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## Assessing the increase in wildfire occurrence with climate change and the uncertainties associated with this projection

Hélène Fargeon, Nicolas Martin-StPaul, Jean-Luc Dupuy, François Pimont, Thomas Opitz, Denis Allard, Julien Ruffault, Miquel de Caceres

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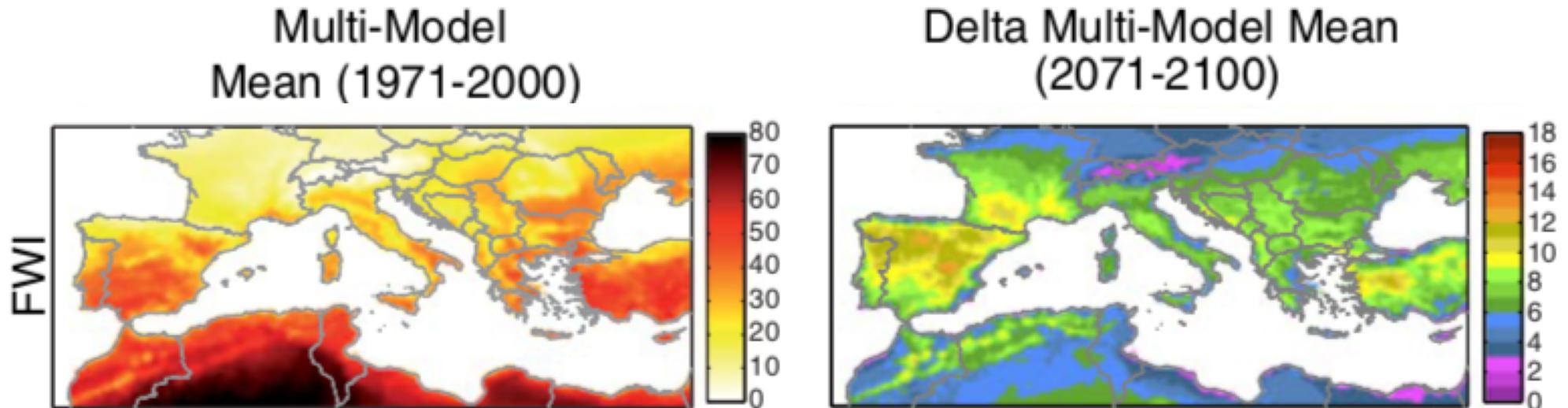
## Assessing the increase in wildfire occurrence with climate change and the uncertainties associated with this projection

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# Introduction: an expected increase in fire danger with climate change

- Increasing temperature and drought duration/intensity in the Mediterranean area
- Expected increase in fire activity, as highlighted by projections of fire danger indices



From *Bedia et al. (2014)*

# Programme

## 1. Uncertainties

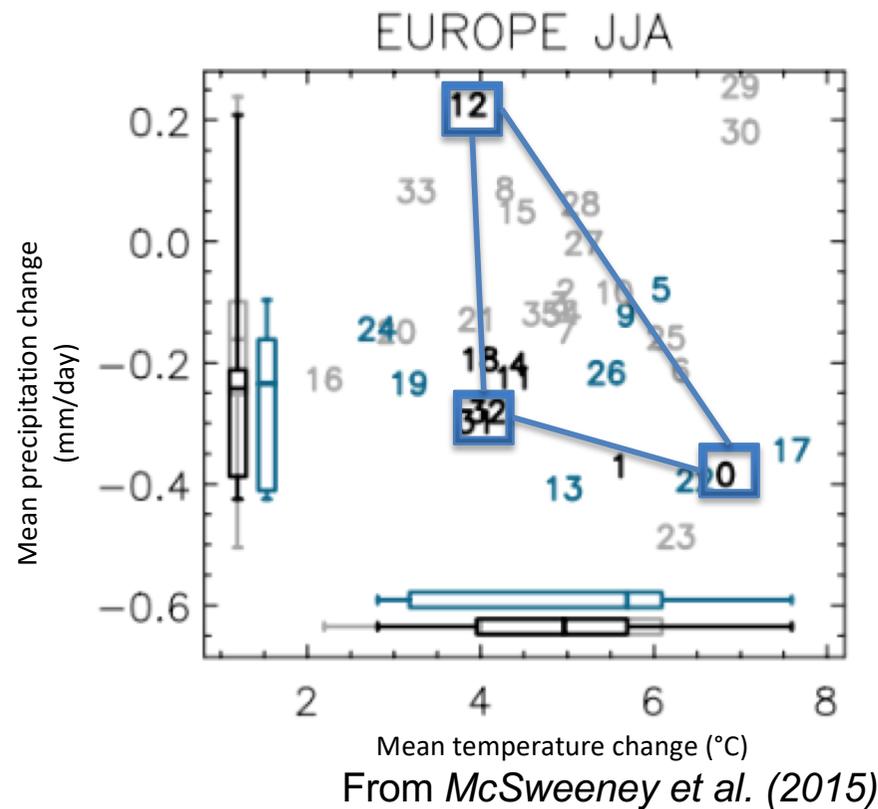
- What are the differences between climate models?
- What are the differences between climate scenarios?
- How strong are these differences compared to current variations of climate?

## 2. Link with fire activity

- What will an increase in fire danger imply in terms of fire activity?
- Are spatial patterns of FWI representative of current fire activity?
- Is FWI a correct metric to predict fire activity?

