Estimating the past and future climate risk of dengue outbreaks in New-Caledonia

Modélisation d'un risque hebdomadaire d'émergence et de réémergence de la dengue an Nouvelle-Calédonie basé sur le climat et estimation de son évolution à l'horizon 2050-2100

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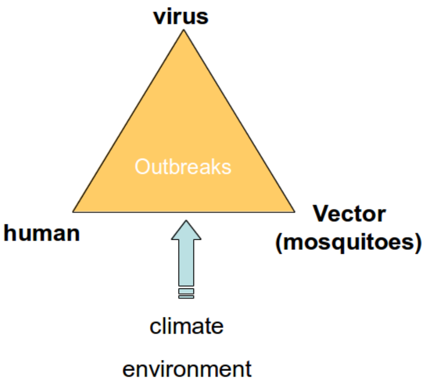
METEO FRANCE Toujours un temps d'avance

Background and objectives

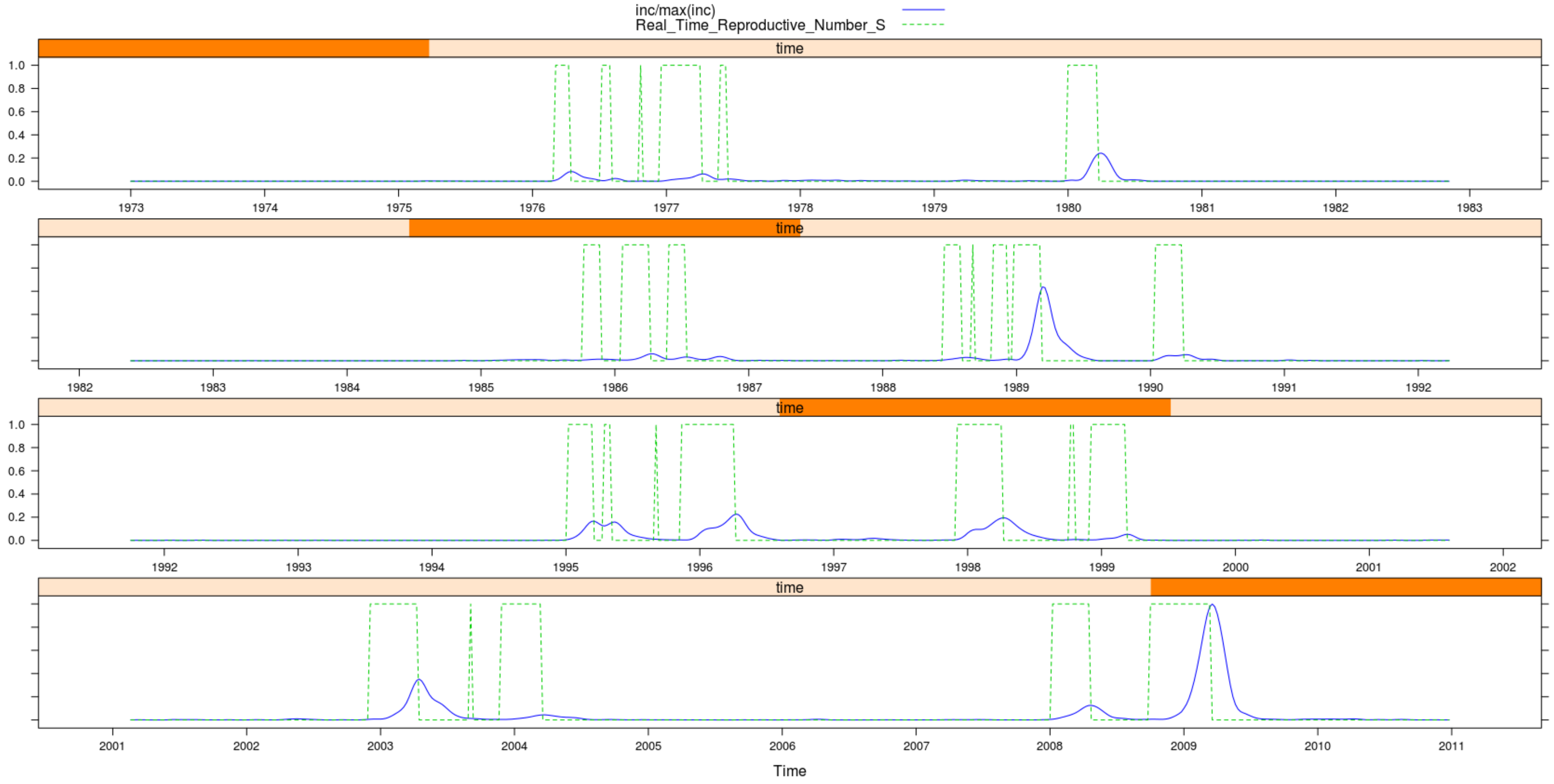


- Background
  - Dengue outbreak occurrence are tightly connected to climate in New-Caledonia (Descloux *et al*, PLOS NTD, 2012)
  - Need to highlight the intraannual climate conditions suitable for dengue transmission
  - Need to estimate the evolution of the dengue dynamic outbreaks
  - Existing models are usually based on incidence dynamic modelling that involves complex interaction between virus, vector, human population and environment
- Objectives
  - To compute a weekly risk of dengue outbreak based on climate variables in New-Caledonia
  - To estimate the evolution of the dengue outbreaks dynamic (interannual and intraannual variations)

Method

