



Influence of the spatial resolution of climate on tree range simulations

Nicolas Martin-StPaul, Julien Ruffault, Christophe François, Marc Stéfanon, P. Drobinsky, Kamel Soudani, Eric Dufrene, Serge Rambal, Florent Mouillot, Paul Leadley

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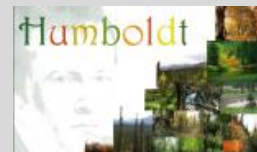
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Martin-StPaul NK, Ruffault J., Francois C., Stéfanon M., Drobinsky P., Cheaib A., Soudani K., Dufrêne E., Rambal S., Mouillot F. & Leadley P.

EGU 2013
Vienna April 04

Drawing of a dying beech, ink (200x250 cm) Adeline Carrion Reyna



Introduction

The footprint of climate change on forests

Beech upward shift (70m) to the top of the mountains



Penuelas *et al.*, 2003 *GCB*

1945

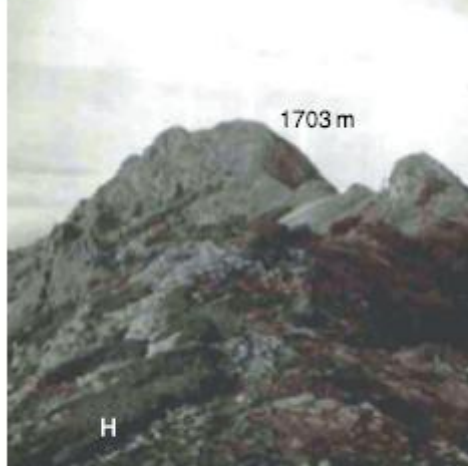
1995

➤ Migration toward higher elevation

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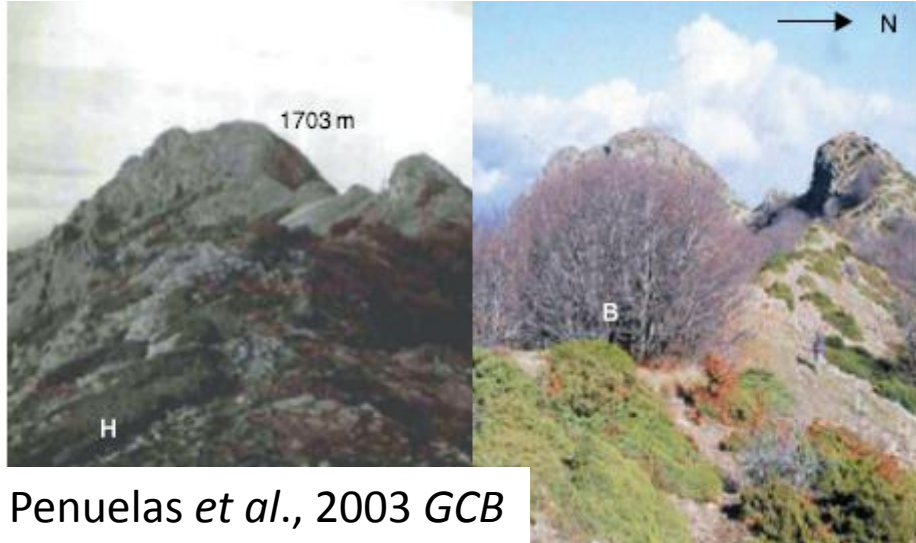
- Migration toward higher elevation
- Increase tree dieback



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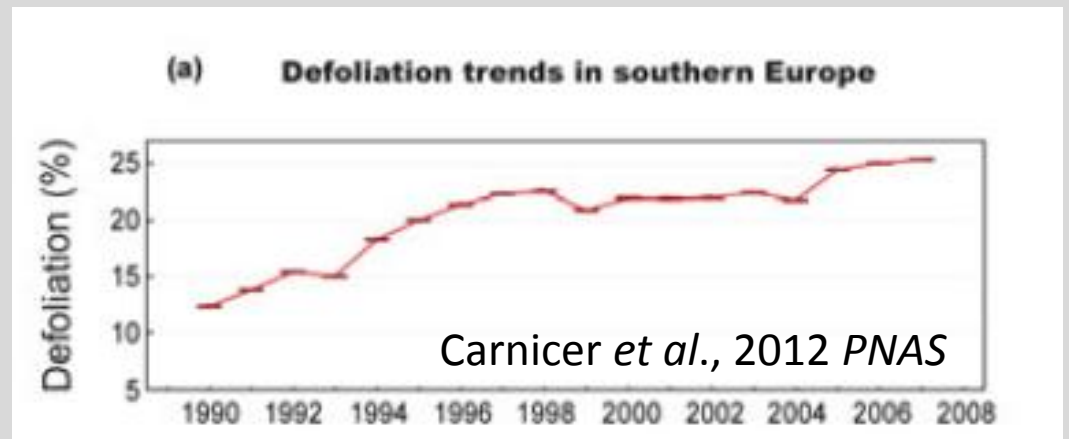
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- Migration toward higher elevation
- Increase tree dieback
- Increase forest defoliation

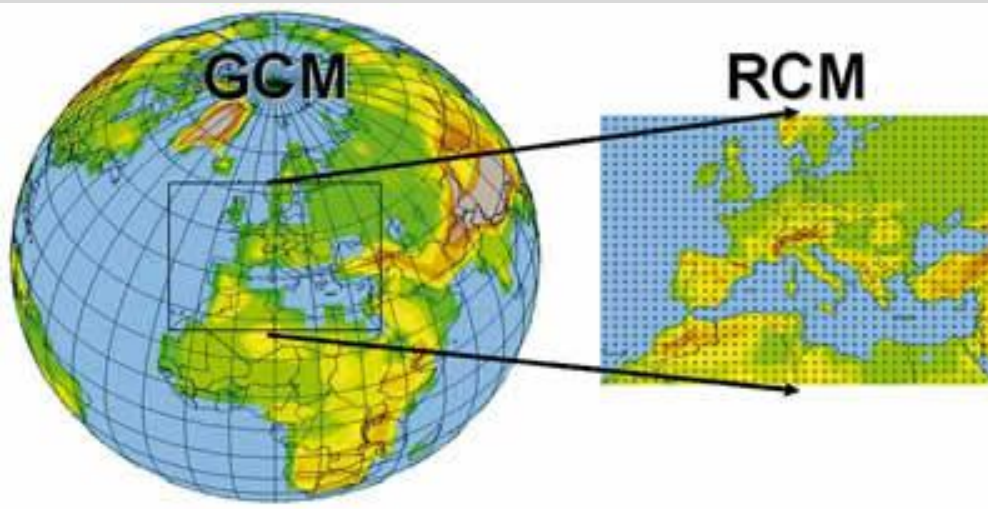


Allen *et al.*, 2009 *FEM*



Introduction

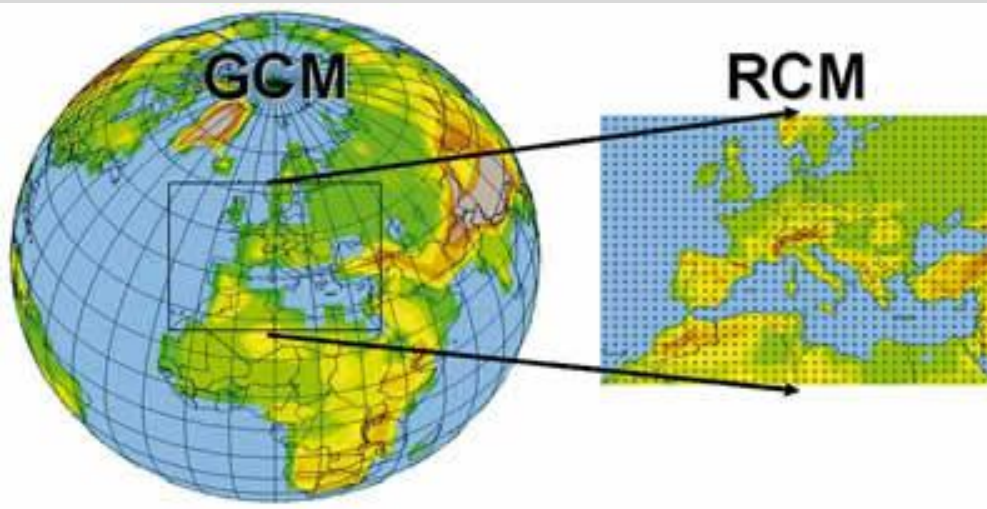
Anticipating climate change effects on trees and forest