# Uncertainties linked to climate projections

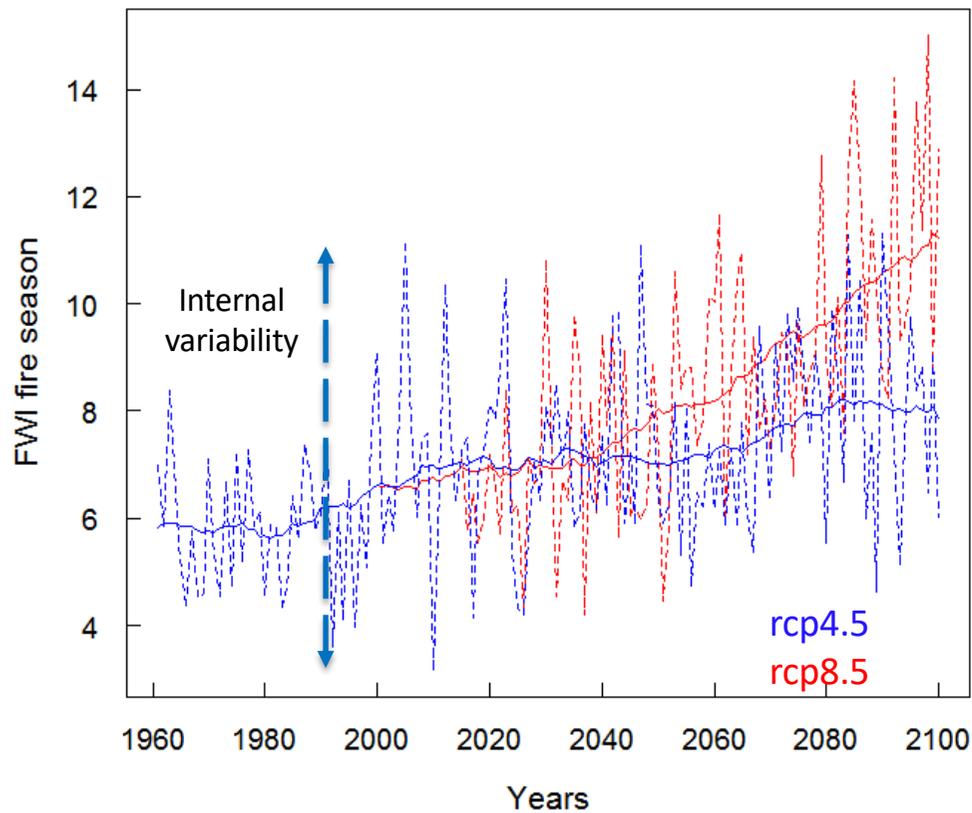
- Design of the study : 5 different climate models



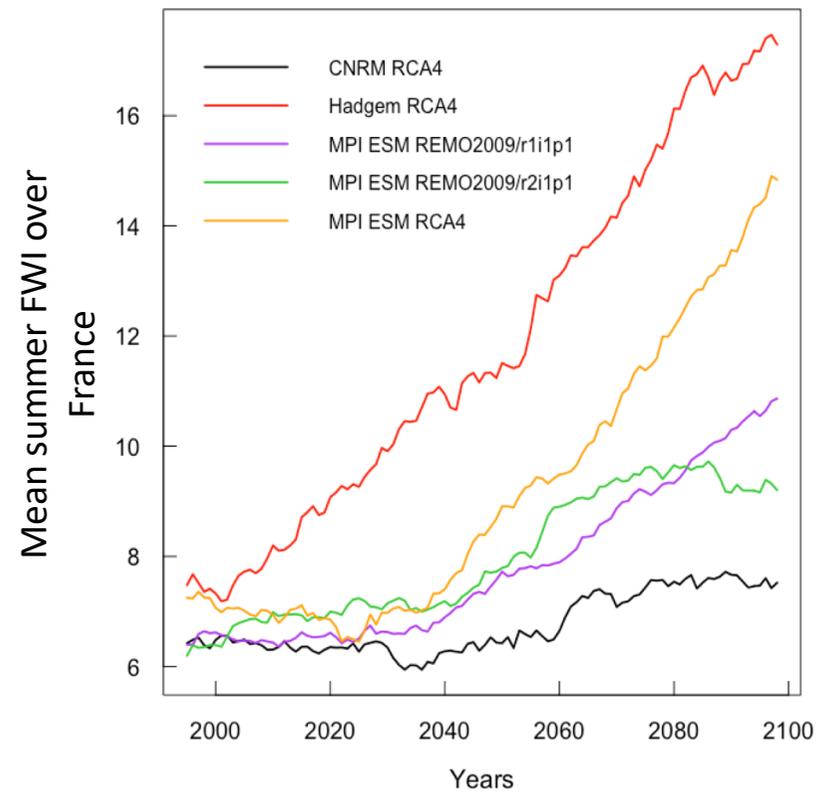
# Uncertainties linked to climate projections

