

## Uncertainty and intra-specific variability in models of forest dynamics



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1 Uncertainty and biodiversity scenarios

- Uncertainty in ecological processes
- Limitations

2 Intra-specific variability

- Definition
- Examples

3 Impact on biodiversity scenario

- Might inverse the scenario
- Depends on species communities

4 Conclusion

- Summary
- Additional remark

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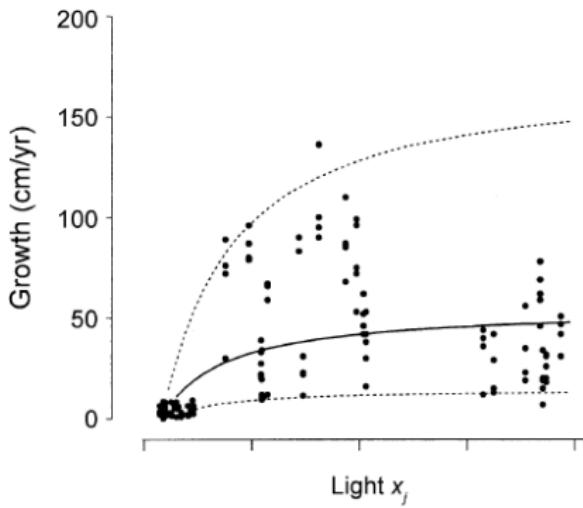
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# Uncertainty in ecological processes

- Scatterplot  $y_i, x_i$
- A statistical model  
 $y_i = f(x_i) + \varepsilon_i,$   
 $\varepsilon_i \sim N(0, \sigma^2)$
- A mean function  $y_i = f(x_i)$
- An uncertainty  $\sigma^2$



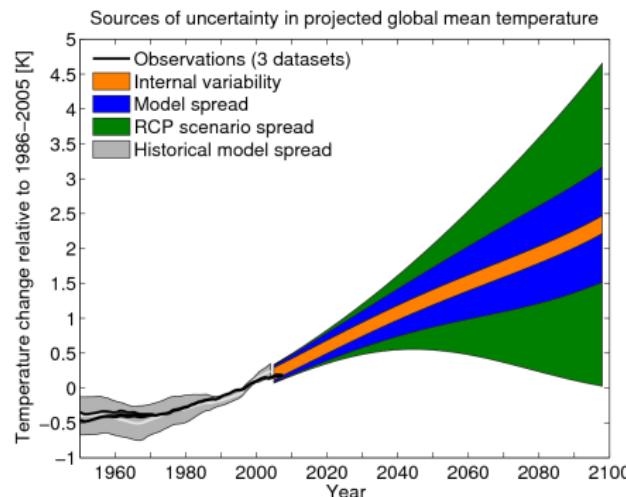
# Uncertainty propagation and biodiversity scenario

## Propagation :

- Several ecological processes with uncertainty
- Uncertainty propagation (e.g. Monte-Carlo simulations)

## Biodiversity scenario

- $\Rightarrow$  Biodiversity scenario
- With (often large) **uncertainty envelope**



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## Uncertainty is not stochasticity

- Uncertainty is not necessarily stochasticity
- Can be associated to **unexplained processes** that can be structured in **space** and **time**
- Unexplained processes affect the biodiversity scenario

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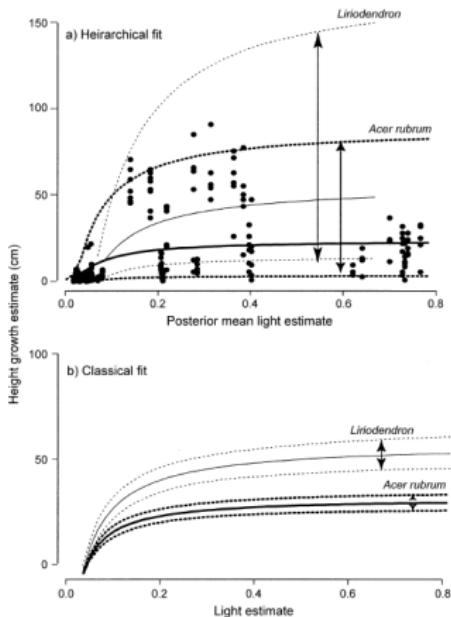
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# Definition of the intra-specific variability

