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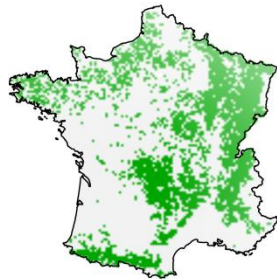
*Structural species distribution models
contrast tree responses to land use and
climate changes*

12 Juin 2014

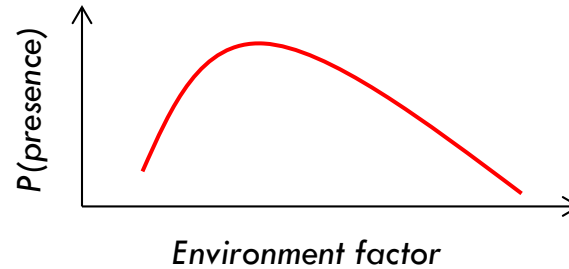
Martin-StPaul NK; Ay J-S; Guillemot J; Doyen L; Leadley P

1. Introduction: What do classic SDMs do?

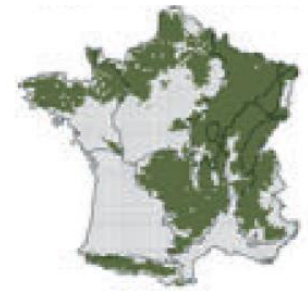
Observations



F. Sylvatica (IFN)



Predictions Bioclimatic range



BIOMOD, Cheaib et al., 2012

Environmental factors



Temperature



Global
radiation



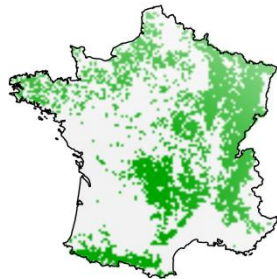
Précipitation

Correlative Species Distribution Model

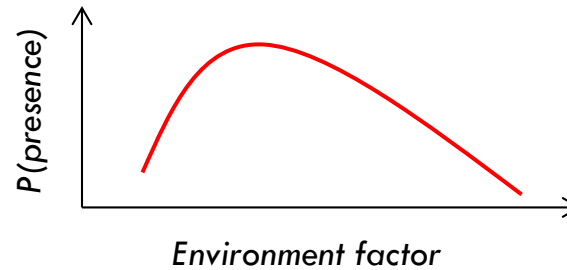
$$\text{Proba}(\text{Presence}) = f(\text{environment})$$

1. Introduction: What do classic SDMs do?

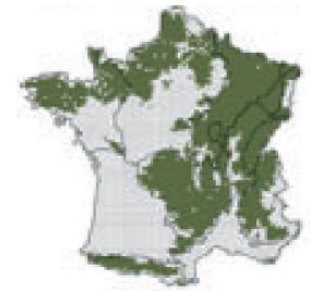
Observations



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Temperature



Global radiation



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?

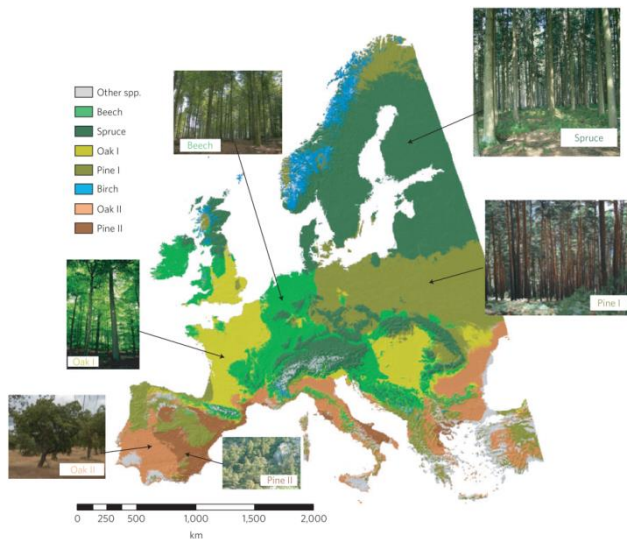
nature
climate change

LETTERS

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

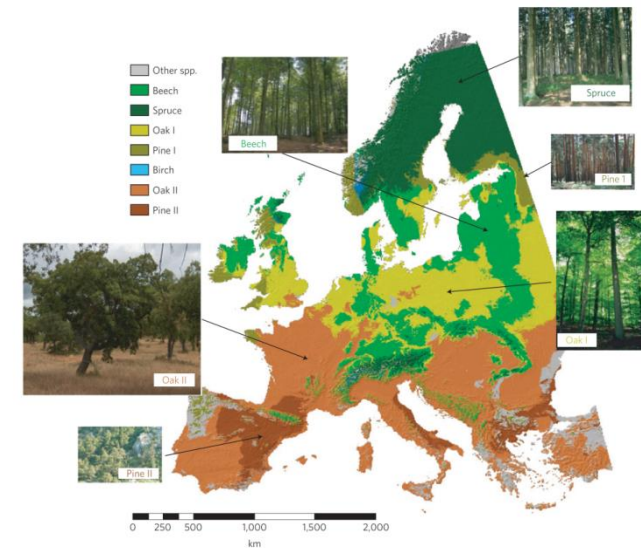
Climate change may cause severe loss in the economic value of European forest land