- Contrasted behaviour at horizon 2100

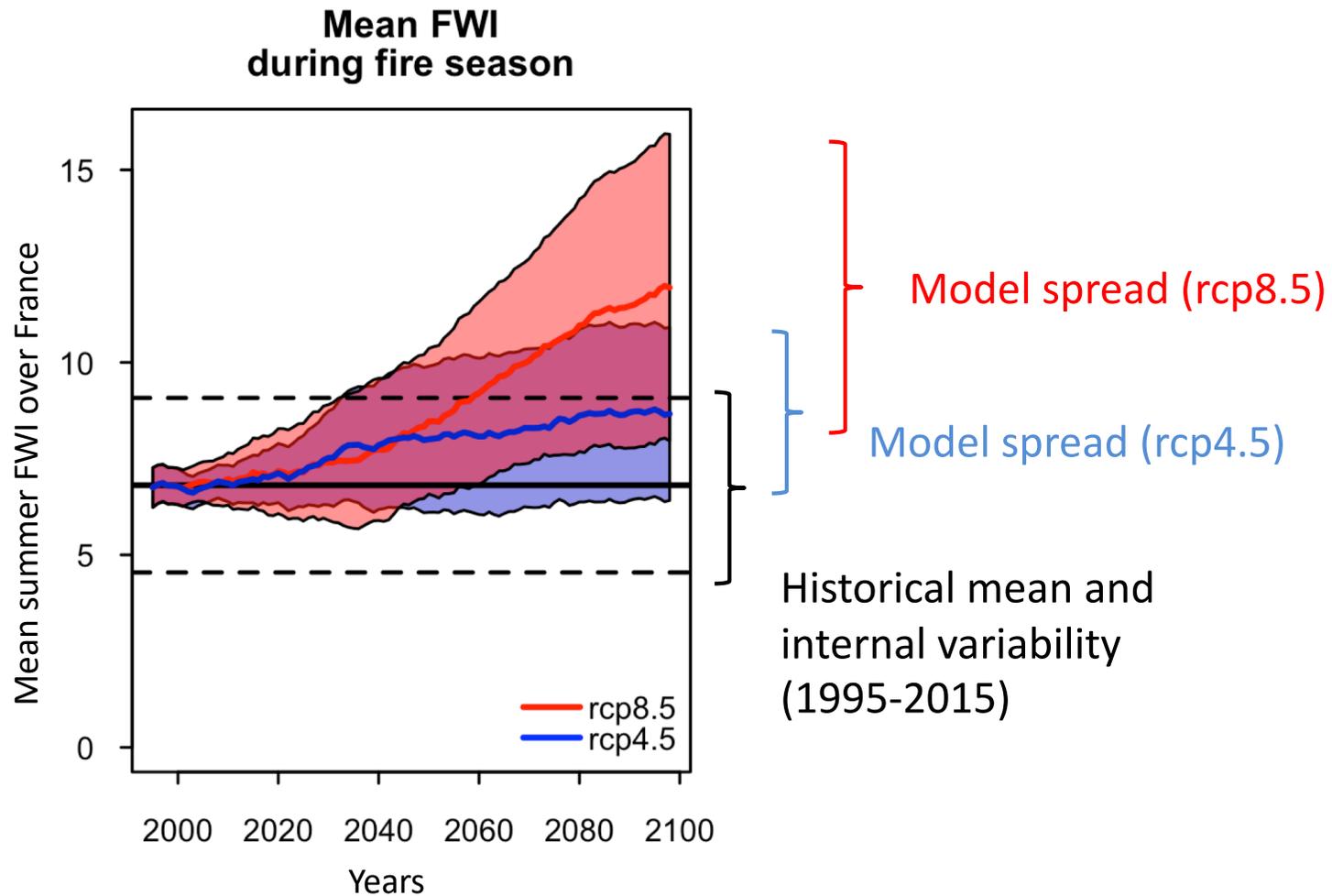
MPI ESM REMO2009/r1i1p1 Scenario rcp4.5 and rcp8.5



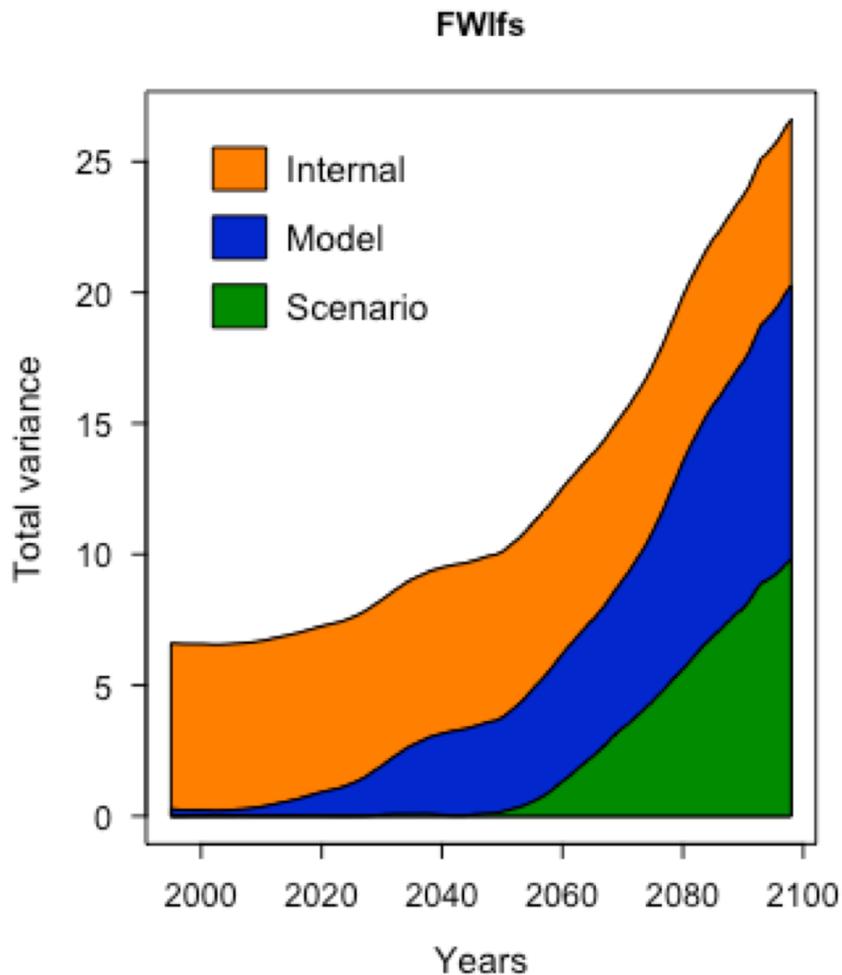
Model spread (scenario rcp8.5)



