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## Structural species distribution models contrast tree responses to land use and climate changes

Nicolas Martin-StPaul, Jean-Sauveur Ay, Joannès Guillemot, Luc Doyen, Paul W. Leadley

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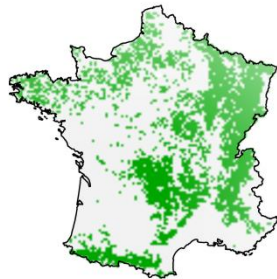
*Structural species distribution models  
contrast tree responses to land use and  
climate changes*

**12 Juin 2014**

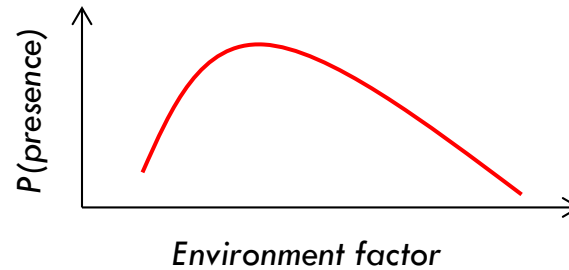
Martin-StPaul NK; Ay J-S; Guillemot J; Doyen L; Leadley P

# 1. Introduction: What do classic SDMs do?

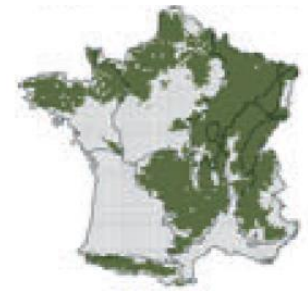
## Observations



*F. Sylvatica* (IFN)



## Predictions Bioclimatic range



BIOMOD, Cheaib et al., 2012

## Environmental factors



Temperature



Global  
radiation



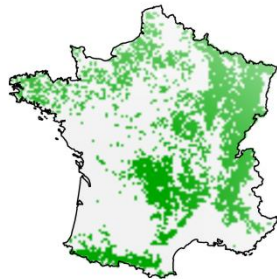
Précipitation

Correlative Species Distribution Model

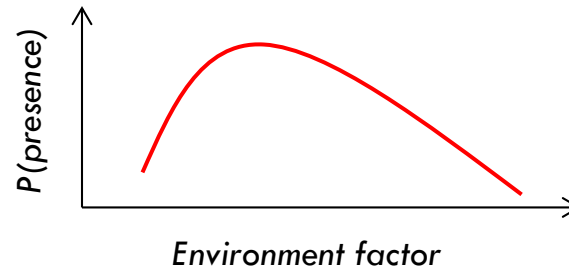
$$\text{Proba(Presence)} = f(\text{environment})$$

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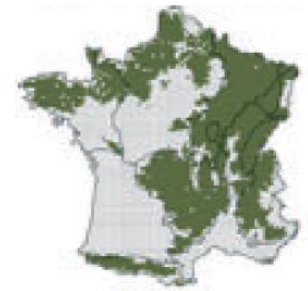
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Precipitation

Correlative Species Distribution Model

$$\text{Proba}(\text{Presence}) = f(\text{environment})$$

**SDMs aim at profiling the species distribution based on the bioclimatic envelope**

**SDMs have been used extensively to address a range of question in ecology and conservation**

# What do classic SDMs project under climate change?

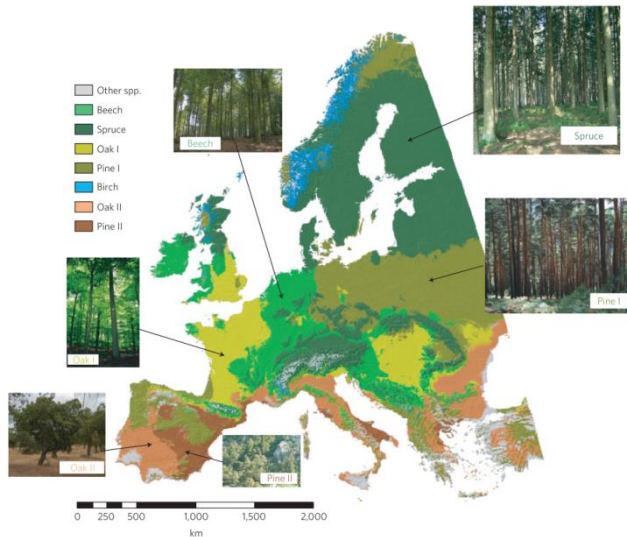
nature  
climate change

LETTERS

PUBLISHED ONLINE: 23 SEPTEMBER 2012 | DOI: 10.1038/NCLIMATE1687

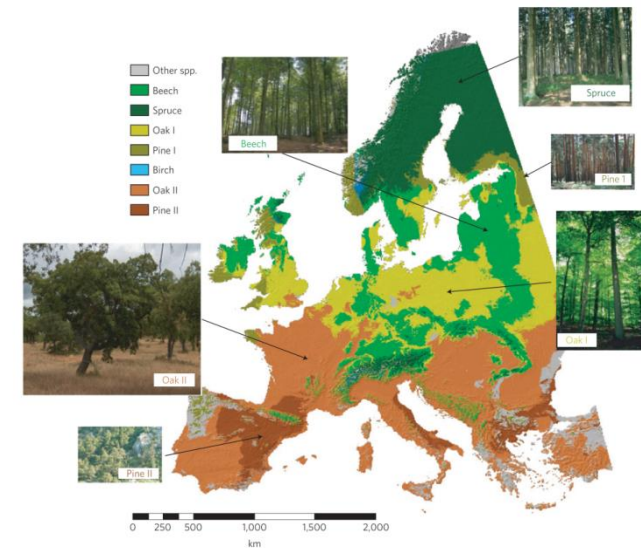
## Climate change may cause severe loss in the economic value of European forest land