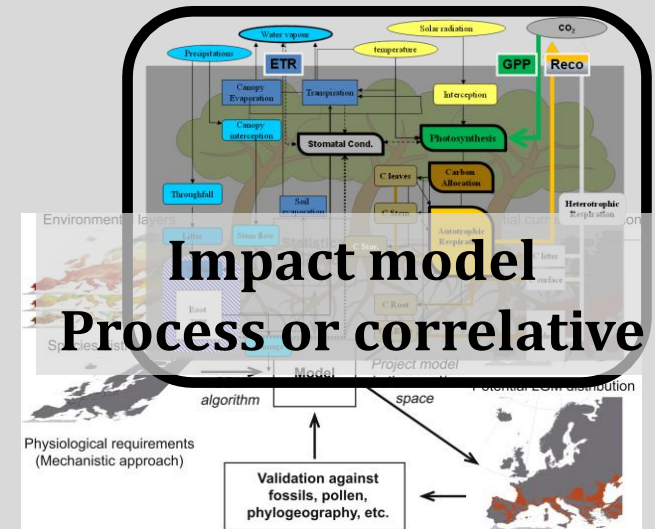
Climate projection (Resolution 300 to 50 km)

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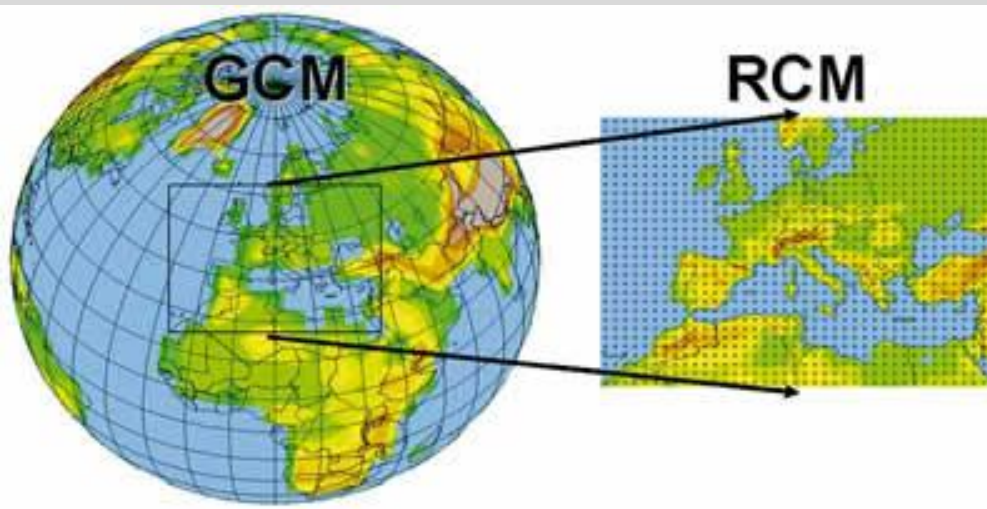


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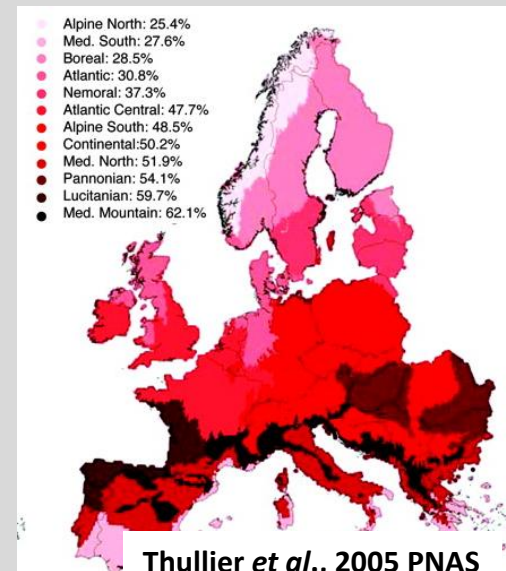
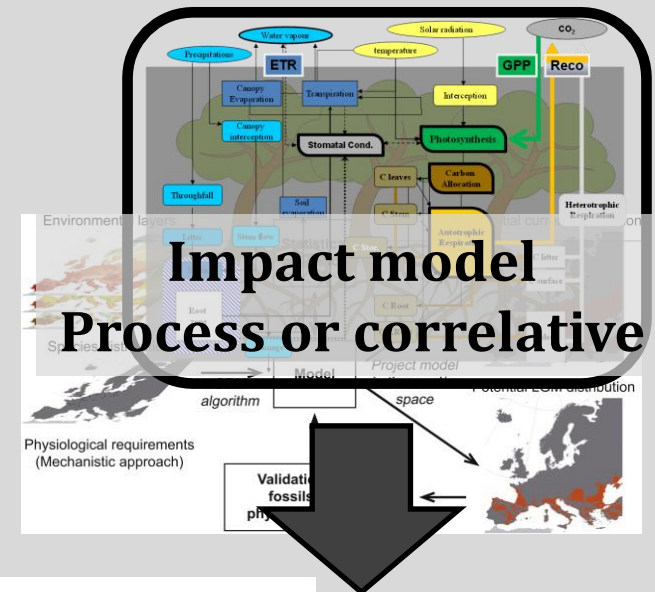


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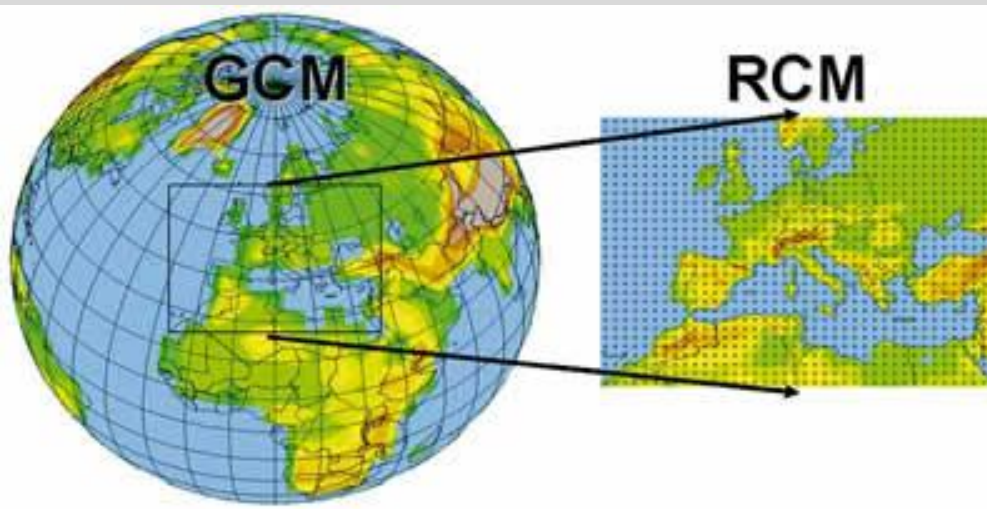
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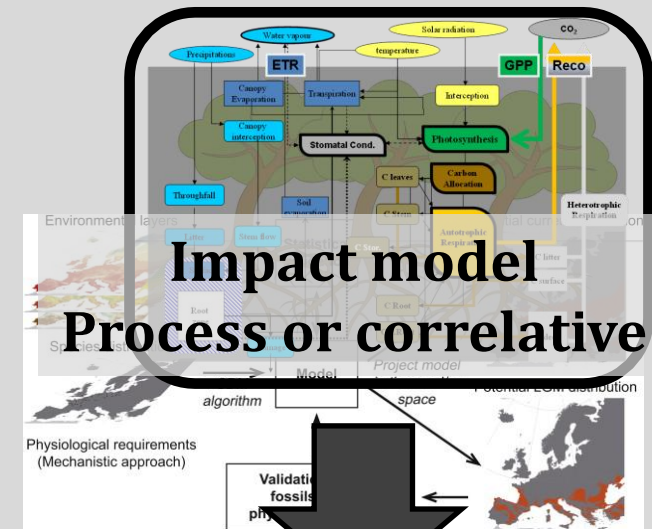
Biodiversity
Losses
2080-2100
Compared to
1970-1990
Using 50km
Resolution climate