Marc Hanewinkel^{1,2*}, Dominik A. Cullmann³, Mart-Jan Schelhaas⁴, Gert-Jan Nabuurs⁵ and Niklaus E. Zimmermann⁶



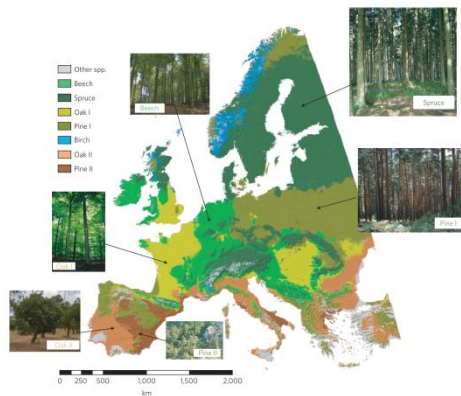
Bioclimatic ranges (1950-2000)

Hanewinkel et al., 2012 NCC



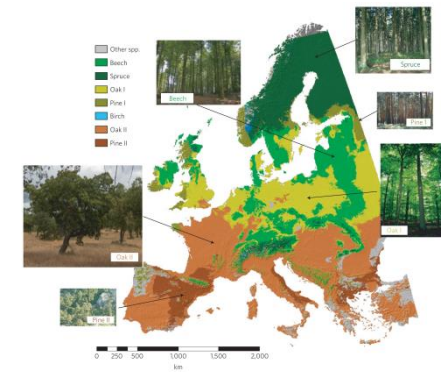
Bioclimatic ranges (2070-2100)

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



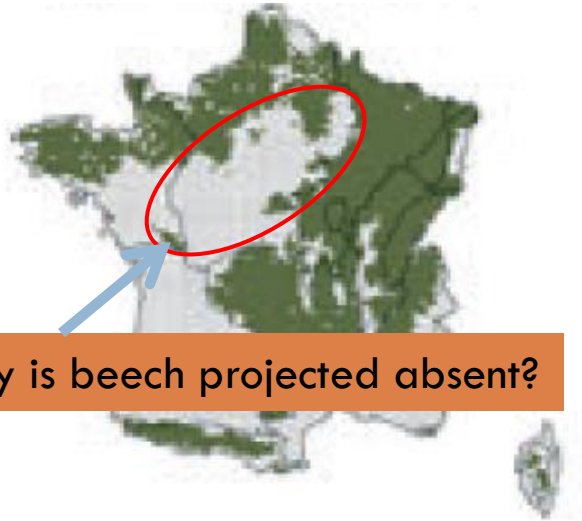
Chebib et al., 2012 Ecology letters

**Correlative
Ensemble models**

**Ecophysiological
based models =
mechanistic**

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

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PHENOFIT



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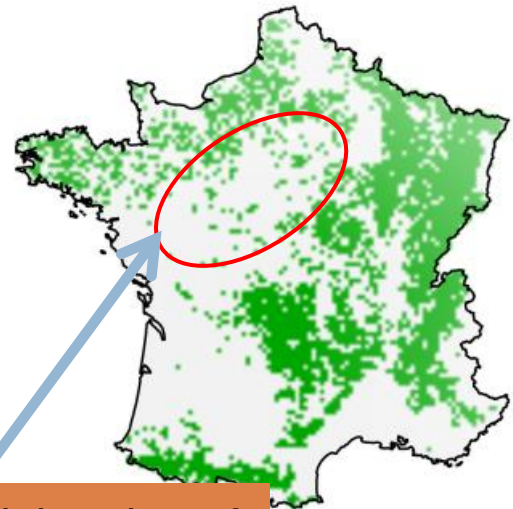
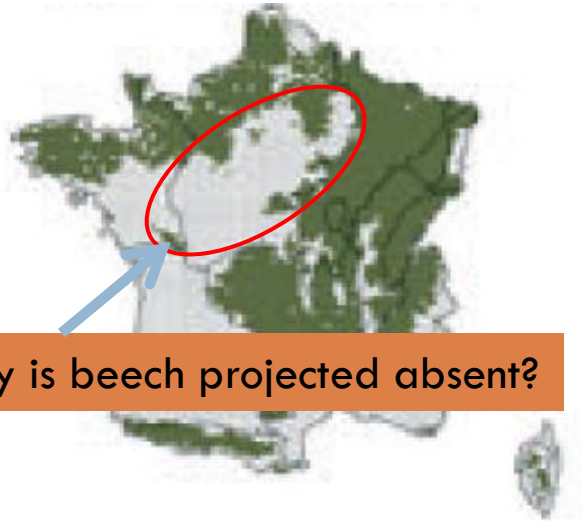
Chebib et al., 2012 *Ecology letters*

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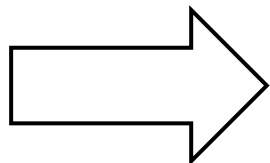
Motivation : land use may trigger selection biases in SDM calibration?