- All individuals within a species are not equal
- Genetic + Micro-environment (e.g. soil, climate)
- Individual response



Clark et al. 2003, Ecology

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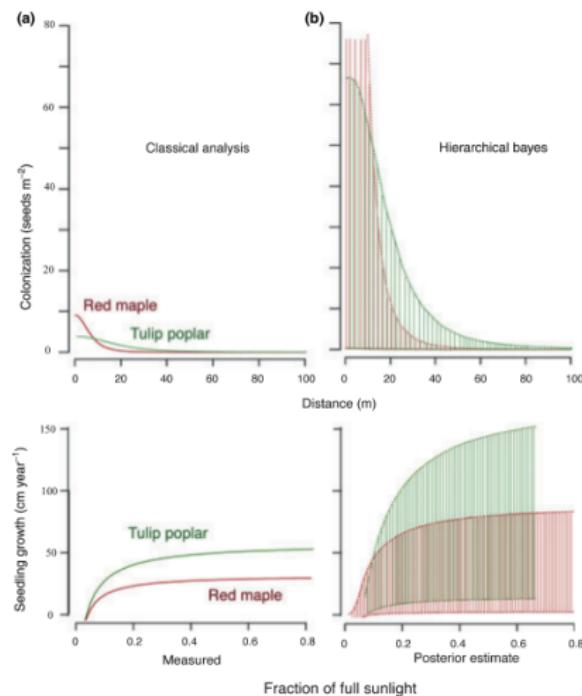
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# Demography

