Modelling the spatial distribution of dengue cases in New-Caledonia : present and future impact of climate

Journée scientifique de l'Institut Pasteur

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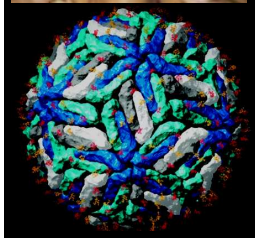
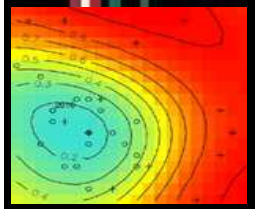
Financements *: Province Sud & IRD*

Determinants of dengue dynamics



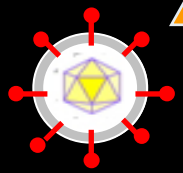


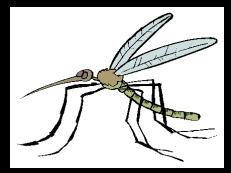



Climate
Environment

Host

Epidemic
dynamics



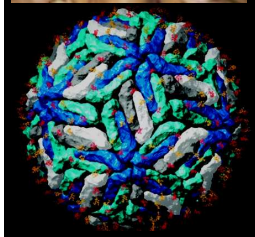


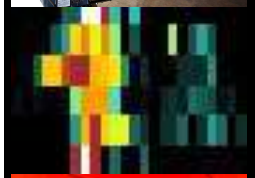
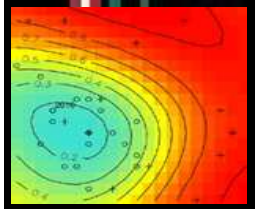
Pathogen

Vector

Objectives of the study



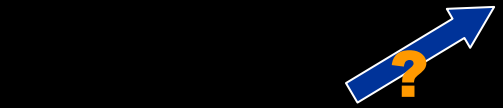


1. Spatial distribution of dengue cases in New-Caledonia
2. Identify the factors influencing this distribution, and quantify the role they play
3. Model the potential impact of climate in the future

Human behaviour

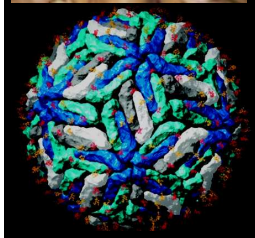
Climate

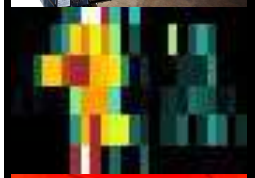
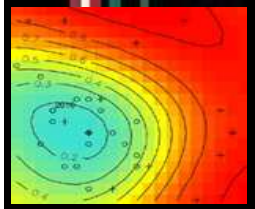


