Relationship between meningitis occurrence and atmospheric conditions over African meningitis belt

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ACMAD's weekly meningitis bulletin

Background

- Link between climate and mechanisms responsible for menigitis development *(Yaka et al., 2008)*
- Meningitis prevalence can last up to 7 months (december to June *(Martiny and Chiapello (2013))*
- Very dry and dusty atmospheric conditions observed during meningitis outbreaks over Sub-saharian region *(Sultan et al., 2005, and Martiny and Chiapello (2013))*
- Desert dust closely linked to the onset and development of the disease *(Martiny and Chiapello (2013))*

Based on weather informations, ACMAD produce a weekly meningitis bulletin during the dry season (Week 1 to 26) for Africa

ACMAD's weekly meningitis bulletin

Data & Methodology

Dataset

- Previous weekly mean relative humidity (RH), and meridional wind speed from NCEP (2.5 X 2.5°) *(http://iridl.ldeo.columbia.edu/expert/ds:/SOURCES/.NOAA/.NCEP-NCAR/.CDAS-1/.DAILY/.Intrinsic/.PressureLevel/.v/dods)*
- previous weekly mean surface dust concentration forecast from NASA-GEOS model (25 X 31 km2) (Barcelona Super Computer Center; *https://dust.aemet.es/forecast)*
- Weekly meningitis reports from WHO to evaluation forecast *(https://www.who.int/emergencies/diseases/meningitis/epidemiological/en/)*

African meningitis belt

Algorithm to produce the vigilance map of meningitis

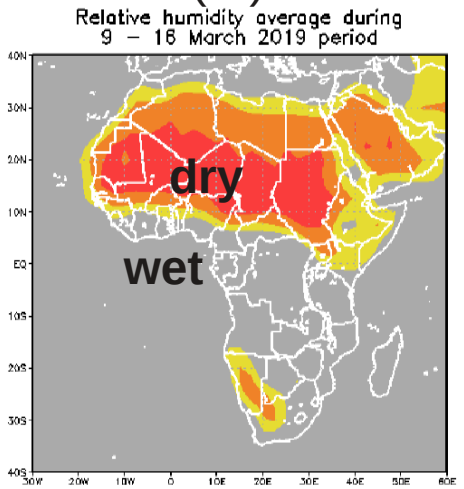
RH (%)	Meridional wind speed (m/s)	Dust concentrations (µg/m3)	Vigilance color
RH < 20	--	--	**red**
20 < RH < 40	V < -1	dust > 300	**red**
20 < RH < 40	-1 < V < 1	150 < dust < 300	**red**
40 < RH < 60	-1 < V < 1	dust > 300	**orange**
40 < RH < 60	V < 1	dust < 150	**yellow**
RH > 60	--	--	**white**

https://africanswift.org/

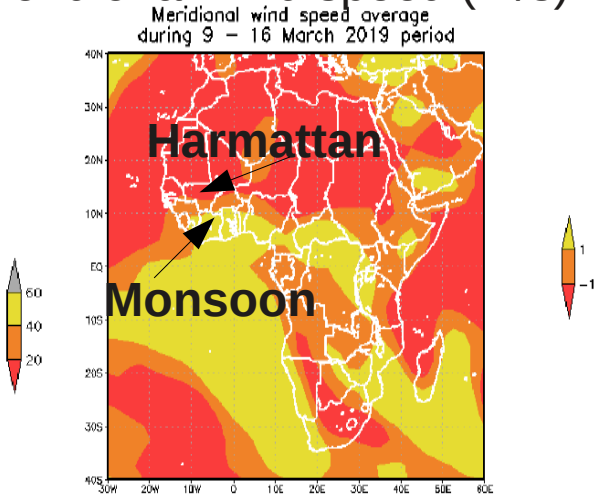
ACMAD's weekly meningitis bulletin

Week 12

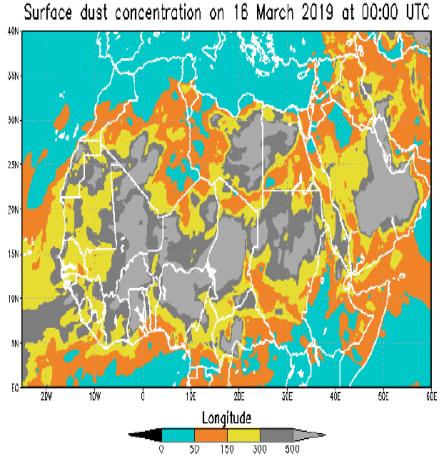
RH (%)



Meridional wind speed (m/s)