BIOMOD



Beech current distribution (NFI)

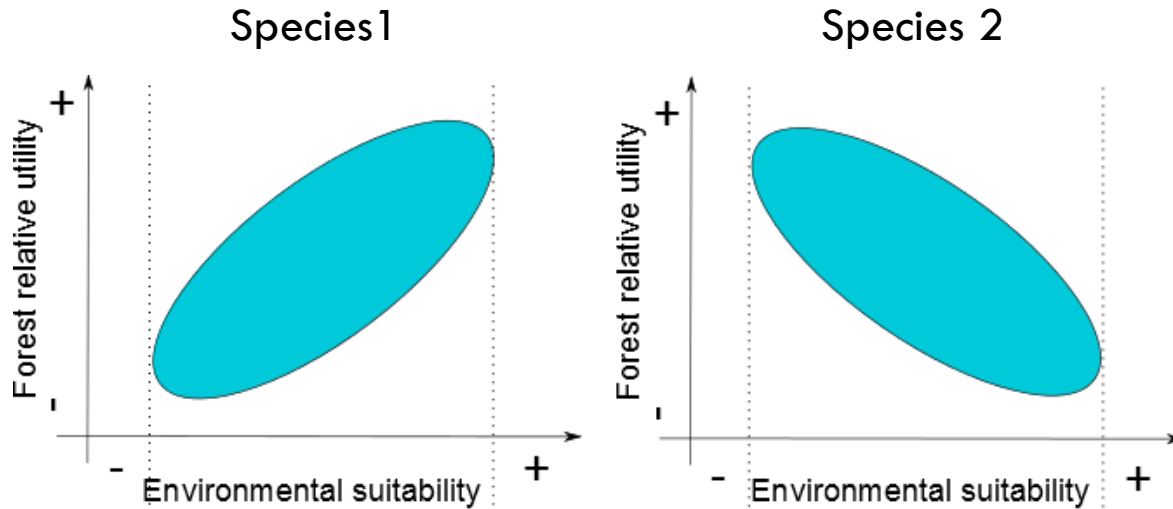
Chebib et al., 2012 Ecology letters



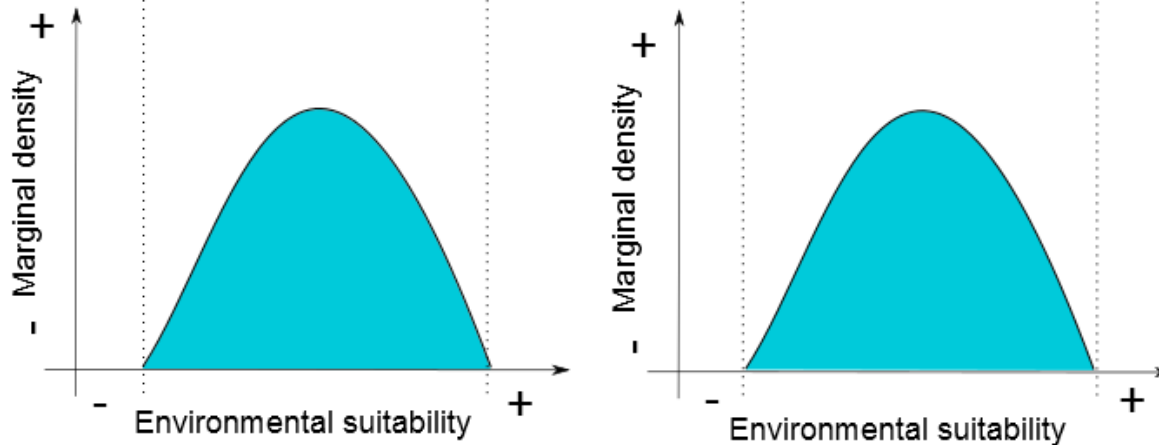
**Alternative land use may cause a
« selection biases »**