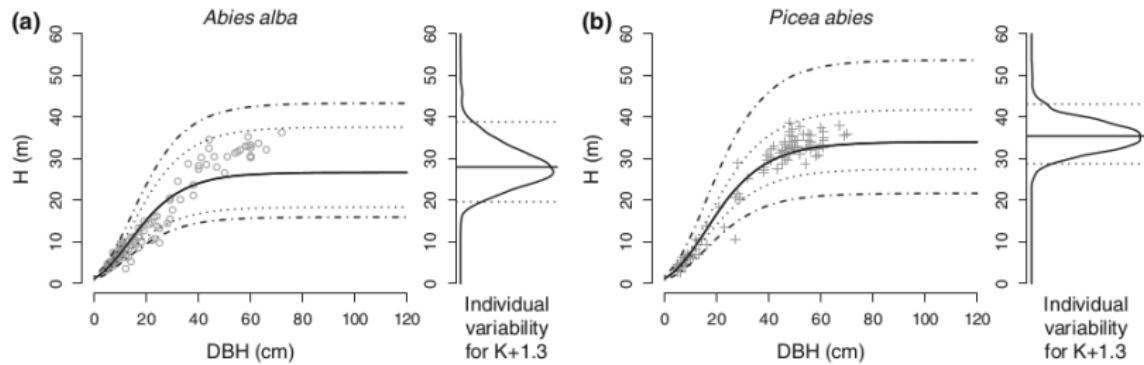
## Competition-colonization trade-off



Clark et al. 2007 *Ecology Letters*

# Allometry

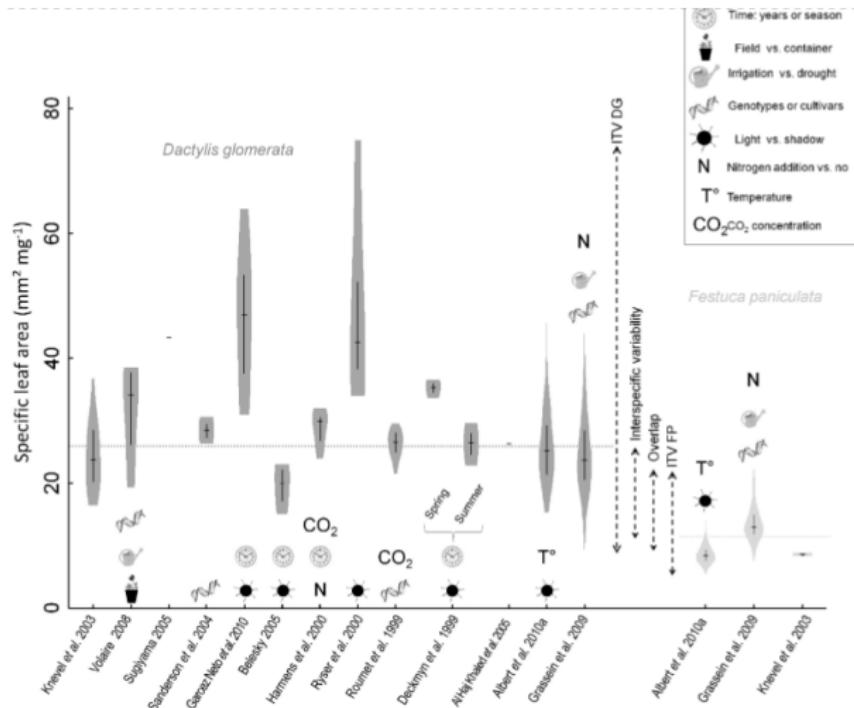
## Height-diameter relationship



Vieilledent et al. 2010 *Oecologia*

# Functional traits

## Specific leaf area (SLA)



Albert et al. 2011 PPEES

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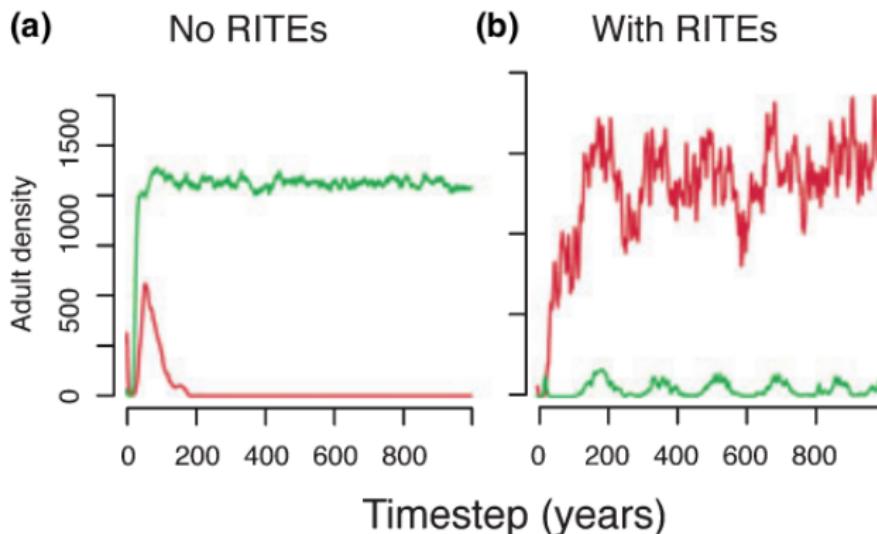
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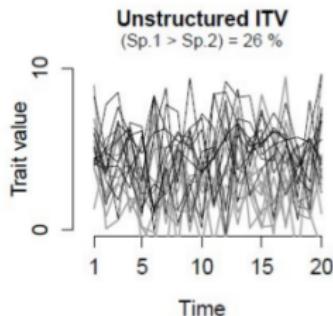
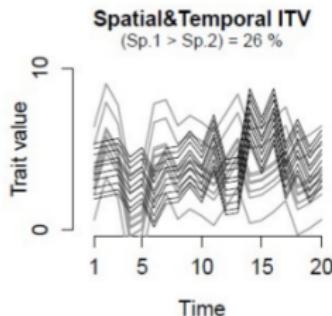
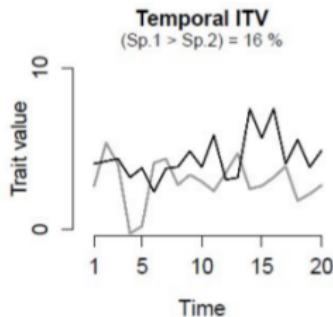
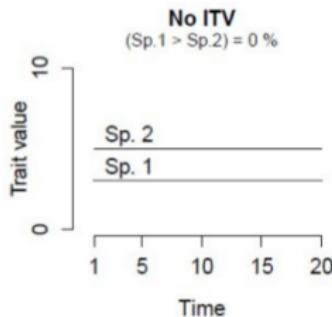
## Intra-specific var. might inverse the biodiversity scenario

