

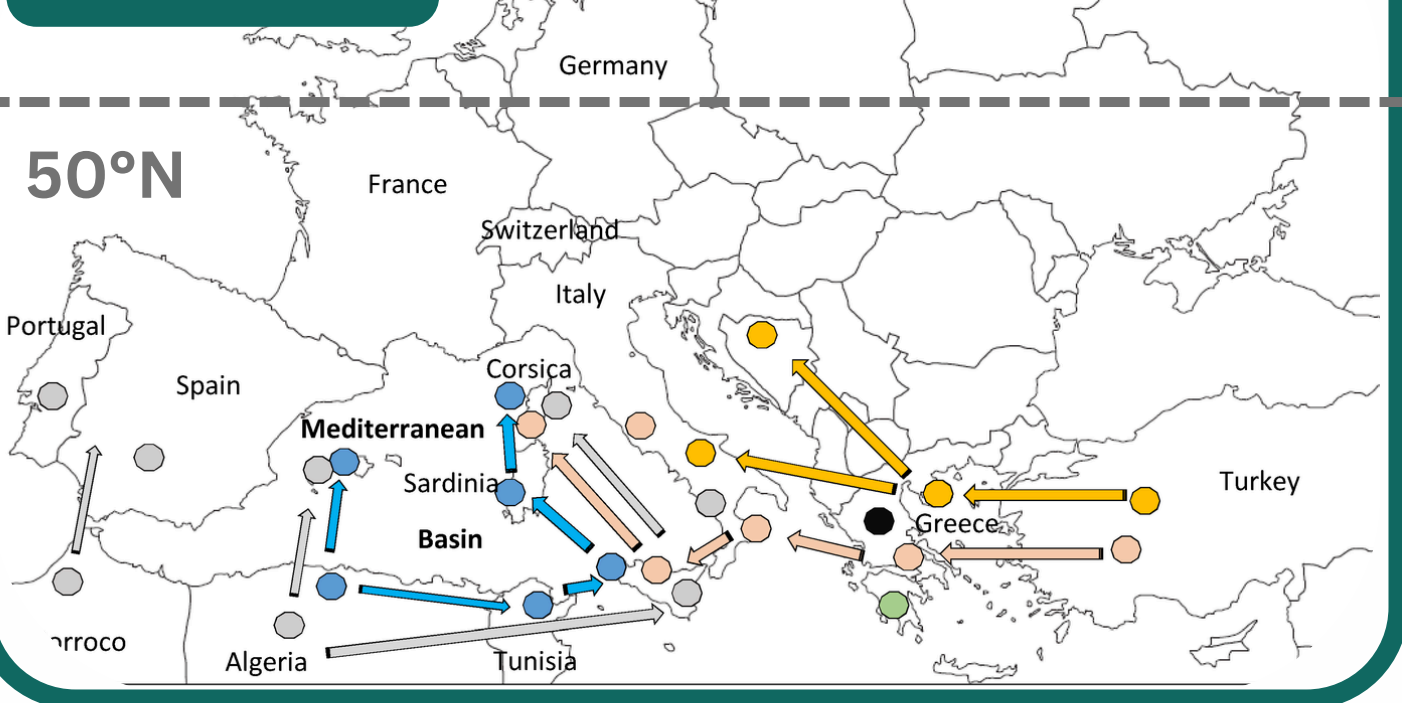
Modeling past, present and future *Culicoides* population dynamics in France using **interpretable Machine Learning**

Ieva Baltusyte
M2 in Eco-epidemiology of Emerging Diseases
Head supervisor: Paul Taconet
Co-supervisor: Pachka Hammami