Potential distribution range

Reality

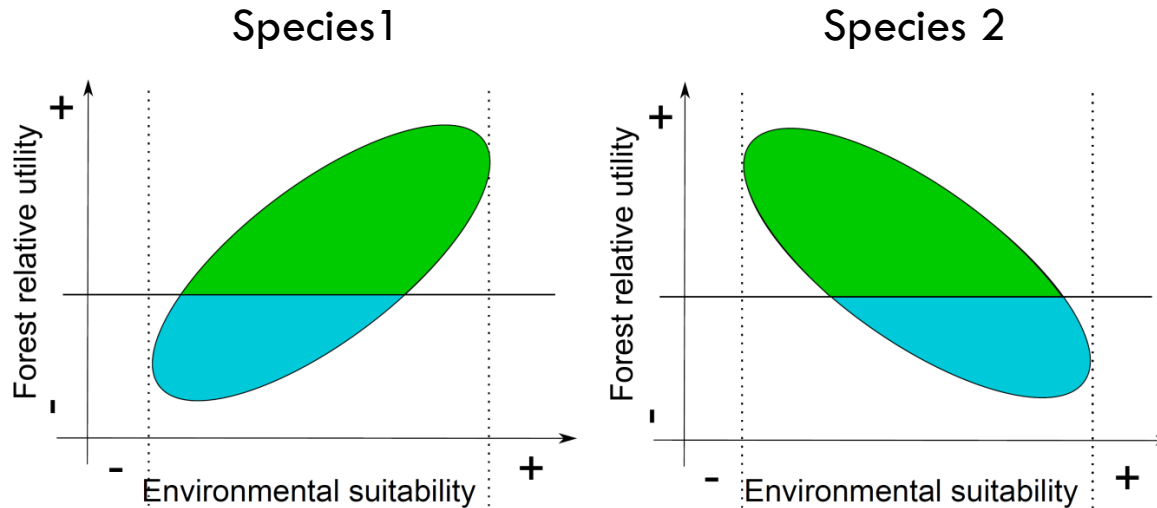


view by
classic SMD

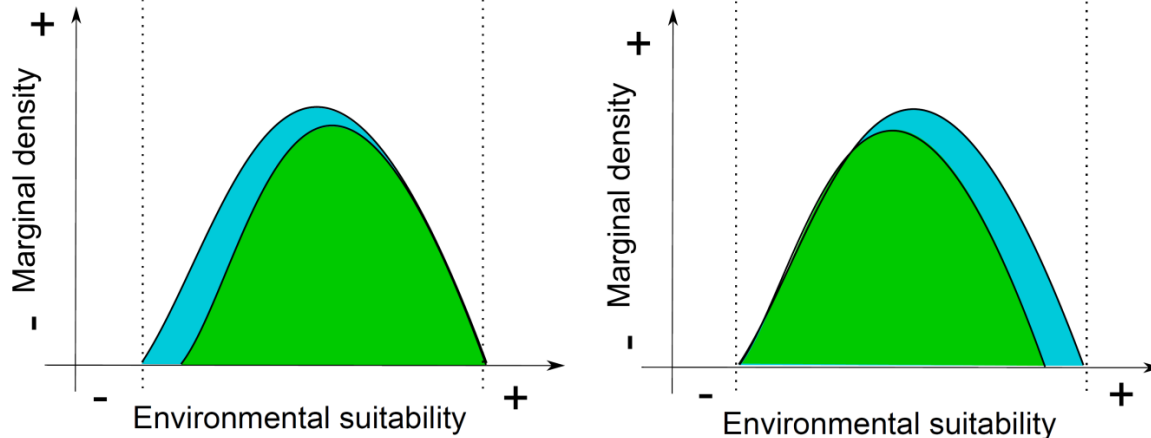


Bias n° 1: contrasted selection

Reality

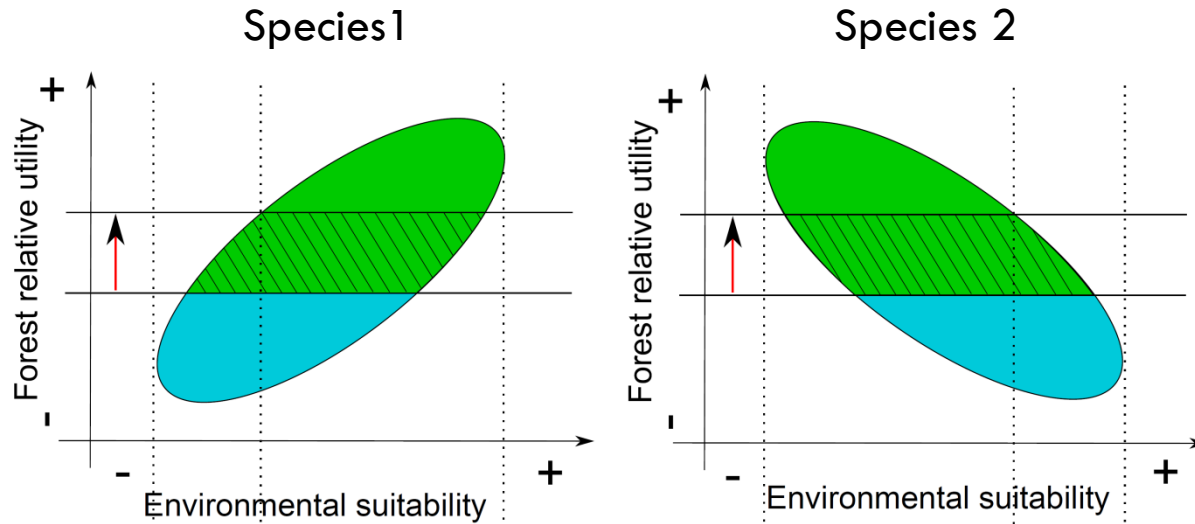


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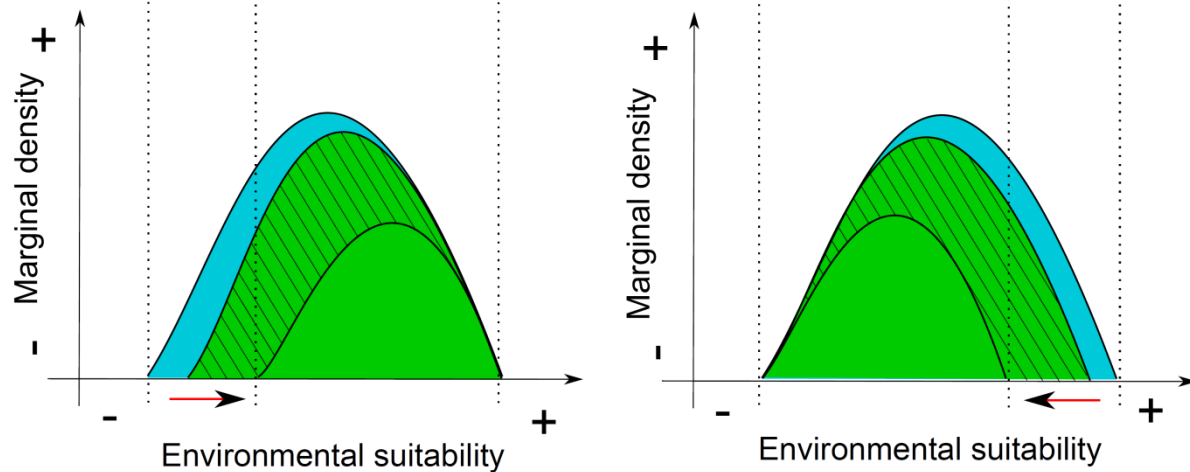


