

Relationship between meningitis occurrence and atmospheric conditions over African meningitis belt

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Context and objective

- ✓ Meningitis is a fever with an average incubation period of 4 days and an endemic disease around the world
 - ✓ Several thousands of meningitis cases with different serogroups are observed every year over Africa
 - ✓ Meningococcal meningitis is a climate sensitive infectious disease that occurs much in the sub-sahara area called African meningitis belt
 - Meningitis epidemics develop during the dry season and end at the monsoon onset (*Sultan et al., 2005, Yaka et al., 2008, and Martiny and Chiapello (2013)*)
 - Miss representation of numerical climate and weather model of the climate metric linked to meningitis outbreak
1. *Identify local and synoptic drivers favoring the large occurrence of meningitis outbreak over Africa*
 2. *Improve their predictability by numerical weather and climate models on intra-seasonal and seasonal timescales.*

Data and methodology

Weekly meningitis reports from World Health organization

[\(https://www.who.int/emergencies/diseases/meningitis/epidemiological/en/\)](https://www.who.int/emergencies/diseases/meningitis/epidemiological/en/)



African Meningitis belt

ERA5 reanalysis

Temperature, relative humidity & meridional wind at 1000hPa

synoptic domain : West Africa

Small domain : 12N – 13N & 2E – 3E

Weekly Mean & anomaly
Climatology [1981-2010]

Observations data from AERONET

Station Banizoumbou Niger

Longitude : 2.66E, latitude : 13.54N

50 km southern Niamey

Hourly PM10 concentration

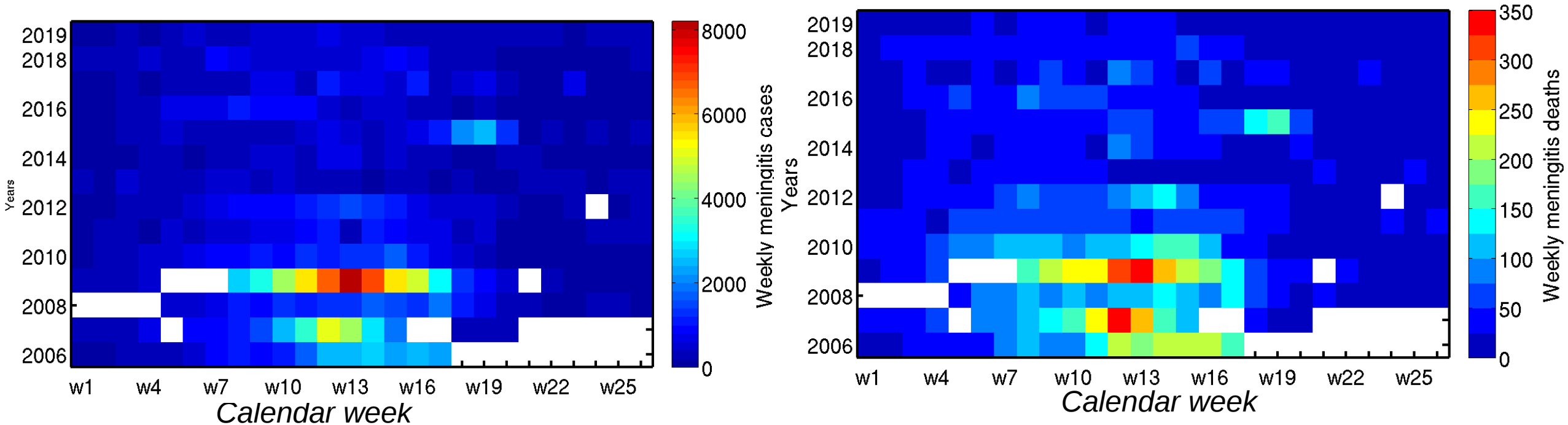
Satellite data

MODIS-Terra

Aerosol optical depth 500 nm

Interannual variability of the meningitis cases over Africa

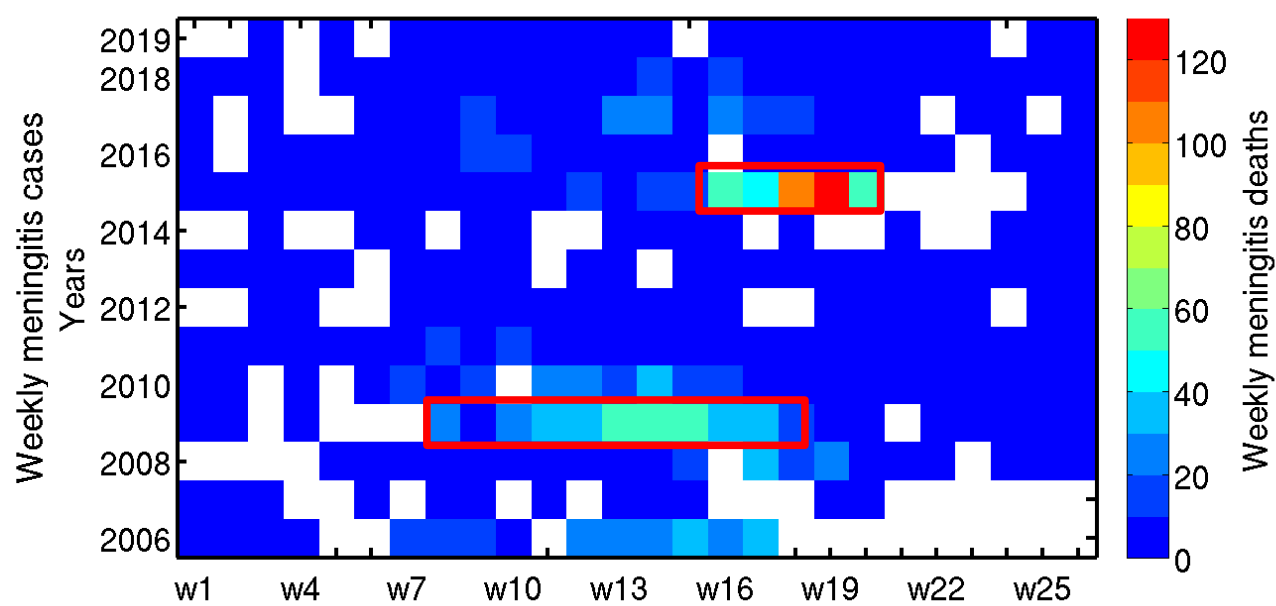
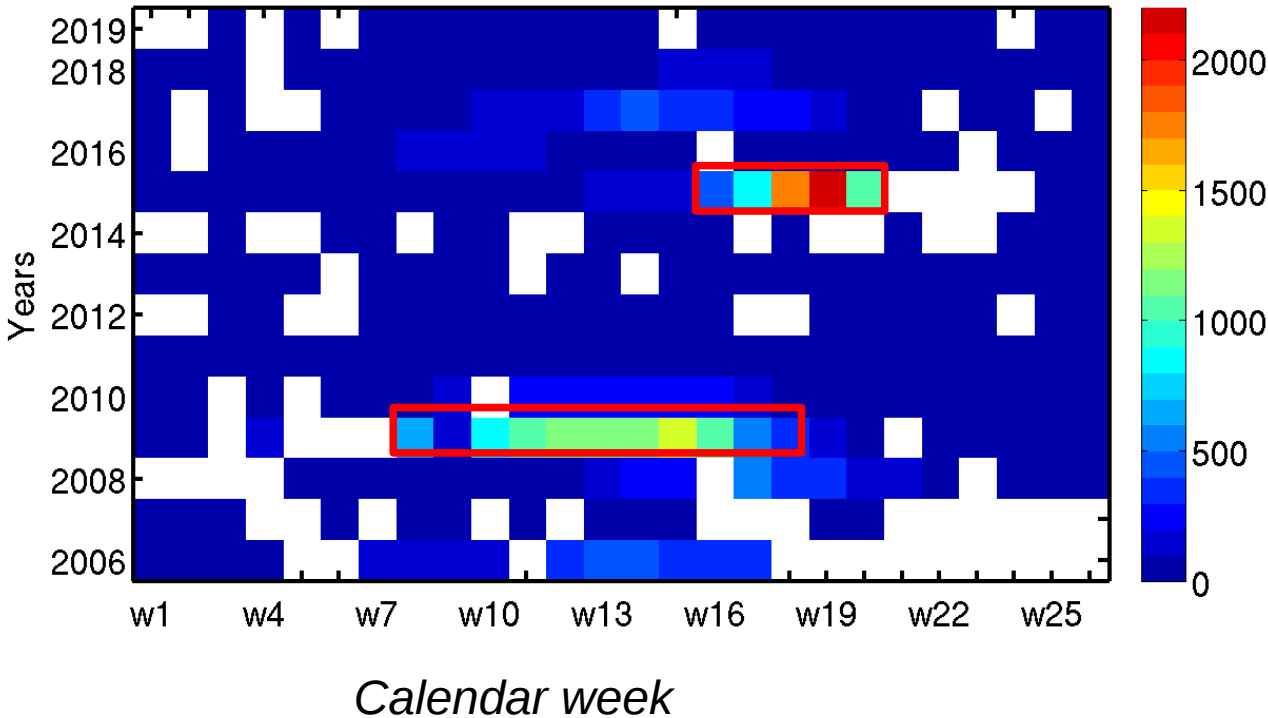
2006 - 2019 period