Vector control

1. Dengue spatial structure

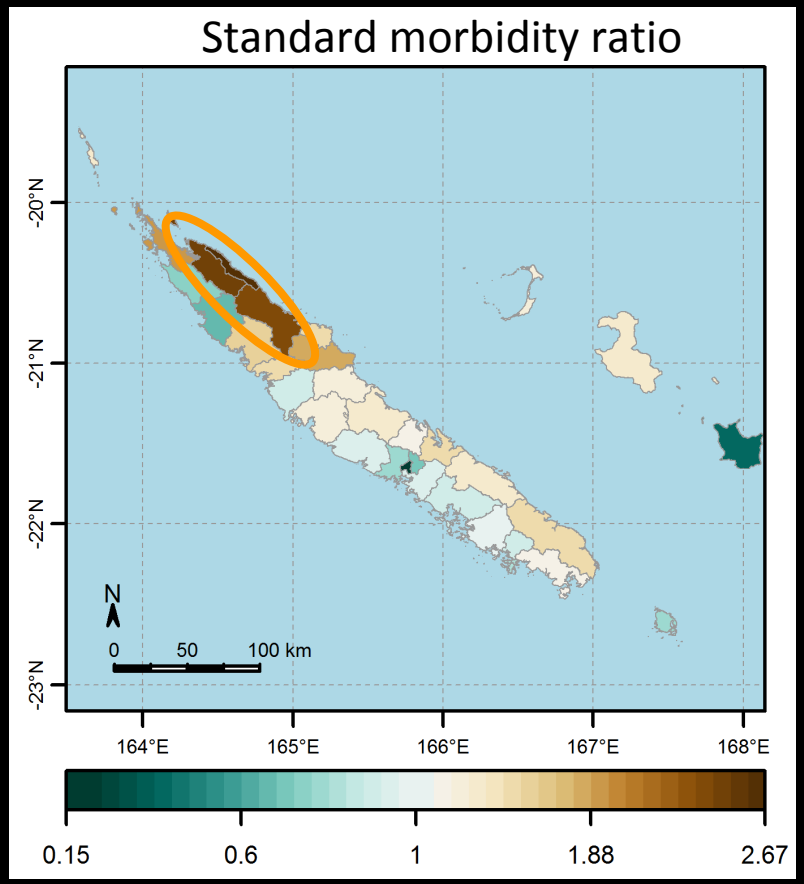


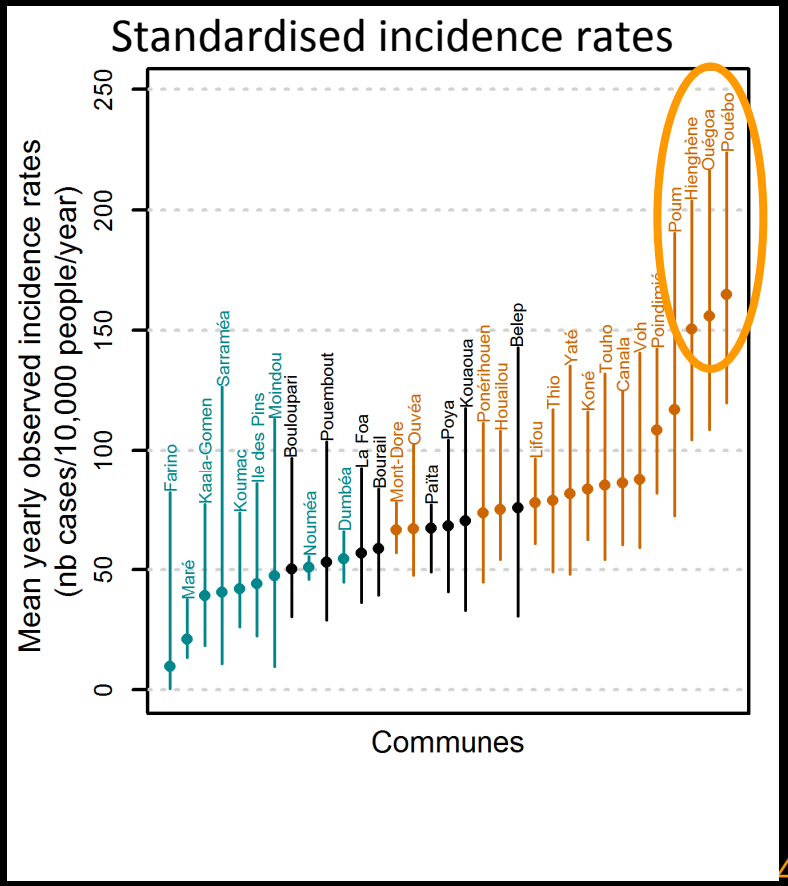


- Building standardised incidences rates
  - Surveillance system
  - Age standardisation
  - Standard morbidity ratio*

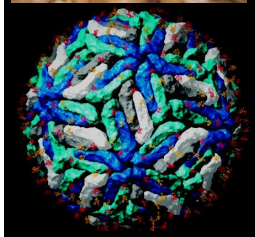
$$*SMR = \frac{\text{Incidence rate in commune i}}{\text{Mean incidence rate over all communes}}$$

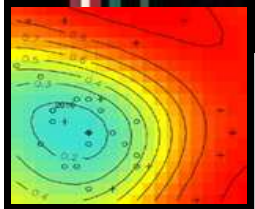




2. Dengue risk model - present





Socio-economic factors

Behaviour

? Pop immunity

? Human movement

Climate

(Environment)

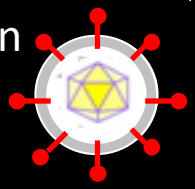
? Vector control

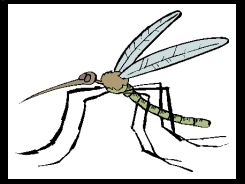
Dengue incidence

Introduction

Virulence

Serotype





Vector density ?

Vectorial capacity ?

Climate

Vector populations

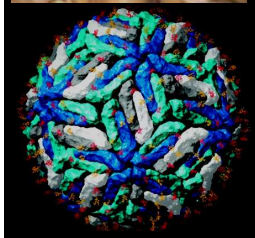
No influence at the scale studied

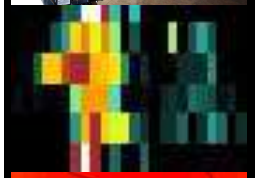
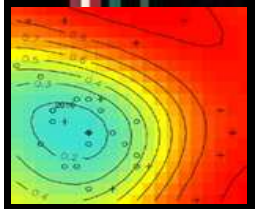
? No data

Data available

2. Dengue risk model - present

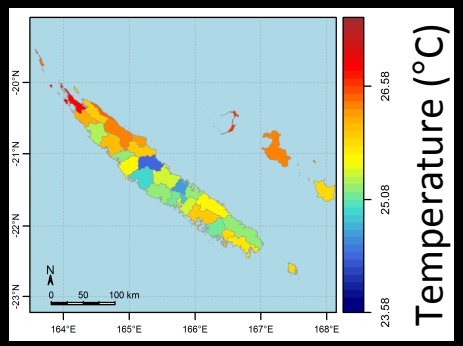




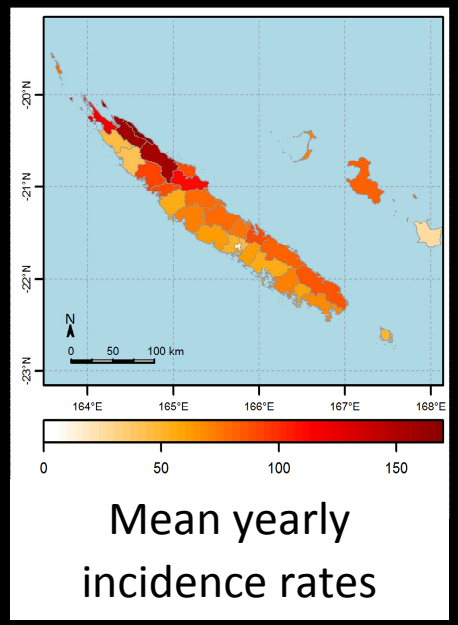



- Model

Explanatory variables → SVM → Response variable



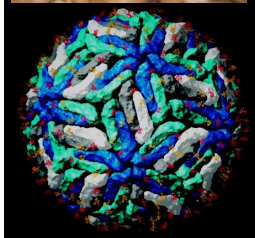
Min temperature
Max tempreature
Rainfall
Socio-economic variables
…