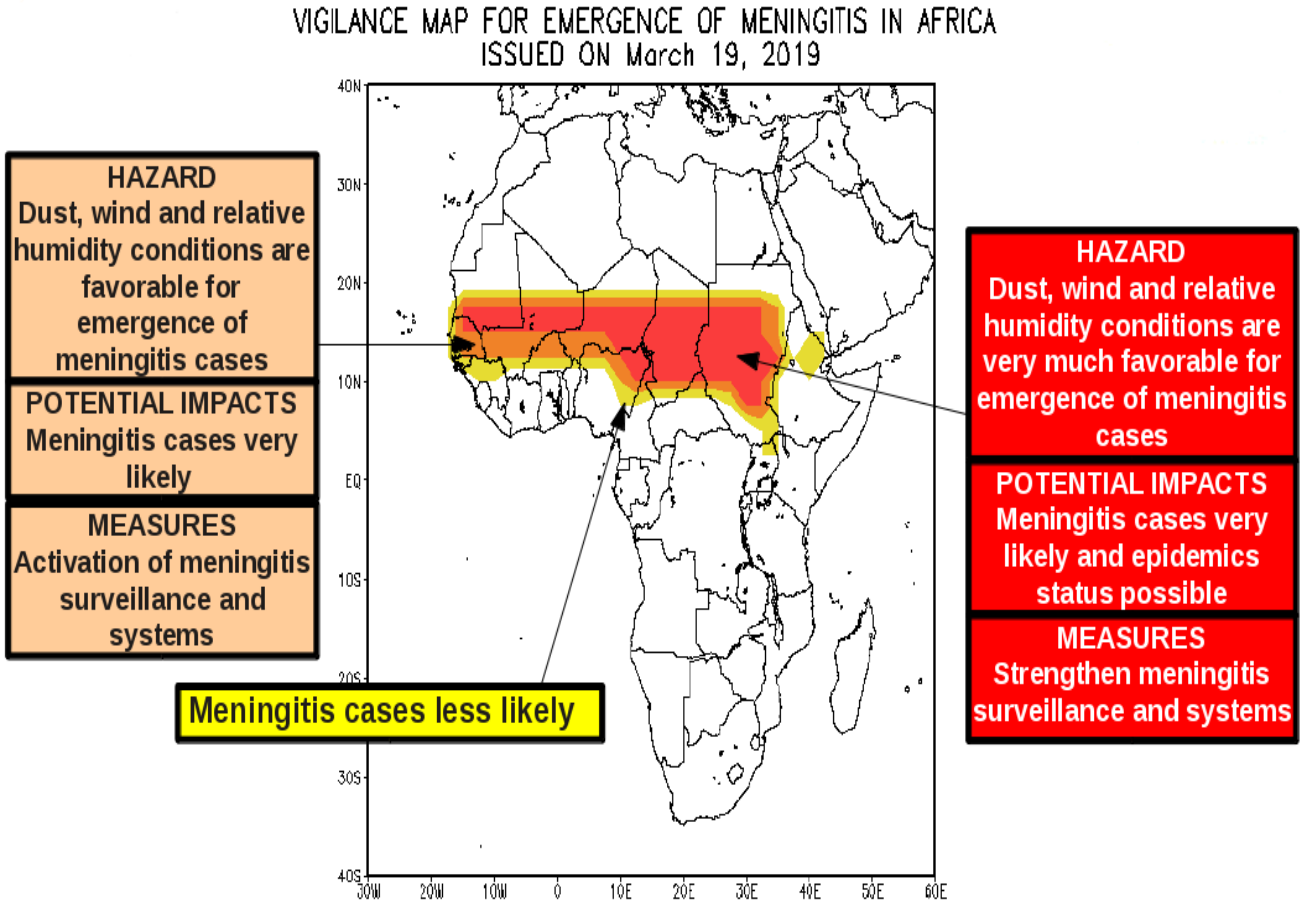


Surface dust concentrations (µg/m³)



very dry and dusty over Sah

dusty and wet over Golf of Guinea



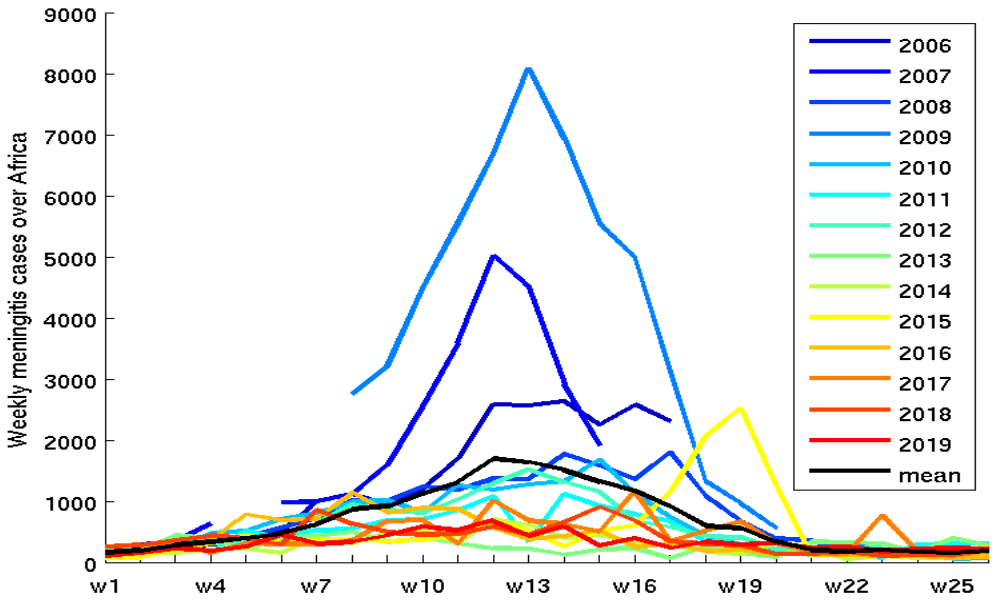
http://www.acmad.net/new/sites/default/files/csirs/index.php/bull_meningite/

