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

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
- 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

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

Climate projection (Resolution 300 to 50 km)

Impact model
Process or correlative

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

Thullier et al., 2005 PNAS
Very large biodiversity losses in Europe >60%!

Impact model
Process or correlative

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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

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Steep climatic gradient

- European Beech
- Pedunculate Oak

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

Dufrêne et al. 2005
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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Dufrêne et al. 2005
Materials & Methods
Databases & simulations

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

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Soil AWC
- 8 km

50 km
- 20 km
- 8 km

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- 8 km

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- 50 km
- 20 km
- 8 km

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

Beech

Oak
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

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
Results

What resolution do we need and where?

**European beech**

- 20 km
- 50 km

**Wood Production Difference (%) to fine resolution**

- Blue: <-10
- Light yellow: -10 - 10
- Red: >10

**Deciduous oak**

- 20 km
- 50 km

**Best resolution**

- White: 50 km
- Light orange: 20 km
- Red: 8 km
Summary & Conclusion & Perspectives

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

- 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...
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

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

What resolution do we need and where?

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