Influence of the spatial resolution of climate on tree range simulations
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Influence of the spatial resolution of climate on tree range simulations

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Drawing of a dying beech, ink (200x250 cm) Adeline Carrion Reyna
Introduction
The footprint of climate change on forests

Penuelas et al., 2003 GCB

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

Migration toward higher elevation
Introduction
The footprint of climate change on forests

- Increase tree dieback
- Migration toward higher elevation

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

Penuelas et al., 2003 GCB
1945 1995

Allen et al., 2009 FEM
Introduction
The footprint of climate change on forests

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

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

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Carnicer et al., 2012 PNAS

Defoliation trends in southern Europe
Introduction

Anticipating climate change effects on trees and forest

Climate projection (Resolution 300 to 50 km)
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Impact model
Process or correlative

Climate projection (Resolution 300 to 50 km)

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

Thullier et al., 2005 PNAS
**Introduction**

Anticipating climate change effects on trees and forest

Very large biodiversity losses in Europe >60%!

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

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Steep climatic gradient
Introduction
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- European Beech
- Pedunculate Oak

Two wide spread tree species

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

Steep climatic gradient

Hyp:
Most changes should appear in montainous regions

- European Beech
- Pedunculate Oak

Two wide spread tree species
Materials & Methods
The model CASTANEA

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

Dufrêne et al. 2005

-C, H$_2$O Fluxes
-NPP, Growth, wood production
-Presence
Materials & Methods

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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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Databases & simulations

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

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Wood production (gC m⁻²)
- Beech
- Oak
Results
Beech and oak productivity at variable climate resolution

The effect of spatial resolution is unbiased at France scale.
Results
Beech and oak productivity at variable climate resolution

The effect of spatial resolution is

Unbiased at France scale

Important locally
Not only in the mountain
Results

Beech and oak productivity at variable climate resolution

Beech

Oak

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At the edge of the species range

Wood Production (gC m\(^{-2}\))

The effect of spatial resolution is

Unbiased at France scale

Important locally

Not only in the mountain

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Results

What resolution do we need and where?

European beech

20 km

50 km

Wood Production Difference (%) to fine resolution

-10
-10 - 10
>10

Deciduous oak

20 km

50 km
Results
What resolution do we need and where?

European beech
- 20 km
- 50 km

Deciduous oak
- 20 km
- 50 km

Wood Production Difference (%) to fine resolution:
- Blue: <-10
- Yellow: -10 - 10
- Red: >10

Best resolution:
- White: 50 km
- Orange: 20 km
- Red: 8 km
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:
**Summary**

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**Conclusion**

**Difficult to assess if there is an optimal resolution:**

**The finer the better...**
Summary

- Climate resolution affects the simulation of beech & Oak productivity
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- Patterns of the optimal resolution differ between species:

Conclusion

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

Perspectives

- Simulations at 1km resolution using statistical downscaling
- Other species; Climate change scenarii
Thank you for your attention
Results

What resolution do we need and where?

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