- Maximum of occurrence of meningitis cases around week 12
- Decrease of meningitis cases over Africa **due to vaccination**
- 2015 particular meningitis epidemic at the end of the dry season
- Interannual variability of the maximum of meningitis cases and deaths

Interannual variability of the meningitis cases over Niger

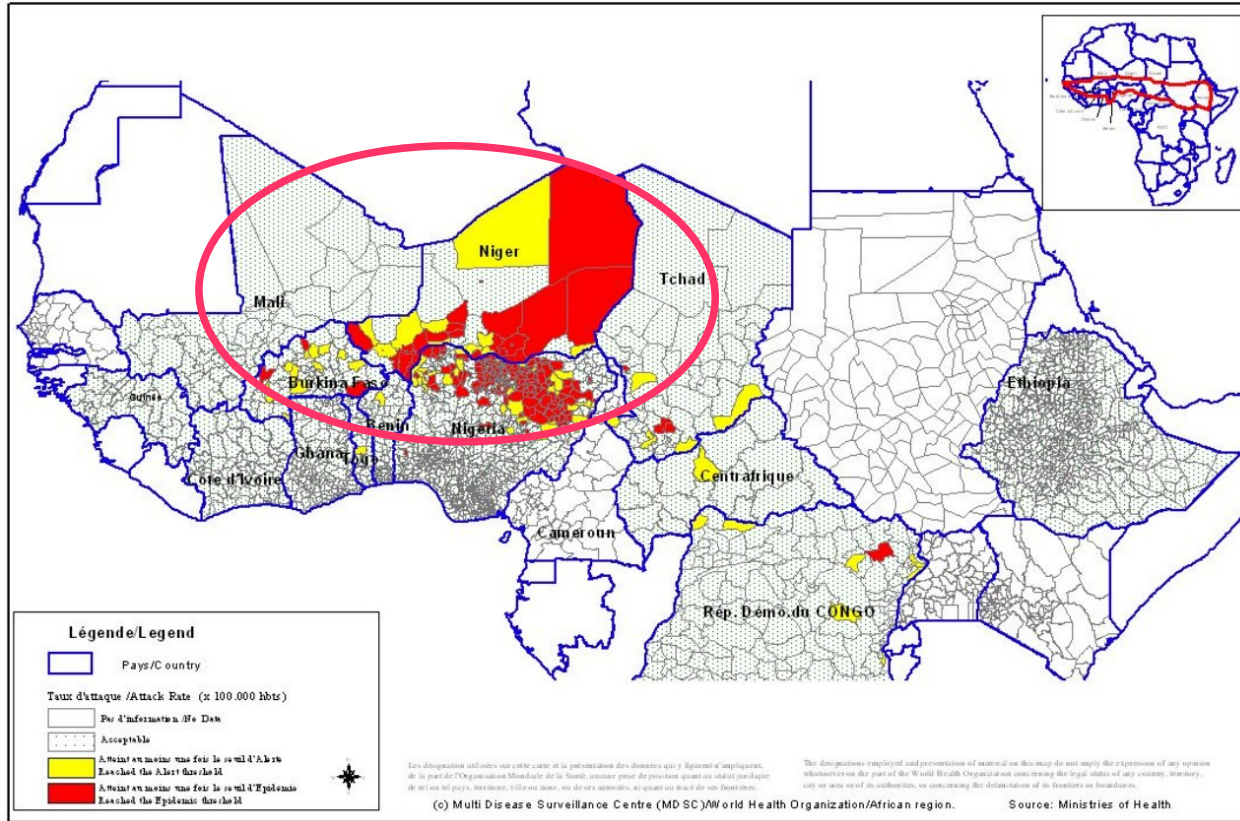
Epidemics over Niger: 2009 & 2015



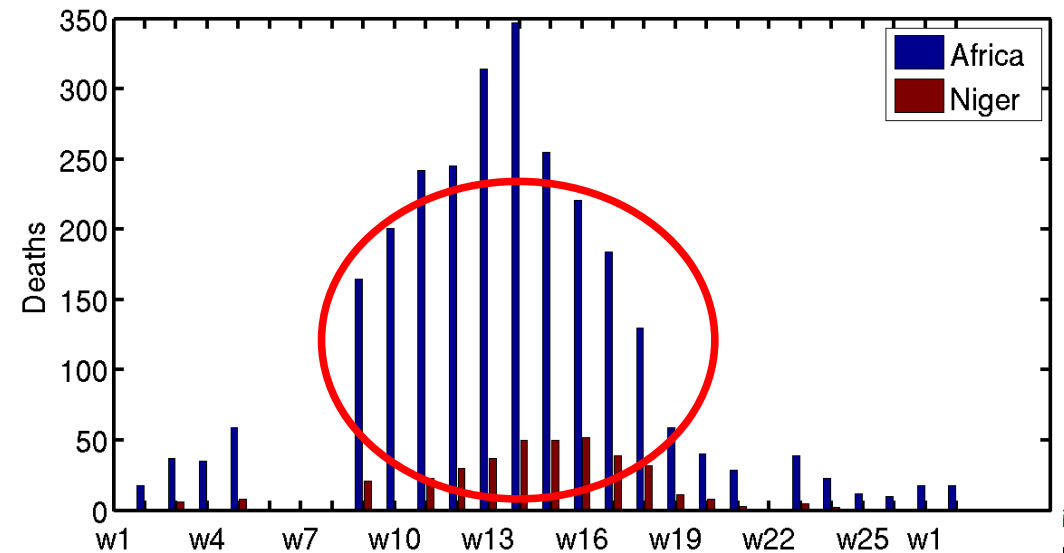
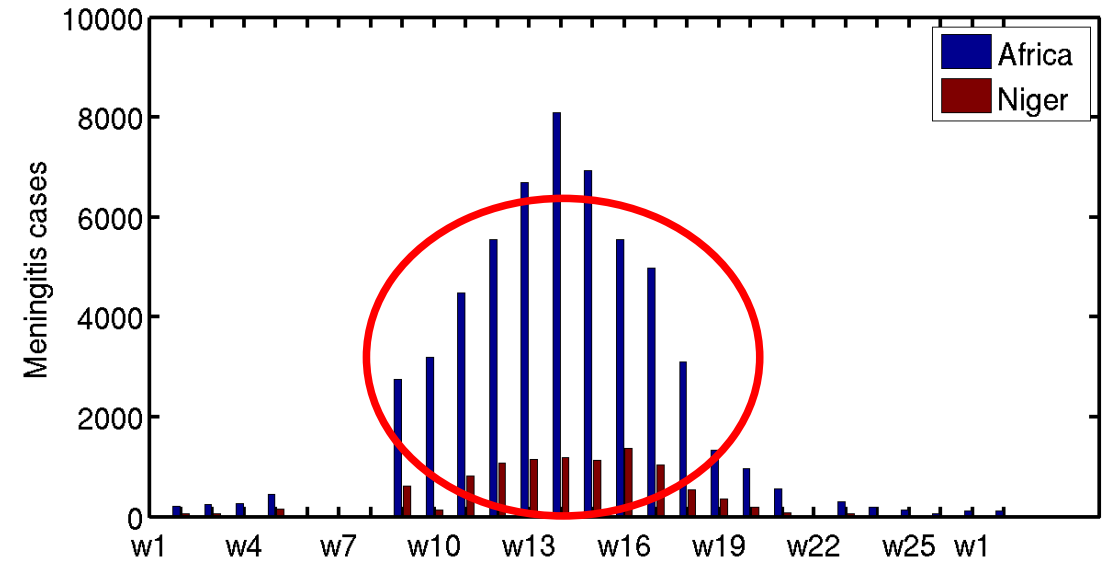
- Two major meningitis epidemics over Niger observed in 2009 and 2015