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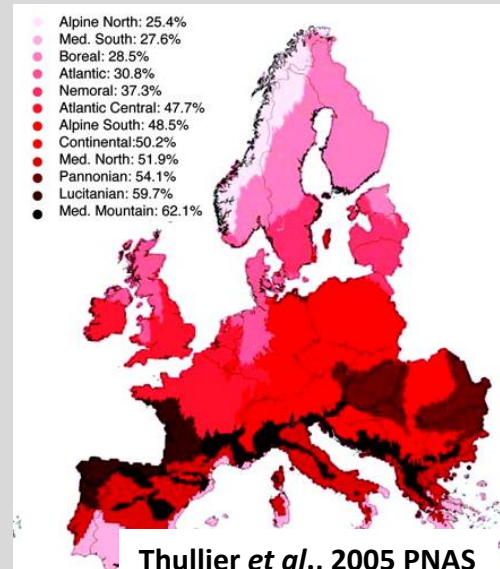
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Climate projection (Resolution 300 to 50 km)



Very large biodiversity losses in europe >60% !

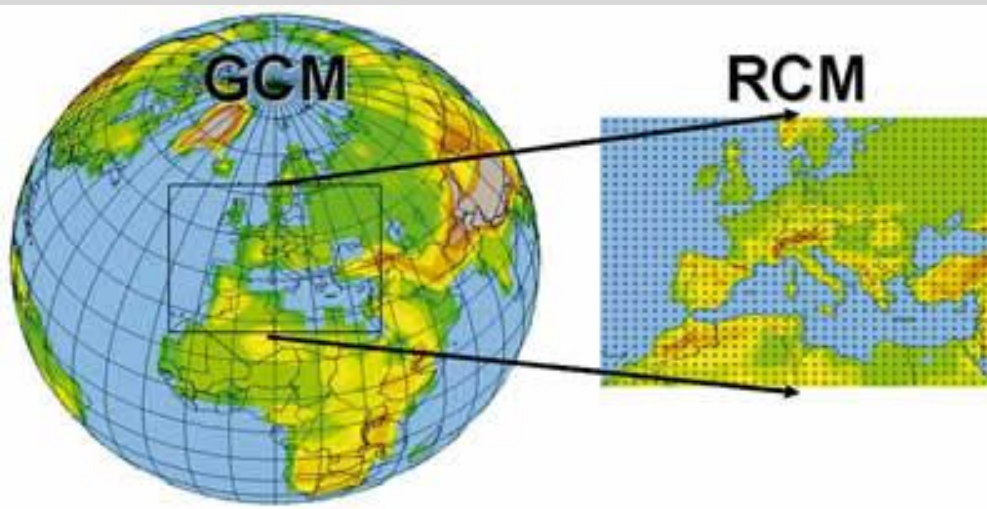


Thullier *et al.*, 2005 PNAS

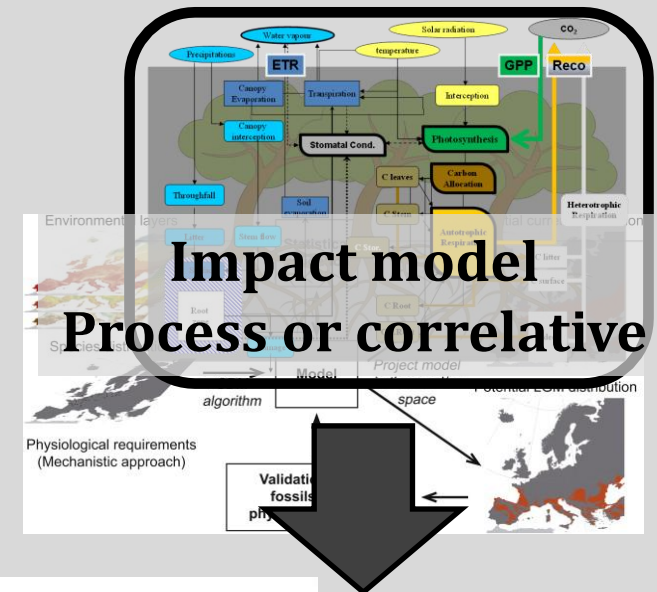
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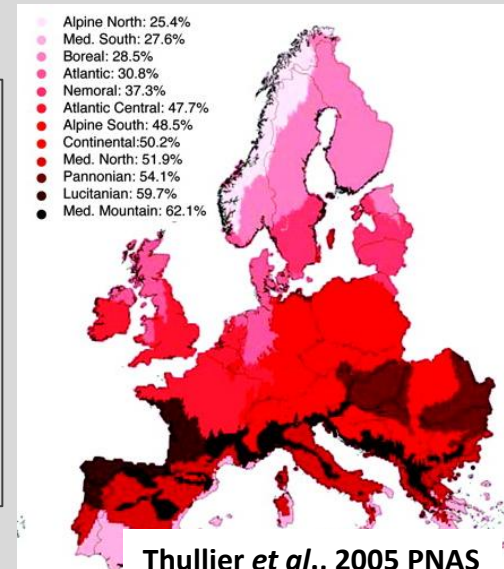


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Very large biodiversity losses in europe >60% !

A matter of resolution ? Randin *et al.*, 2009 (GCB) ...

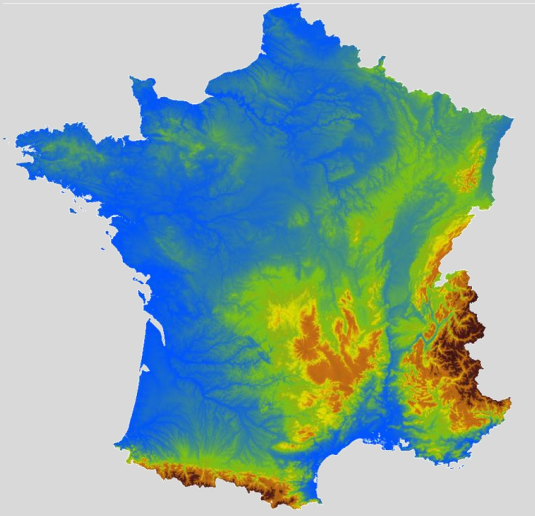


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A matter of spatial scale ?

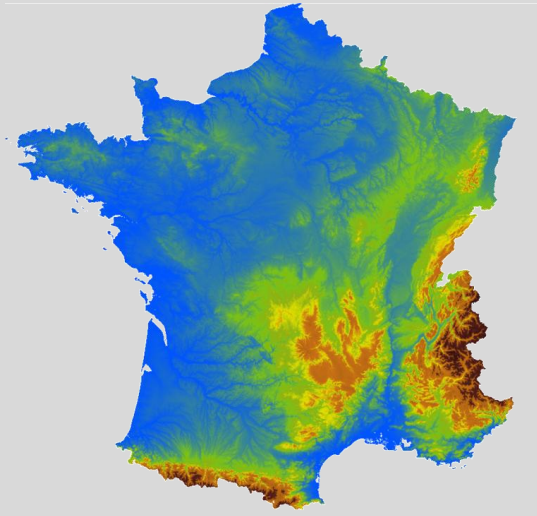
Does the spatial resolution of climate affect the simulations of the productivity of beech and oak forest over France?