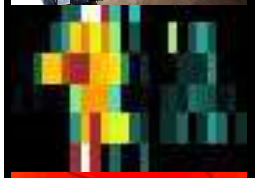
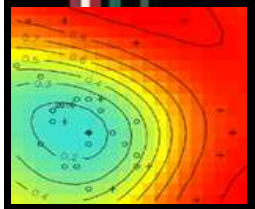


- Non linear link
- No need to specify the link

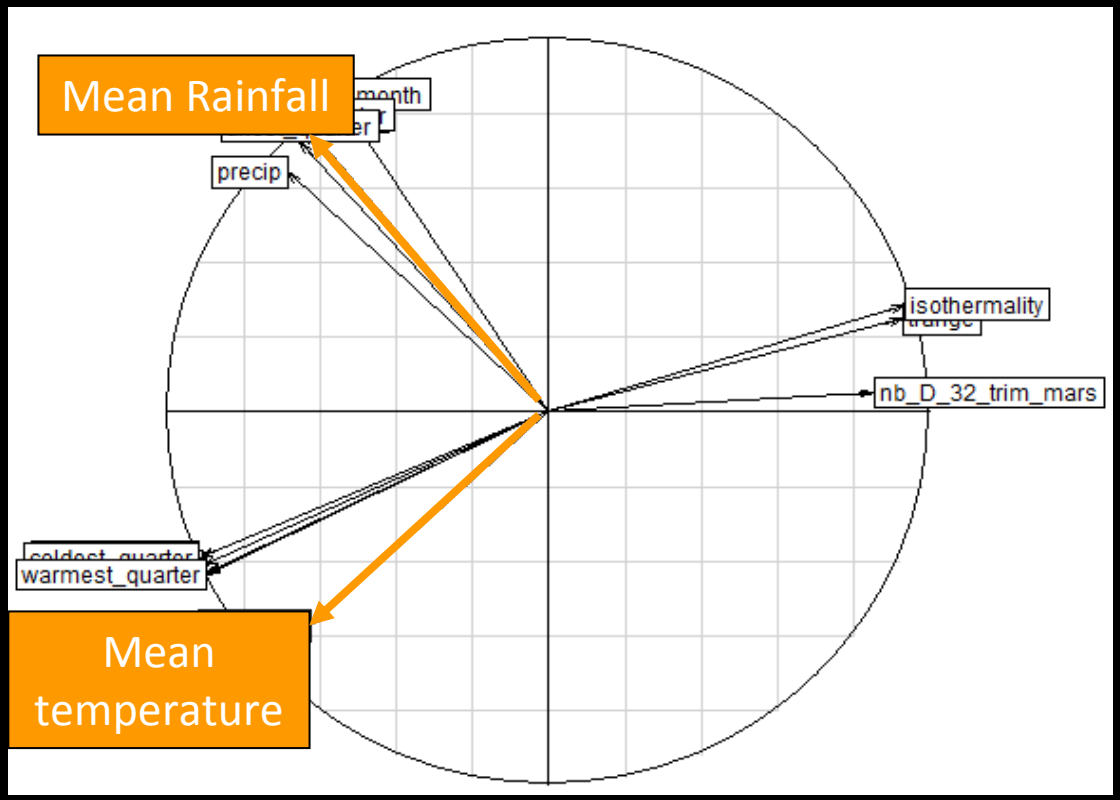
2. Dengue risk model - present





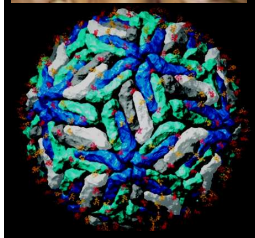



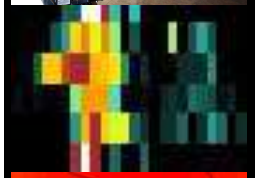
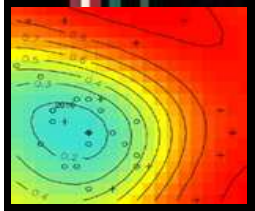
- Explanatory variable selection via Principal Component Analysis (PCA)
  - 2 Climatic variables