CONTEXT

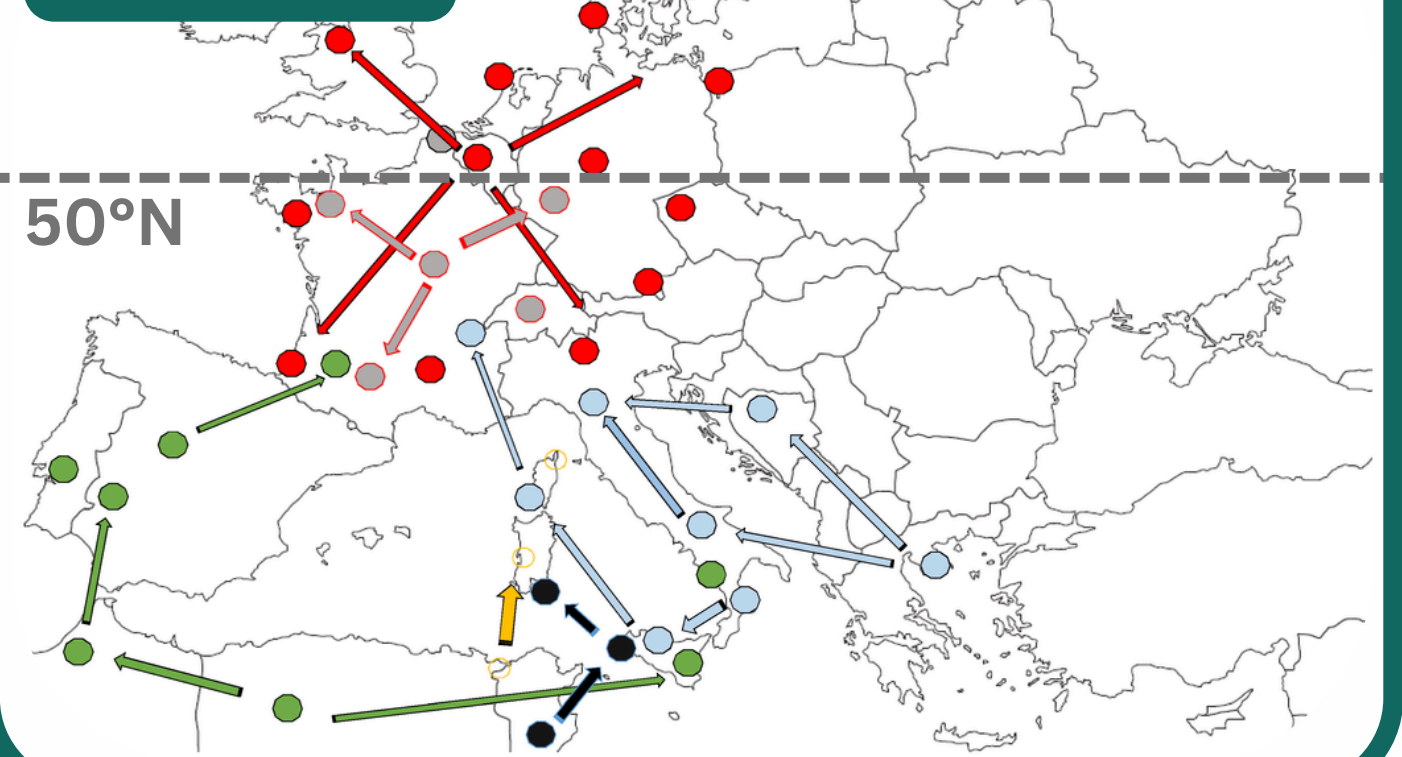
Before 2006



- **Bluetongue (BT)** - endemic in several tropical, subtropical and temperate climate regions
- **Endemic zones are expanding their borders**

BT outbreaks are occurring more and more north: in 2006, BT passed for the first time latitude 50°N

After 2006



Cost assessment of the movement restriction policy in France during the 2006 bluetongue virus episode (BTV-8)

Damian Taao^a, James K. Hammitt^{a,b}, Alban Thomas^a, Didier Raboisson^{c,d,e}

Economic impact of Bluetongue: a review of the effects on production

Jonathan Rushton^{1*} & Nick Lyons²

Review > Vet J. 2000 Sep;160(2):107-17. doi: 10.1053/tvj.2000.0470.