Marc Hanewinkel<sup>1,2\*</sup>, Dominik A. Cullmann<sup>3</sup>, Mart-Jan Schelhaas<sup>4</sup>, Gert-Jan Nabuurs<sup>5</sup> and Niklaus E. Zimmermann<sup>6</sup>



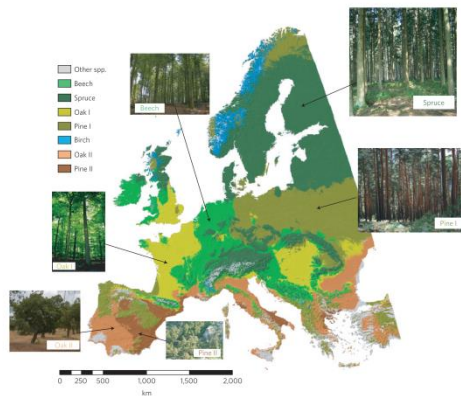
**Bioclimatic ranges (1950-2000)**

*Hanewinkel et al., 2012 NCC*



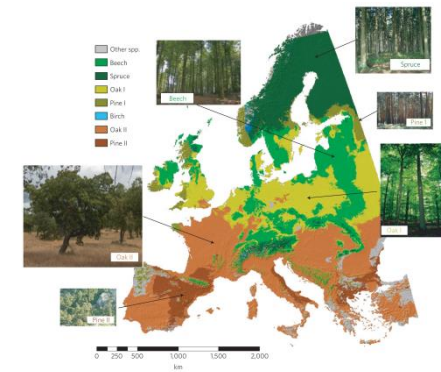
**Bioclimatic ranges (2070-2100)**

# What do classic SDMs project under climate change?



→

**Projection of the futur of species distribution under global changes**



Valuable tool to project the outcome of global changes on

- Forest biodiversity
- Forest productivity
- Forest economic value
- Conservation cost

# Motivation : land use may trigger selection biai in SDM calibration?

BIOMOD



PHENOFIT



CASTANEA



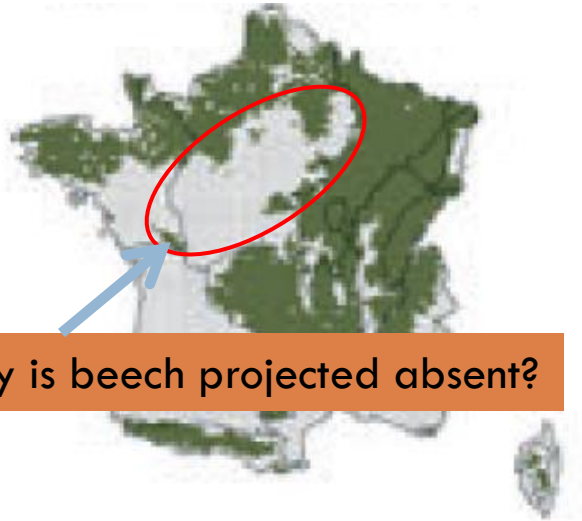
*Chebib et al., 2012 Ecology letters*

**Correlative  
Ensemble models**

**Ecophysiological  
based models =  
mechanistic**

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Chebib et al., 2012 *Ecology letters*

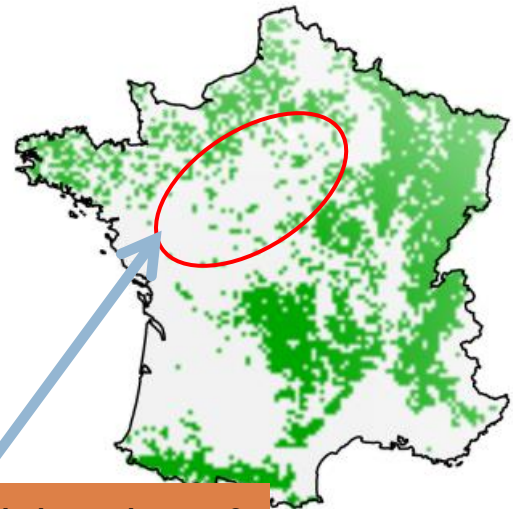
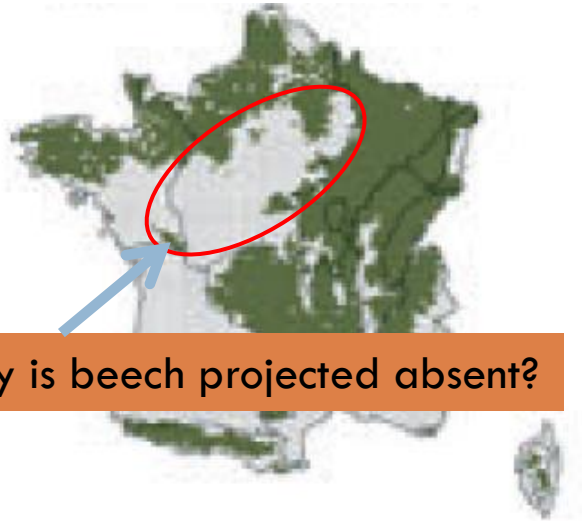
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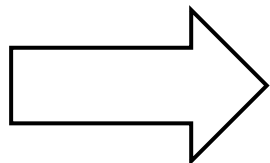
# Motivation : land use may trigger selection biases in SDM calibration?