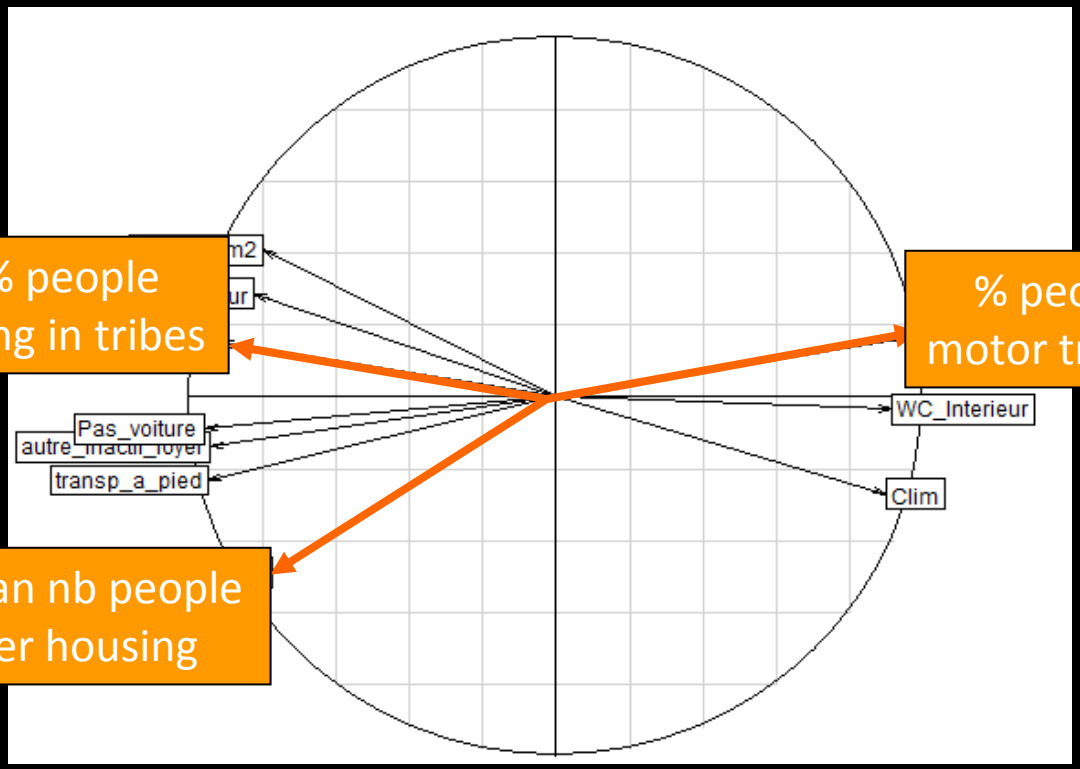
2. Dengue risk model - present





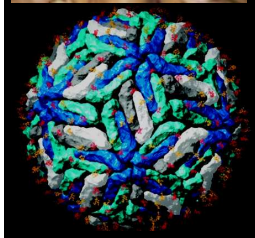



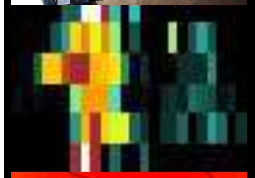
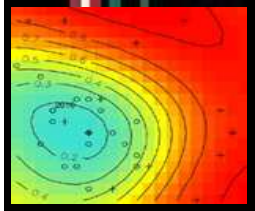
- Explanatory variable selection via Principal Component Analysis (PCA)
  - 2 Climatic variables
  - 3 Socio-economic variables



2. Dengue risk model - present



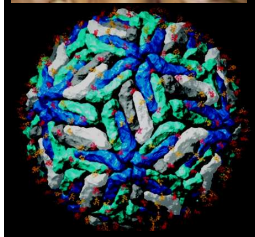


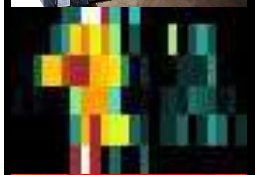
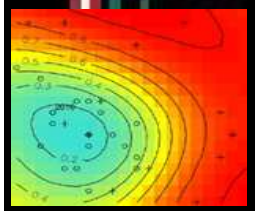



- Best explanatory variables
  - ~ 20 models
  - Model performance evaluation : Root Mean Square Error (RMSE)