Bias n°2: Land use projections

Reality



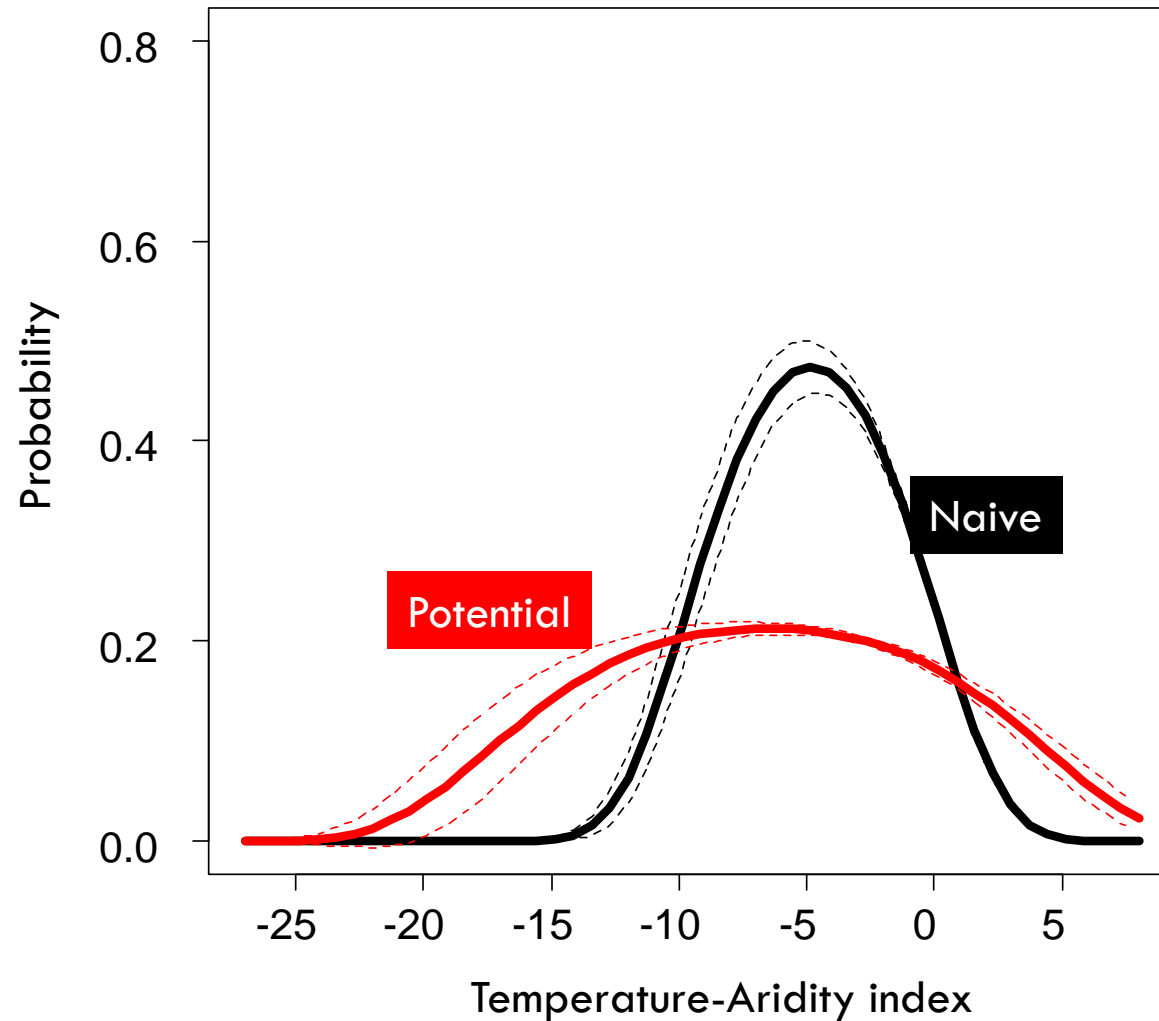
view by
classic SMD