Climate change effects on culicoides--transmitted viruses and implications for the UK

E J Wittmann¹, M Baylis



OBJECTIVES

1. Identify environmental determinants



2. Simulate past, present and future *Culicoides* population dynamics

which will help in..

- Improving our knowledge of *Culicoides* **biology**
- Studying the causes of shifts in **seasonal activity**



which will help in..

- Identifying potential impacts of **climate change**
- Detecting regions exposed to **higher risk**



MATERIALS & METHODS

Entomological data

4 year study
 ~ 200 traps = 1-2 traps / department
 ~ 62 traps employed per week
 = 14895 trapping sessions



Spatiotemporal data

ERA5-Land
 MODIS
 Simulated climate data

MACHINE LEARNING

objective 1

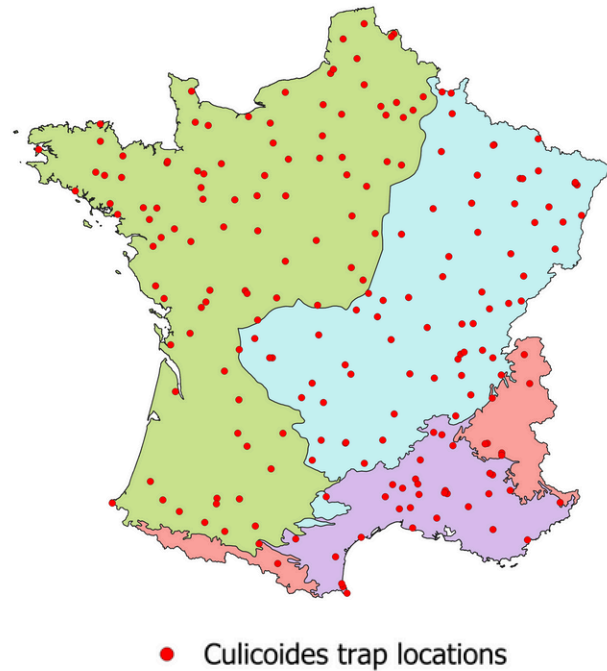
objective 2

Explainable findings

Predictions with climate data

Target-Oriented Cross-Validation
 Variable Importance
 Partial Dependence Plots

1996-2005 historical data
 2050 - 2060 predictions
 2080 - 2090 predictions

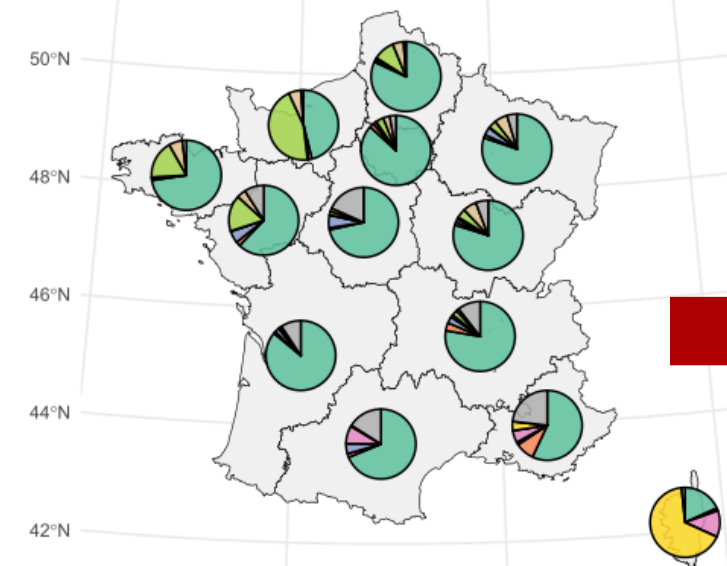


A spatio-temporal *Culicoides* species dataset produced by the French surveillance program from 2009 to 2012