2. Dengue risk model - present

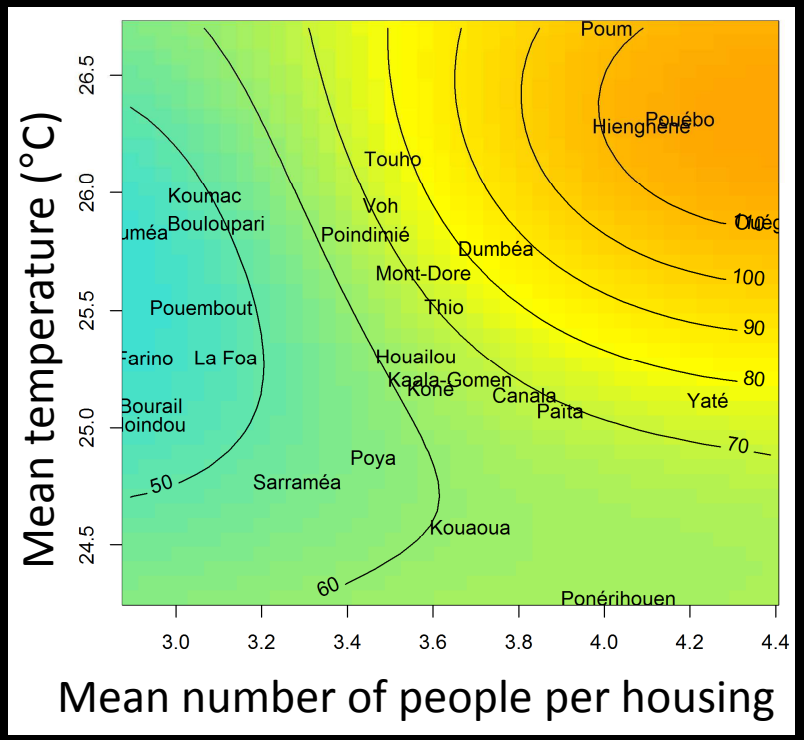


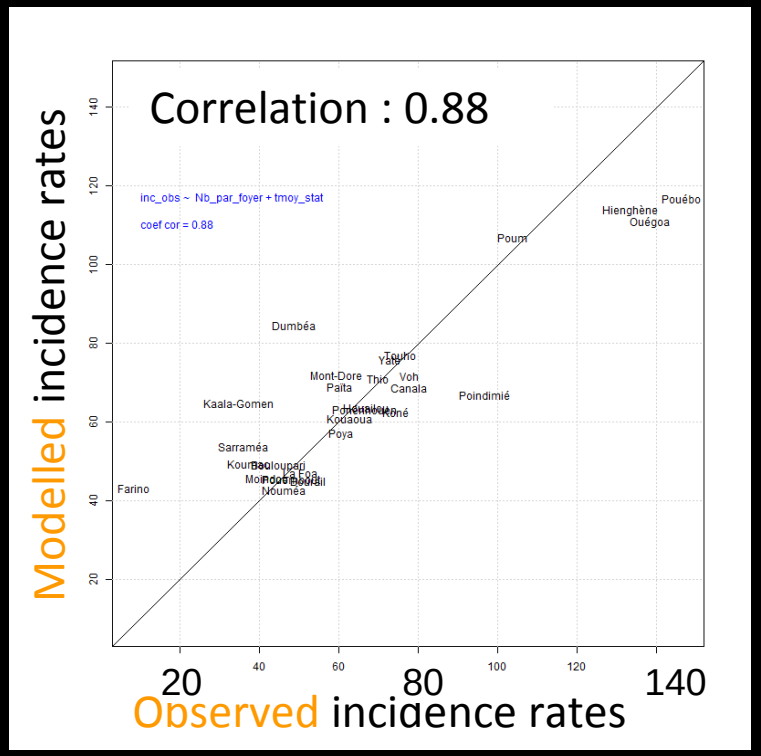


- Best explanatory variables
  - Mean temperature + 1 socio-economic factor
  - Best model

RMSE : 20 cases / 10,000 people / Year



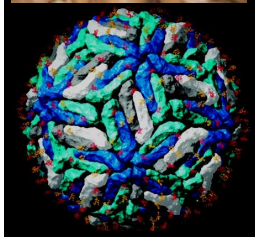


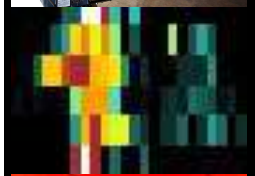
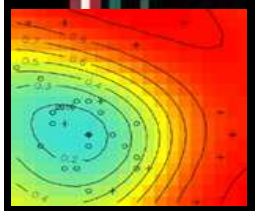
Modelled incidence rates