# Results: projections of FWI under climate change



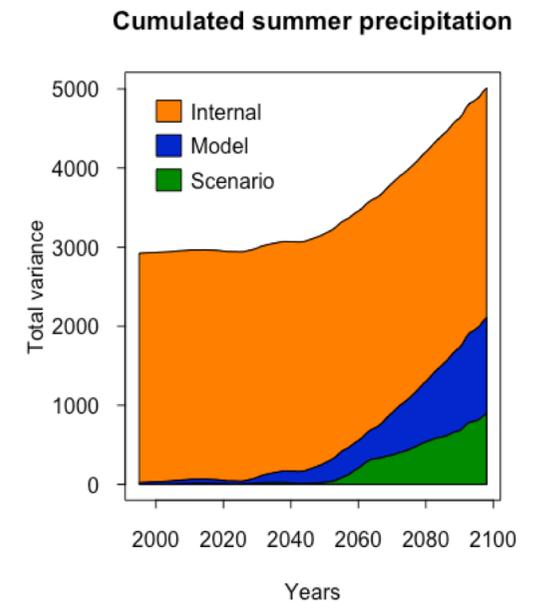
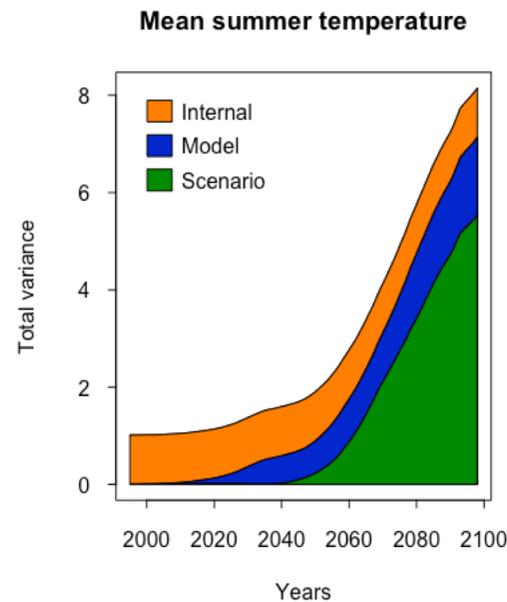
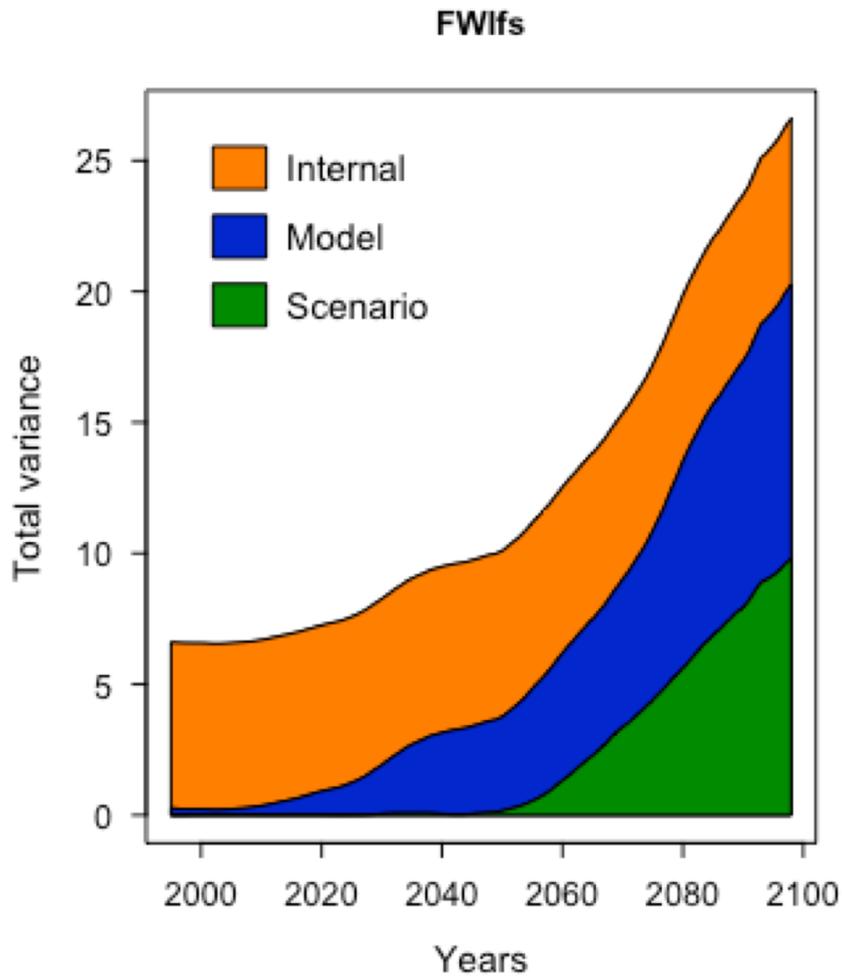
# Results: projections of FWI under climate change



- Two scenarios
- Importance of the internal variability

# Results: projections of FWI under climate change

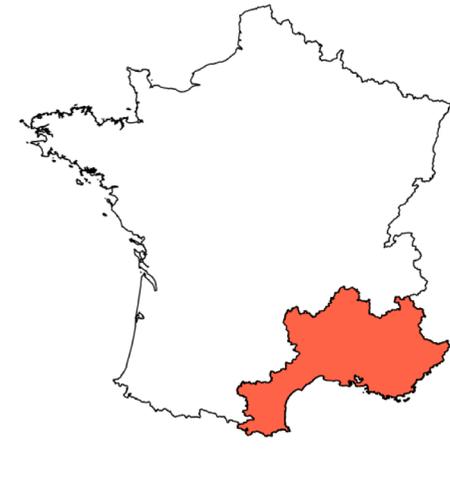
- Two scenarios
- Importance of the internal variability



