Integrating economic constraints into tree species distributions models

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Outline

1 – INTRODUCTION

2 – THEORY

3 – DATA

4 – RESULTS

5 – CONCLUSIONS

Species Distribution Models (SDM)

Very used statistical tool to study natural species distribution

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Once $F(\cdot)$ is estimated, one can predict the probabilities of species presence according to current or projected values of X_i

Economics of selection bias

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Not observing a tree species in an agricultural area does not mean that this area has unsuitable bio-climatic conditions

$\Rightarrow$ Economic choices about land use produce a selection bias

Contribution of the paper

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We found that modeling land-use selection process is of increasing importance when working at fine spatial resolutions

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Source of selection bias

The potential event of interest is unobservable because of the condition of having a Compatible Land Use (forests here):

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Table : What is observed instead of m_p

	forest	not forest
$m_p = 1$	1	0
$m_p = 0$	0	0

Bias from classical SDMs

The fundamental source of bias comes from the correlation between the errors of the economic and ecological equations

- positive correlation Positive bias (over-estimation)
- negative correlation Negative bias (under-estimation)
- independent errors Without bias

Technical details

Ay, J.-S., Guillemot, J., Martin-StPaul, N., Doyen, L. and Leadley, P. (2016), *The economics of land use reveals a selection bias in tree species distribution models*. Global Ecology and Biogeography. 10.1111/geb.12514.

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Presence/absence data

French *Inventaire Forestier National* (2014) at 2, 4 and 8 km resolutions. Regular grid sampling with all forests surveyed:

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4 tree species: sessile oak (*Q.petrae*), pubescens oak (*Q.pubescens*), beech (*F.sylvatica*) and fir (*A.alba*)

R package SemiParBIVProbit: Semi-parametric Sample Selection Binary Response Modeling 2013 by Marra and Radice

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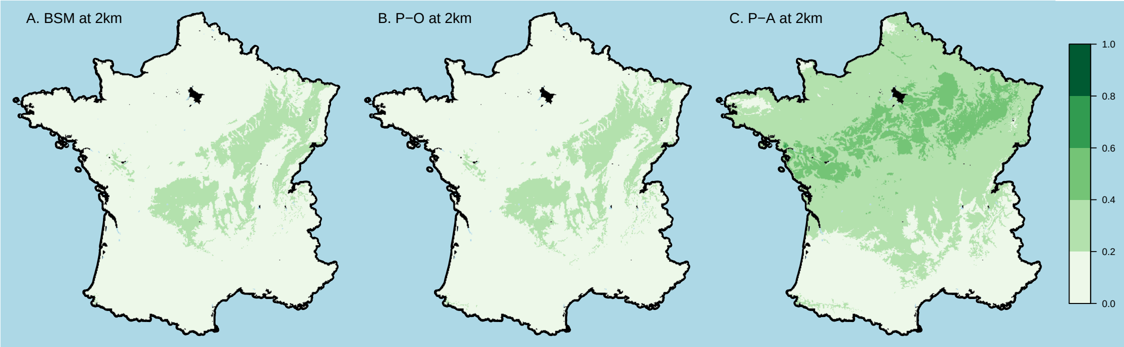
Significant selection bias

Table : Correlations ρ between errors and 95% CI

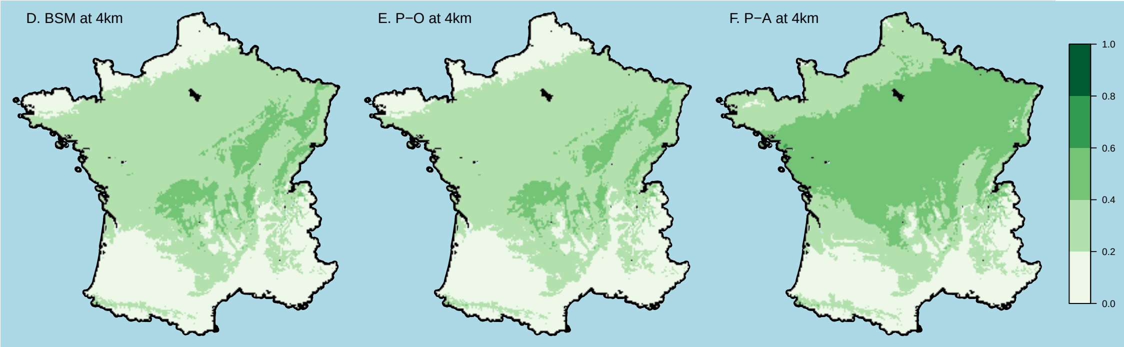
	Q.petrae	Q.pubescens	F.sylvatica	A.alba
2 KM	0.536 [0.5, 0.55]	0.557 [0.51, 0.57]	-0.486 [-0.53, -0.43]	-0.551 [-0.58, -0.51]
4 KM	0.424 [0.3, 0.48]	0.494 [0.41, 0.52]	-0.355 [-0.41, -0.29]	-0.353 [-0.42, -0.26]
8 KM	-0.303 [-0.49, 0.07]	0.536 [-0.54, 0.54]	0.345 [0.18, 0.44]	0.042 [-0.12, 0.2]

