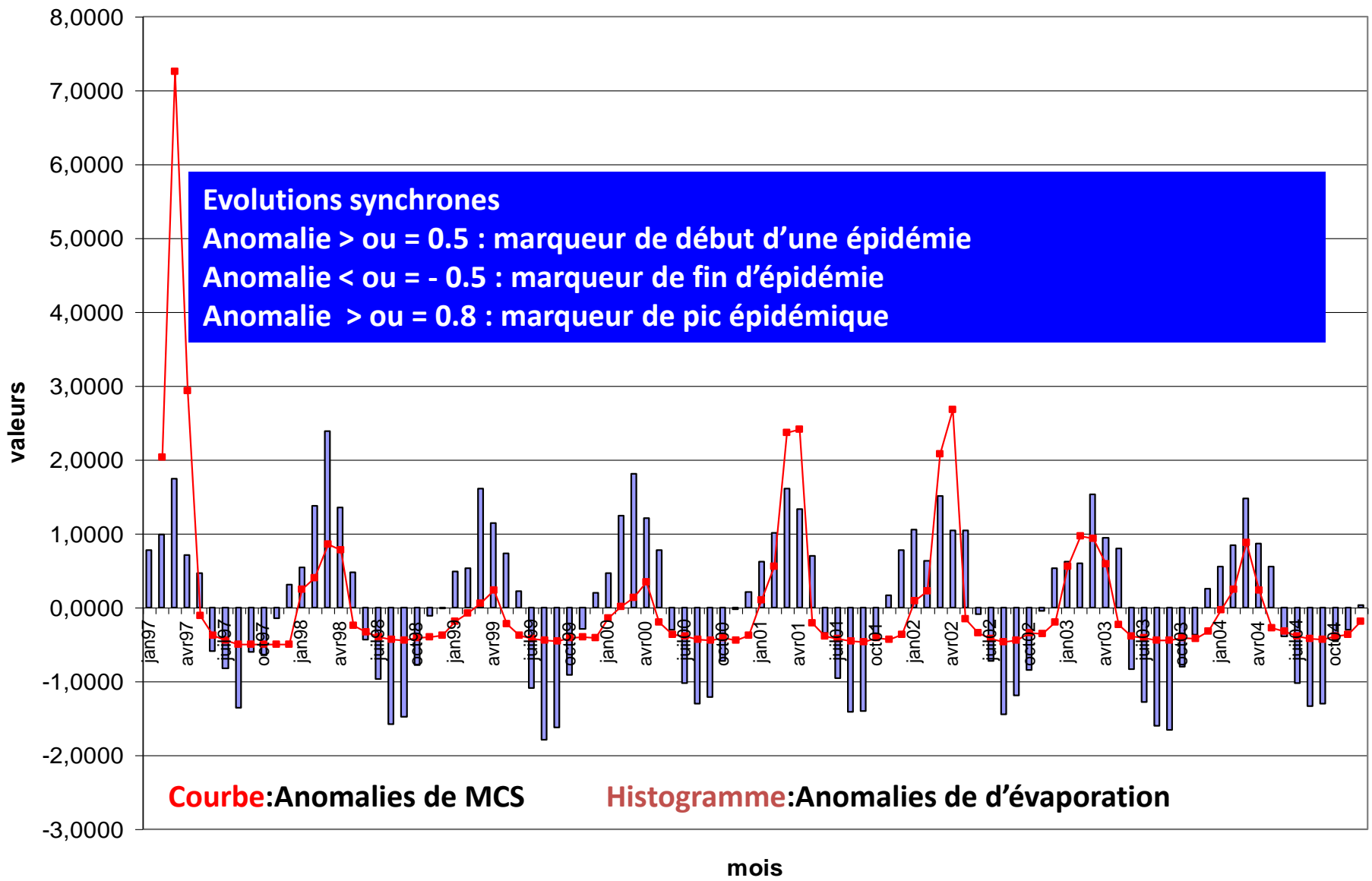


Distribution temporelle d'anomalies des cas de méningite cérébro-spinale et d'humidité maximale au Burkina Faso de janvier 1997 à décembre 2004