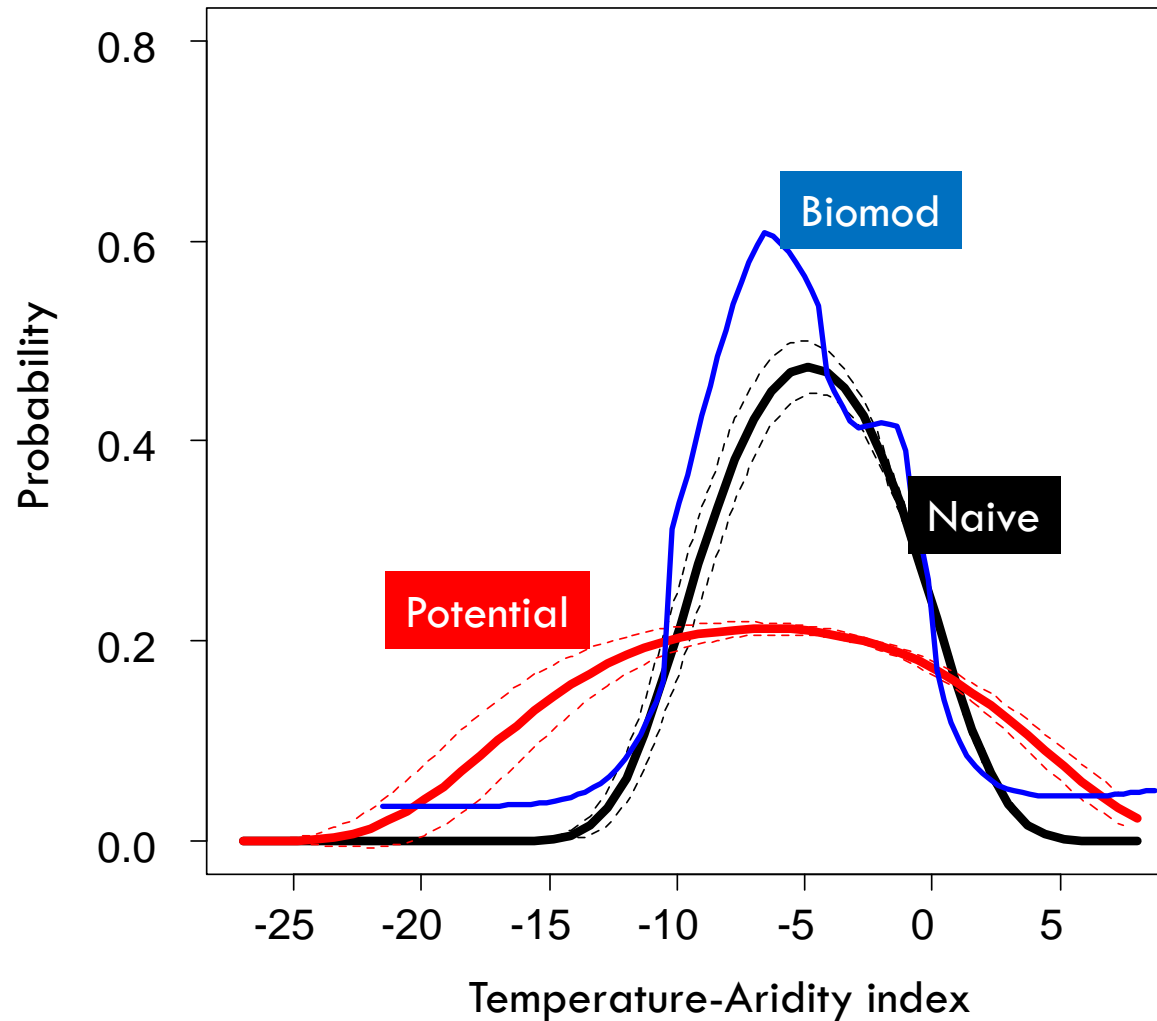
Structural equation modelling (SEM)

- 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)