Low | Medium | High

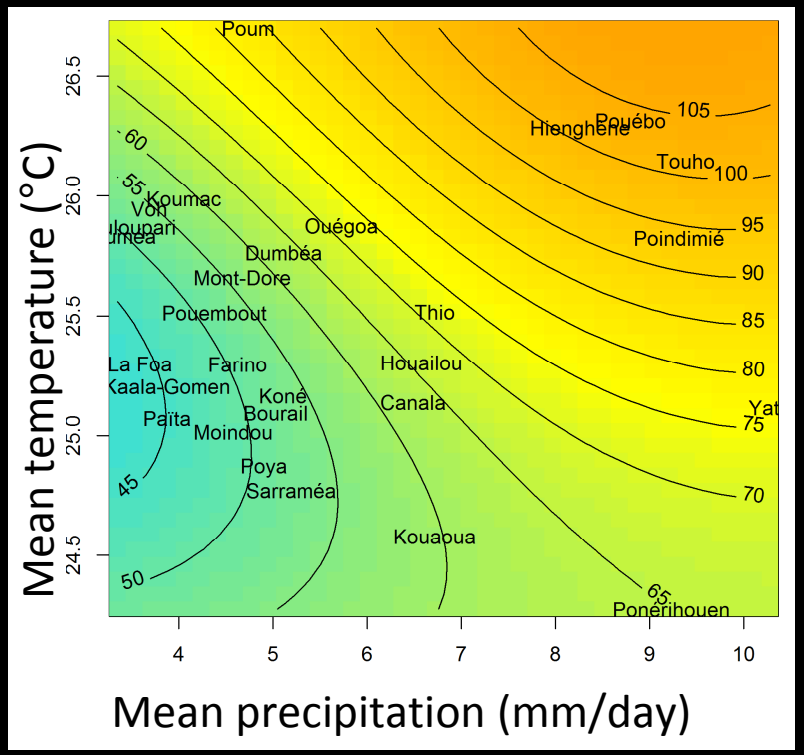
2. Dengue risk model - present



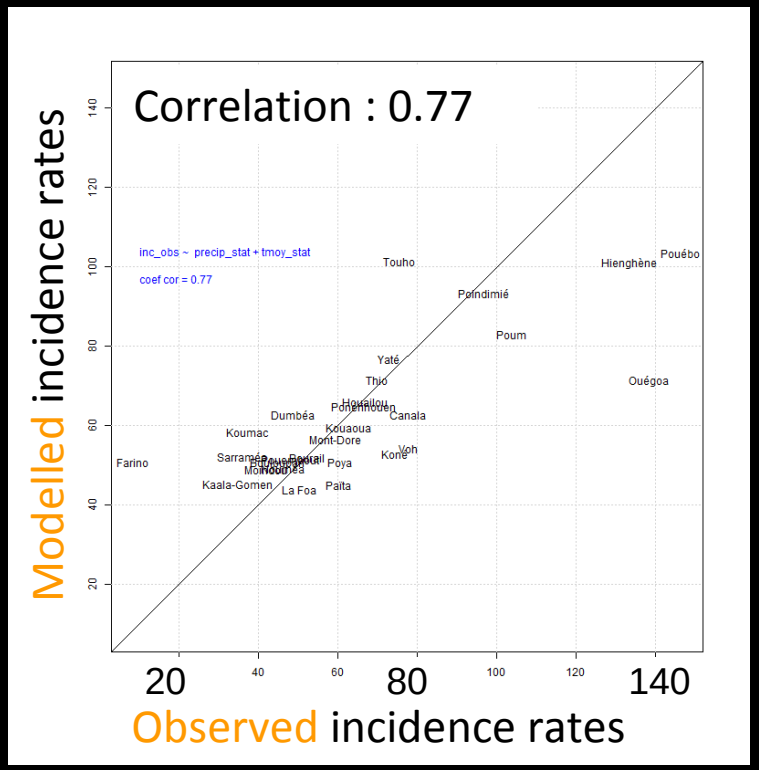


- Best explanatory variables
  - Best climatic model



RMSE : 25 cases / 10,000 people / Year

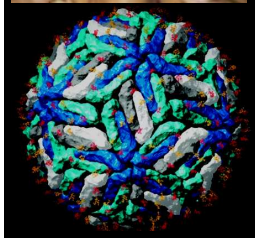


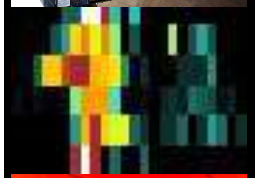
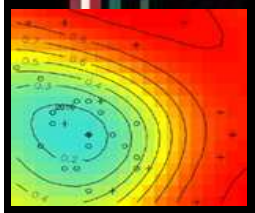
Modelled incidence rates

Low | Medium | High

2. Dengue risk model - present





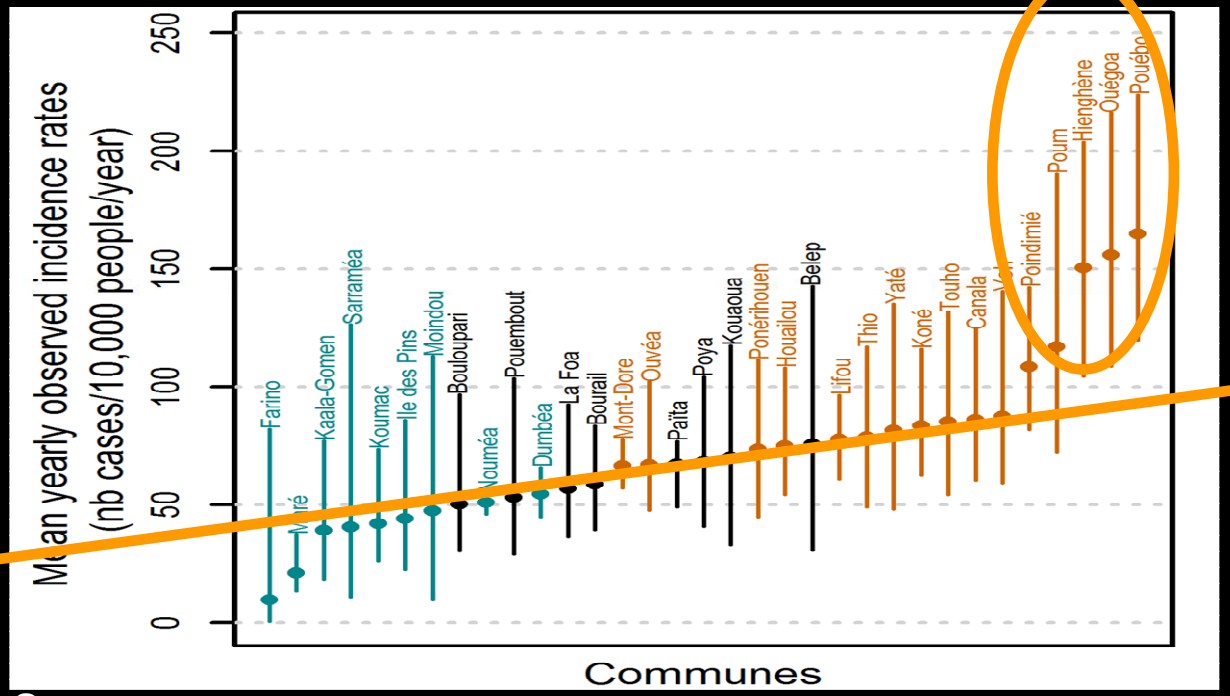



- Summary

Temperature

Rainfall ?