Case study of meningitis epidemic in 2009 over Niger

Week 1-19



Source : WHO



Large and strong epidemic over Niger, Nigeria, Chad, and Burkina Faso



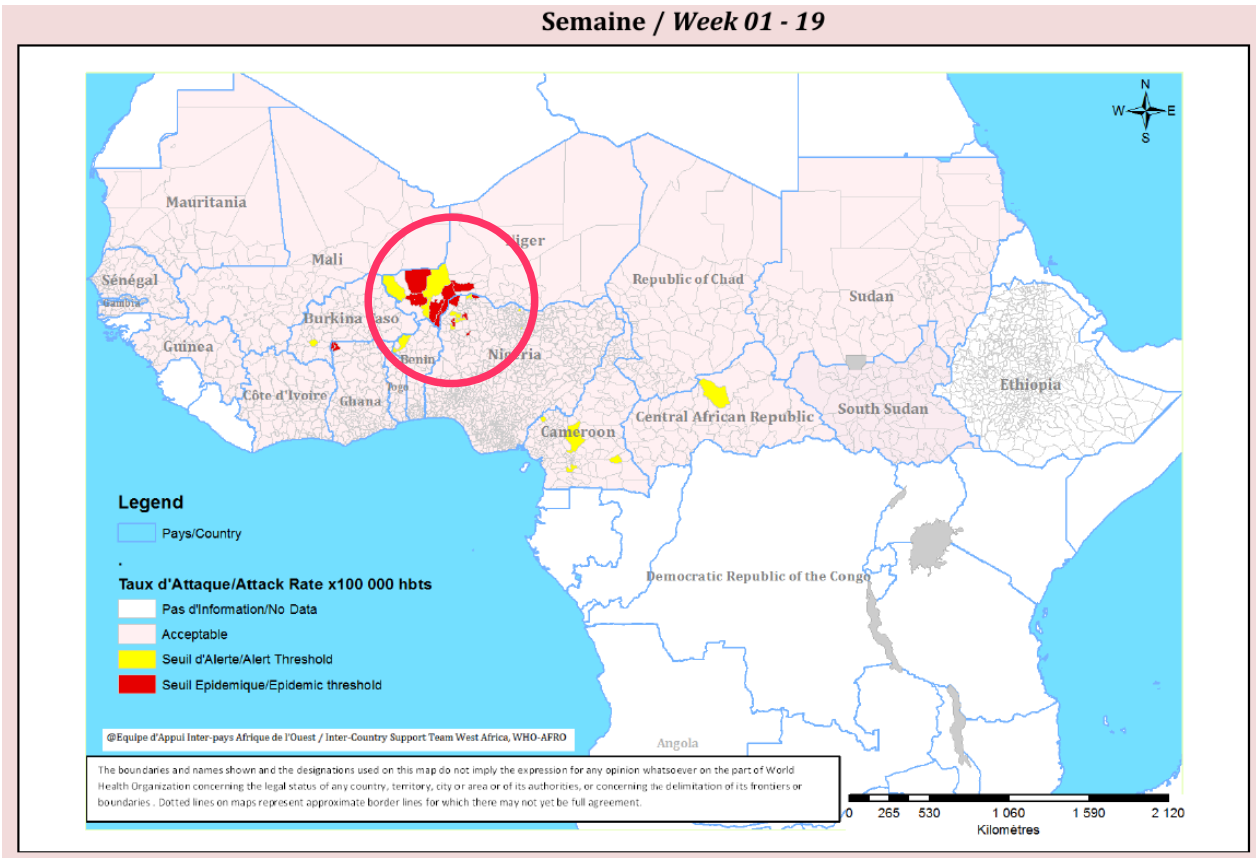
UK Research and Innovation



<https://africanswift.org/>

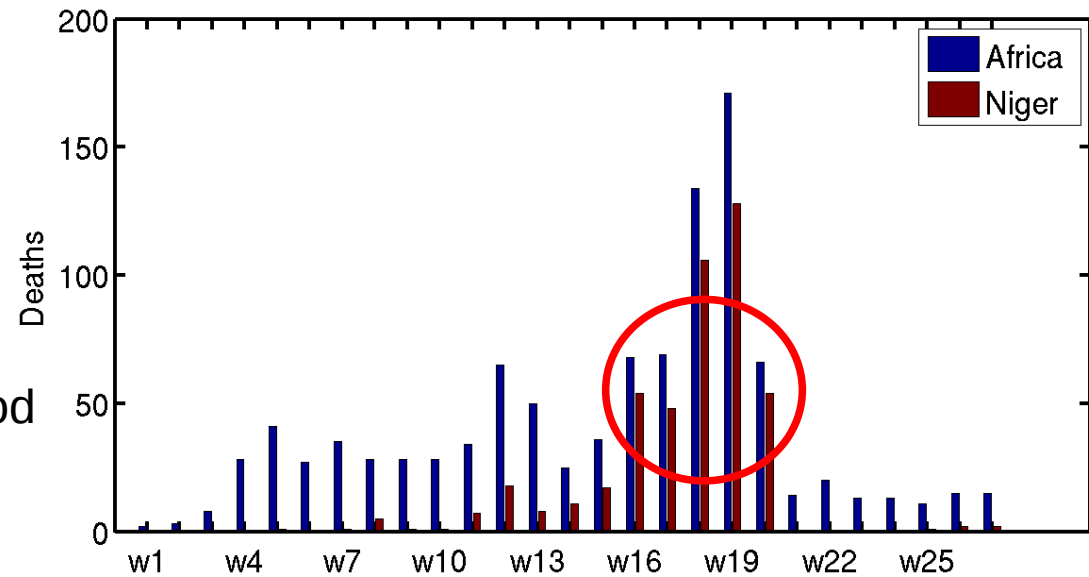
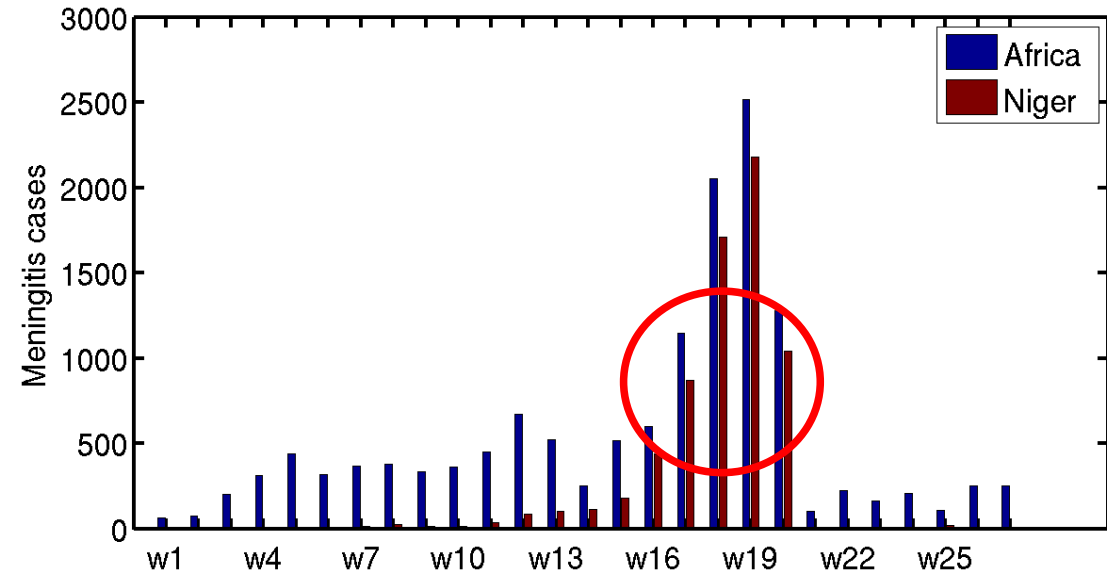