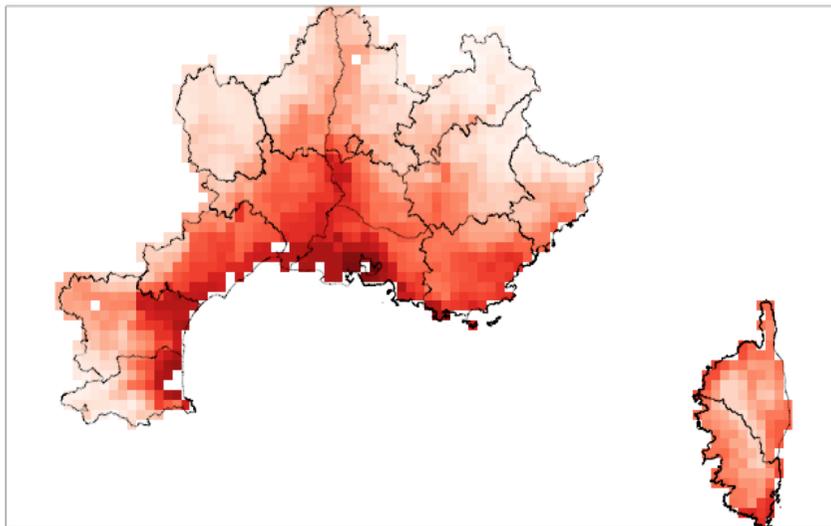
# Climate alone does not explain fire records

The projection of fire activity is of higher interest for policy makers and stakeholders than fire danger

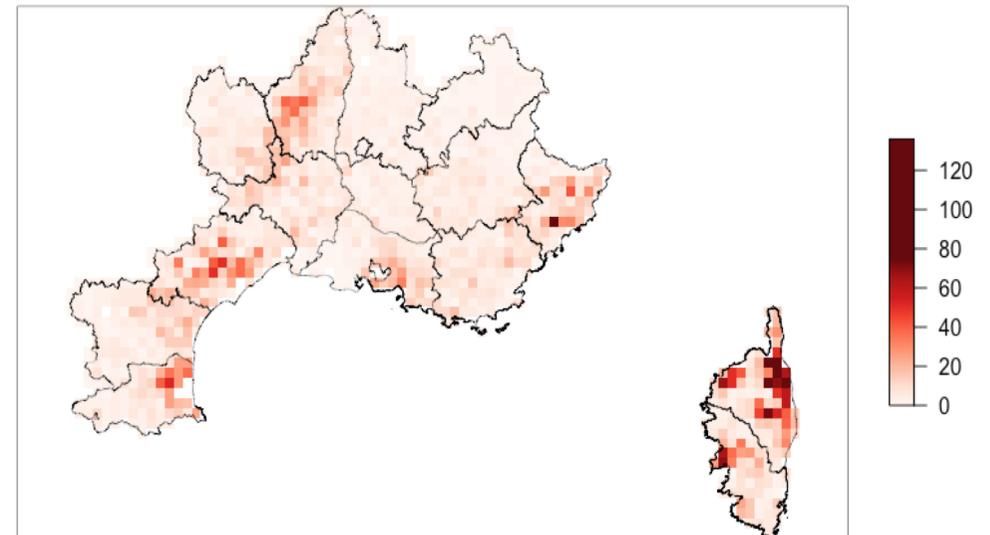
Focus on fire occurrence in the French Mediterranean area



Mean FWI per pixel  
(1995-2015)



Observed number of fires > 1 ha  
per pixel (1995-2015)



# Development of a fire occurrence model including daily FWI



- Input data: Promethee, a database of fire occurrence in the Mediterranean French area (1995-2015)  
<http://www.promethee.com/>
- Selected explanatories:
  - Daily FWI
  - Forest cover of the pixel
- Probability-based model adjusted using INLA
- Model form:

$$\text{Fire number} = \text{Intercept} * S * f(S) * g(\text{FWI})$$

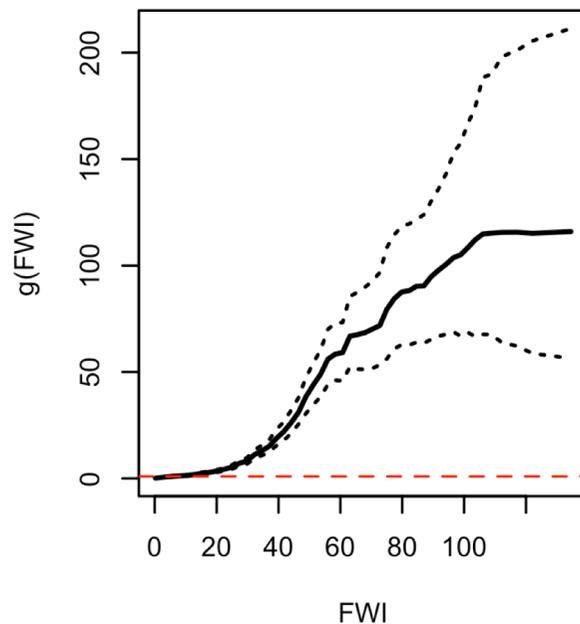
# FWI is correlated with fire occurrence, but response is non-linear



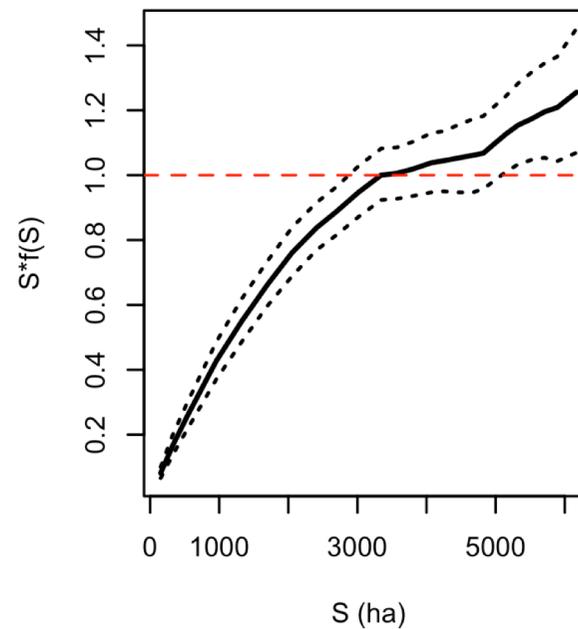
- Model form:

