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

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

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**Penuelas et al., 2003 GCB**

1945 | 1995

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

- Increase forest defoliation
  - Carnicer et al., 2012 PNAS

- Increase tree dieback

- Migration toward higher elevation

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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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Very large biodiversity losses in Europe >60% !

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

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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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- European Beech
- Pedunculate Oak

Two wide spread tree species
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A matter of spatial scale?

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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
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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

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

Dufrêne et al. 2005
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Materials & Methods
Databases & simulations

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

Process model CASTANEA
- European Beech
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**Soil AWC**
- 8 km

**Climate:**
- 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

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

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

Wood Production (gC m⁻²)

NPP₈ₘᵢₚ vs. NPP₅₀ₘᵢₚ (gC m⁻² y⁻¹)
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
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

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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 × \left( \frac{NPP_{\text{coarse}} - NPP_{\text{fine}}}{NPP_{\text{fine}}} \right)