Anomalies Hx et MCS

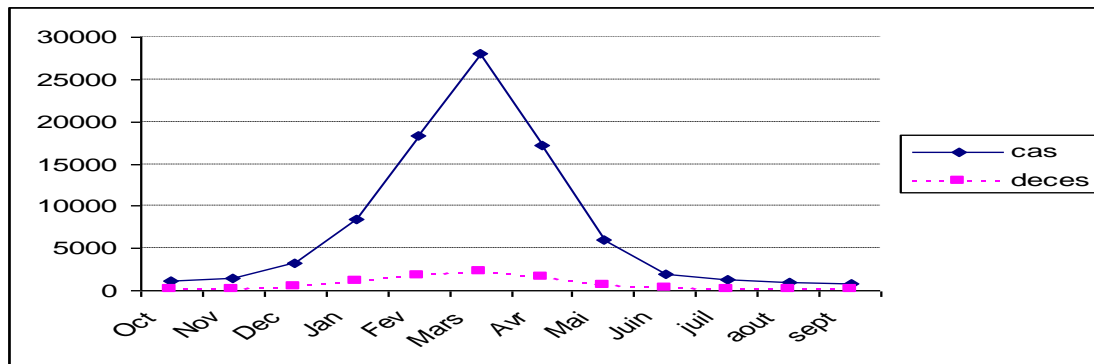


Distribution temporelle d'anomalies des cas de méningite cérébro-spinale et de hauteur d'évaporation au Burkina Faso de janvier 1997 à décembre 2004



Spatio-temporal Analysis and Meningitis epidemics forecast by using climate factors in Burkina Faso

Linear regression models of meningitis seasonal cases (FMA) in Burkina health districts by using seasonal (SON, OND, NDJ) climate variability.



Regression Equation	Number of time serie	multiple R	R ²	F - ratio	P
$MCS_{Dori} = 0,87 * Op_{Dori_OND}$	8	0.87	0.76	21.9	0.003
$MCS_{Fada} = -0,76 * Vt_{Fada_OND}$	8	0.76	0.58	9.62	0.017
$MCS_{Po} = -0,644 * Tv_{Po_SON}$	8	0.65	0.42	4.95	0.06
$MCS_{Ouaga} = 0.698 * Op_{Ouaga_OND}$	8	0.7	0.49	6.642	0.03

S2E-ARGOS Project : Integrating Health people to Meteorological data collection and analyzing

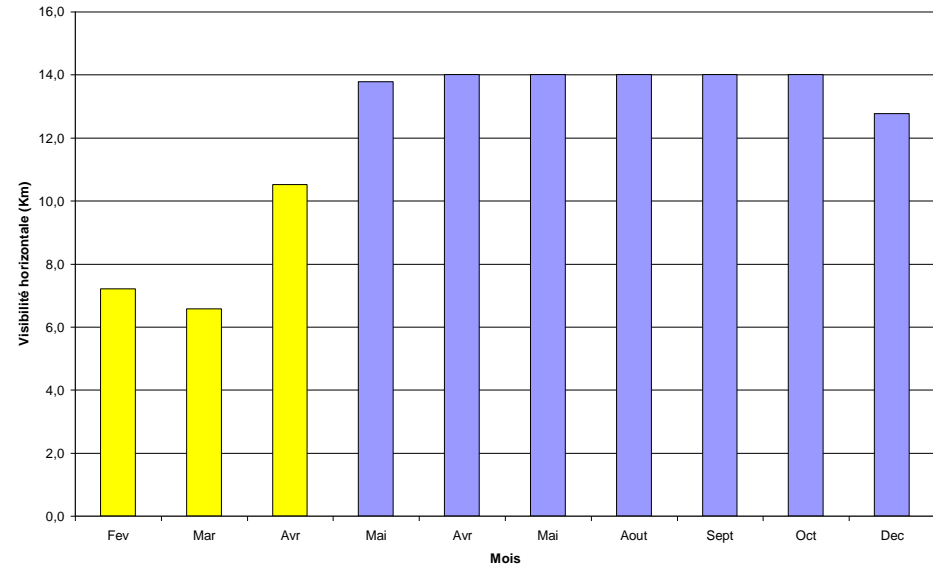
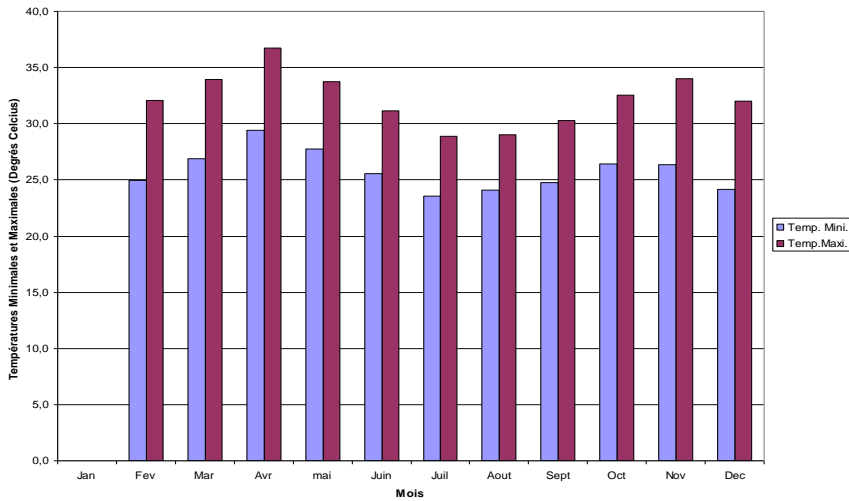
Training of health people to collect / manage Met Data and health information for epidemics control (10 village in Burkina; 04 in Niger)