BIOMOD



*Beech current distribution (NFI)*

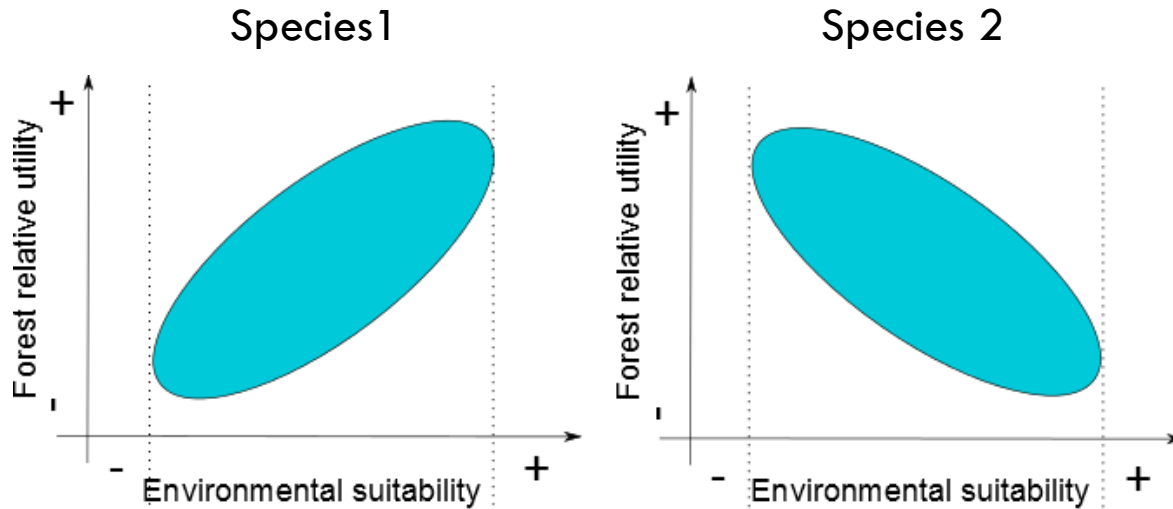
*Chebib et al., 2012 Ecology letters*



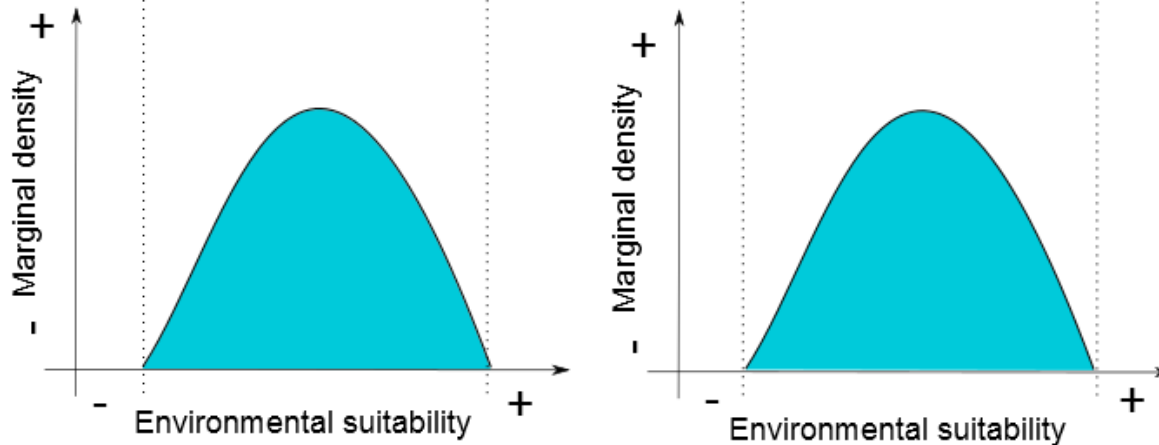
**Alternative land use may cause a  
« selection biases »**