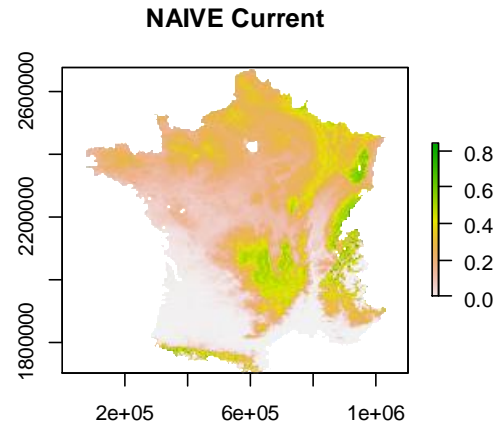
Response curves (Beech)



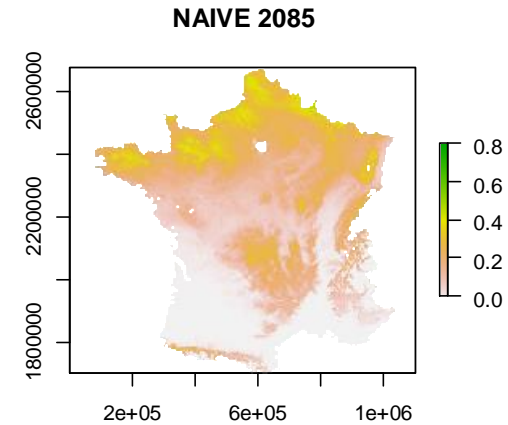
« Potential distribution » : beech



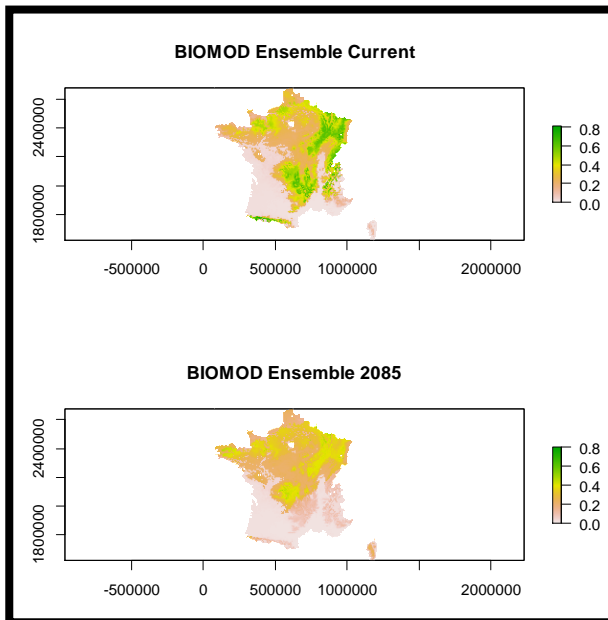
Observation NFI (Beech)