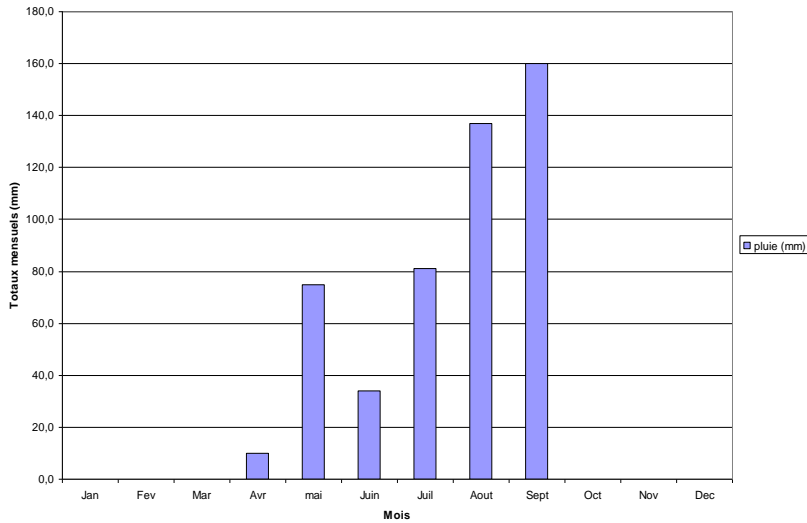
Project S2E-ARGOS Epidemic Spatial Survey in Burkina Faso with European Spatial Agency

- ✓ Daily minimum temperature
- ✓ Daily maximum temperature
- ✓ Daily rainfall
- ✓ Daily visibility (dust occurrence)

Moyennes Mensuelles des Températures Minimales et Maximales (Degrés Celcius) à DIABO en 2004



Totaux mensuels de pluie à DIABO (mm) en 2004
(données manquantes pour certaines semaines)



Minimal and maximal temperature, rainfall, visibility data were collected and analysed by health people (nurses) living in village with farmers far away from town.

AT REGIONAL LEVEL - HEALTHMET Project

Capacity building for the establishment of links between weather, climate and health services.

Banjul Action Plan:

Action 2.3 HEALTHMET: "Support to the development of the activities of the National Health-Climate Working Groups (NHCWG) in participant countries (*Burkina Faso, Mali, Mauritania, Niger, Nigeria*) in accordance with the main outputs of the Niamey Workshop (October 2009) on reinforcement of links between Weather, Climate and Health"

- "Information gathering: Information gathering: on the current status of collaboration between health and met in each country"
- "National Seminars: Enhance and initiate NHCWG activities as applicable to each country and develop a short term national action plan to implement activities"
- "Training: Capacity building at regional and national level"
- "Fund raising activities: Respond to Banjul Action Plan"

HEALTMET Project

National Health and Climate Working Groups

- **Mission:** promotion and implementation of joint activities of their institutions, directed to the acquisition and use of data and weather, climate and health information for the management, prevention and fight against climate sensitive diseases.
 - To propose projects.
 - To monitor them.
 - To help in seeking funding.

This group is not dedicated to research but to operational activities.
- **Diseases targeted:** according to the Banjul Action Plan, NHCWG will initially target mainly two diseases:
 - Meningitis
 - Malaria
- **Organization:**
 - Activities and coordination conducted by the two focal points (Health and Met) , with the supervision of their Directors.
 - The membership must be adjudicated before the first meeting. The composition must be open.