# Potential distribution range

Reality

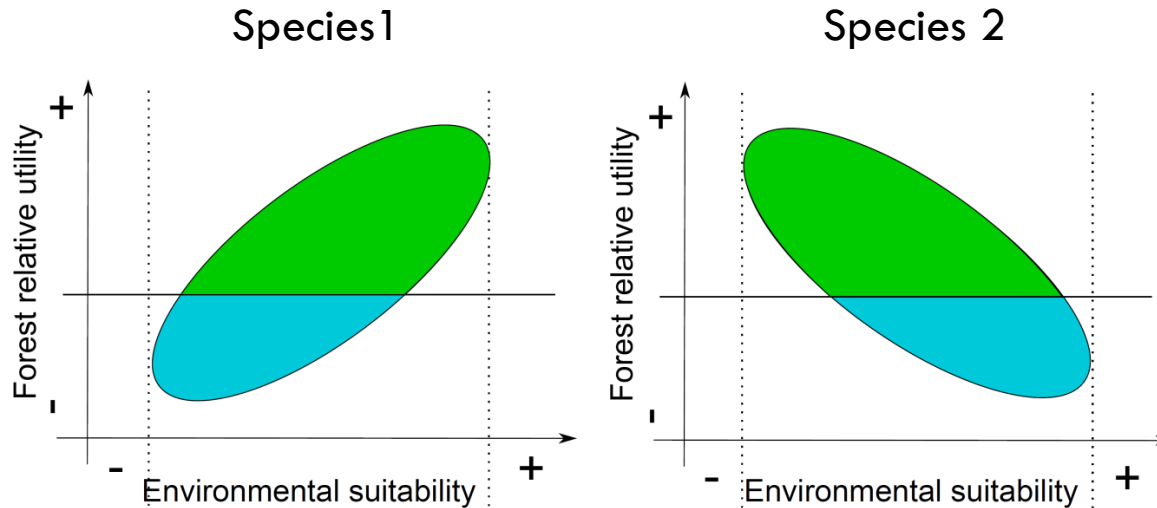


view by  
classic SMD

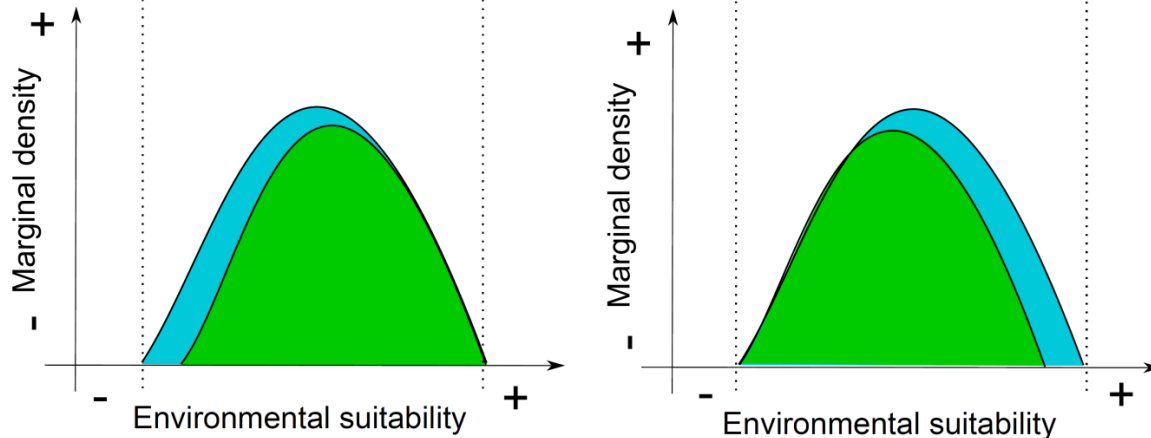


# Bias n° 1: contrasted selection

Reality

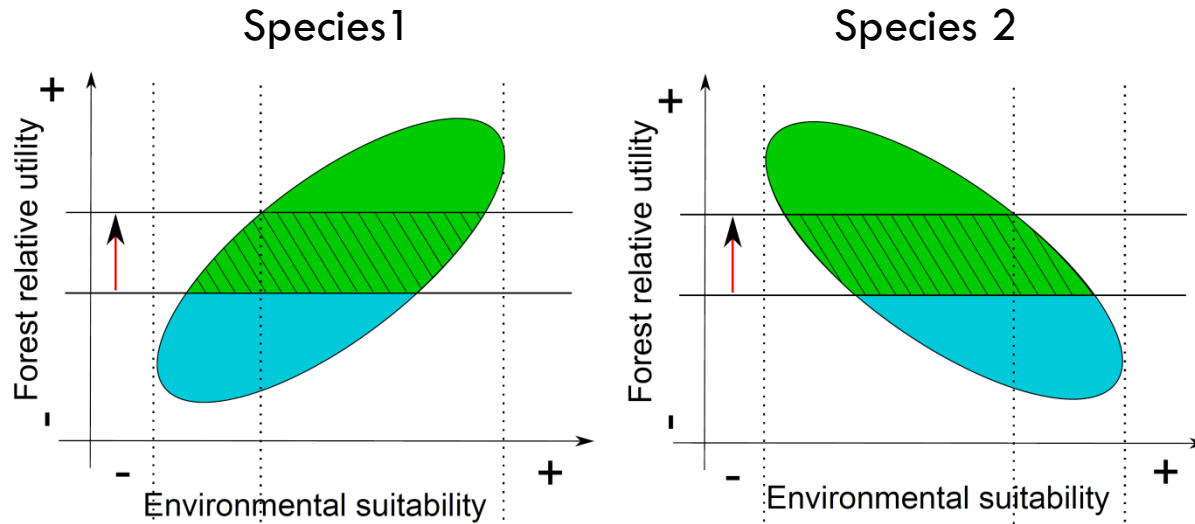


view by  
classic SMD

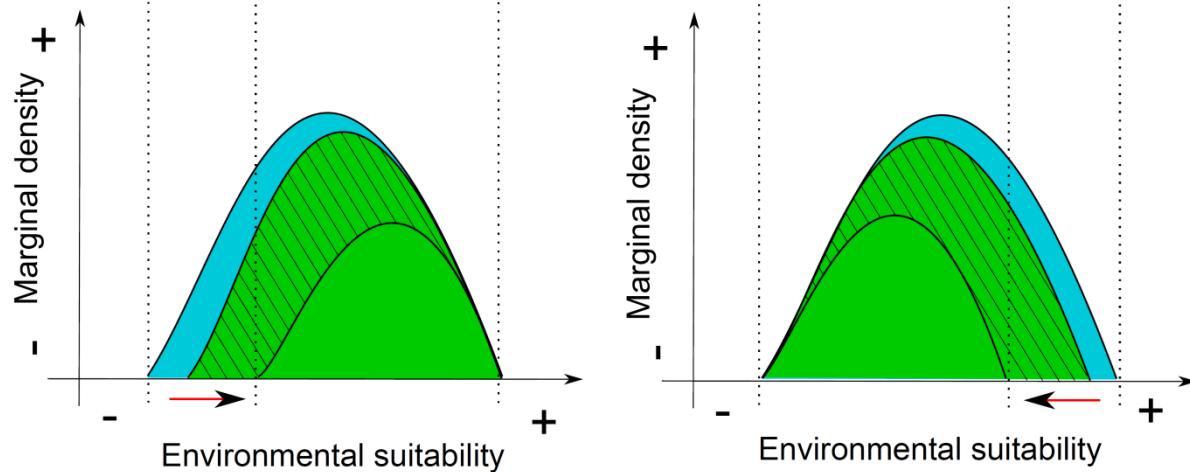


# Bias n°2: Land use projections

Reality