Case studies of meningitis epidemic in 2015 over Niger



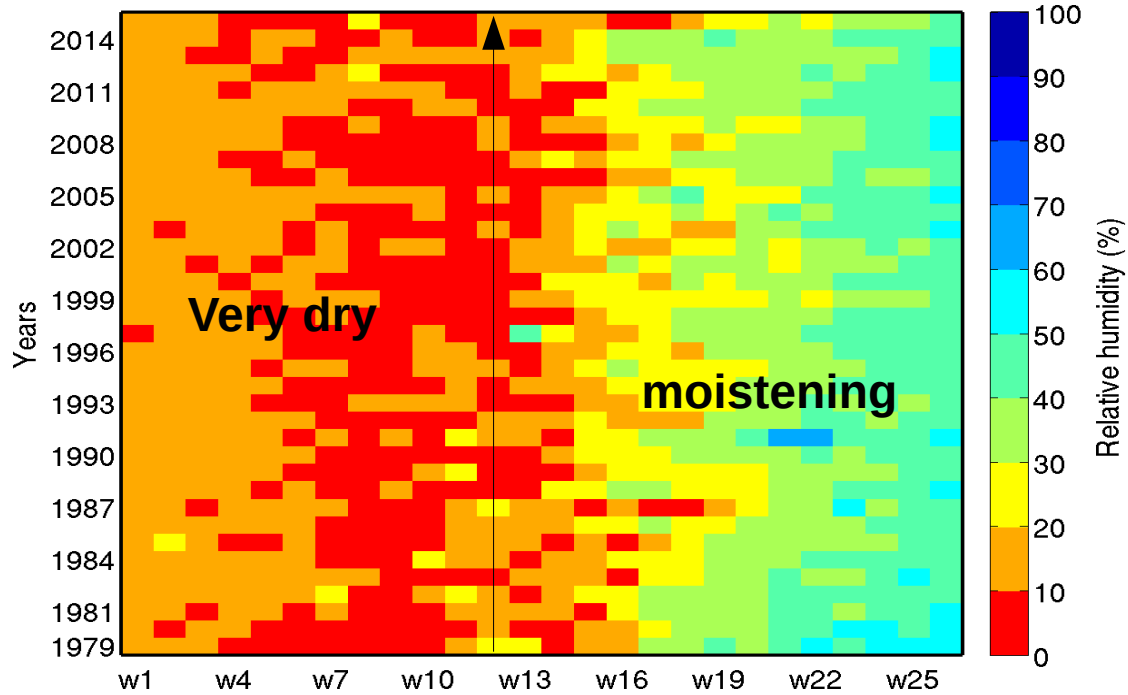
Source : WHO

Short and strong epidemic out of the meningitis outbreak period



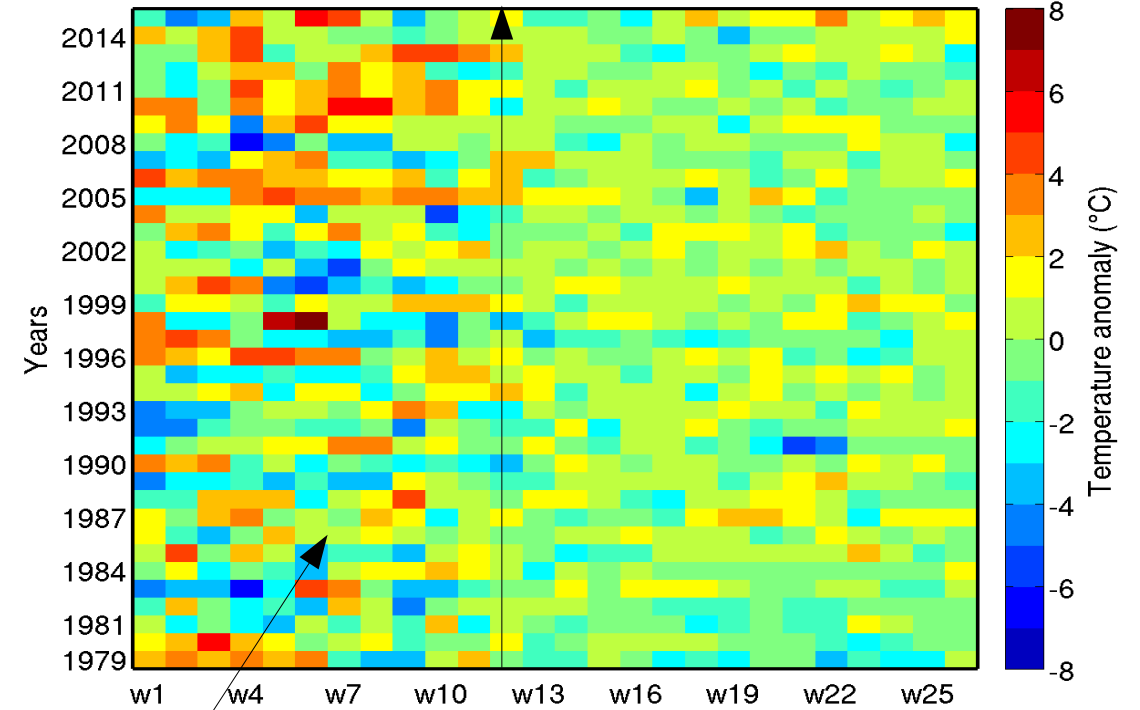