https://africanswift.org/

Case studies of meningitis epidemic

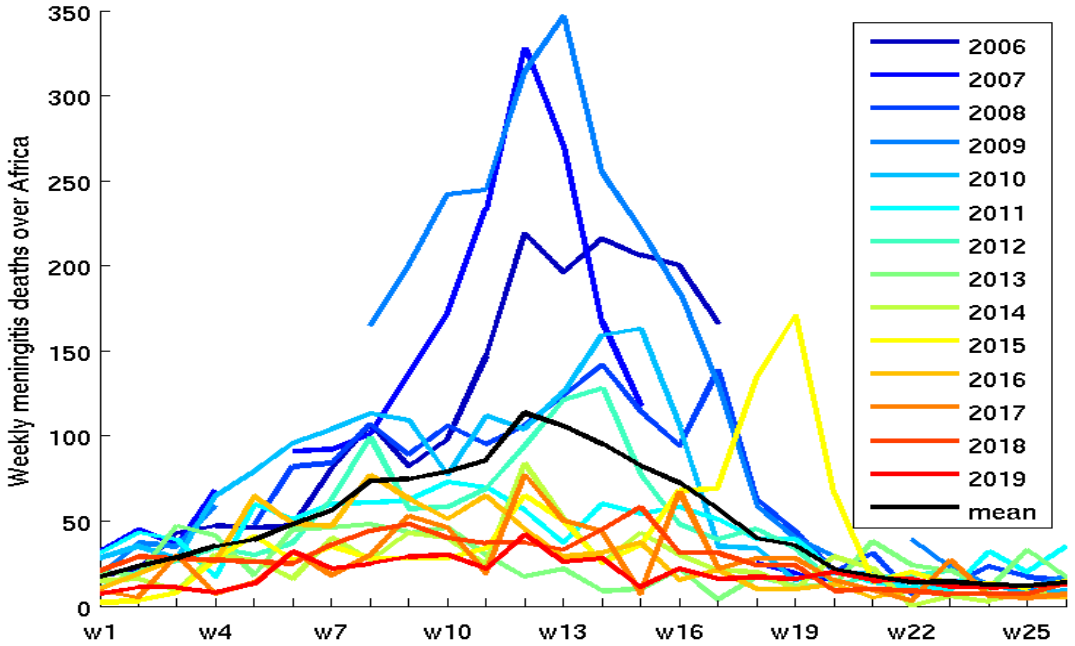
Interannual variability of the meningitis cases over Africa

2006 - 2019 period



Calendar week

2006 - 2019 period



Calendar week

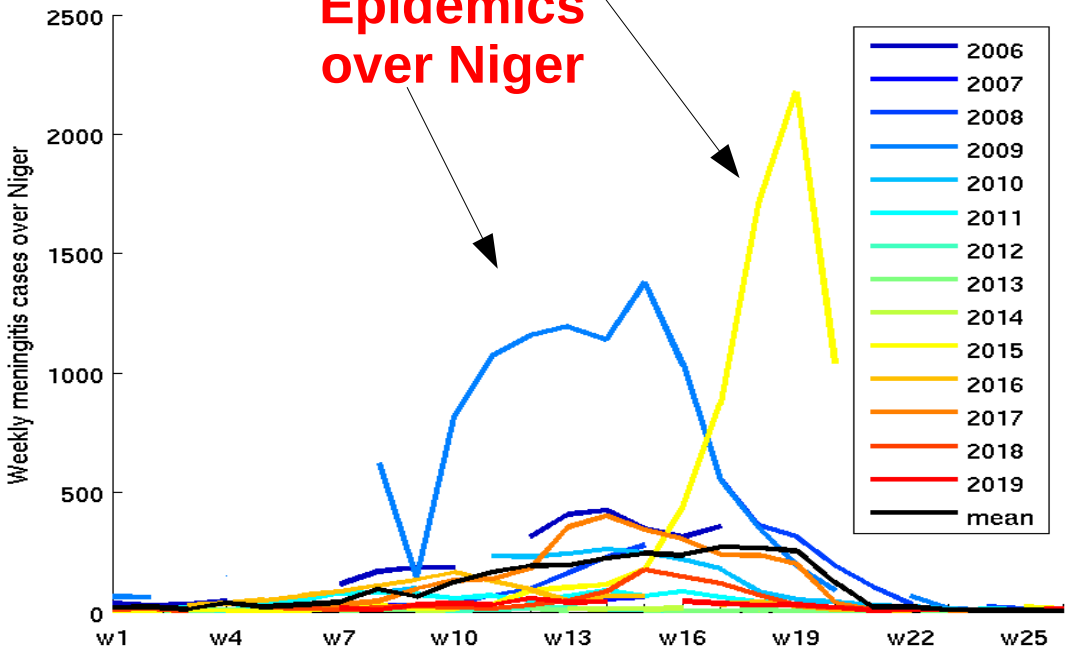
- Maximum of occurrence of meningitis cases around week 12
- Decrease of meninigitis cases over Africa (vaccination?)
- 2015 particular meningitis epidemic at the end of the dry season
- Interannual variability of the maximum of meningitis cases