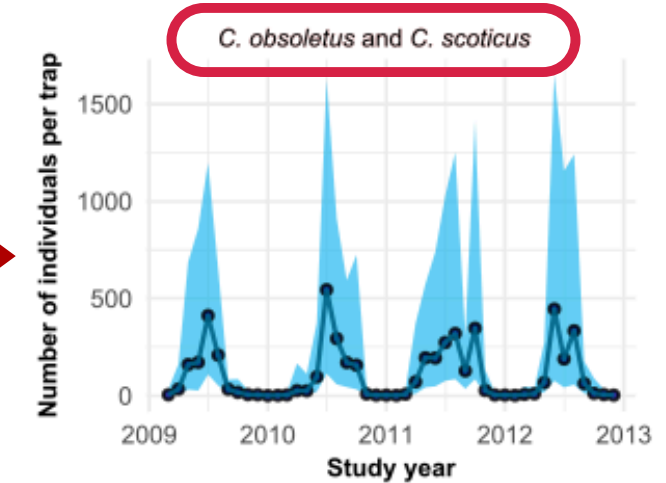
Published by Cirad - UMR ASTRE

Balenghien T • Garros C • Delécolle J • Setier-Rio M • Mathieu B • Delécolle D • Akaddar A • Allène X • Rakotoarivony I • Lhoir J • Scheid B • Venail R • Chavernac D • Baldet T • Hammami P

Culicoides spp. population composition per region (2009 - 2012)