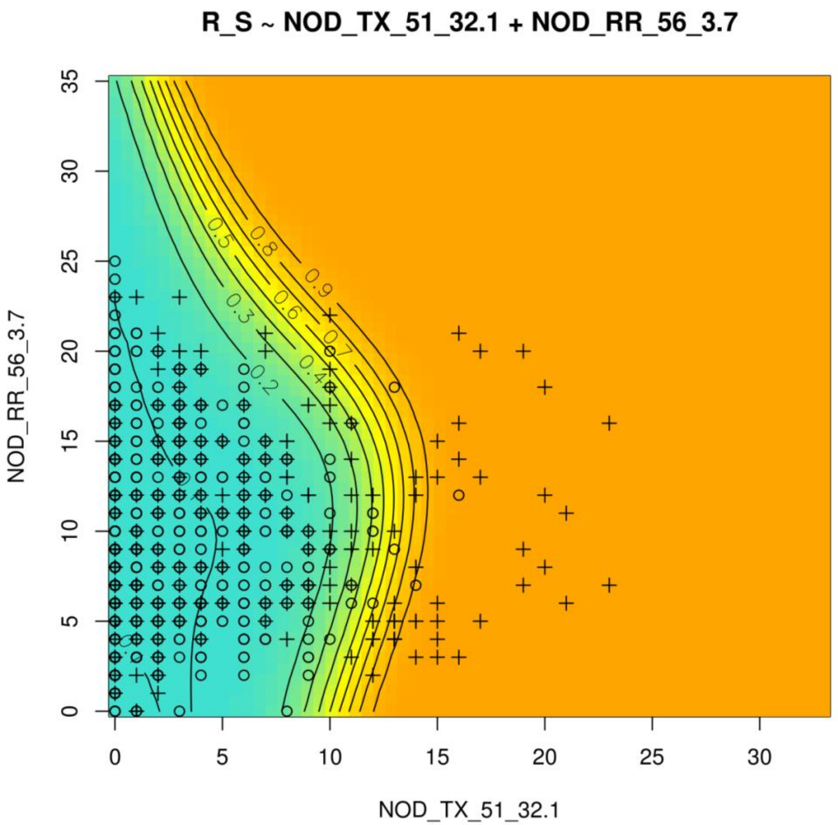
1. To target the intraannual period suitable for epidemics: estimation of a weekly time dependant reproduction number (*R*) based on incidence according to Wallinga & Teunis (2004)
   - Basic reproductive rate(*R0):* number of secondary cases produced by a primary case in an entirely susceptible population. When *R0* < 1 the infection will die out but any value for *R0* ≥ 1 will cause epidemics.
   - Effective reproductive number or time dependant reproduction number (*R*) is the actual average number of secondary cases per primary case observed in a population with an infective disease.
2. To classify the periods *(R>1)* with a non linear model (SVM) based on selected climate variables
3. To improve the local knowledge about climate change: statistical downscaling on the IPCC climate projection :
   - Scenario RCP4.5 (**medium-low**): stabilization without overshoot pathway to 4.5 W/m2 at stabilization after 2100
   - Scenario RCP4.5 (**high**): rising radiative forcing pathway leading to 8.5 W/m2 in 2100.
4. To compute and analyze the future weekly risk using the model and the climate projection