Diagnostic of the mains metric for meningitis outbreak

RH at 1000 hPa



Western Niger

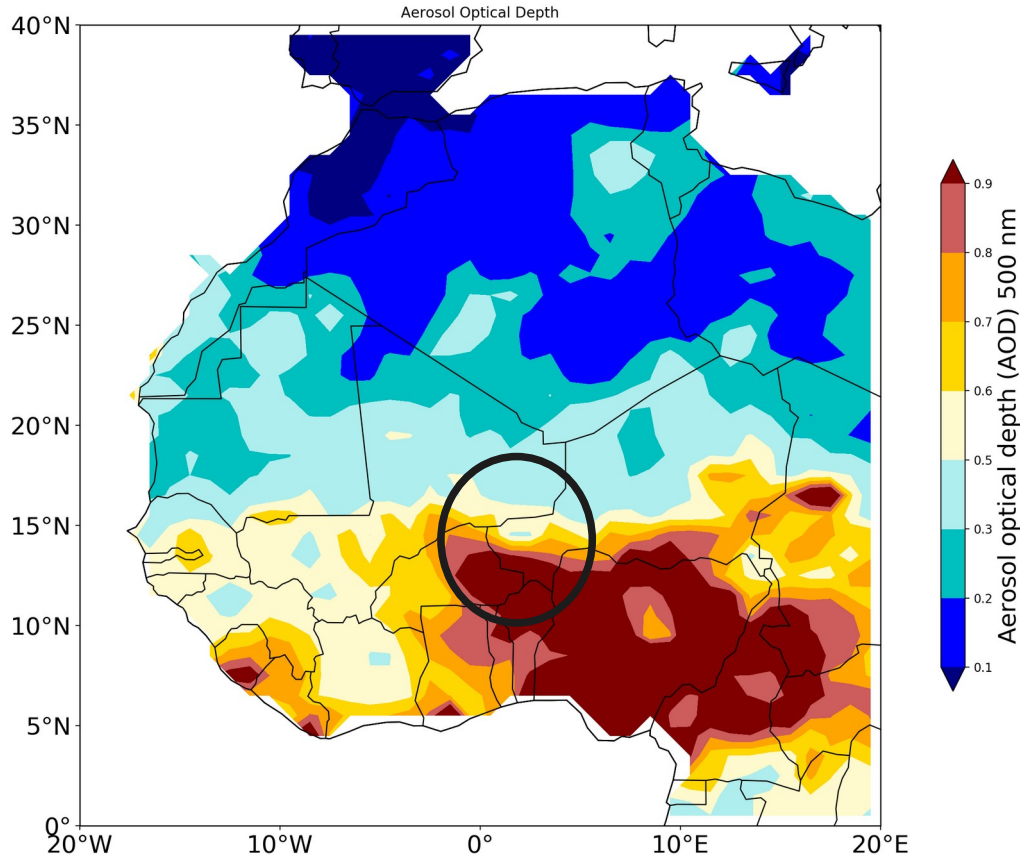
Temperature anomaly at 1000 hPa



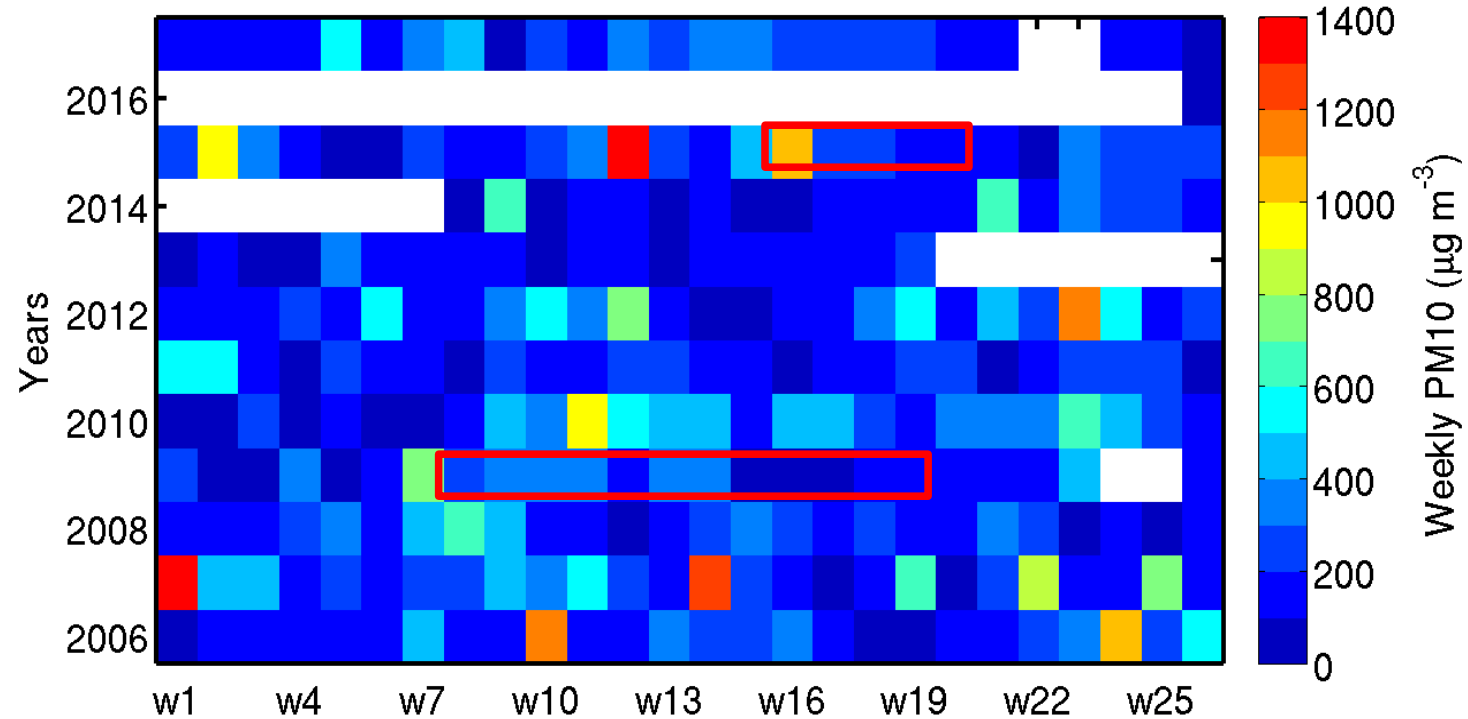
Strong variability of weekly temperature