Case studies of meningitis epidemic

Interannual variability of the meningitis cases over Niger

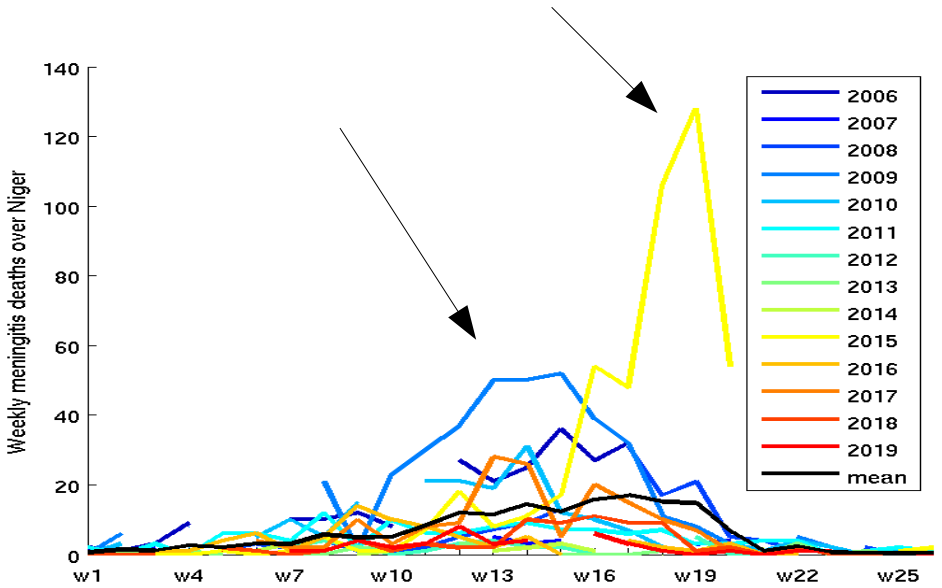
2006 - 2019 period

Epidemics over Niger



Calendar week

Epidemics over Niger

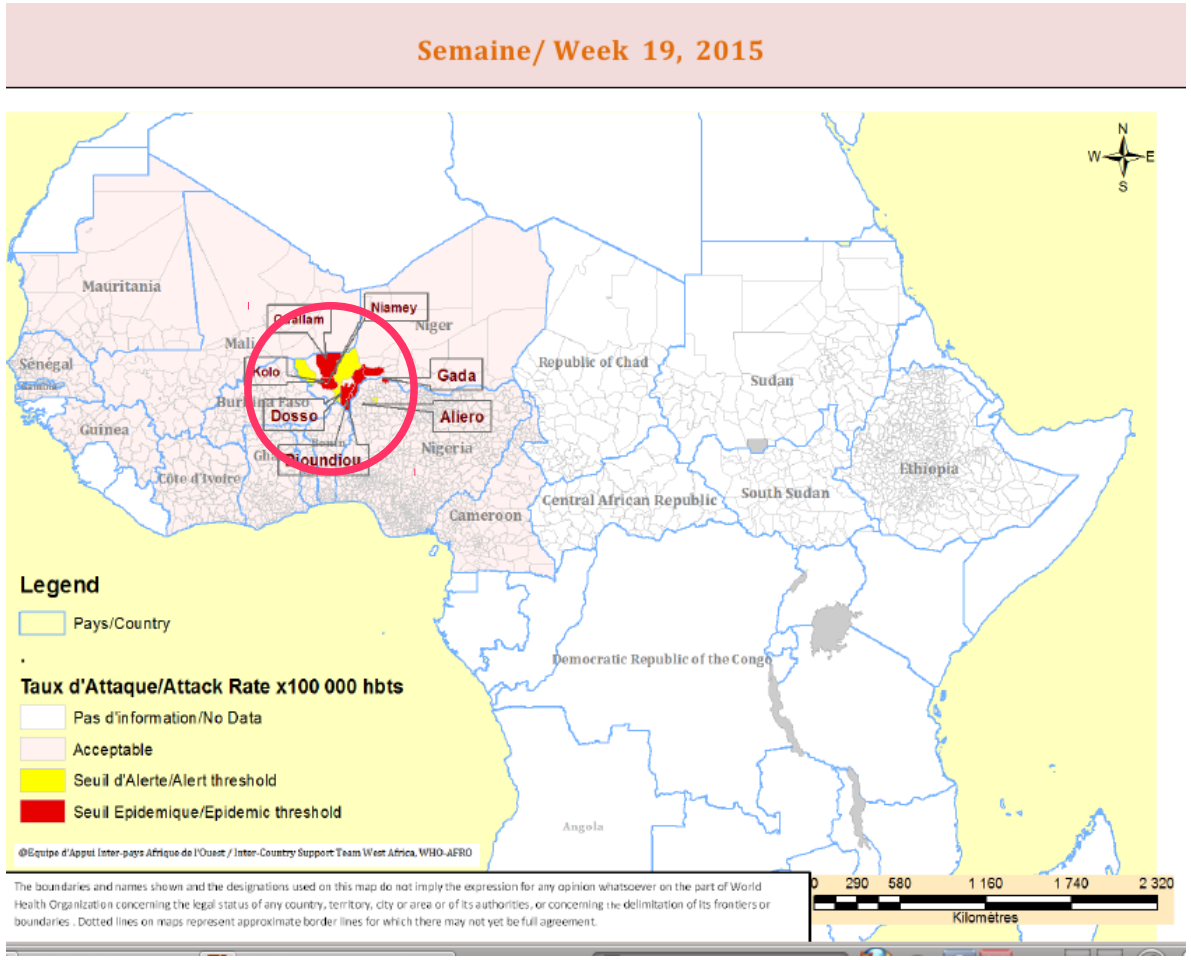


Calendar week

- Two major meningitis epidemics over Niger observed in 2009 and 2015
- Intra-seasonal variability of the meningitis cases and deaths