NAIVE Current

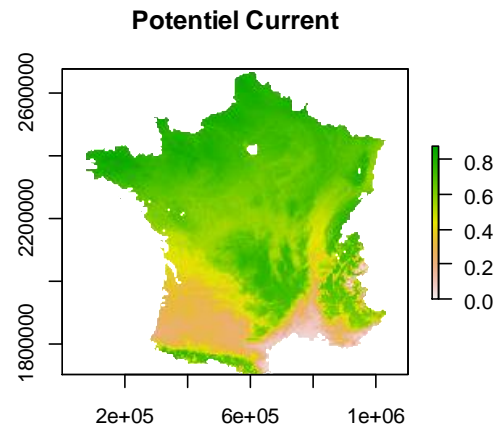


NAIVE 2085

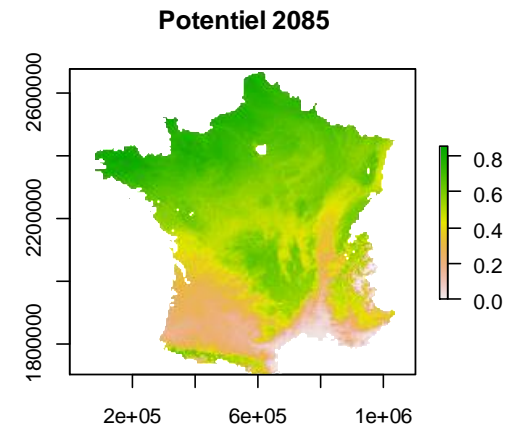


BIOMOD Ensemble Current

BIOMOD Ensemble 2085

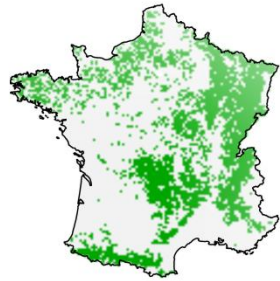


Potentiel Current

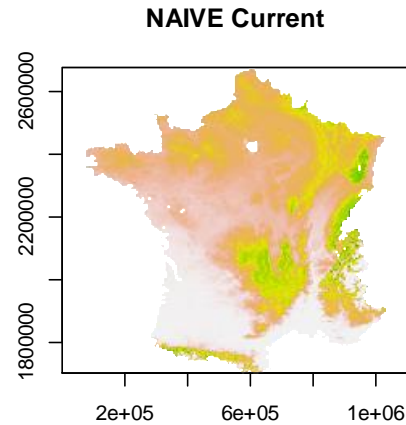


Potentiel 2085

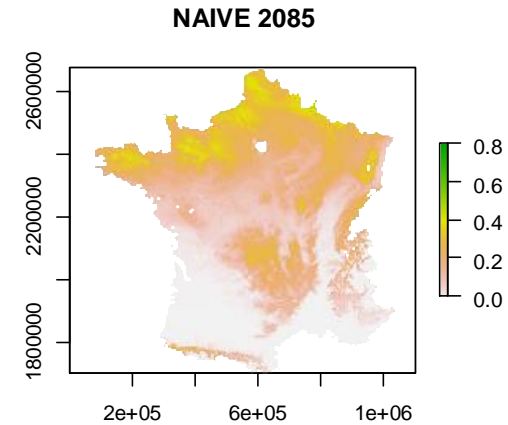
« Realized distribution » : beech



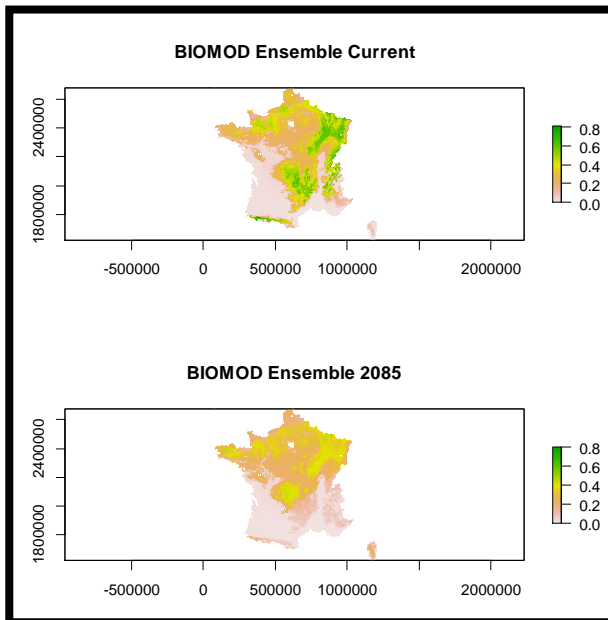
Observation NFI (Beech)



NAIVE Current

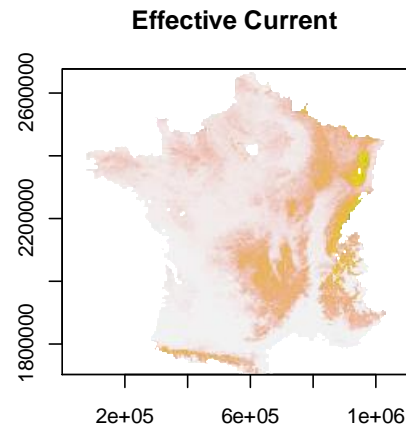


NAIVE 2085

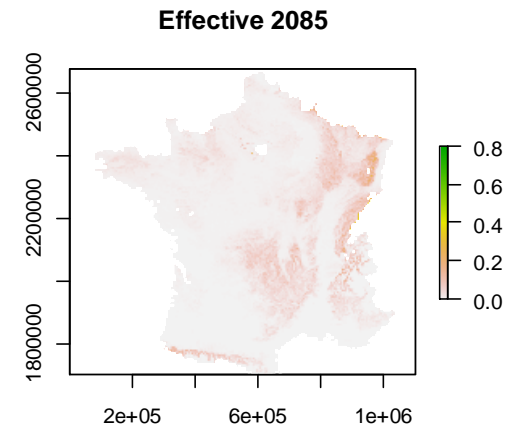


BIOMOD Ensemble Current

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

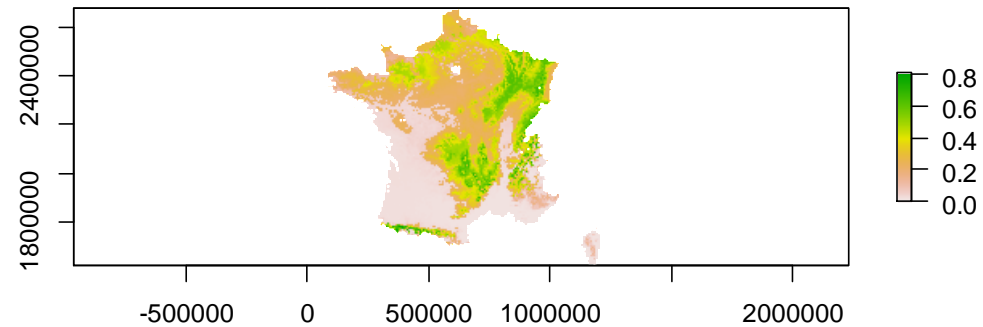


THANKS



« Biomod distribution » : beech

BIOMOD Ensemble Current



BIOMOD Ensemble 2085