Diagnostic of the mains metric for meningitis outbreak

MODIS-Terra – March 2015



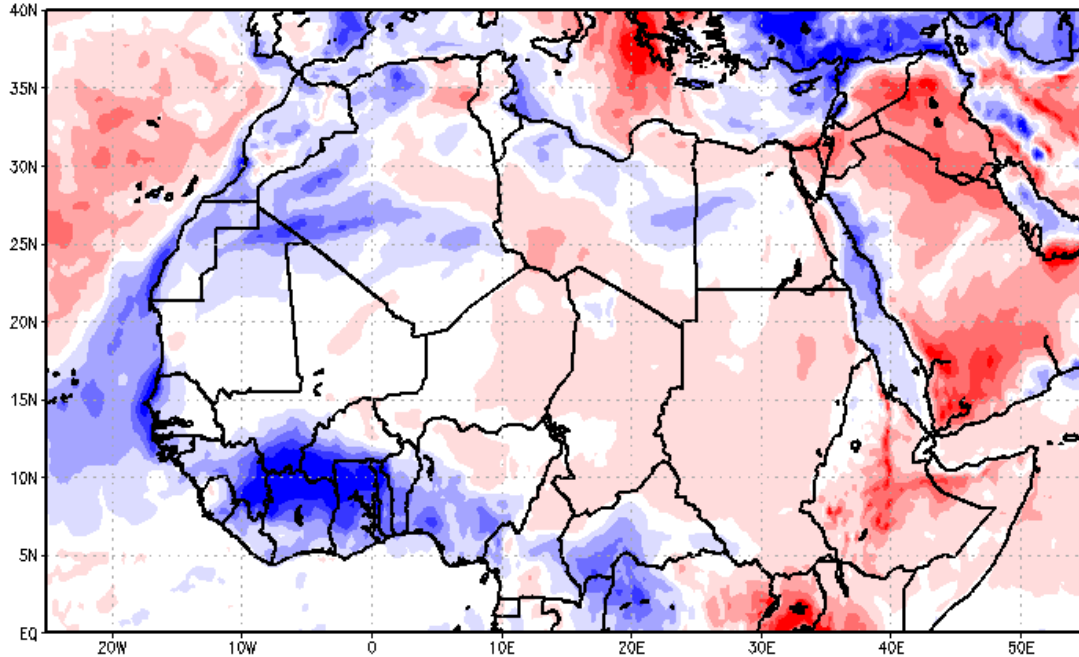
Concentration of PM 10 at Banizoumbou



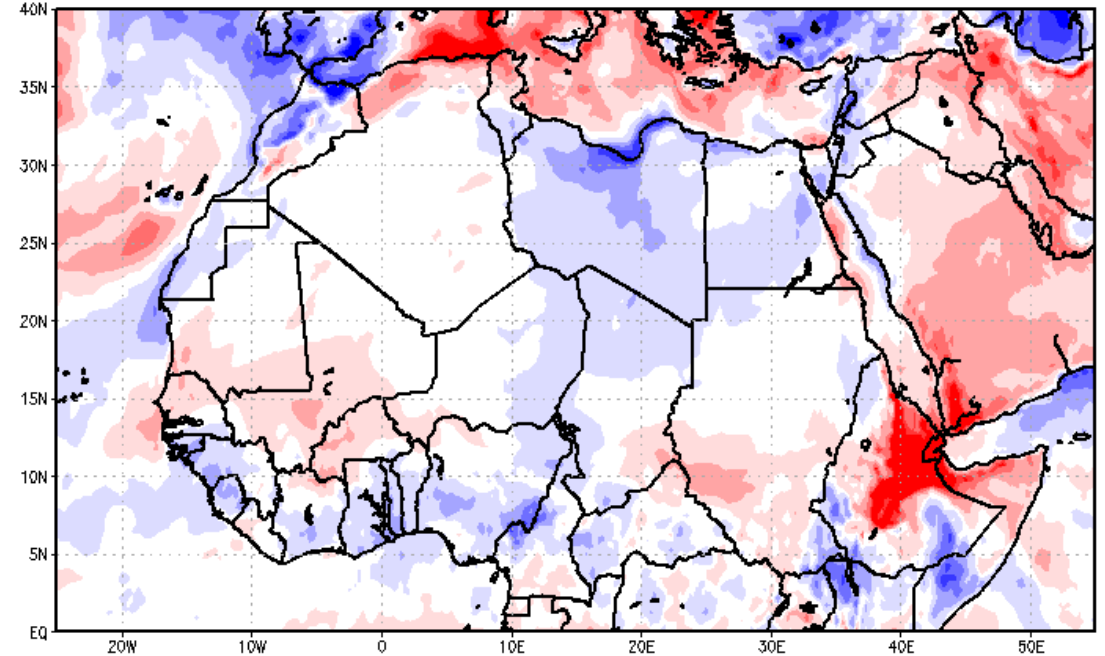
Dusty atmospheric conditions arrived before each meningitis outbreak

Diagnostic of the mains metric for meningitis outbreak

Relative humidity anomaly (%) : week 7
9 - 15th February 2009



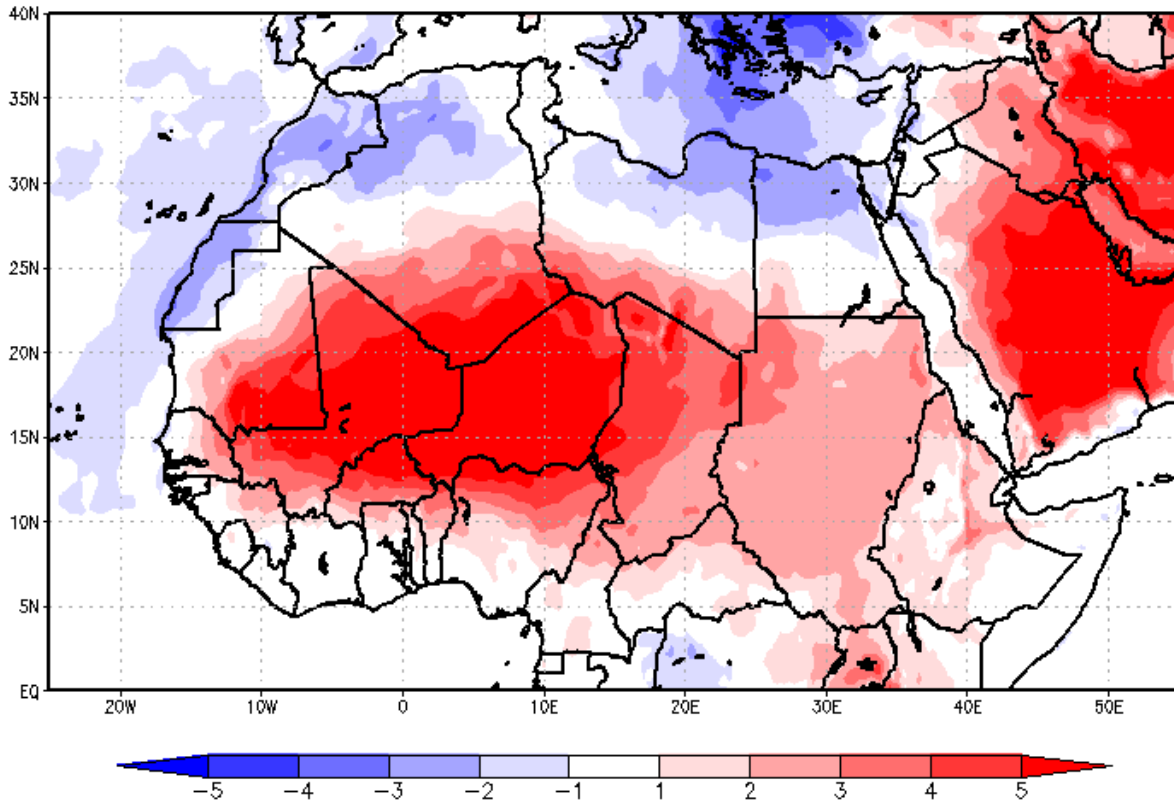
Relative humidity anomaly (%) : week 15
6 - 12th April 2015