Case studies of meningitis epidemic

meningitis epidemic in 2015 over Niger

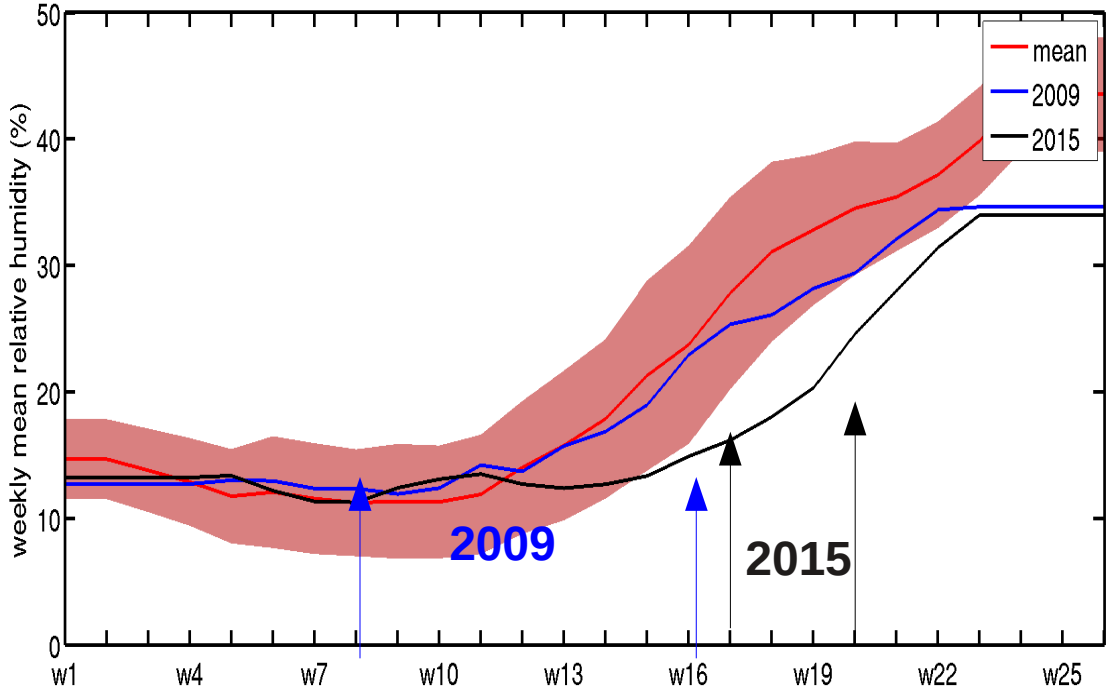


Localized epidemic over western Niger

	Niger		Africa	
Weeks	cases	deaths	cases	deaths
18	1708	106	2054	134
19	**2177**	**128**	**2518**	**171**
20	1041	54	1278	66

