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

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
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
Introduction
The footprint of climate change on forests

- Migration toward higher elevation
- Increase tree dieback

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

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

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Carnicer et al., 2012 PNAS
Introduction

Anticipating climate change effects on trees and forest

Climate projection (Resolution 300 to 50 km)
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Anticipating climate change effects on trees and forest

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Anticipating climate change effects on trees and forest

Impact model

Process or correlative

Biodiversity Losses

2080-2100

Compared to

1970-1990

Using 50km Resolution climate

Climate projection (Resolution 300 to 50 km)

GCM

RCM
Introduction

Anticipating climate change effects on trees and forest

Very large biodiversity losses in europe >60%!

Impact model
Process or correlative

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Biodiversity Losses
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Thullier et al., 2005 PNAS
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Anticipating climate change effects on trees and forest

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Very large biodiversity losses in europe >60%

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

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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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Steep climatic gradient
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Introduction

A matter of spatial scale?

- Pedunculate Oak
- European Beech

Steep climatic gradient

Two wide spread tree species
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?

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

-C, H₂O Fluxes
-NPP, Growth, wood production
-Presence

Dufrène et al. 2005
Materials & Methods
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- Process based model
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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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Climate:
- Analysis at different resolution: SAFRAN
- Period (1989-2010) × 7: Forest rotation

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Soil AWC
- 50 km
- 20 km
- 8 km

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Soil AWC

8 km

8 km

50 km

Climate:
- Climate 50 km
- Climate 20 km
- Climate 8 km

Wood production (gC m²)

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

The effect of spatial resolution is biased at France scale.

Important locally, not only in the mountain.

At the edge of the species range.
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

European beech

20 km

50 km
Results

What resolution do we need and where?

European beech

- 20 km
- 50 km

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

Deciduous oak

- 20 km
- 50 km

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:
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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
- Not only in mountainous area... At the edge of species range
- 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?

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