Sessile oak at 2 km



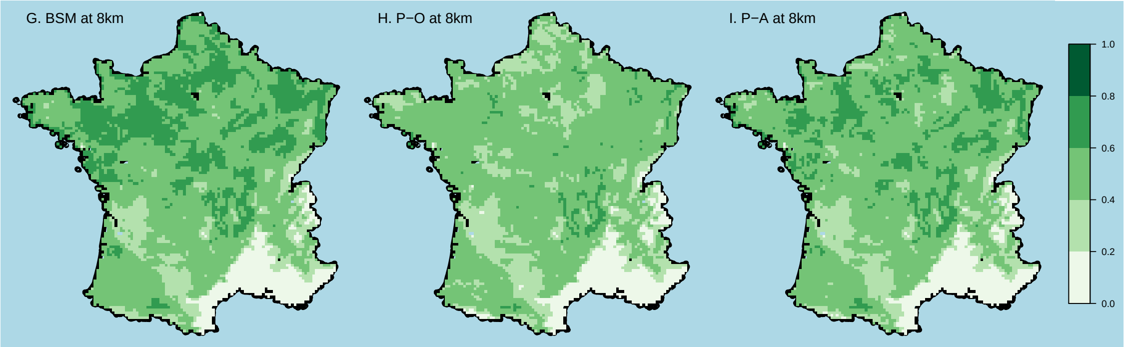
(positive correlation)

Sessile oak at 4 km



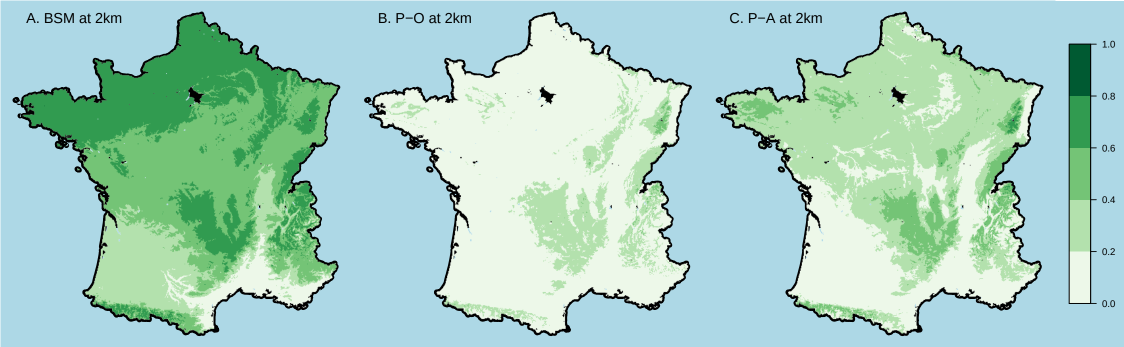
(positive correlation)

Sessile oak at 8 km



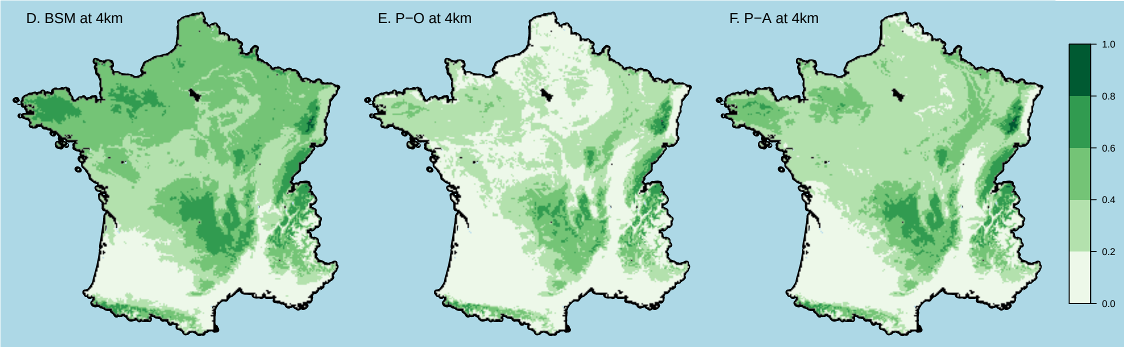
(null correlation)

Beech at 2 km



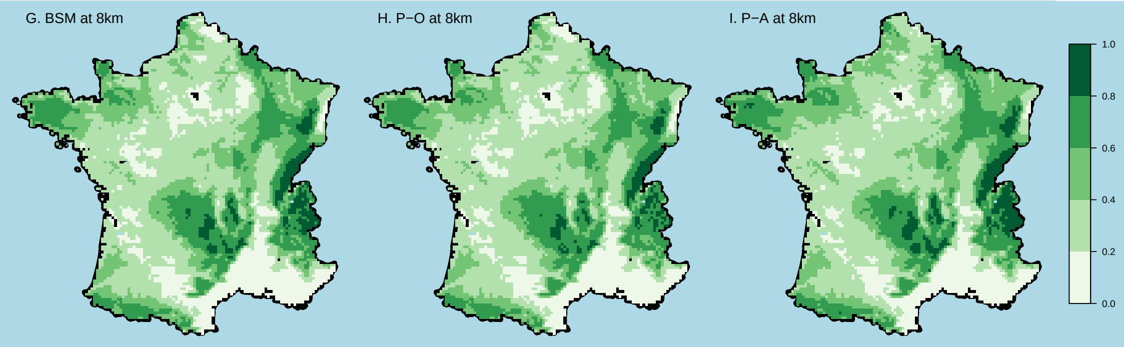
(negative correlation)

Beech at 4 km



(negative correlation)

Beech at 8 km



(positive correlation)

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Synthesis

We known since Ricardo (1821) that best plots of land are first dedicated to crops, hence forests are a residual land use

Our results are complementary as forests correspond to the best plots of species niche ($\rho > 0$) or the worst plots ($\rho < 0$)

Depending on the correlation, climate change projections from classical SDMs can be over-optimistic or over-pessimistic