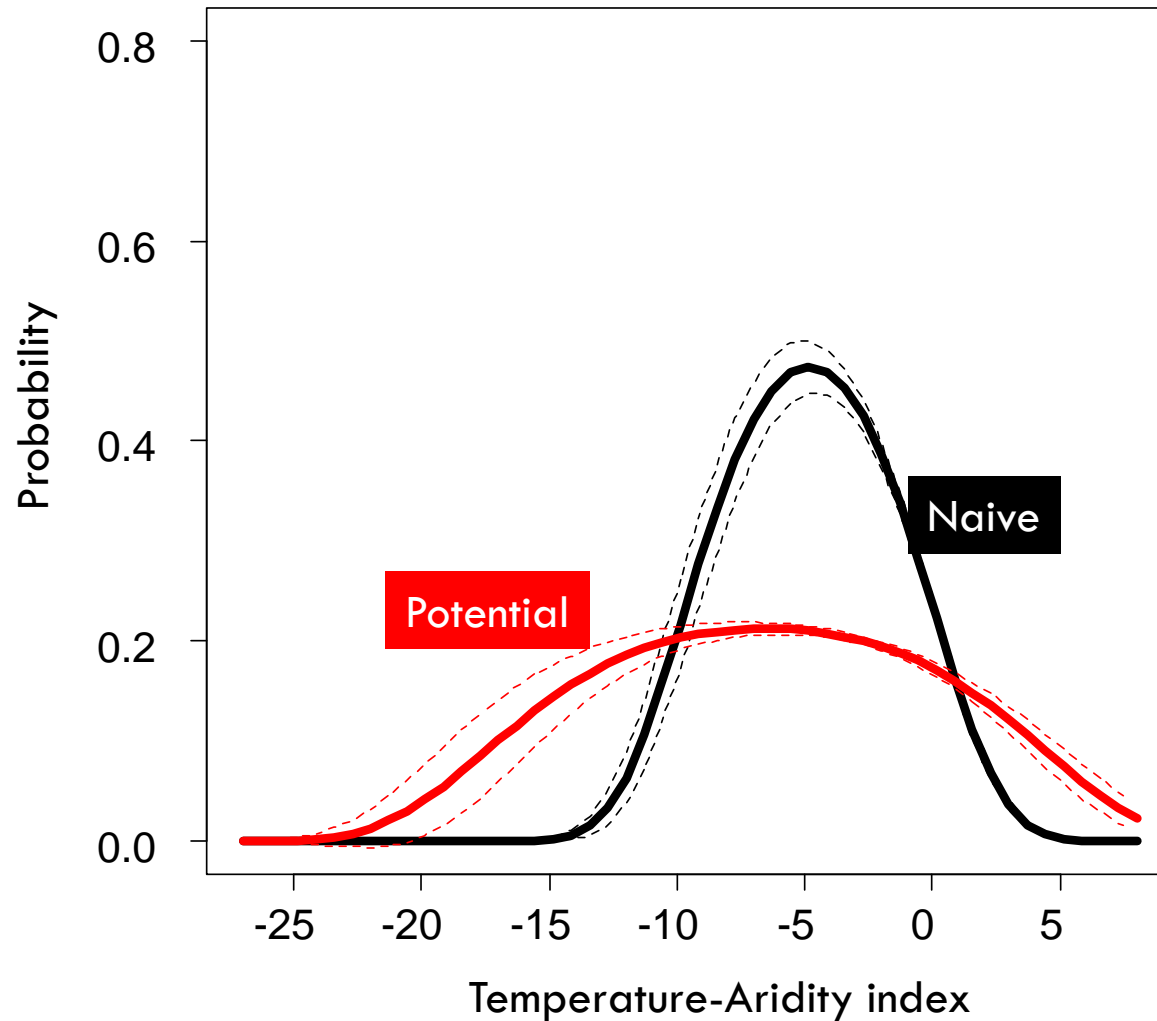
view by  
classic SMD



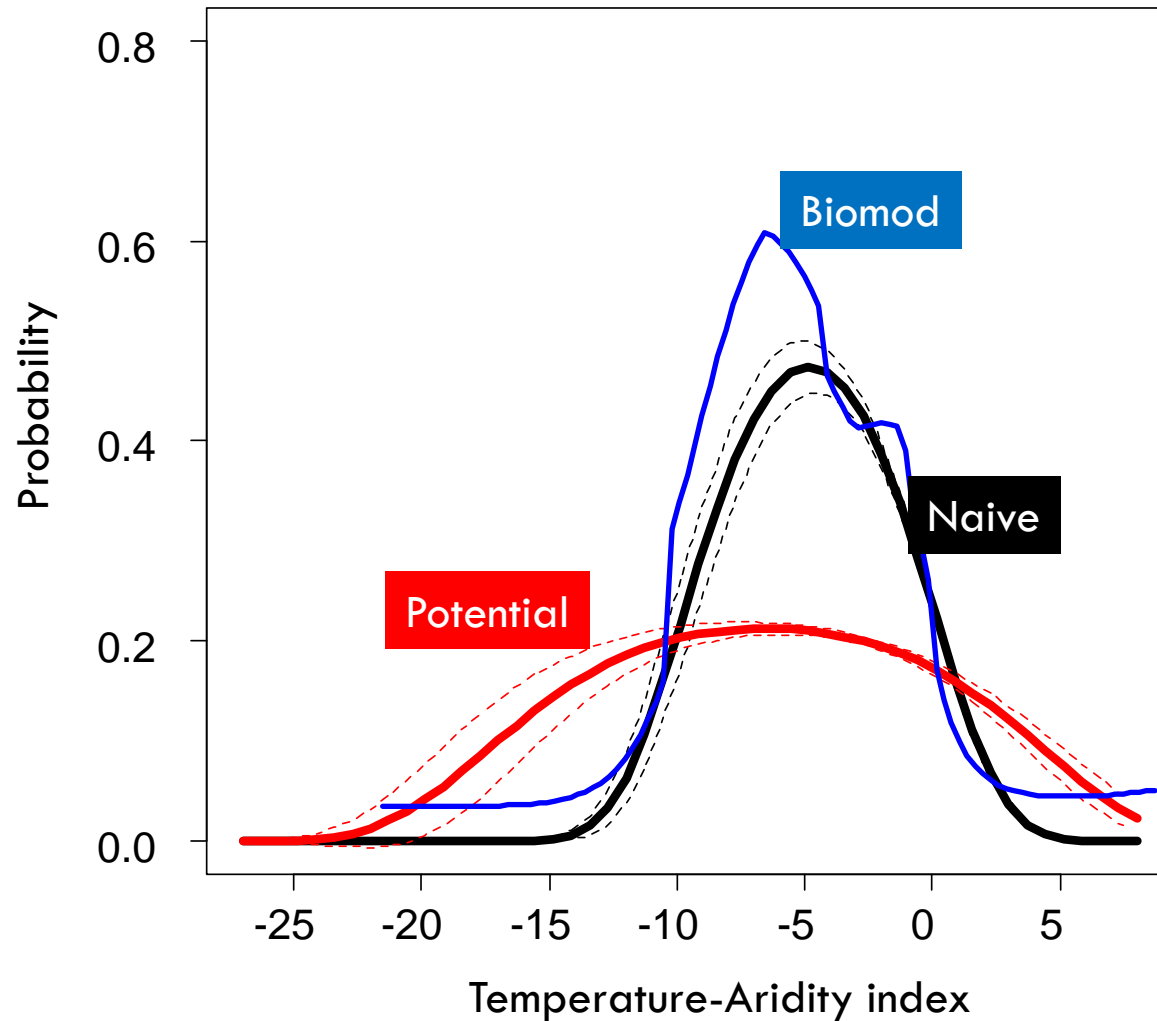
# Structural equation modelling (SEM)

- Presence of a tree specie is only observable in the case of **compatible land use: forest**
  - We model explicitely the presence of forest in the « **selection equation** » according to relative returns
  - The selection equation is used to:
    - ▣ **Correct** the estimation of distributional range
    - ▣ **Integrate** the land use effects in projections/ scenarios
- 
- Climate & Species observations (NFI) at ~2km resolution
  - Comparison with « state of the art » SDM (Bimod ensemble)
  - Example with European beech