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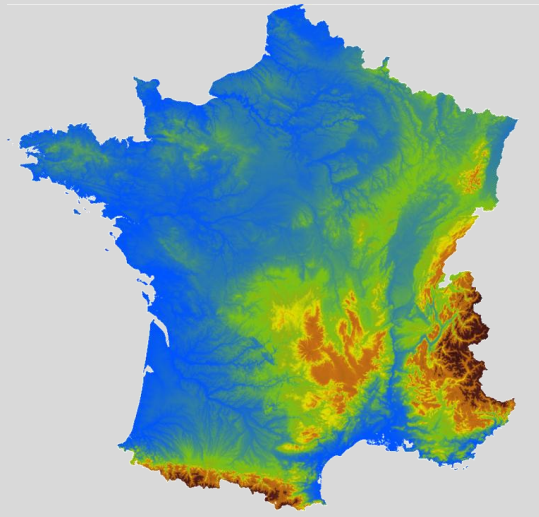


➡ Steep climatic gradient

Introduction

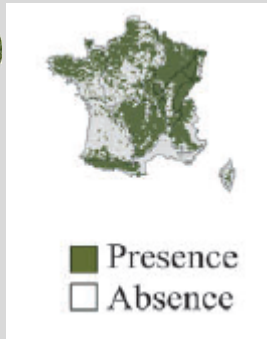
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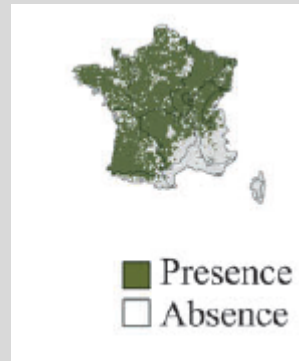


➔ Steep climatic gradient

▪ *European Beech*



▪ *Pedunculate Oak*

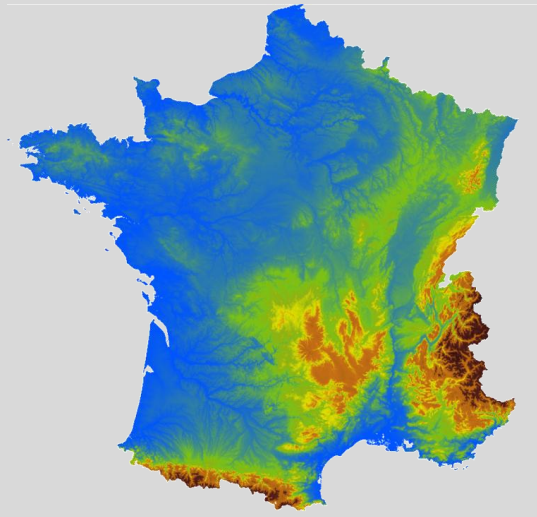


➔ Two wide spread tree species

Introduction

A matter of spatial scale ?

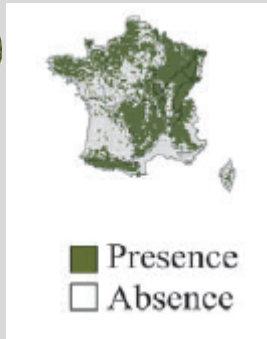
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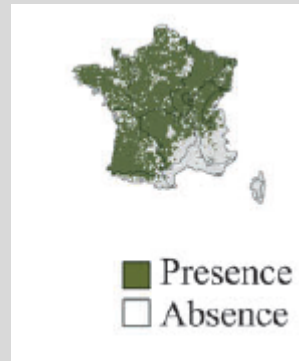
➔ Steep climatic gradient