$$\text{Fire number} = \text{Intercept} * S * f(S) * g(\text{FWI})$$

Climate effect



Forested area effect



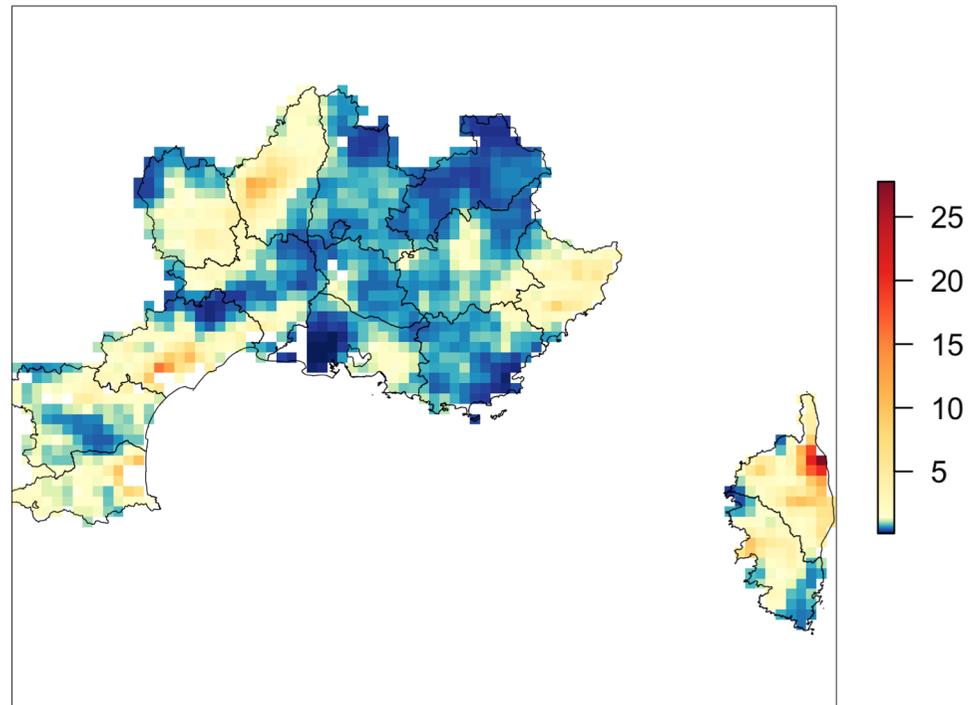
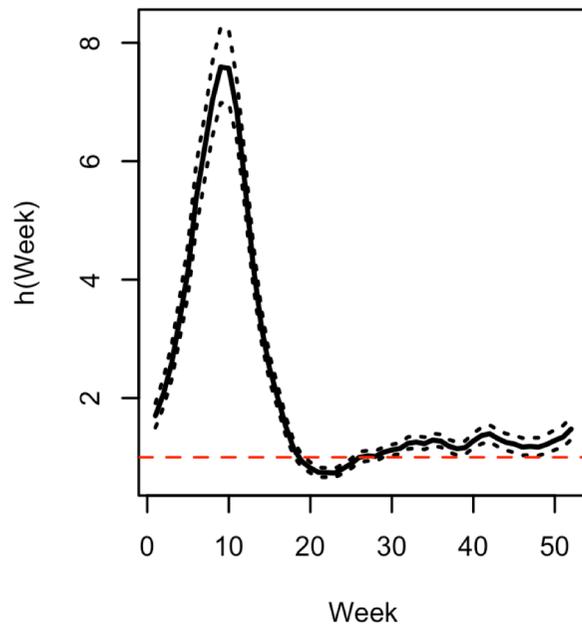
# Existing spatio-temporal residuals and integration in the model



$$\text{Fire number} = \text{Intercept} * S * f(S) * g(FWI) * h(\text{Week}) * i(\text{Pixel})$$

Spatial effect

Seasonal effect



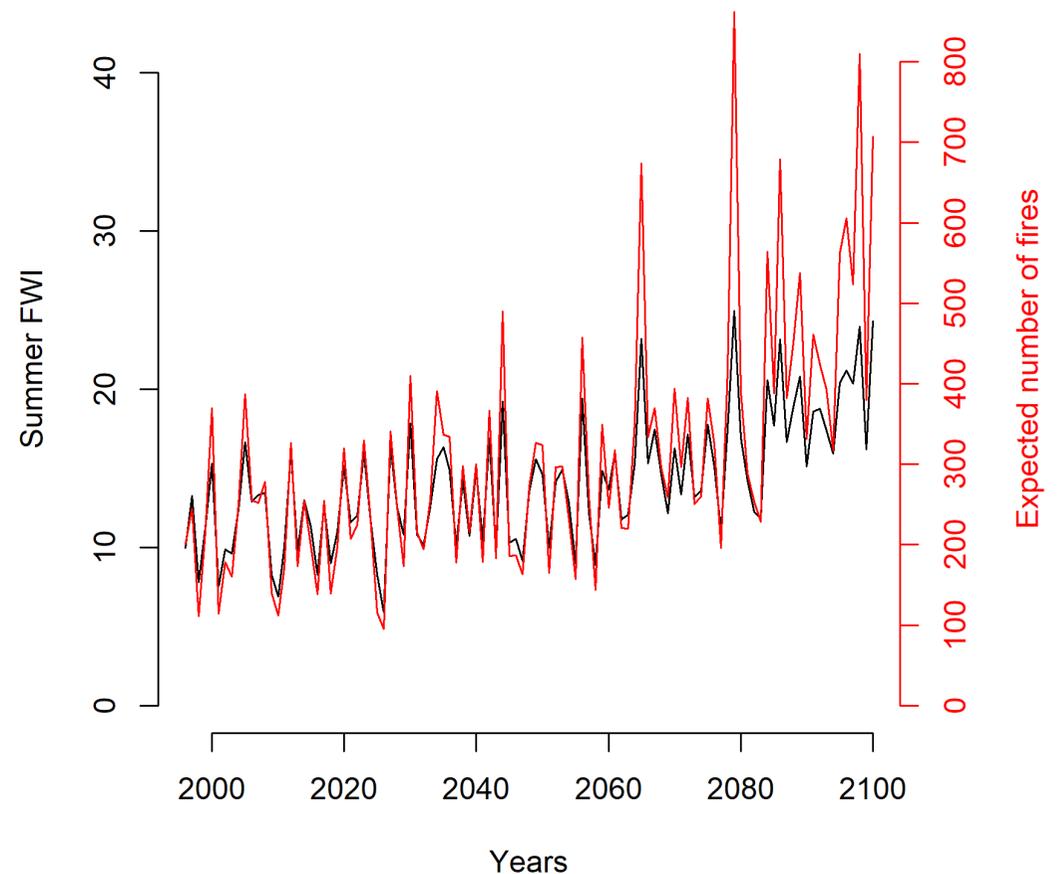
Resulting of : population density, land use, FWI limits, fuel characteristics, firefighting...