# Response curves (Beech)



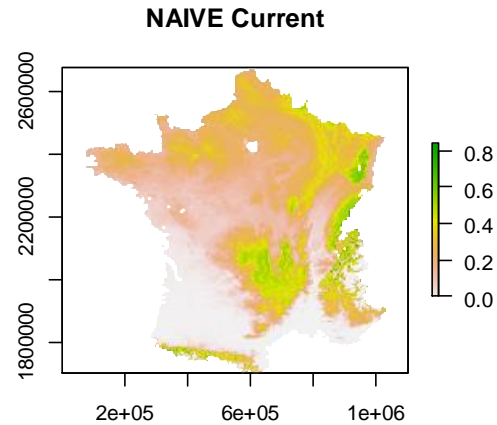
# Response curves (Beech)



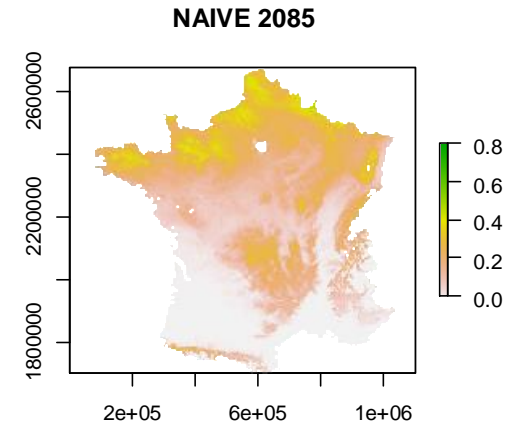
# « Potential distribution » : beech



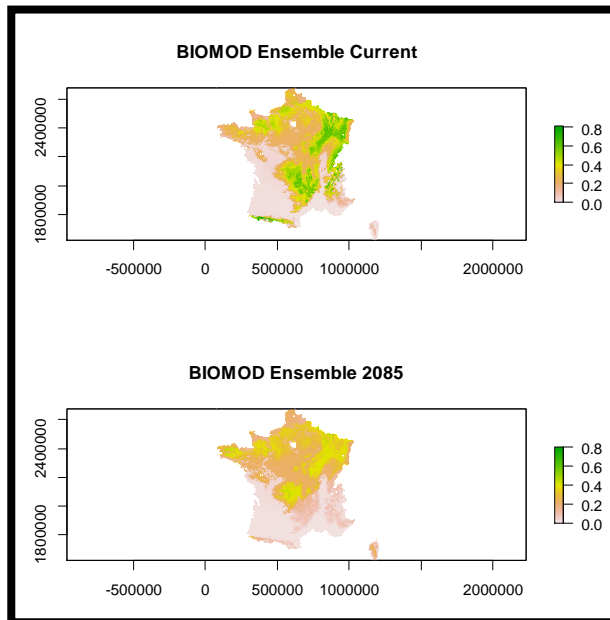
Observation NFI (Beech)