Hyp:
**Most changes should appear in
mountainous regions**

▪ *European Beech*



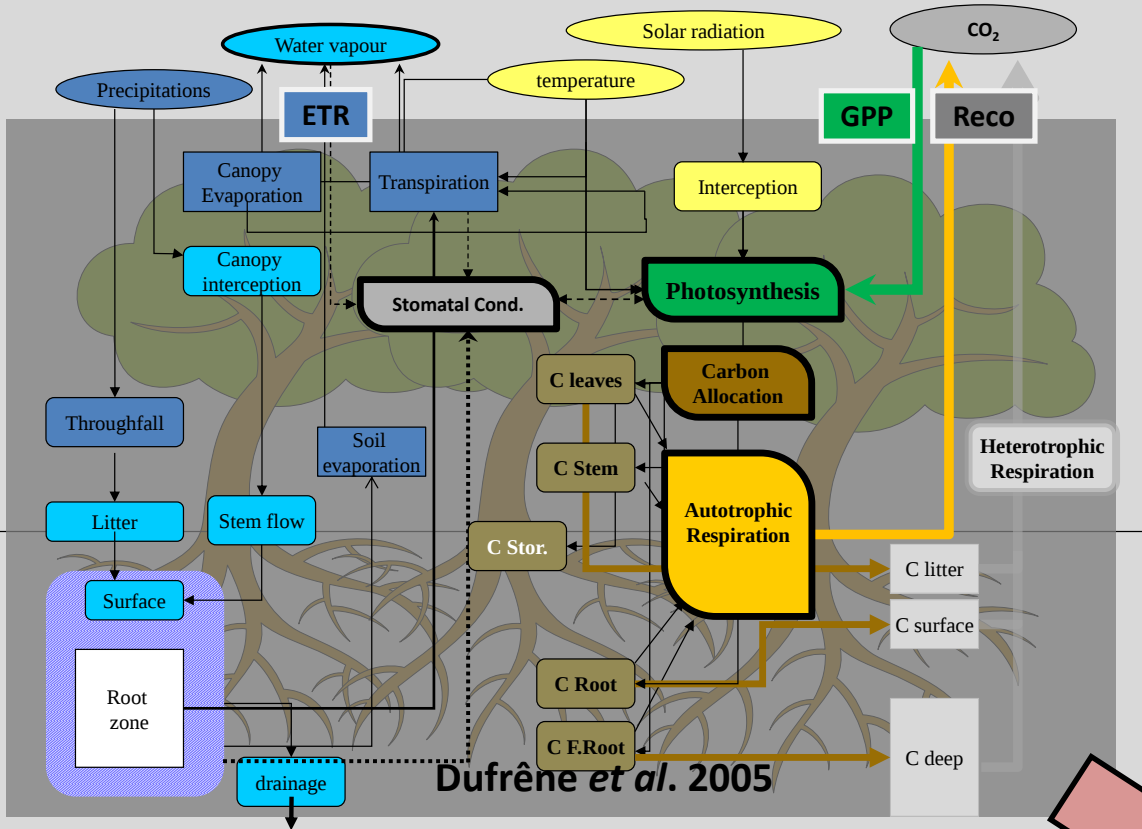
▪ *Pedunculate Oak*



➔ Two wide spread
tree species

Materials & Methods

The model CASTANEA

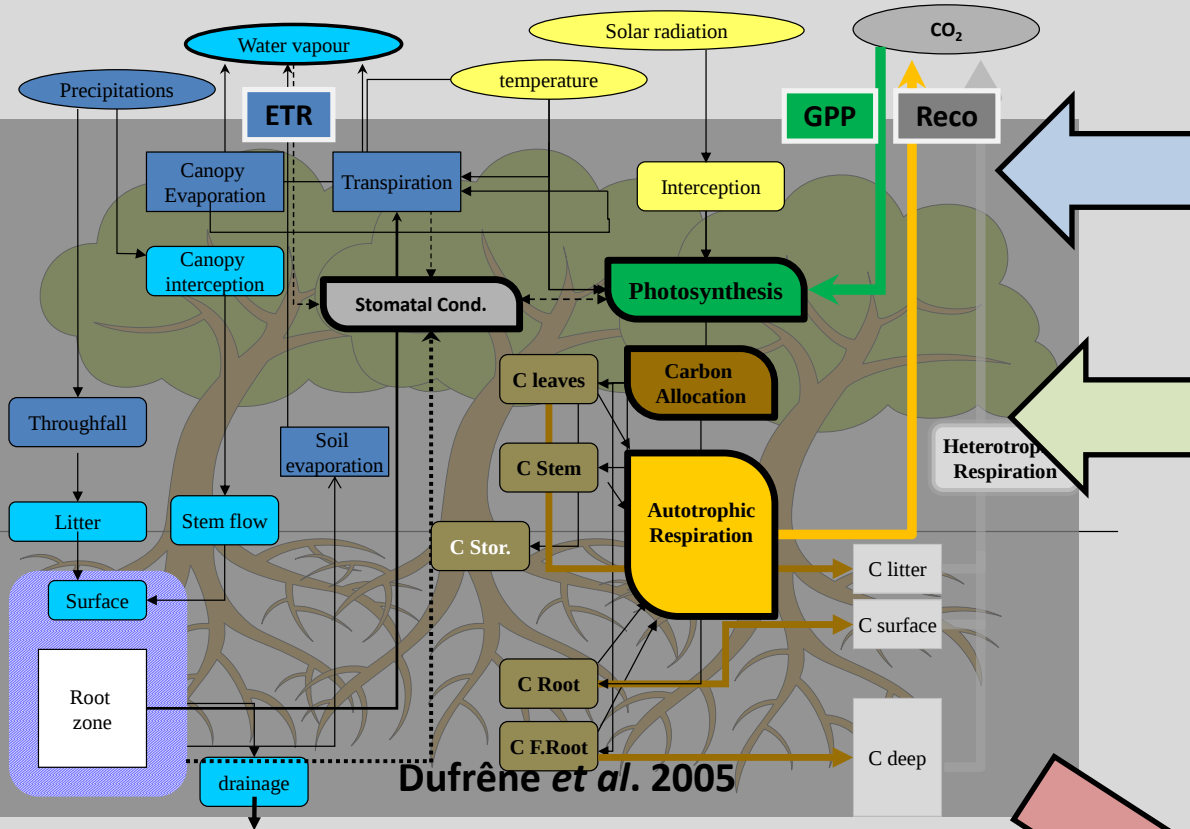


- ✓ Process based model
- ✓ Monospecific
- ✓ Average tree
- ✓ Daily time step

-C, H_2O Fluxes
-NPP, Growth, wood production
-Presence

Materials & Methods

The model CASTANEA



Daily climatic input
- Rainfall ; Temperature;
Radiation ; Wind speed
Humidity

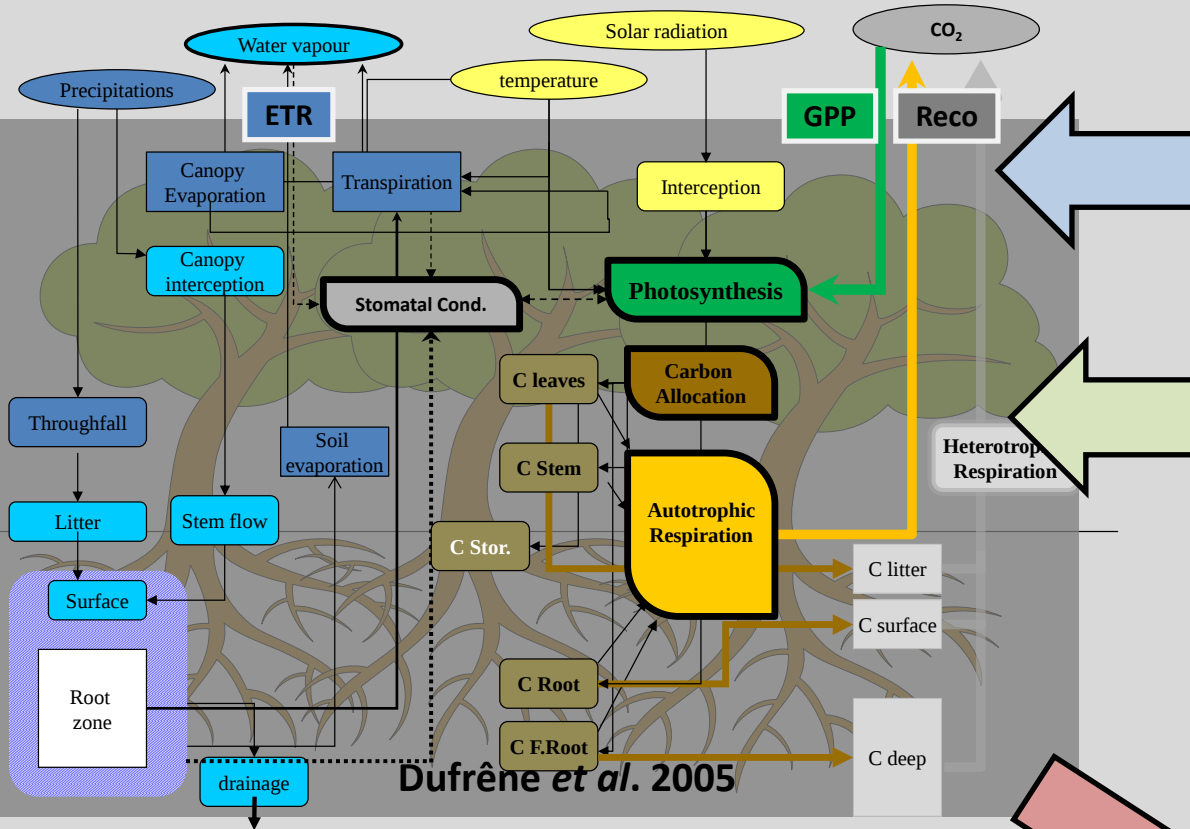
Stand and species parameters
➤ LMA, Photosynthetic capacity, C Allocation...
➤ Soil available water content

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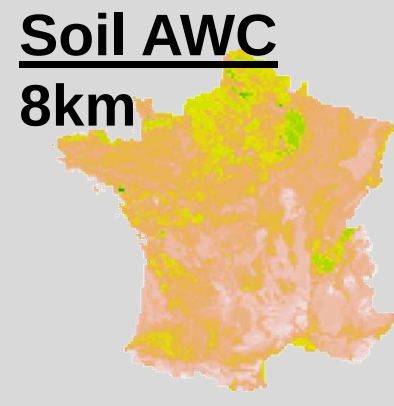
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Databases & simulations

- **Analysis at different resolution : SAFRAN**
- **Period (1989-2010) × 7 : Forest rotation**