# Projections: which fire activity in the future?



- Choice of an “intermediate” climate model
  - MPI-ESM-REMO2009 (run 1)
  - Rcp8.5
  - Important internal variability highlighted

Summer FWI and expected fires

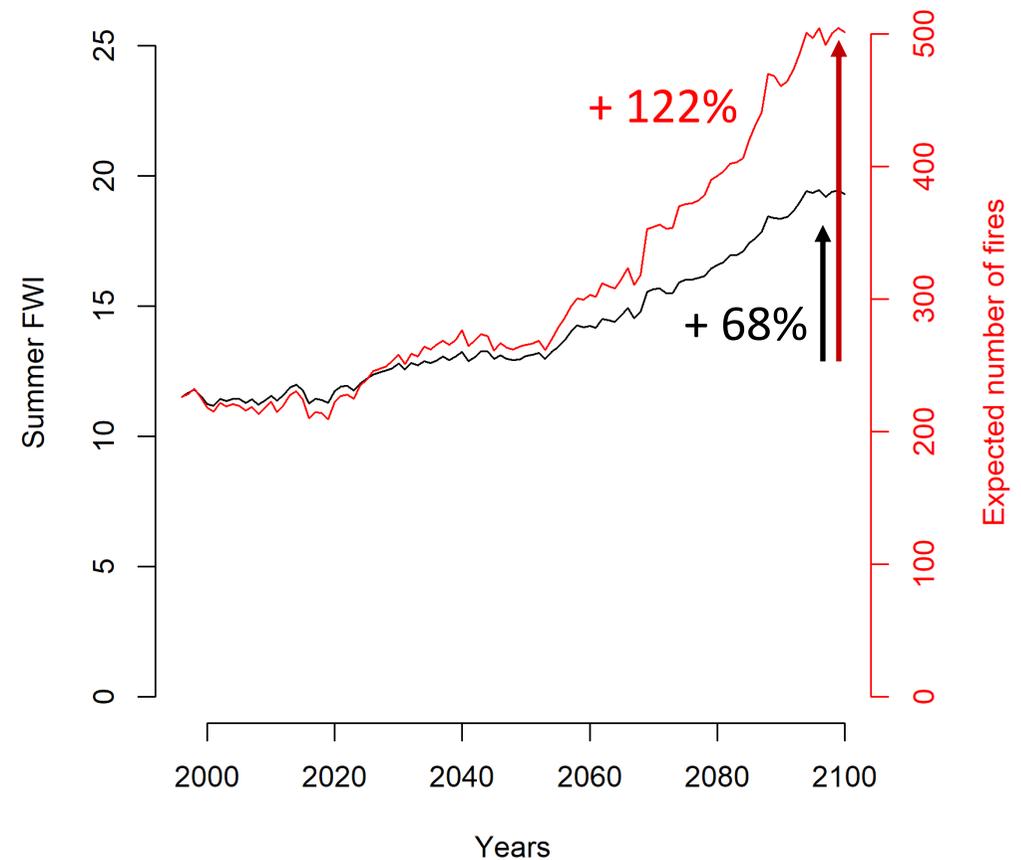


# Projections: which fire activity in the future?

- We evidence differences between FWI increase and expected fire occurrence

After 30-year temporal smoothing...