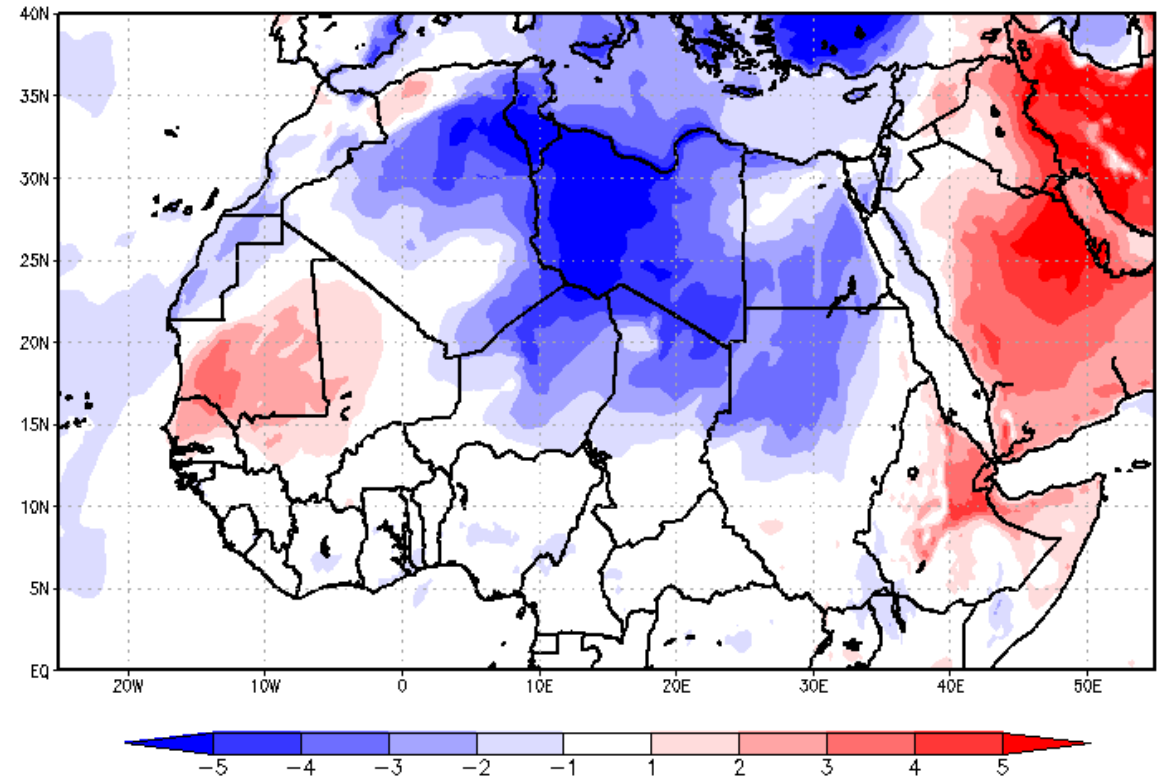
Dry atmospheric conditions before meningitis outbreak onset

Diagnostic of the mains metric for meningitis outbreak

Temperature anomaly (°C) : week 7
9 - 15th February 2009

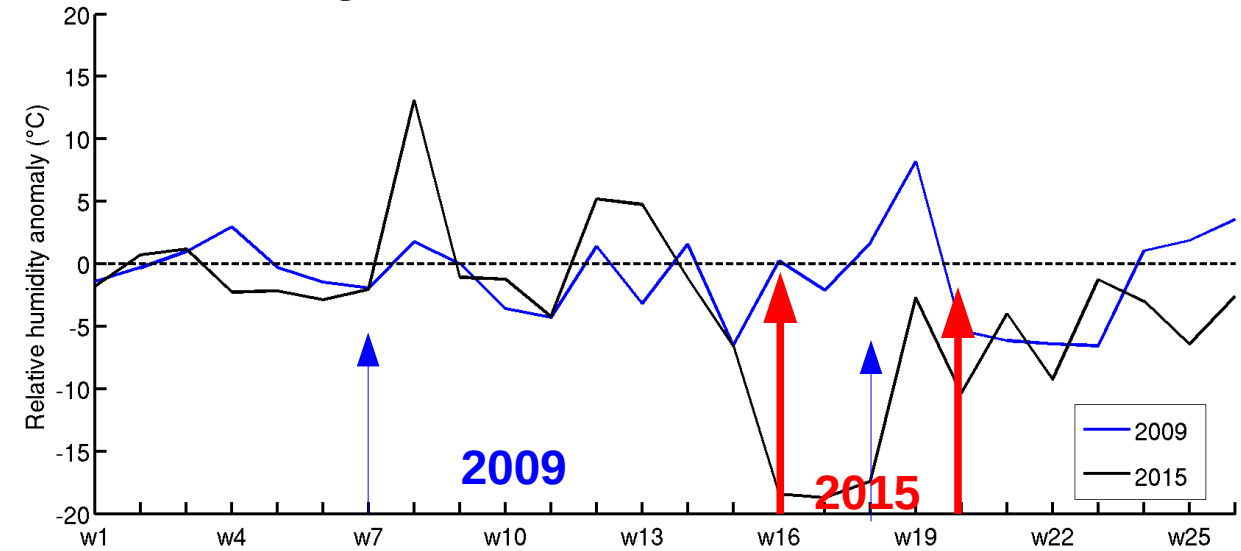
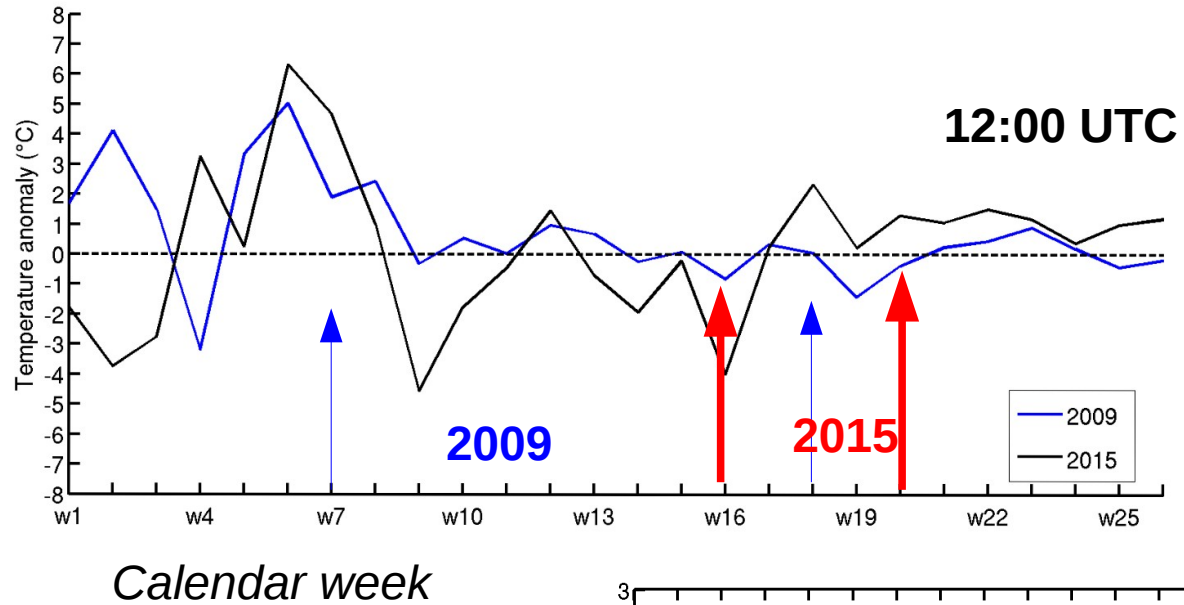