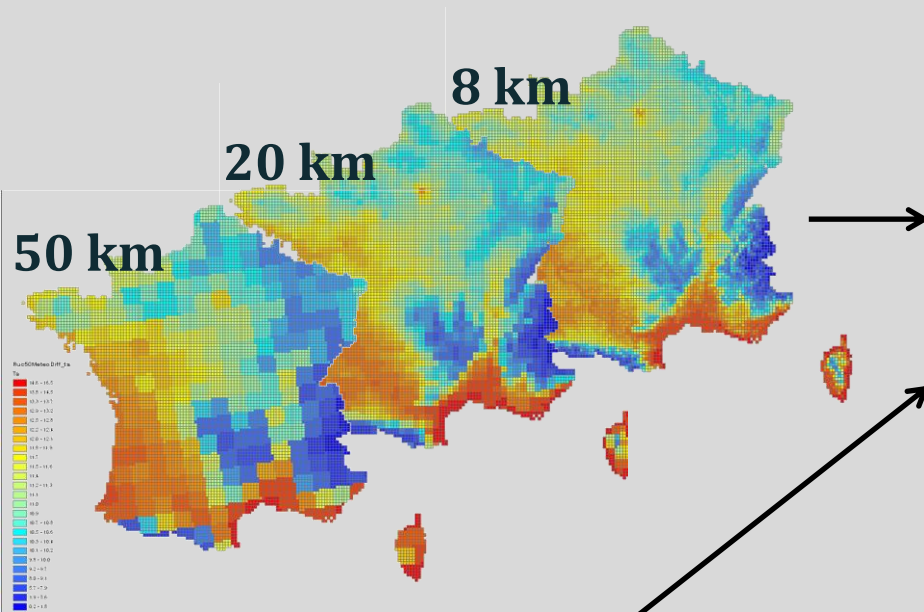


Materials & Methods

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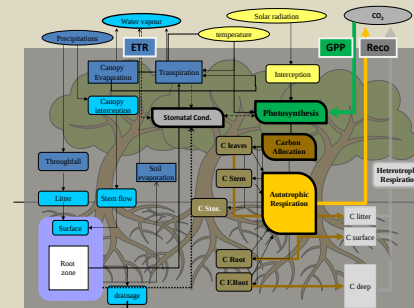


Soil AWC

8km



Process model CASTANEA



Dufrène *et al.* 2005

▪ European Beech



▪ Deciduous Oak

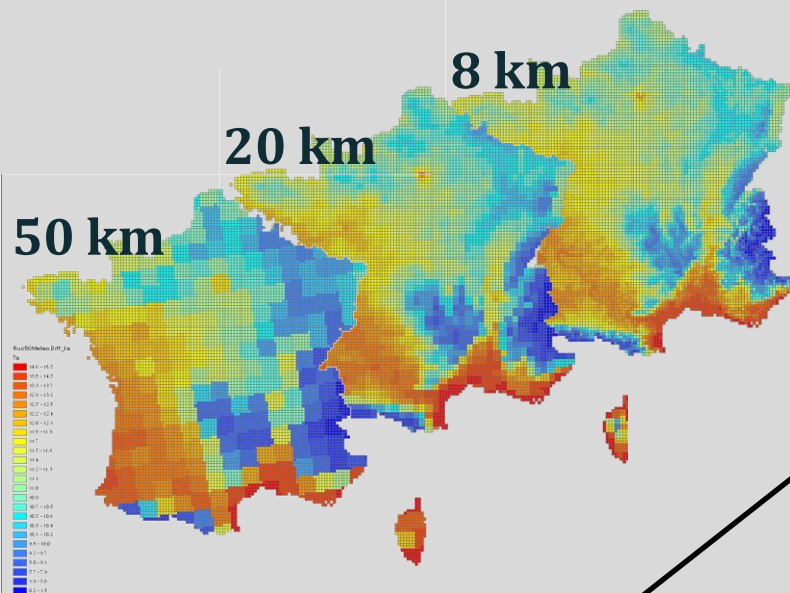


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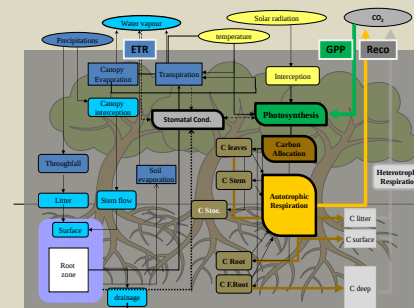
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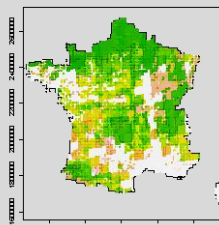
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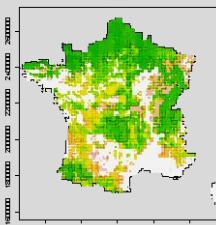
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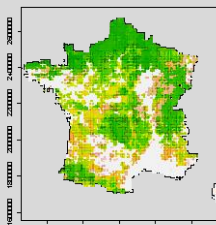
Climate
50km



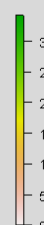
Climate
20km



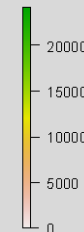
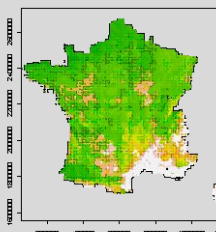
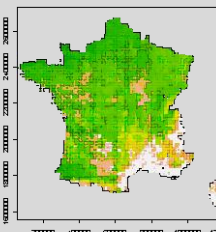
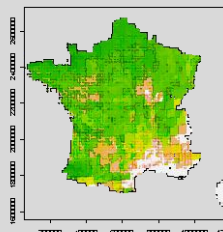
Climate
8km



Wood production
(gC m⁻²)



Beech



Oak



Results

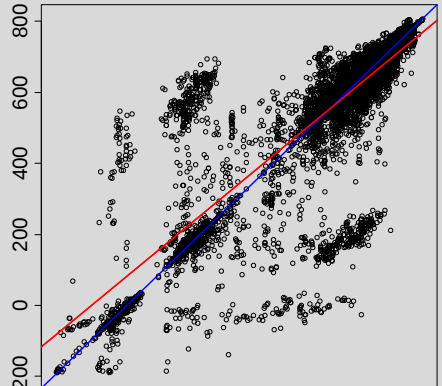
Beech and oak productivity at variable climate resolution

NPP_{8km} vs. NPP_{50km}
($gC\ m^{-2}\ y^{-1}$)