Summer FWI and expected fires

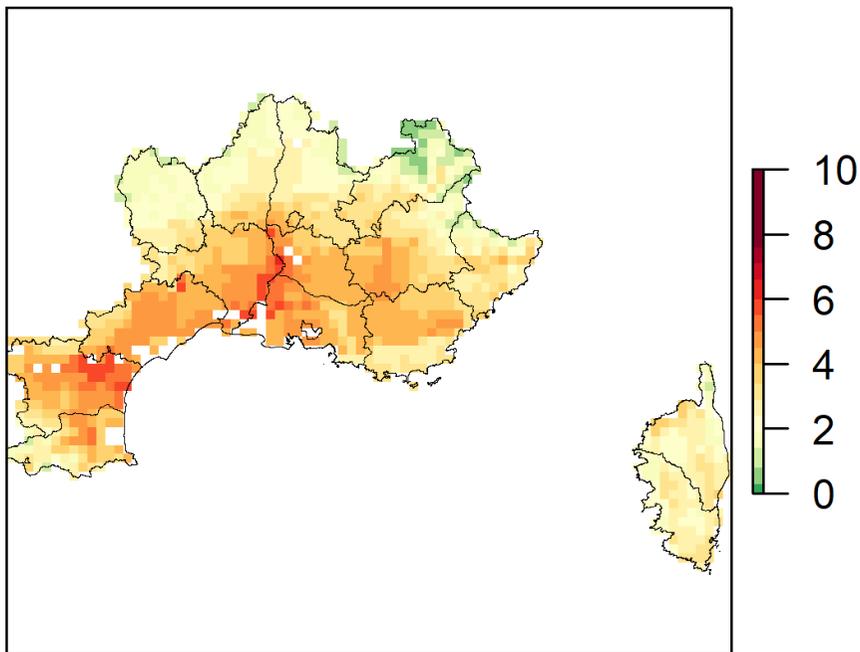


# Spatial patterns: regional projections

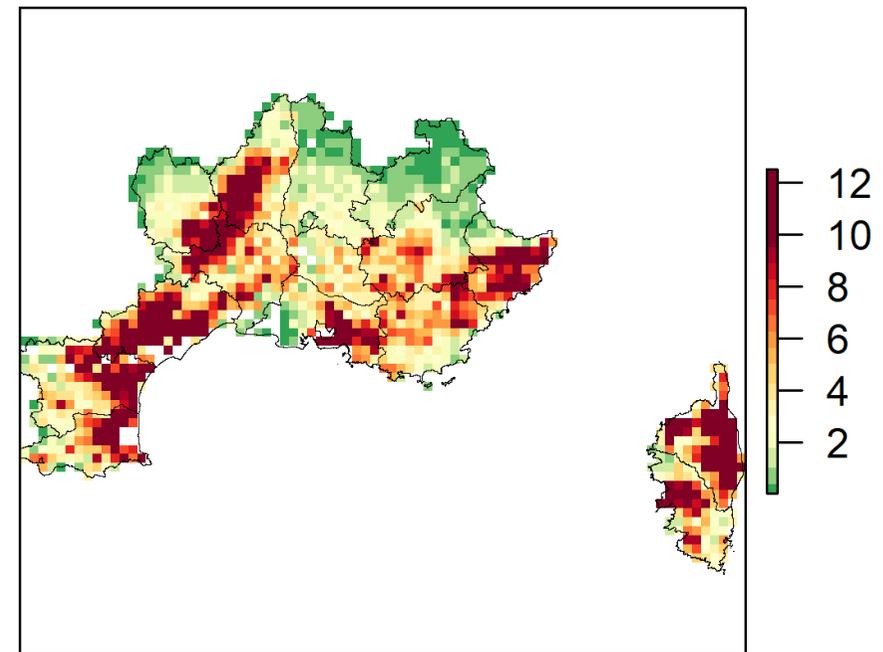


- Differences between FWI spatial pattern and projected fire distribution

**FWI anomaly**



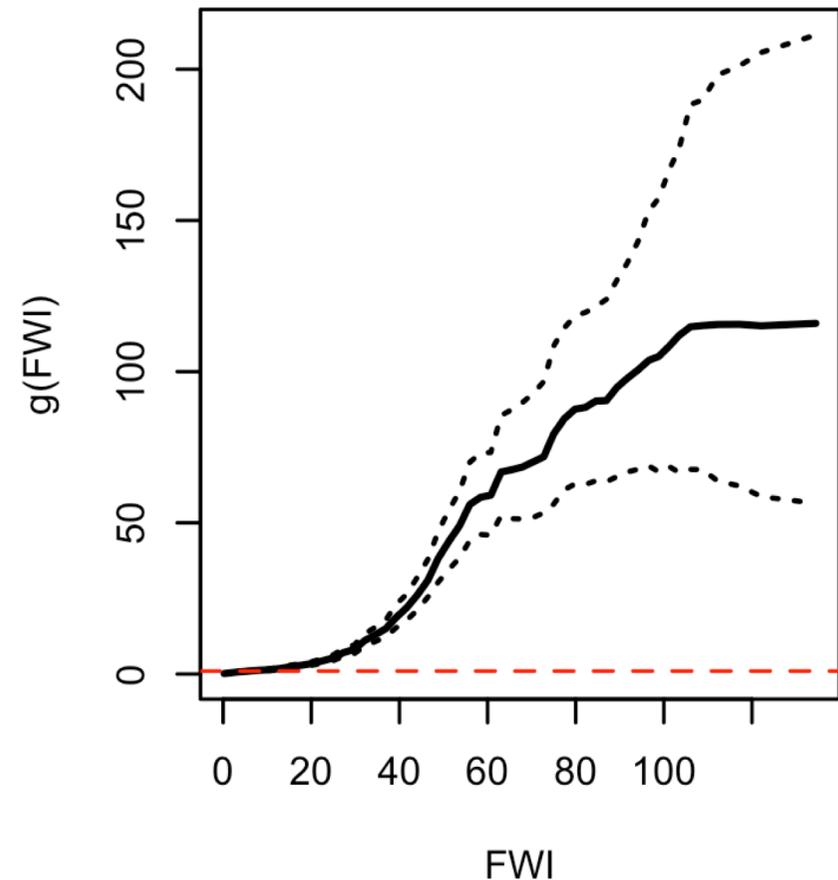
**Anomaly in expected number of fires**



# Key points

- An increasing fire danger over France, especially in the Mediterranean area
- Important uncertainties arising from different sources
- The isolation of a non-linear climate effect
- An approach complementary with projections of fire danger indices
- Many potential applications

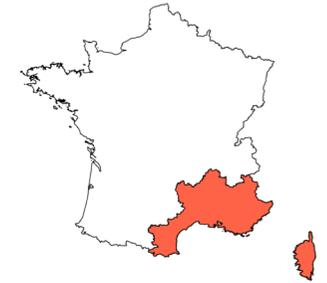
Climate effect



# Thank you for your attention



# References



Bedia J, Herrera S, Camia A, et al (2014) Forest fire danger projections in the Mediterranean using ENSEMBLES regional climate change scenarios. *Clim Change* 122:185–199. doi: 10.1007/s10584-013-1005-z

McSweeney CF, Jones RG, Lee RW, Rowell DP (2015) Selecting CMIP5 GCMs for downscaling over multiple regions. *Clim Dyn* 44:3237–3260. doi: 10.1007/s00382-014-2418-8