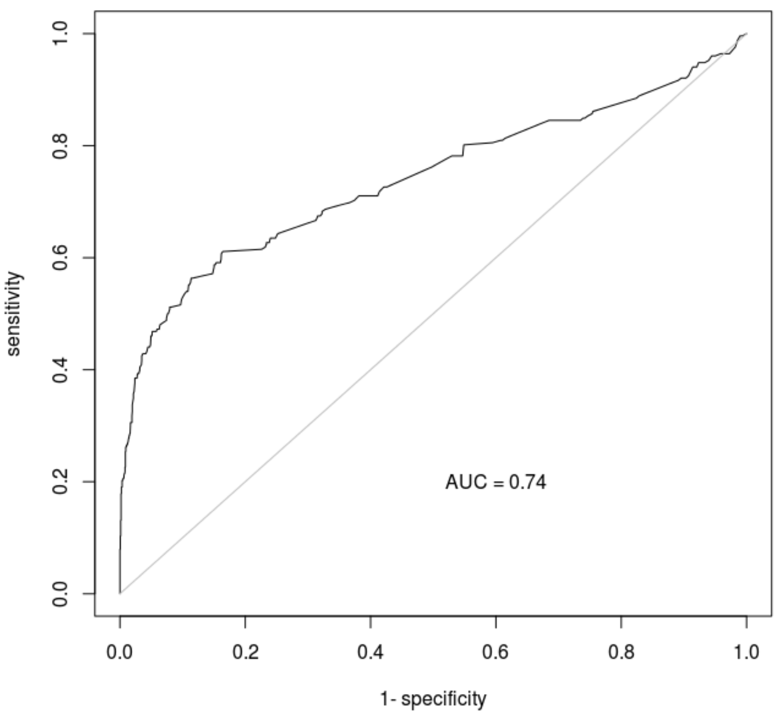
Effective reproduction number estimation ($R > 1$)