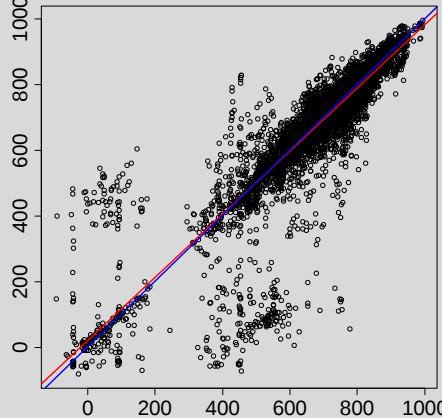
Beech



NPP_{8km}



Oak



NPP_{50km}



The effect of
spatial resolution is

Unbiased at
France scale

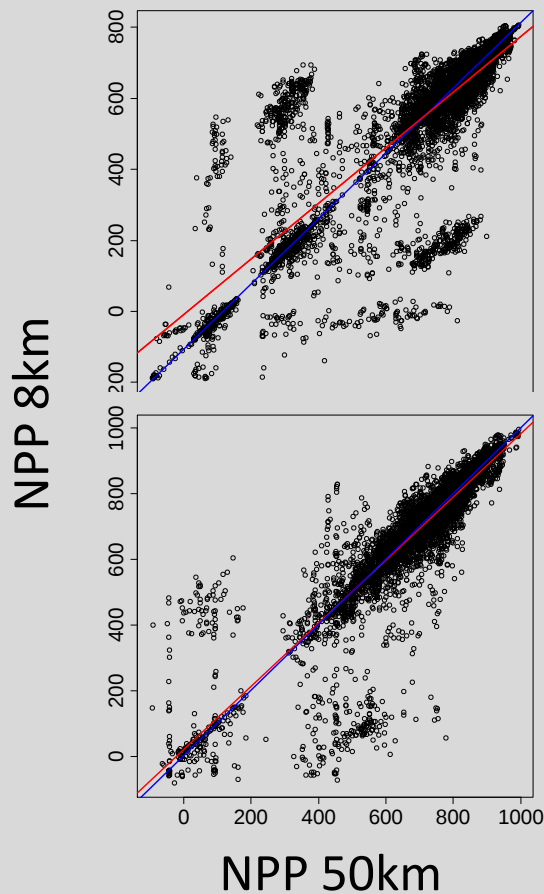
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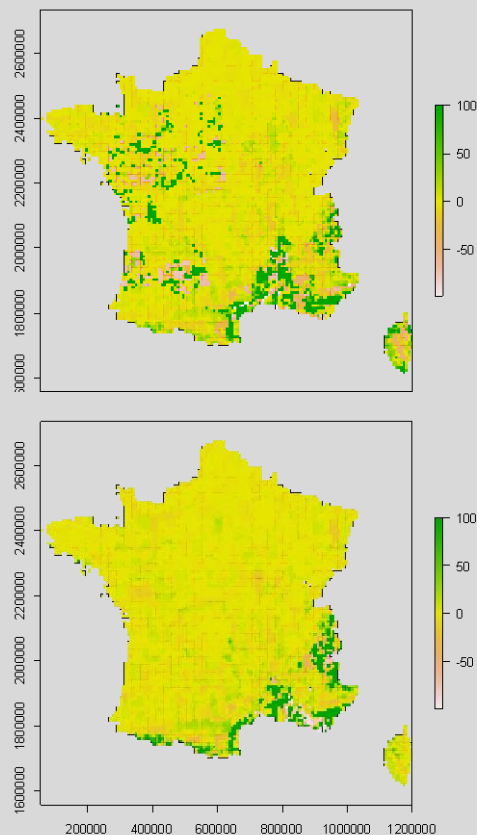
NPP_{8km} vs. NPP_{50km}
(gC m⁻² y⁻¹)



Oak



$$100 \times \left(\frac{NPP_{\text{coarse}} - NPP_{\text{fine}}}{NPP_{\text{fine}}} \right)$$



The effect of
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Unbiased at
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Important locally
Not only in the mountain

Results

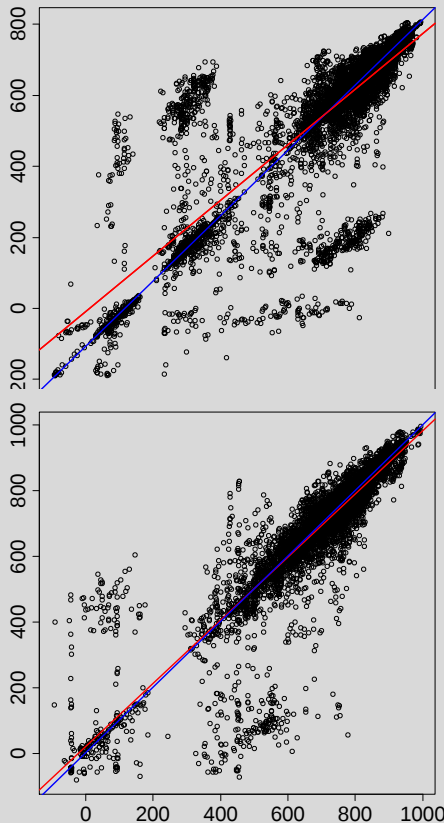
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NPP 8km



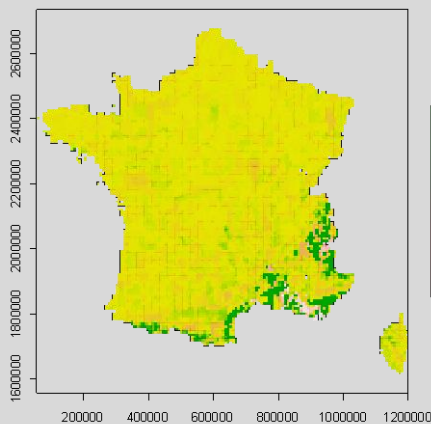
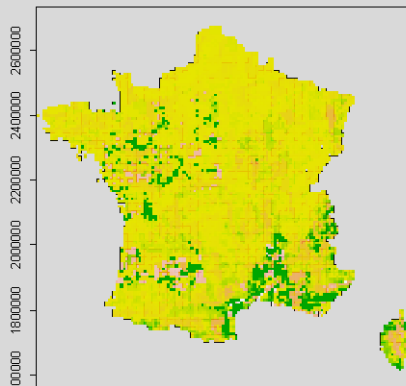
NPP 50km



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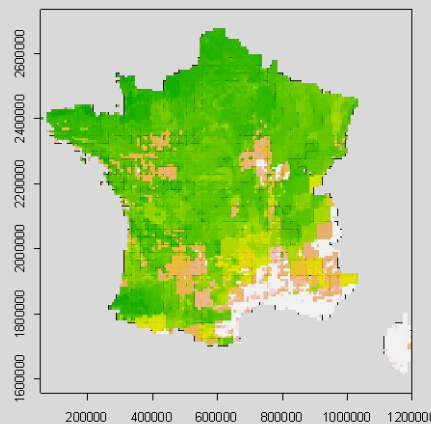
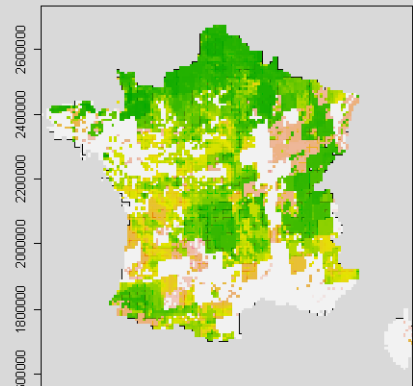
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Wood
Production (gC m⁻²)



At the edge²³
of the species range



Results

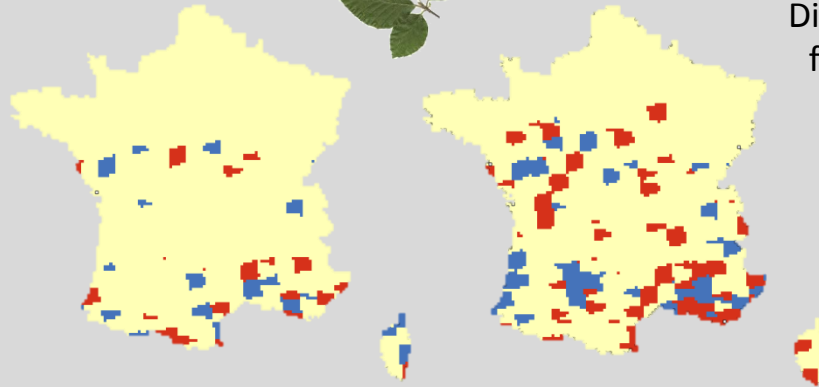
What resolution do we need and where ?

