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

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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

Penuelas et al., 2003 GCB

1945 1995

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

- Increase forest defoliation
- 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

Carnicer et al., 2012 PNAS

Defoliation trends in southern Europe
(a)

Defoliation (%)
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

Impact model
Process or correlative

Climate projection (Resolution 300 to 50 km)

Biodiversity Losses
2080-2100
Compared to 1970-1990
Using 50km Resolution climate
Introduction
Anticipating climate change effects on trees and forest

Very large biodiversity losses in Europe >60%!

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Very large biodiversity losses in Europe >60%

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

Biodiversity Losses
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Resolution climate
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
Introduction

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

**A matter of spatial scale?**

- Pedunculate Oak
- **European Beech**

Steep climatic gradient

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

Two wide spread tree species
Materials & Methods
The model CAST ANEA

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

-Dufrêne et al. 2005

-C, H₂O Fluxes
-NPP, Growth, wood production
-Presence
Materials & Methods
The model CASTANEA

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

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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Soil AWC
8 km

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**Soil AWC**
- 8 km

**Wood production**
- (gC m²)

**Dufrêne et al. 2005**
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

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

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

Wood Production (gC m^{-2})

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

**Deciduous oak**

- 20 km
- 50 km

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

20 km:
- European beech: 
- Deciduous oak:

50 km:
- European beech: 
- Deciduous oak:
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:

- Orange: 20 km
- Orange: 8 km
- Blue: 50 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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- Not only in mountainous area... At the edge of species range
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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

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Results

What resolution do we need and where?

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