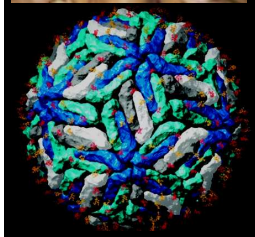
Human behaviour ?

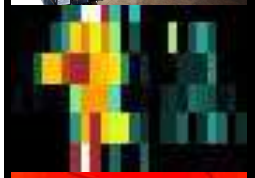
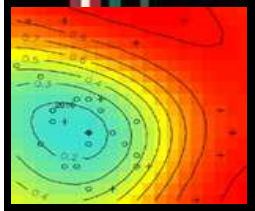


– Clear climatic signal (Temperature)
– Other factors to take into account in North-East (vector control ?)

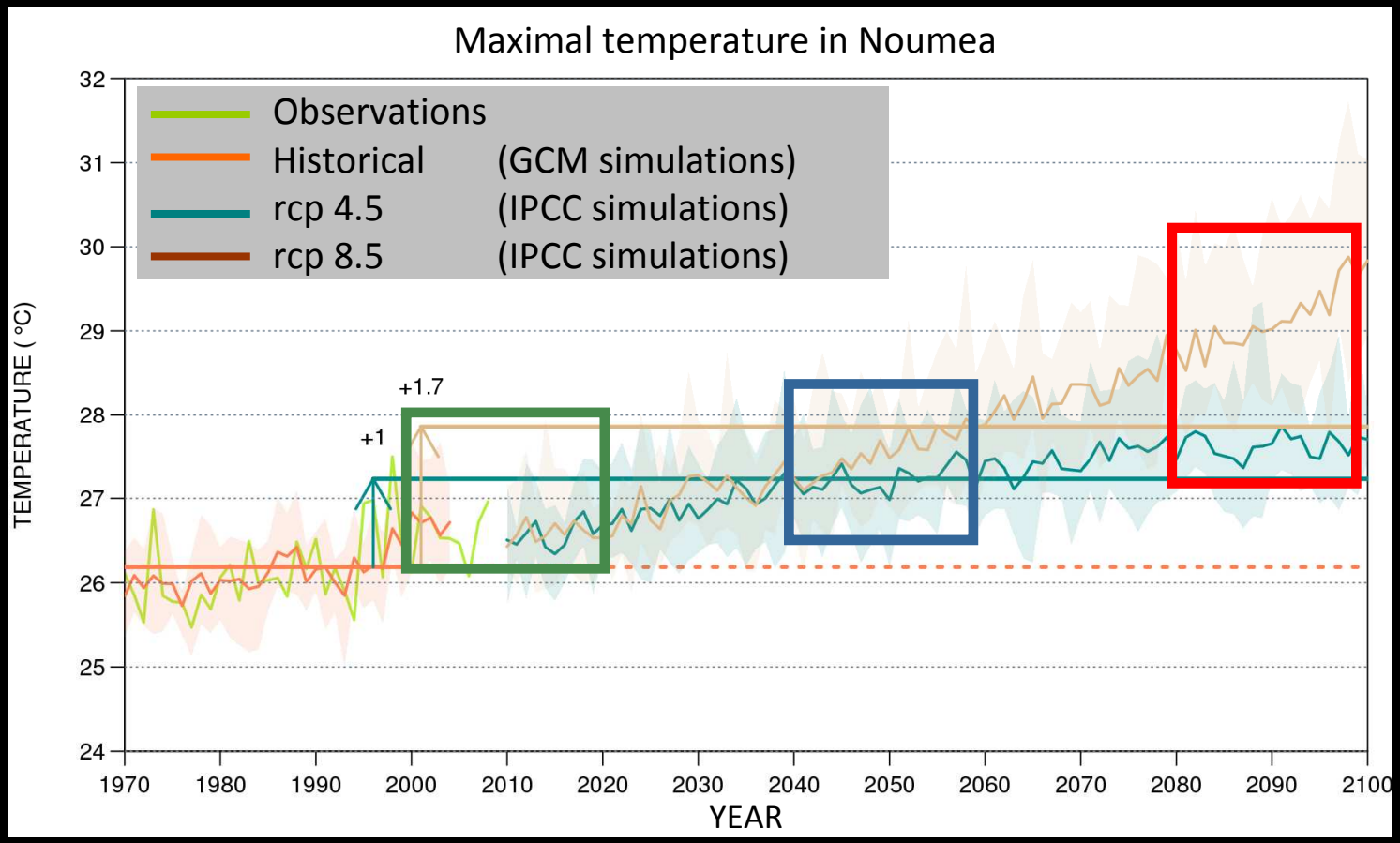
3. Dengue risk model - Applications





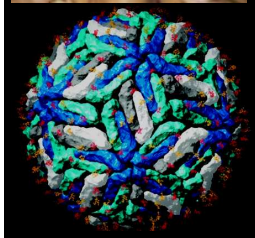
- Climatic projections
  - Evaluation of mean climatic change in New-Caledonia (5 stations)

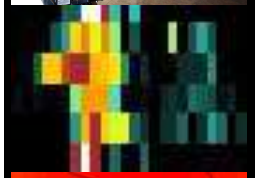
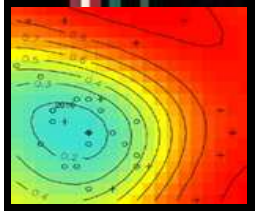


