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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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

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
Introduction
The footprint of climate change on forests

- Migration toward higher elevation
- Increase tree dieback

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

- Increase forest defoliation: Carnicer et al., 2012 PNAS
- Increase tree dieback: Penuelas et al., 2003 GCB
- Migration toward higher elevation

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Defoliation trends in southern Europe: Carnicer et al., 2012 PNAS
Introduction
Anticipating climate change effects on trees and forest

Climate projection (Resolution 300 to 50 km)
Introduction

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Anticipating climate change effects on trees and forest biodiversity losses 2080-2100 compared to 1970-1990 using 50km resolution climate projection (Resolution 300 to 50 km).
Very large biodiversity losses in europe >60% !
Introduction
Anticipating climate change effects on trees and forest

Very large biodiversity losses in europe >60%!

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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Steep climatic gradient
Introduction
A matter of spatial scale?

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Steep climatic gradient

- European Beech
- Pedunculate Oak

Two wide spread tree species
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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, H₂O Fluxes
- NPP, Growth, wood production
- Presence

Dufrêne et al. 2005
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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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- Analysis at different resolution: SAFRAN
- Period (1989-2010) × 7: Forest rotation

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8km

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Soil AWC 8km

8 km
20 km
50 km

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Soil AWC

8 km

50 km

20 km

Climate:

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

The effect of spatial resolution is

- Unbiased at France scale
- Important locally in the mountain
- At the edge of the species range

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

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Deciduous oak

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Best resolution

- 50 km
- 20 km
- 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?

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