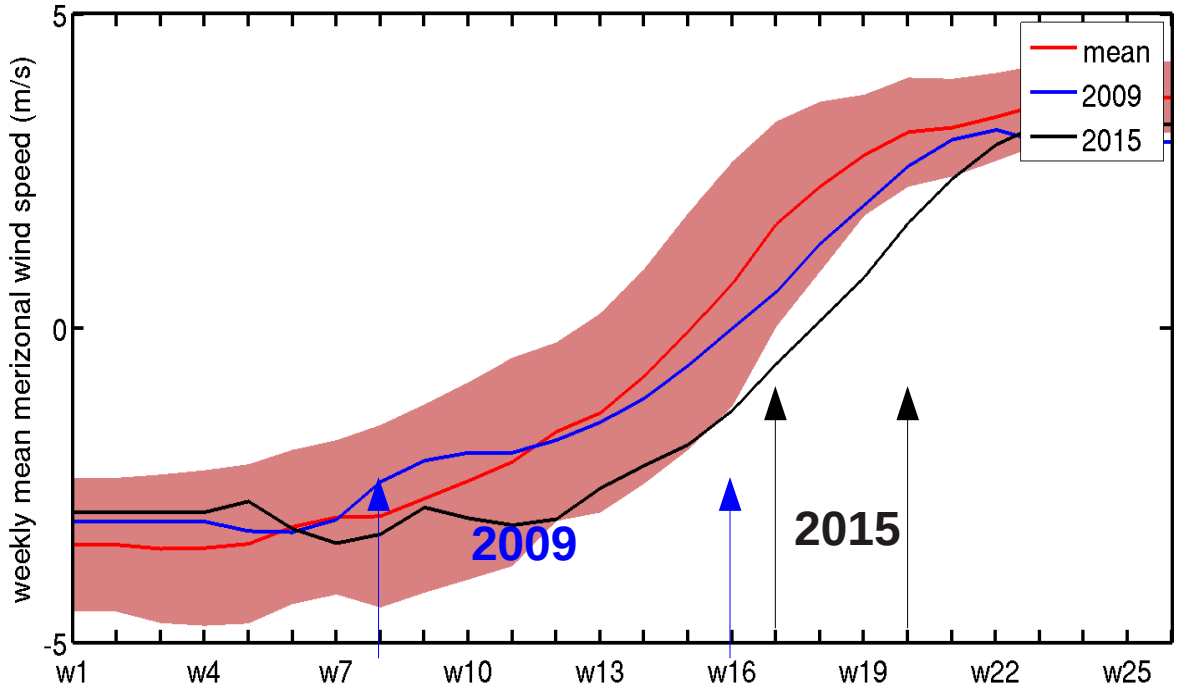
Case studies of meningitis epidemic

Period 2006 - 2017



Calendar week

- High relative humidity than during the mean peak of meningitis outbreaks but lower the mean for 2015
- Normal conditions for 2009