Source : Meteo France

3. Dengue risk model - Applications

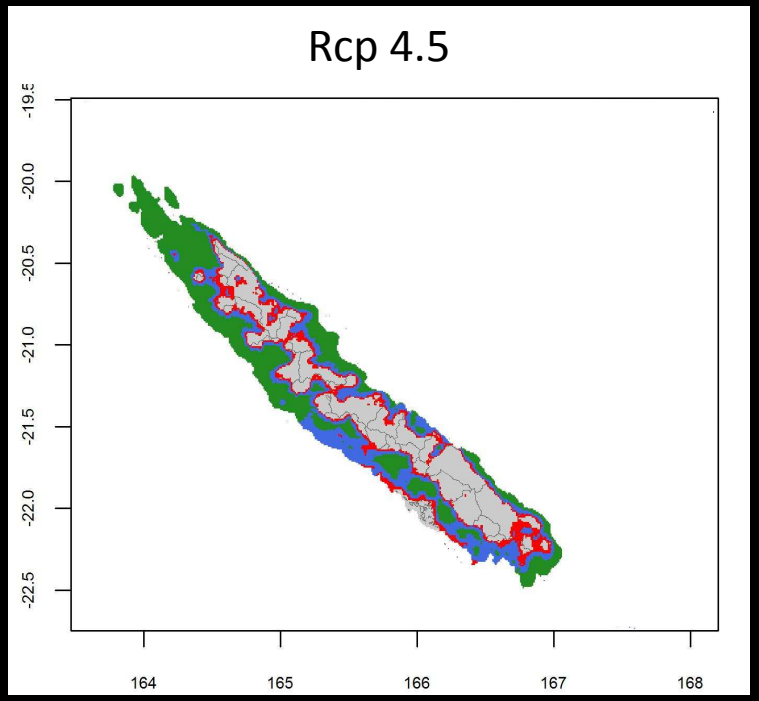


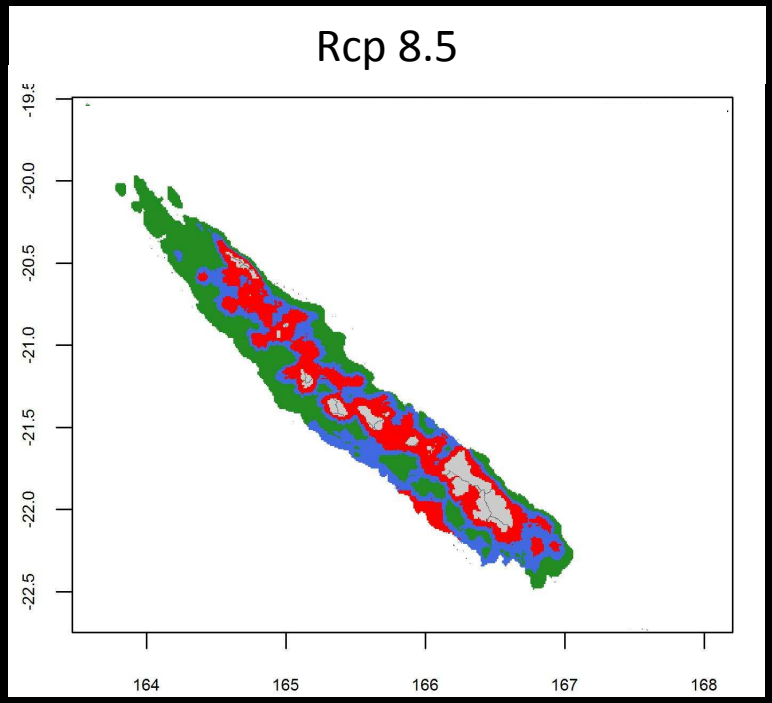


- Predicting incidence rates

Climatic map (present) → Climatic map (future) → Incidence rates (future)



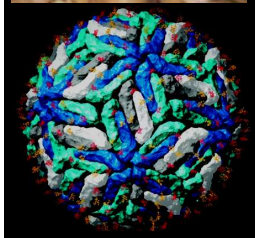


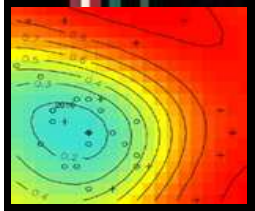
Incidence rates >= 50 cases / 10,000 people / year

- 2000 - 2020
- 2040 - 2060
- 2080 - 2100

Conclusions





- Dengue spatial distribution is heterogenous
- Role of temperature +++
- Multi-factorial
  - Limiting factor might be different in other countries
  - Limiting factor might change with time
  - Modelling is challenging !!
- Perspectives
  - Apply methodology to other places
  - Other scales in NC ?

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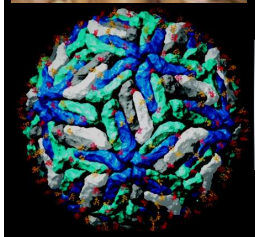
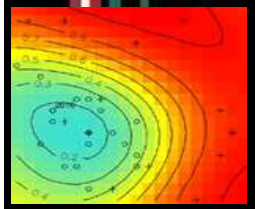


Thank you !



Any questions ? .....