NAIVE Current

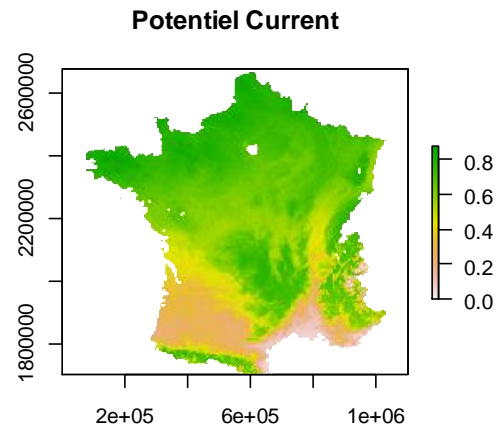


NAIVE 2085

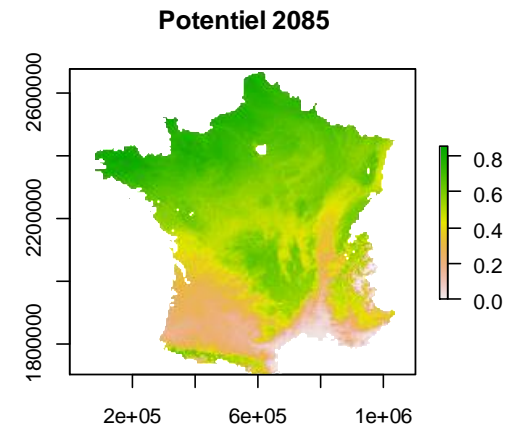


BIOMOD Ensemble Current

BIOMOD Ensemble 2085



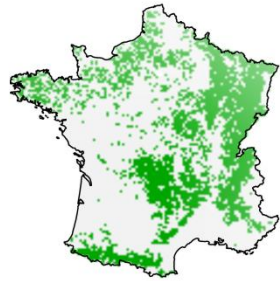
Potentiel Current



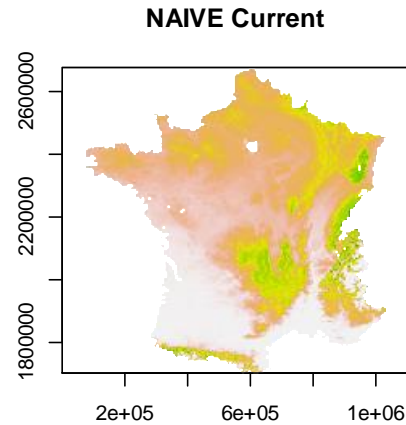
Potentiel 2085



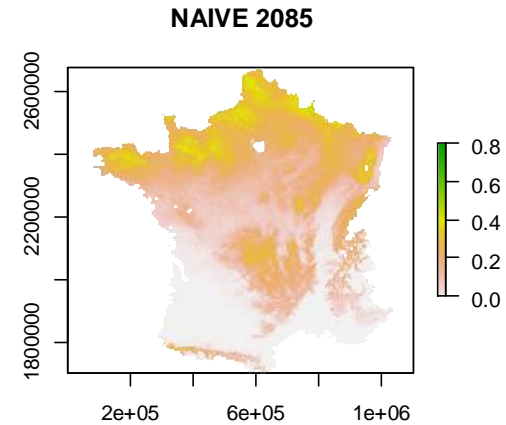
# « Realized distribution » : beech



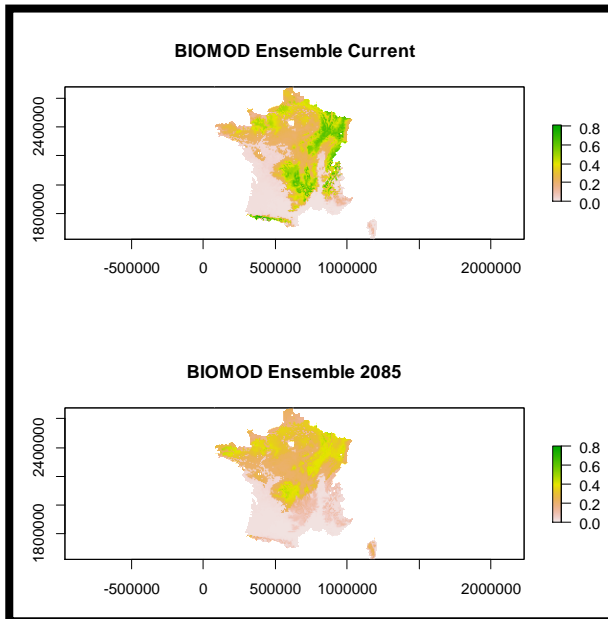
Observation NFI (Beech)



NAIVE Current

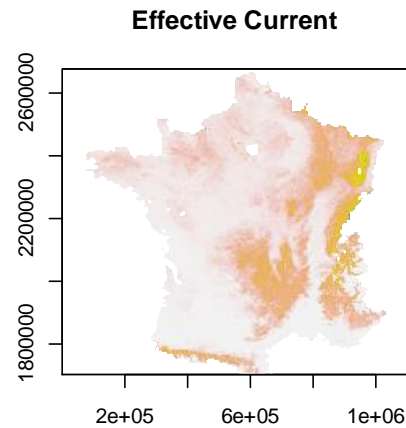


NAIVE 2085

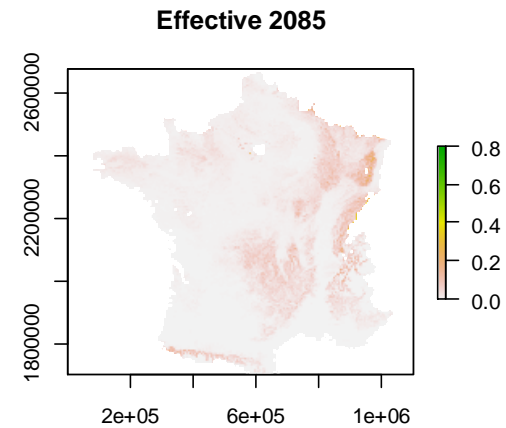


BIOMOD Ensemble Current

BIOMOD Ensemble 2085



Effective Current



Effective 2085

# Summary and conclusion

- Strong evidences of bias from classical SDM
- Contrasted directions of selection bias
  - ▣ Positive: Oak
  - ▣ Negative: Beech
- Intuition about a global over-estimation of the loss
- On-going work
  - ▣ Multi species
  - ▣ Scenarios about returns from land, land use change, and conservation policy

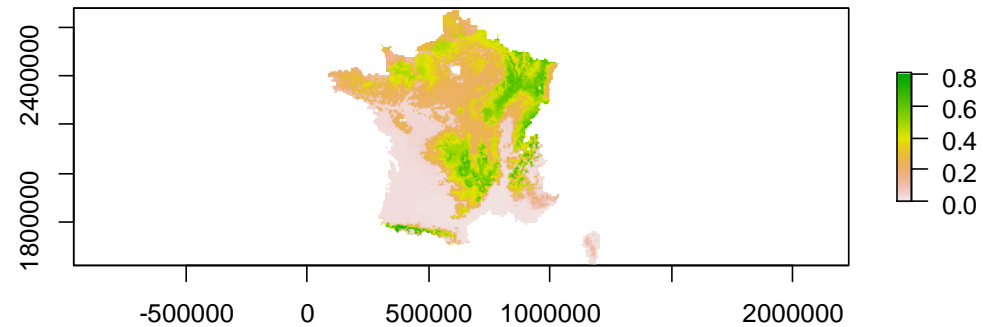


THANKS



# « Biomod distribution » : beech

**BIOMOD Ensemble Current**



**BIOMOD Ensemble 2085**