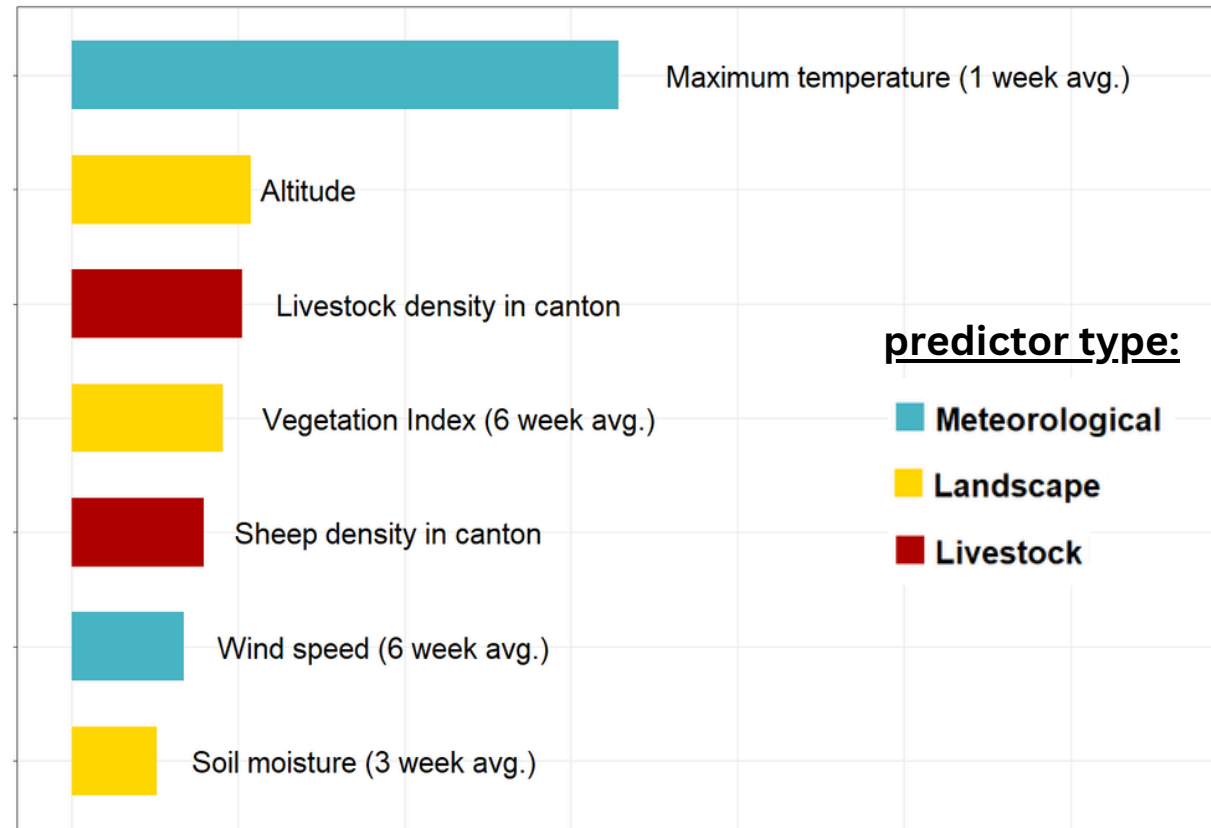


Species

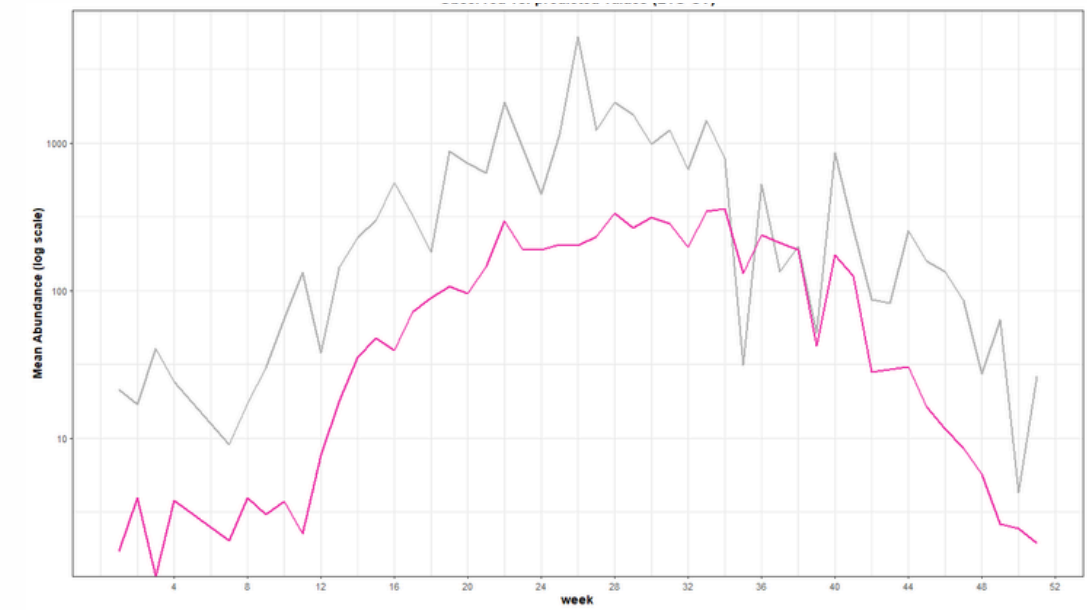
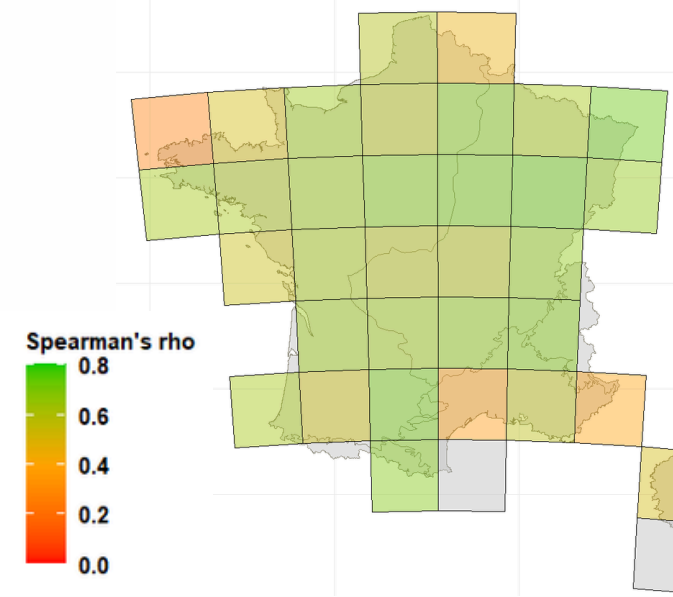