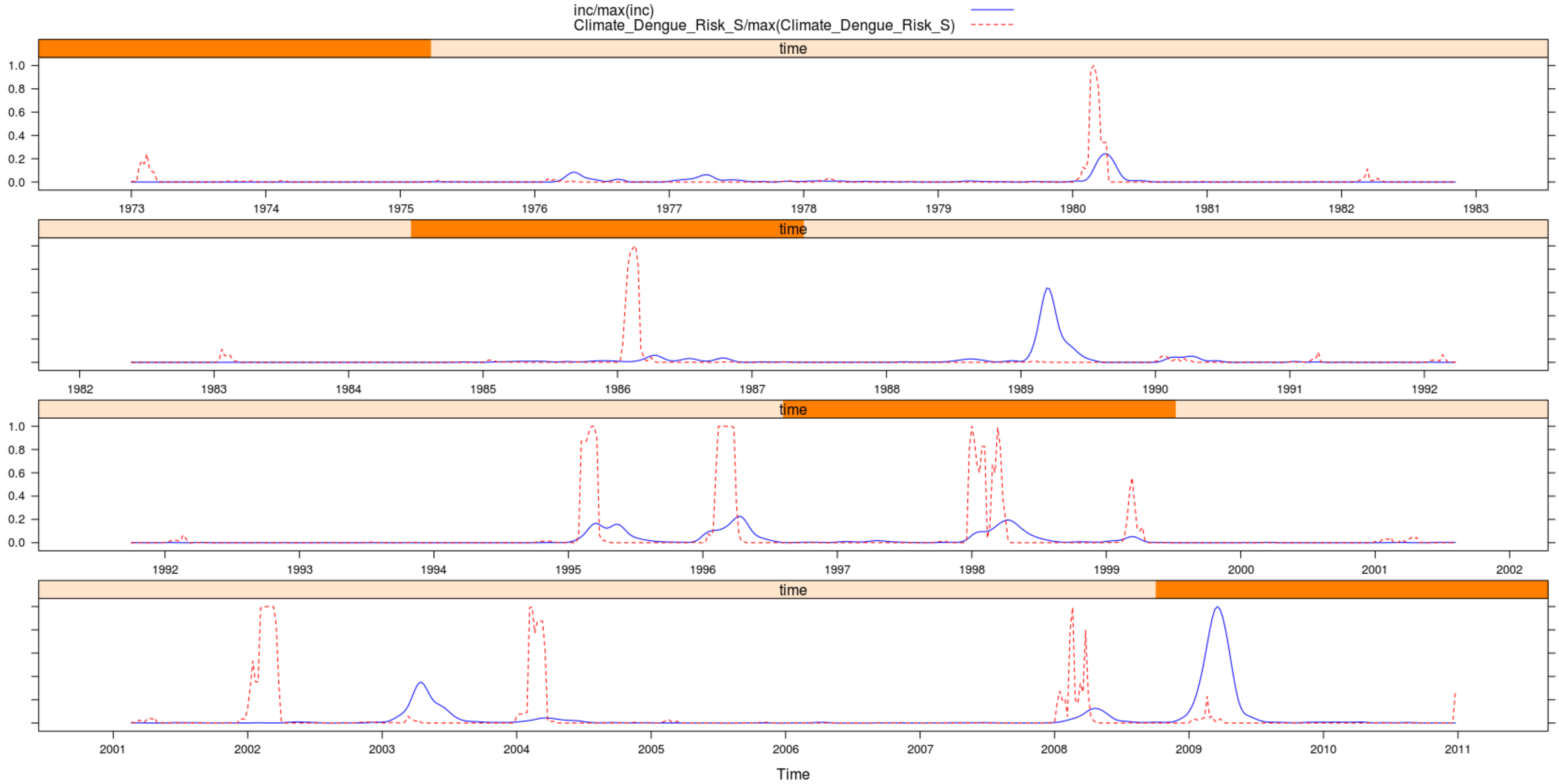
Modeling and accuracy

- Selected climate variables (among ~2500)
  - Number of days with maximal temperature exceeding 32°C within a sliding windows of the two previous months
  - Number of days with precipitation exceeding 3.8 mm within a sliding windows of the two previous months