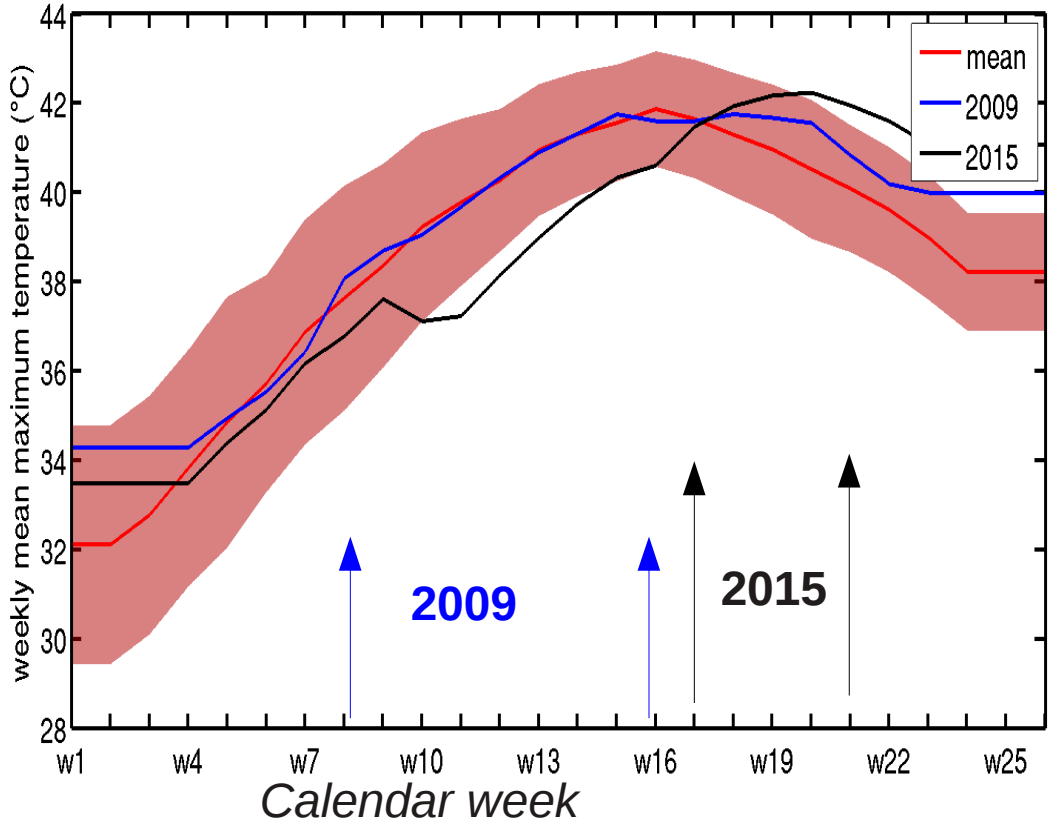


Calendar week

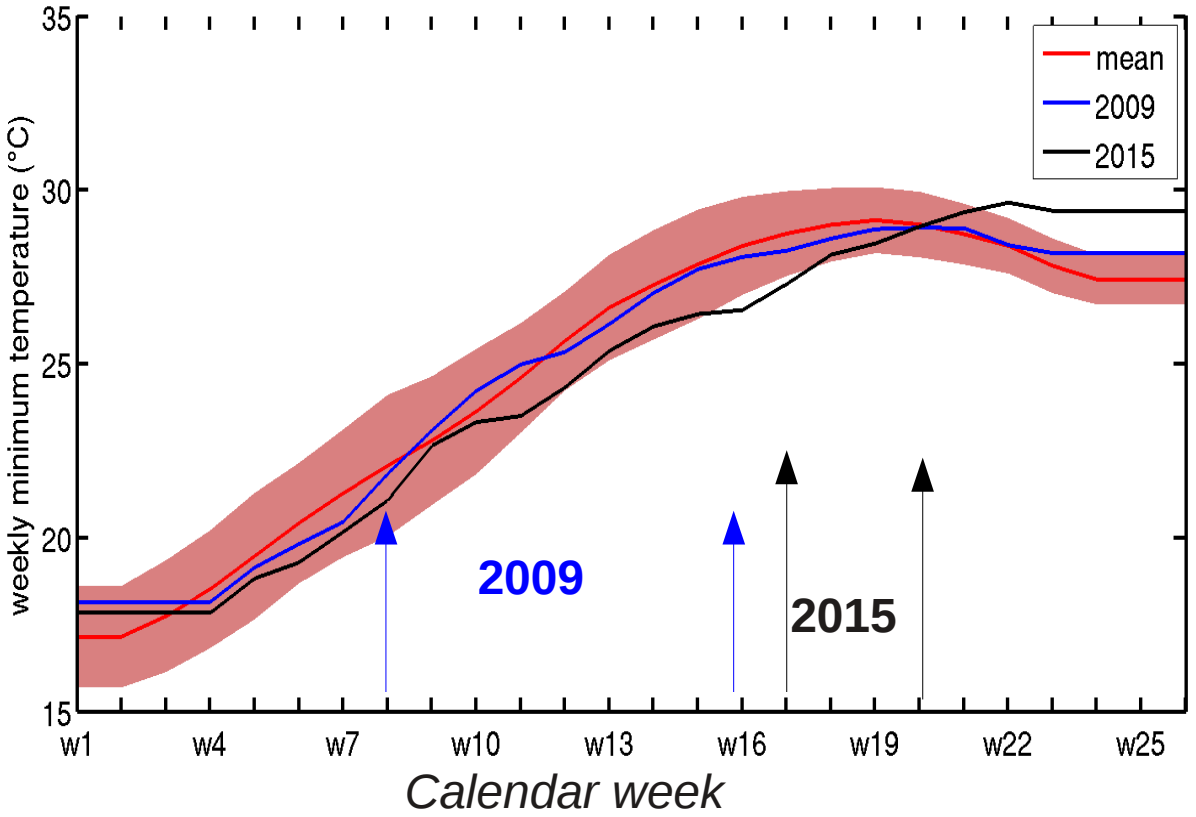
- Low wind speed than during the mean peak of meningitis outbreaks but high than the mean for 2015
- No change in wind for 2009

Case studies of meningitis epidemics

Period 2006 - 2017

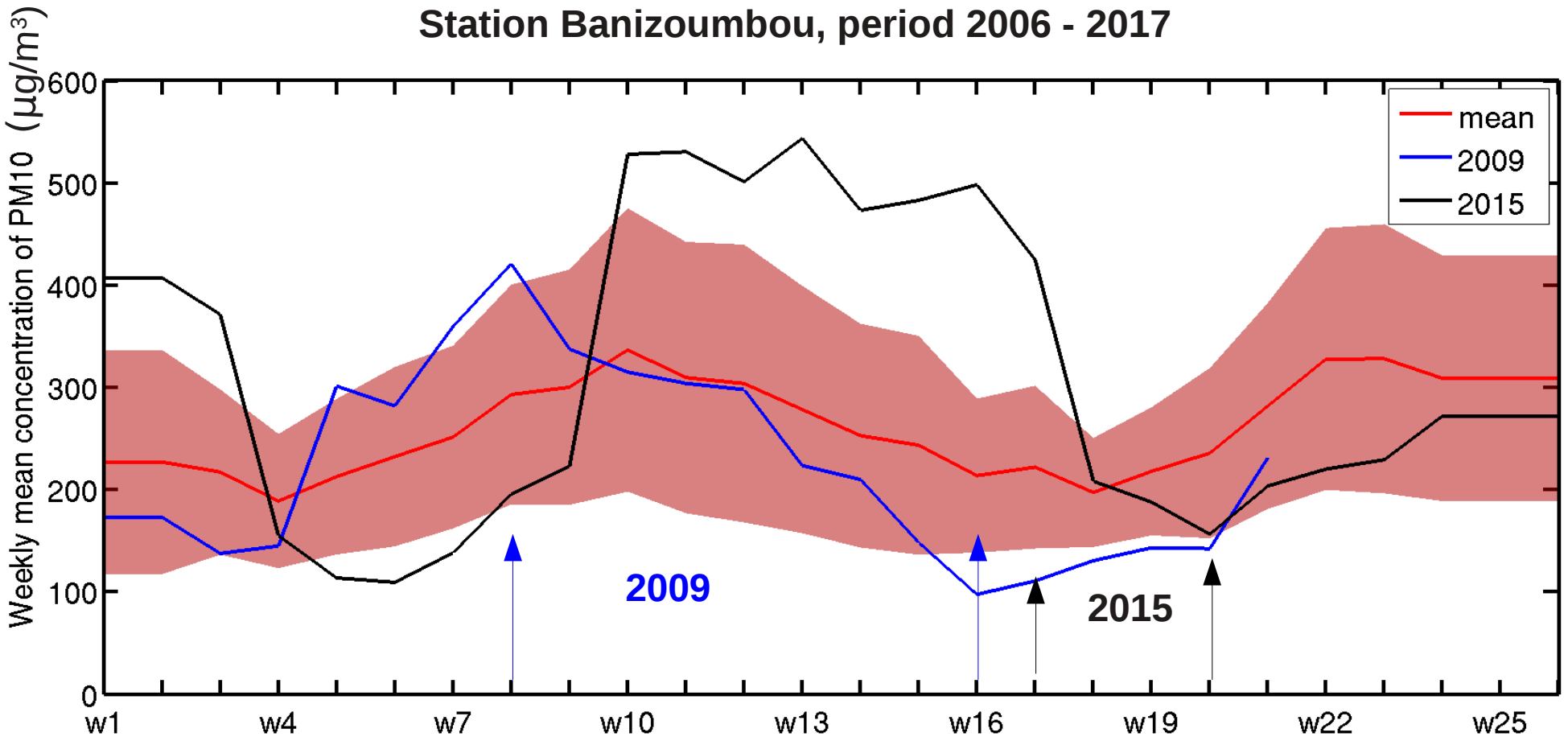


- Increase of the maximum temperature during the meningitis epidemic in 2015
- No significant change for 2009