RESULTS

ENVIRONMENTAL DETERMINANTS ~ POPULATION DYNAMICS



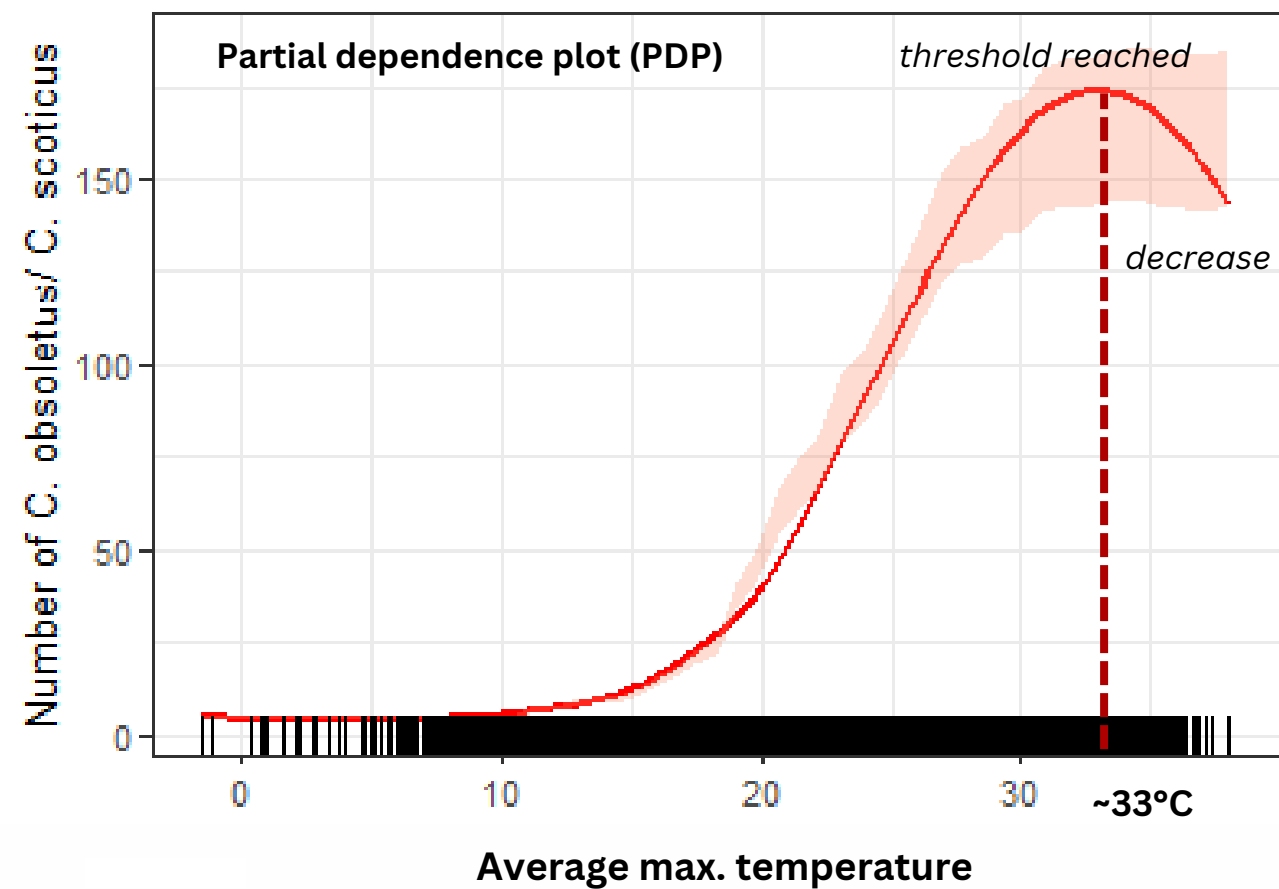
SPATIAL + TEMPORAL PERFORMANCE VALIDATION



Number of *C. obsoleteus/C. scoticus*
 — Observed (grey line)
 — Model (pink line)

Abundance model