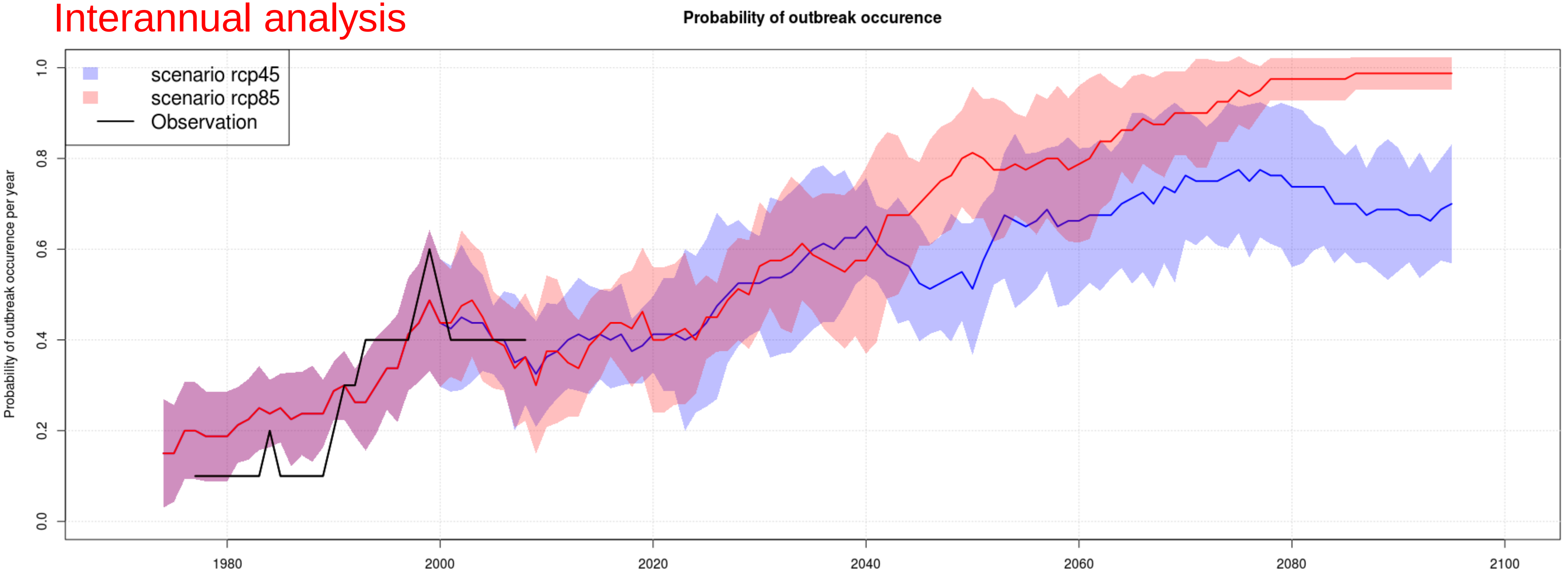


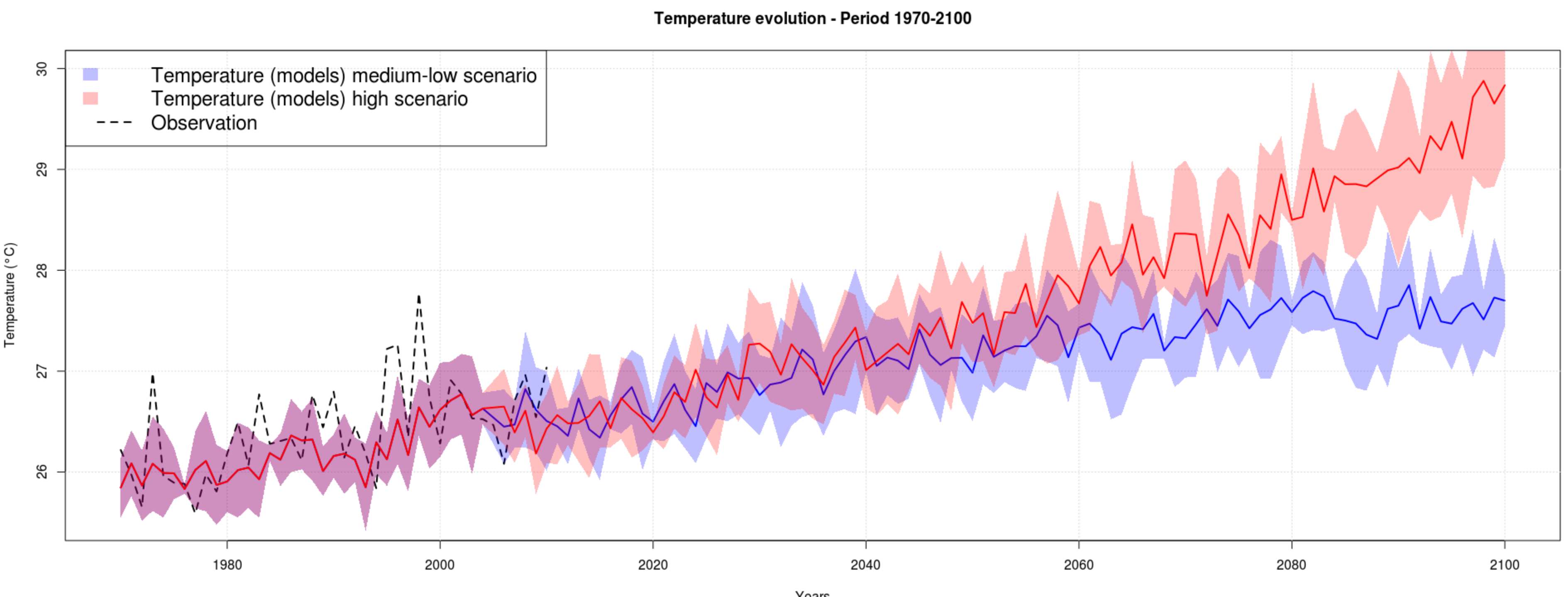


Weekly climate-based risk of outbreak occurrence



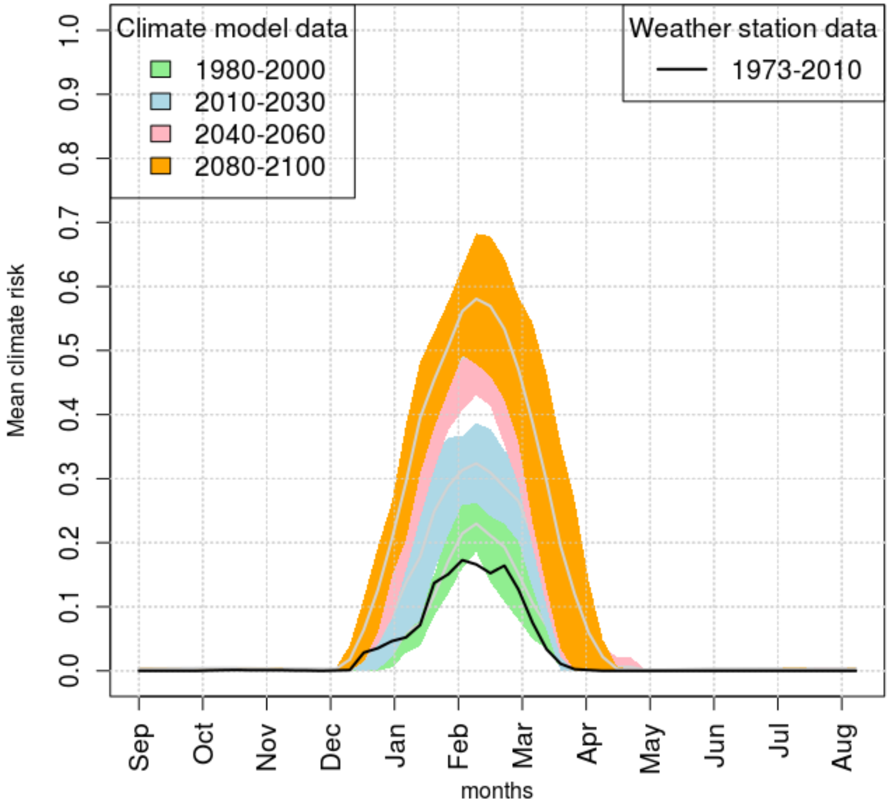
Interannual analysis



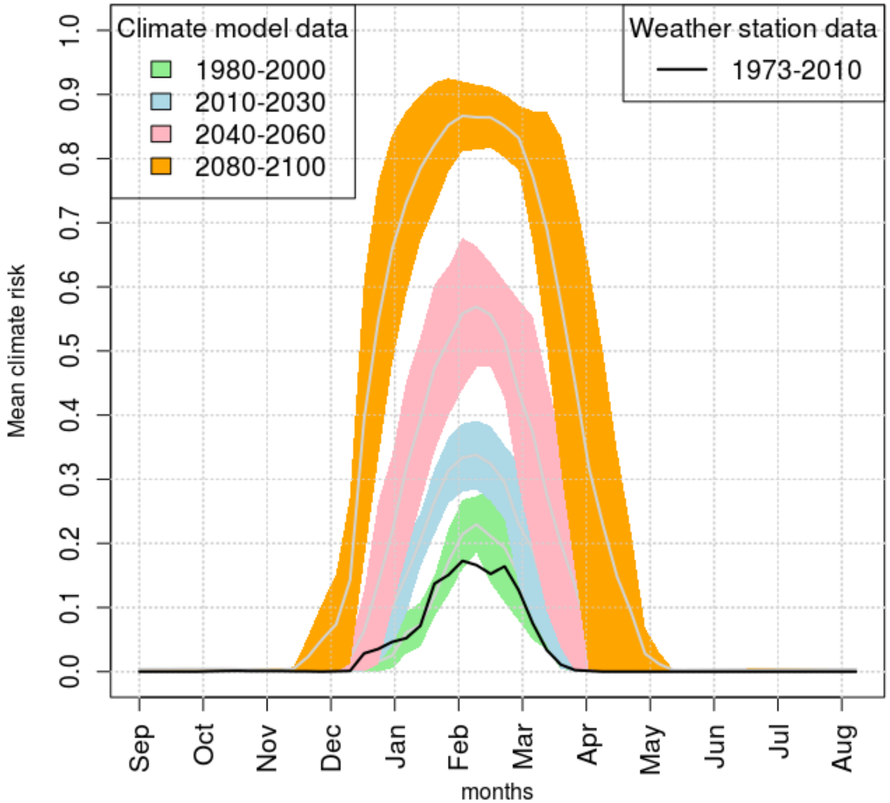


Intraannual analysis of the evolution of the future dengue dynamic

Medium-low scenario
(RCP4.5)



High scenario
(RCP8.5)



Conclusion

- 3 new insights:
  - To target *R*>1 rather than the incidence series (simplifying and focusing on time window suitable for epidemics)
  - To use high quality climate series (observation and model+downscaling)
  - To estimate the interannual and intraannual dynamic in a specific region (present and future)
- Modeling based on historical data
  - Accurate weekly model of the risk of dengue outbreak based : i) number of days with maximal temperature exceeding 32°C and ii) number of days with precipitation exceeding 3.8mm within a time window (two previous months)
  - Results consistent with prior findings
- Analysis of the evolution of the dengue outbreak dynamic
  - Interannual analysis: Risk that a outbreak occurs will continuously increase to reach one outbreak every two years (both scenarii, 2050) and up to one every year in 2100 (high scenario, 2100)
  - Intraannual analysis: the outbreaks could last one more month (2100, medium-low scenario) and start one month earlier as well as last 2 months later (2100, high scenario)

Perspectives