- Nocturnal temperature remains below the mean for 2015
- No significant change for 2009

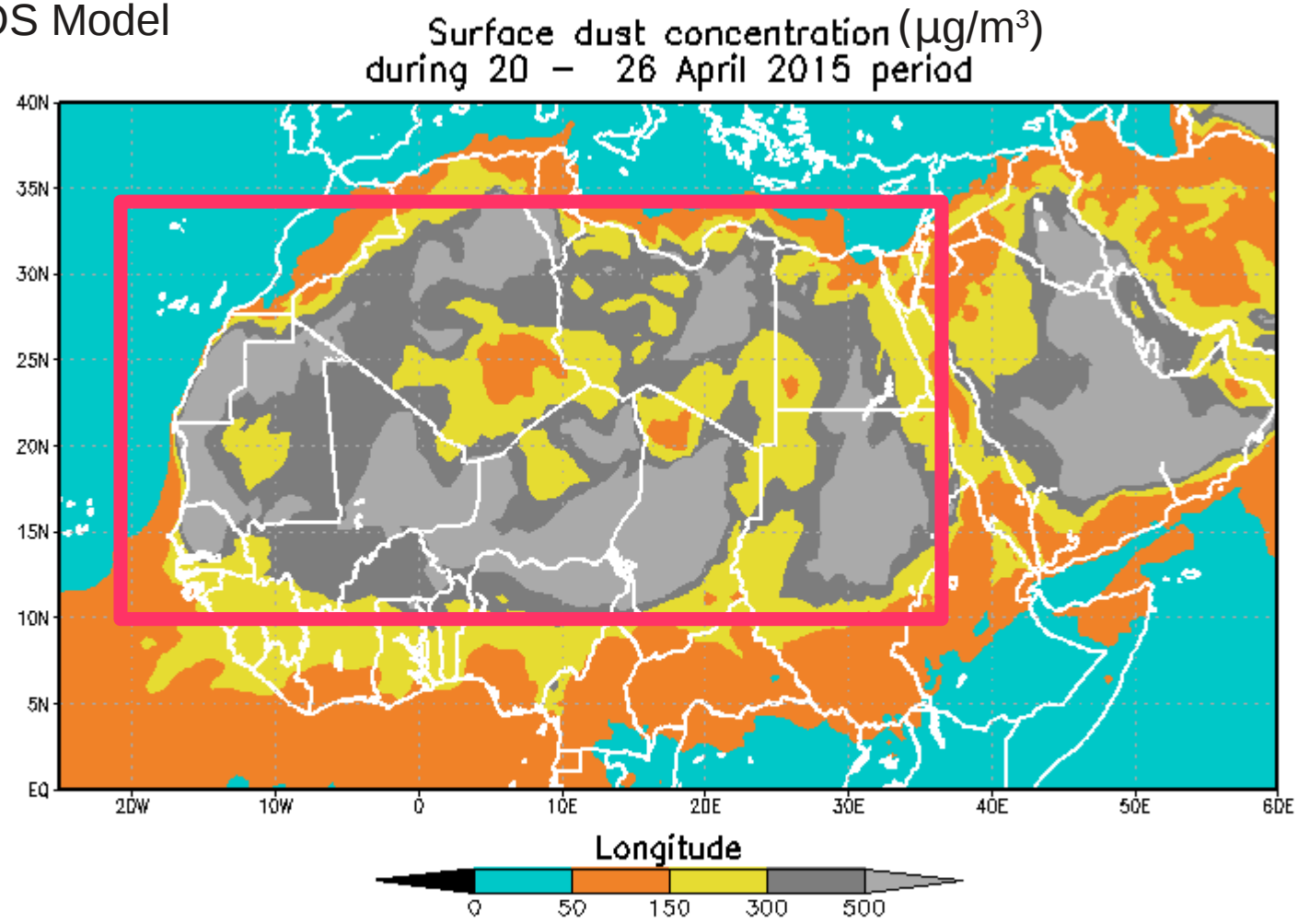
Case studies of meningitis epidemic



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

Case studies of meningitis epidemic

NASA-GEOS Model



Very dusty atmospheric conditions over Sahel and North Africa

Conclusions and future work

- Agreement between the meningitis cases observed and level menigitis vigilance but improvment is needed.
- 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 the day and 8 previous weeks of very dusty atmospheric conditions
- Increase of maximum temperature and previous weekly dusty events are the main climate factors for meningitis outbreak in 2009 and 2015 over Niger
- More case studies over other areas to further document the influence of dust and maxumum temperature on meningitis

Questions ?