PREDICTIONS UNDER FUTURE CLIMATE CHANGE SCENARIOS



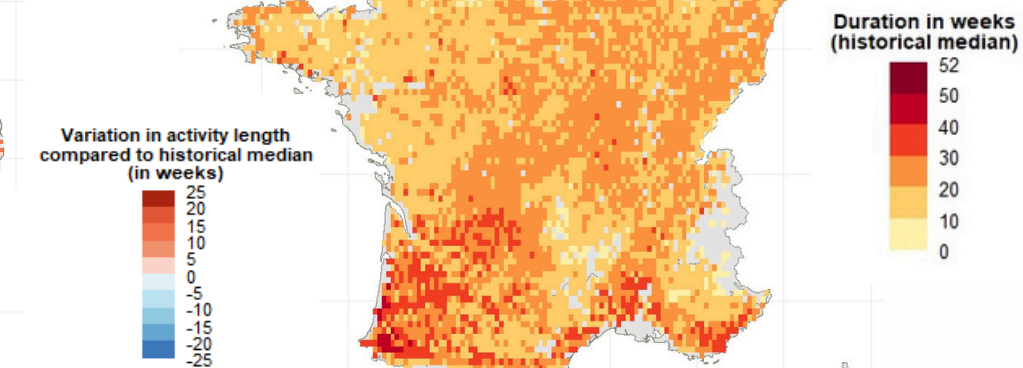
RCP4.5 (2050-2059)

RCP8.5 (2050-2059)

Historical (1996-2005)

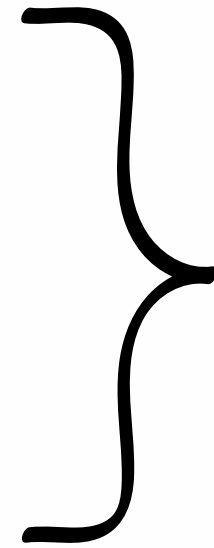
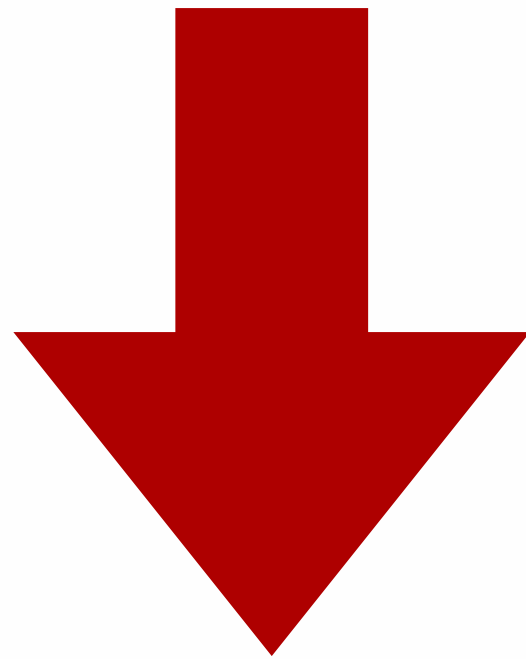
RCP4.5 (2080-2089)