Temperature anomaly (°C) : week 15
6 - 12th April 2015

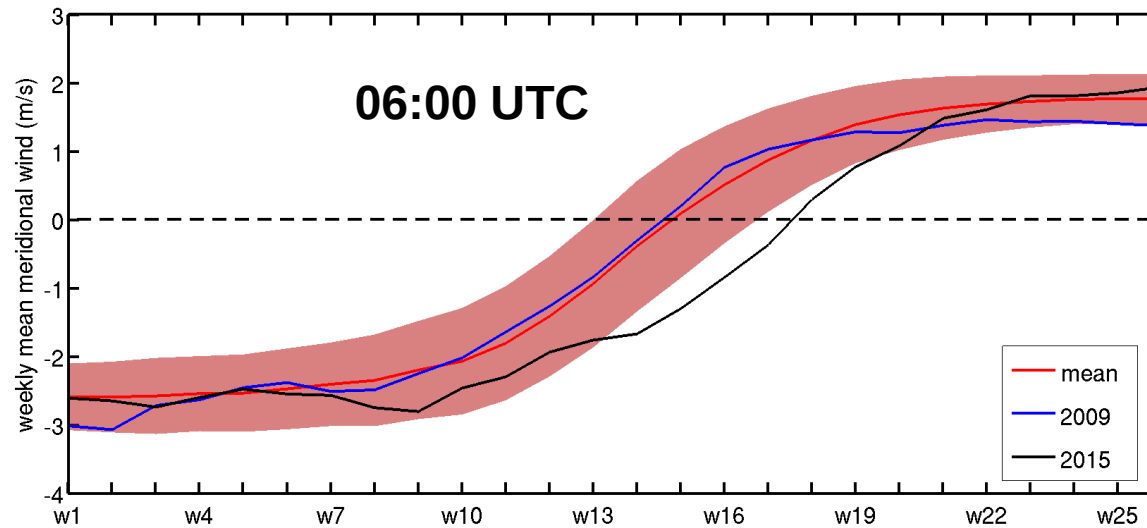


Warm temperature before early meningitis epidemic

Diagnostic of the mains metric for meningitis outbreak



Increase of temperature

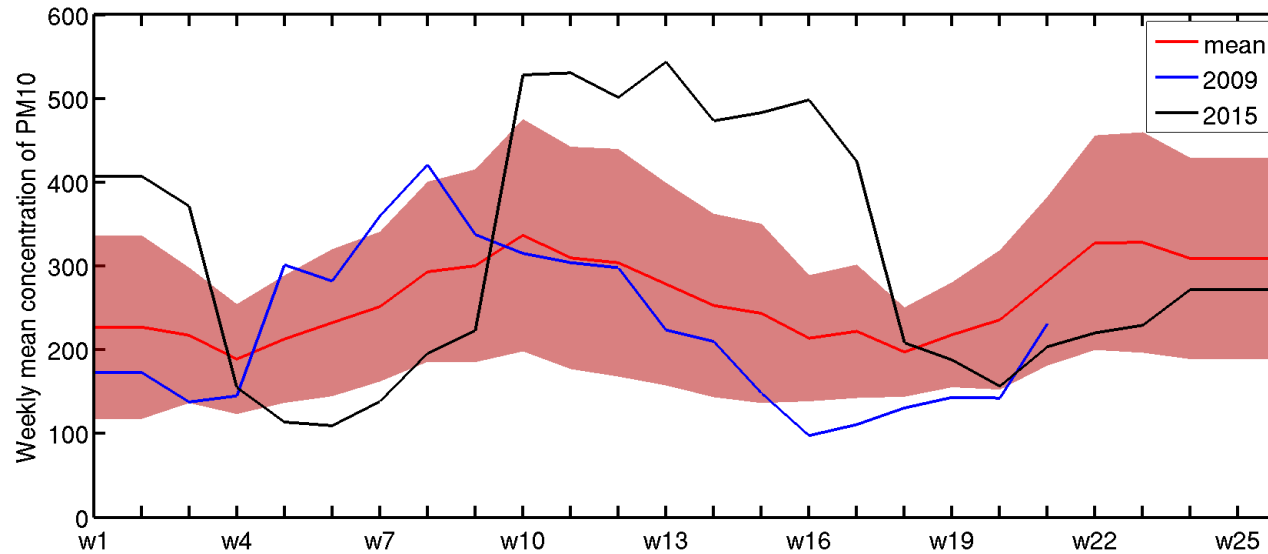


Decrease of relative humidity

Late monsoon onset in 2015

Diagnostic of the mains metric for meningitis outbreak

Period 2006 - 2017



8 weeks of very dusty atmospheric conditions over Banizoumbou before the development of the meningitis outbreak

Conclusions and future work

- Interannual variability of the peak of the meningitis occurrence over Africa
- Strong sub-seasonal variability of the meningitis cases over the African meningitis belt
- The peak of meningitis epidemic over Niger during 2015 was observed under warm atmospheric conditions during and arrived ahead of several dusty weeks
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- Dusts seem to be the most important factor driving the meningitis outbreak
- Increase of temperature decrease of relative humidity before meningitis outbreak 2009 and 2015 over Niger
- Quantify the role of large and local scale climate variability on the onset of meningitis outbreak using analogue flow method