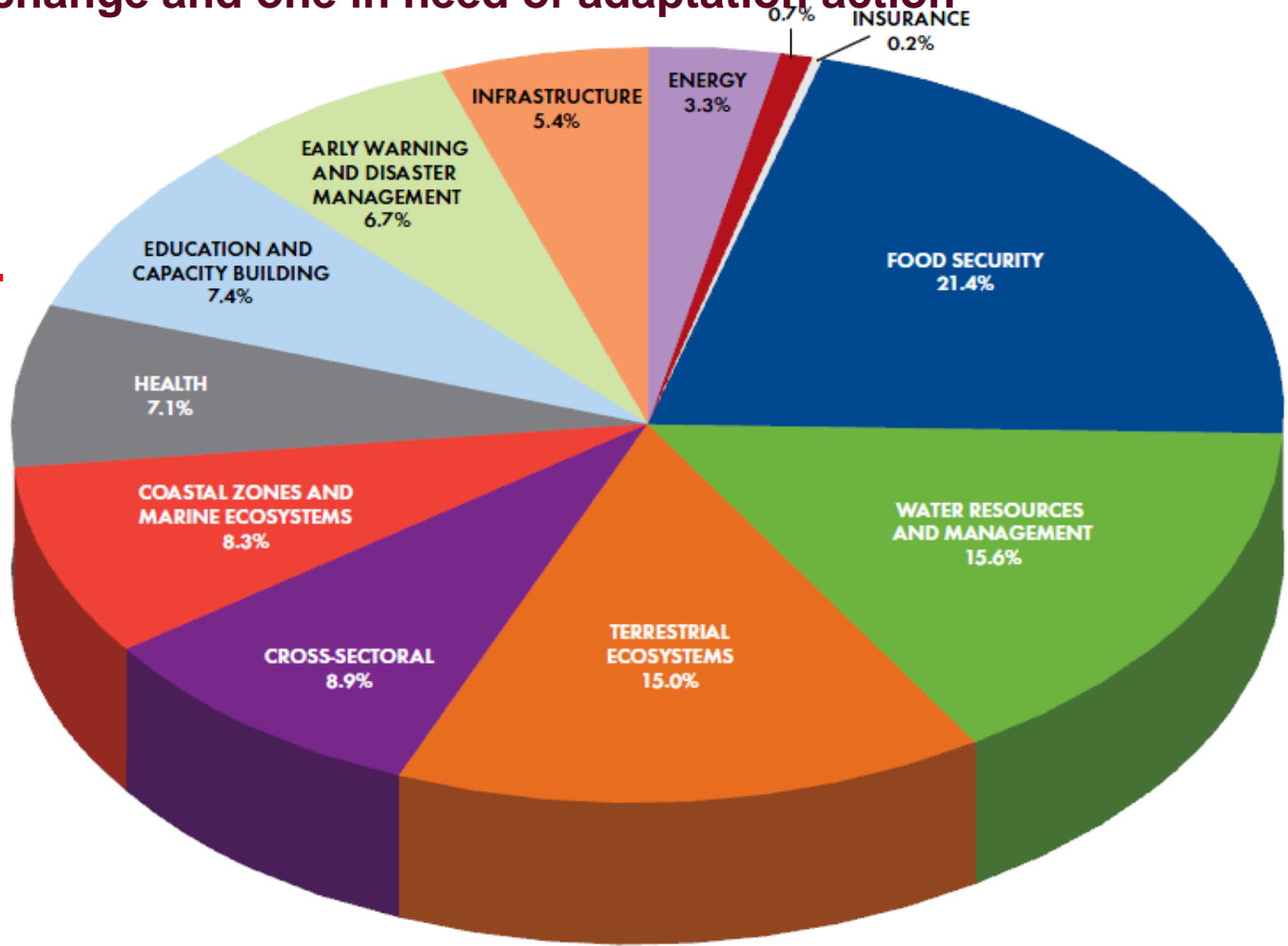
Terms of Reference of NCHWG / HEALTHMET Project Challenges

- Identify the needs of Health Services in terms of data, information and services on weather and climate.
- Identify inconsistencies and problems that handicap the use of routine information on weather and climate in the Health sector.
- Formulate a protocol for exchanging data between both sectors.
- Identify needs for research in Climate and Health issue.
- Identify needs in education and training.
- Facilitate access to tools on weather and climate in the Health sector.
- Increase use of early warning systems for climate-dependent disease prevention.
- Increase and strengthen the capacity of national, local and community organizations in this area.
- Establish an Internet access secure database on Climate and Health.
- Organize, and present policy makers with, the scientific evidence on the impacts of climate change and climate variability on health.
- Organize an annual workshop on Climate and Health issue.
- Collaborate with similar entities throughout the region to share experiences and ideas.
- Mobilize resources to ensure sustainability of this Project.

Distribution of NAPAs projects by sector (from 44 least developed countries on 49 that have submitted their NAPAs program to the UNFCCC). Source: Mutunga and Hardee 2009

All 44 countries identify health, or the health sector, among the most vulnerable sectors to climate change and one in need of adaptation action

BIG GAP
Need to be
REVERSED



The health sector accounts for only about 7 % of the 448 total projects and not ranked among the first five priorities in any of the countries