European beech

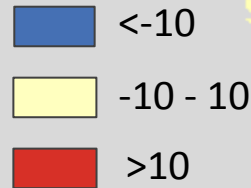
20 km



50 km



Wood Production
Difference (%) to
fine resolution

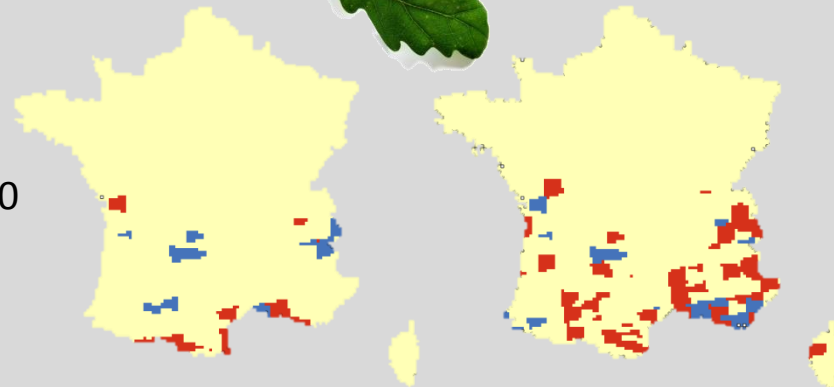


Deciduous oak

20 km



50 km



Results

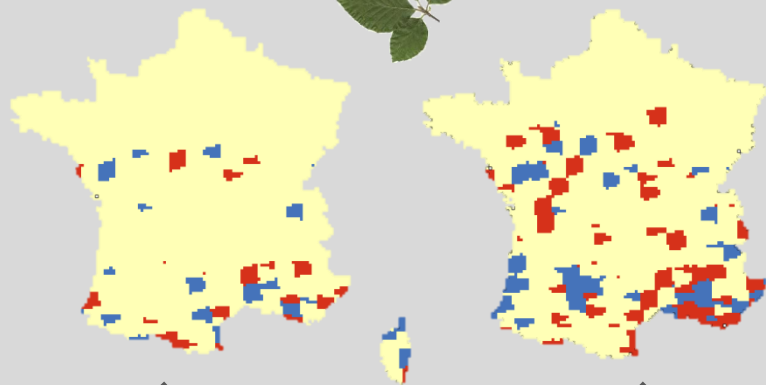
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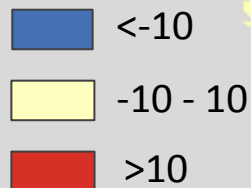
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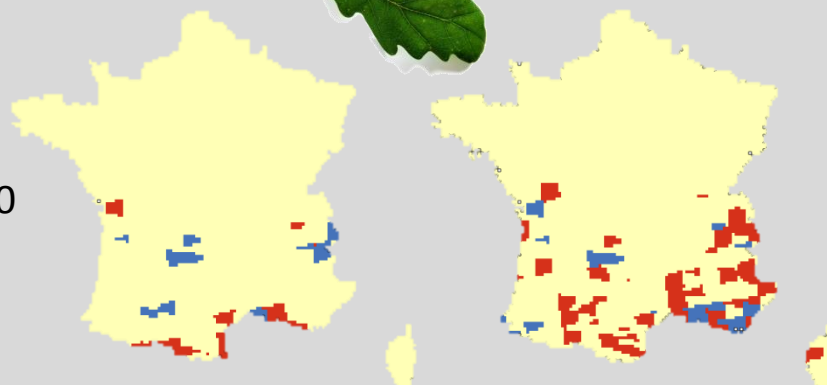


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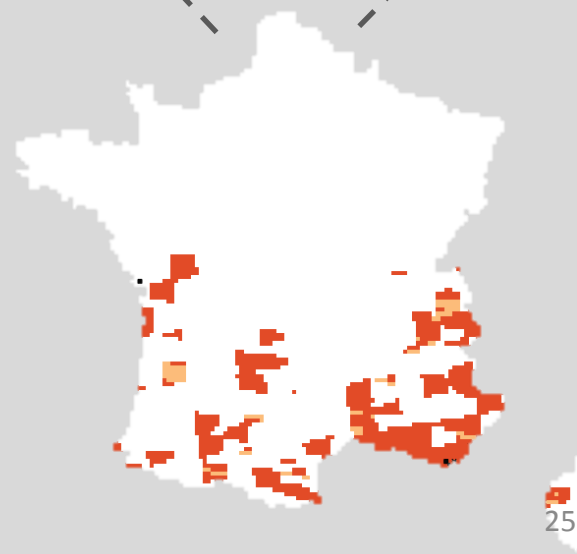
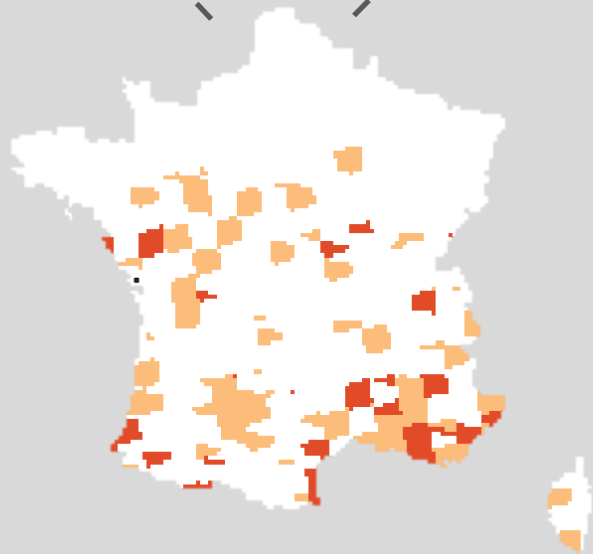
20 km



50 km



Best resolution



Summary

- Climate resolution affects the simulation of beech & Oak productivity
- Not only in mountainous area... At the edge of species range
- Patterns of the optimal resolution differ between species :

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Conclusion

**Difficult to assess if there is an optimal resolution :
The finer the better...**

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The finer the better...**

Perspectives

- Simulations at 1km resolution using statistical downscaling
- Other species; Climate change scenari

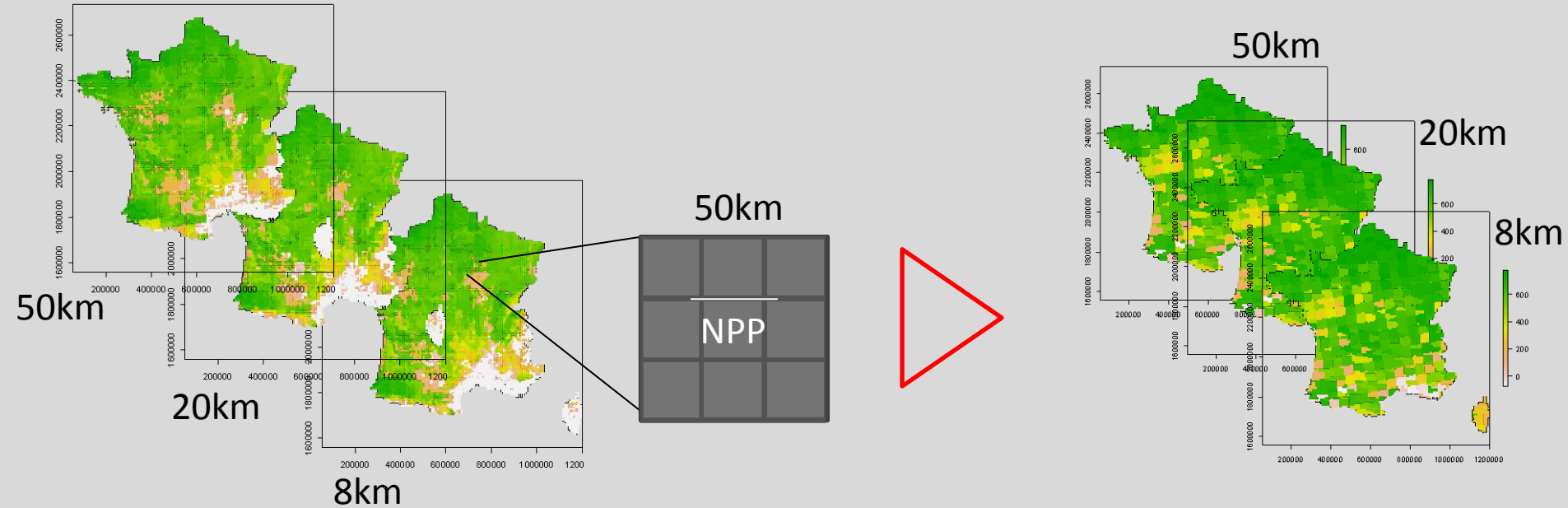


Thank you for your attention

Drawing of a dying beech, ink (200x250 cm) Adeline Carrion Reyna

Results

What resolution do we need and where ?



$$100 \times \left(\frac{NPP_{\text{coarse}} - NPP_{\text{fine}}}{NPP_{\text{fine}}} \right)$$