RCP8.5 (2080-2089)

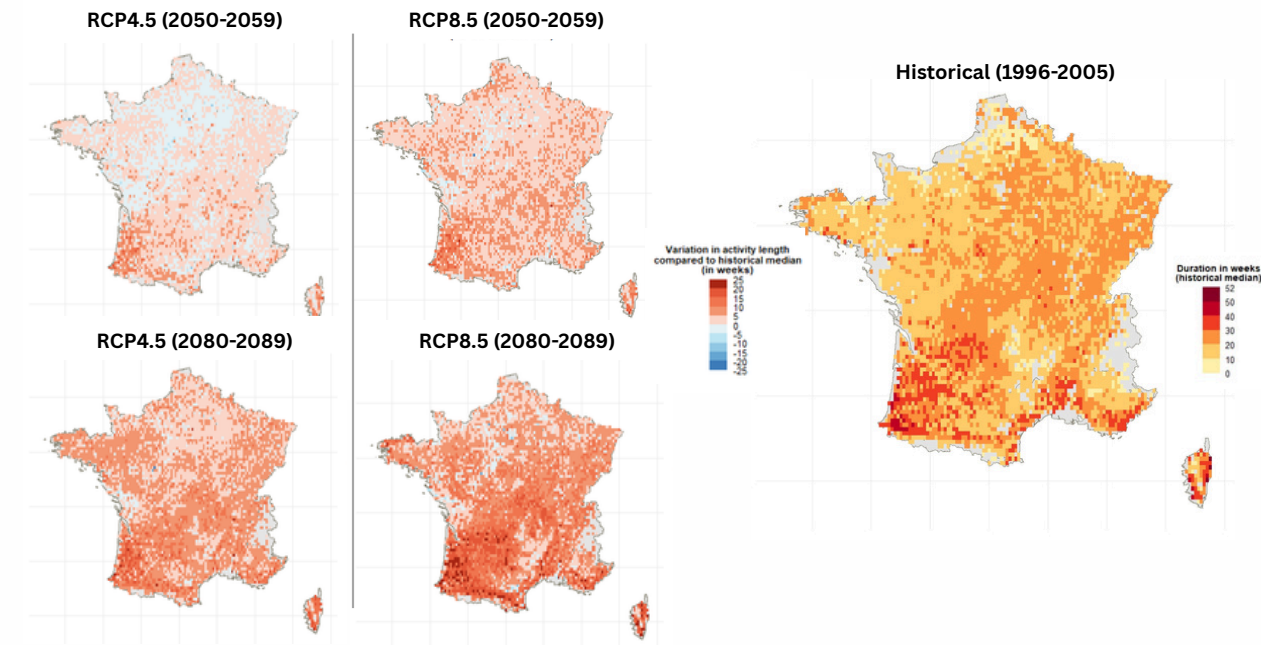


Closing remarks

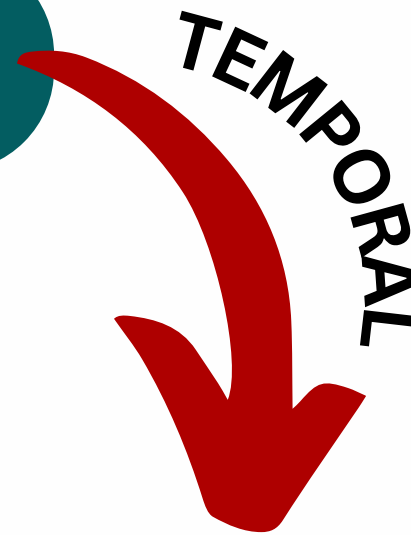
Growing amount of fine-scale data



*Tools to exploit
the granularity*



Large scale predictions at a high resolution !



2030

2040

2050

2060

2070

2080

2090