- **RITES** = Random Individual and Temporal EffectS
- Individual effects = intra-specific variability
- Temporal effects = inter-annual variability (affecting all individuals of one species, e.g. climate, masting effect)



# Structuring variability with RITES

RITES  $\neq$  stochasticity, RITES = structured variability



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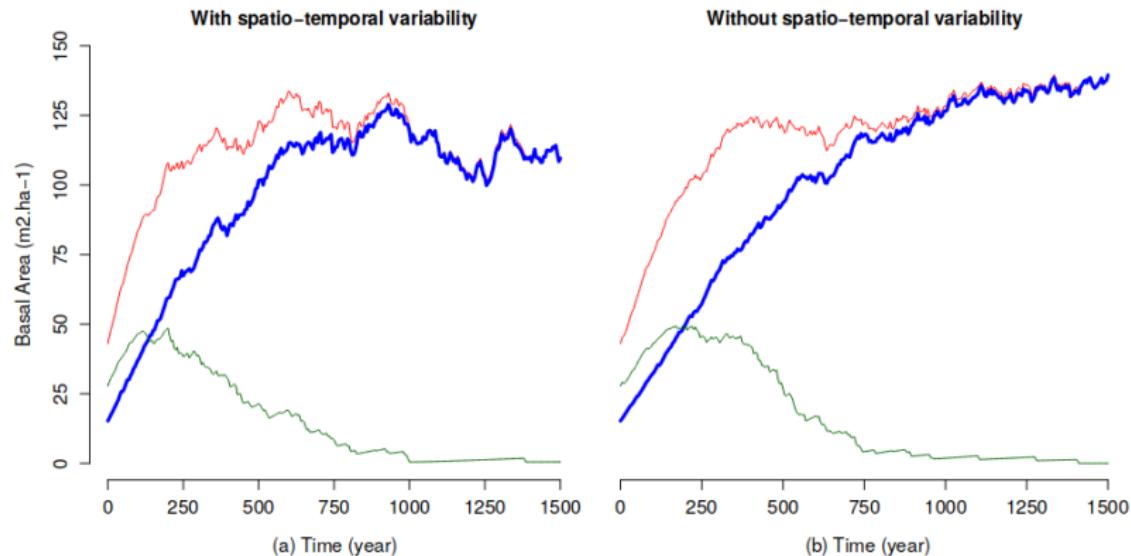
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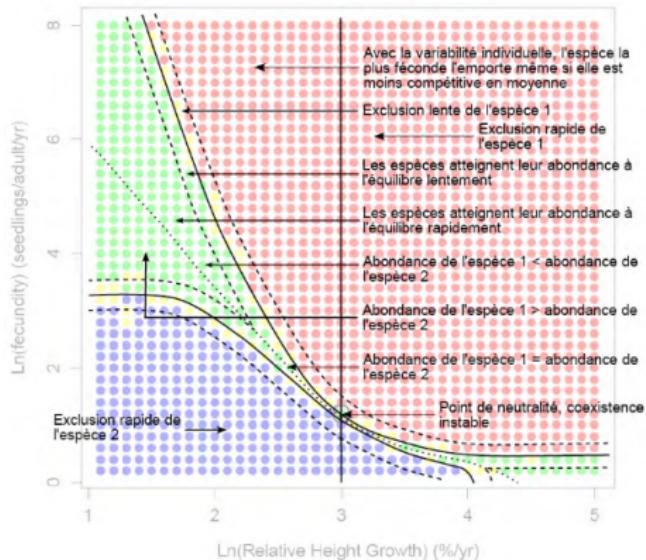
# Outputs depend on species communities

- Results depend on ratio species differences/intra-individual variability
- If ratio is big enough, no effect on output
- E.g. silver fir and Norway spruce



# Unstable/stable coexistence

- Species differences + intra-specific variability
- All possible scenarios : **competitive exclusion** (Gause's law), **unstable coexistence** (neutral theory), **stable coexistence** (niche differentiation)



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# Summary

- Structuring uncertainty in space and time can lead to opposite biodiversity scenarios or slow down changes in biodiversity (transient dynamics)
- Not all uncertainties are important for biodiversity scenario and decision making (cf. presentation by B. Wintle)
- One good model (fewer limitations) > several rather imperfect models (cf. presentation by P. Leadley)

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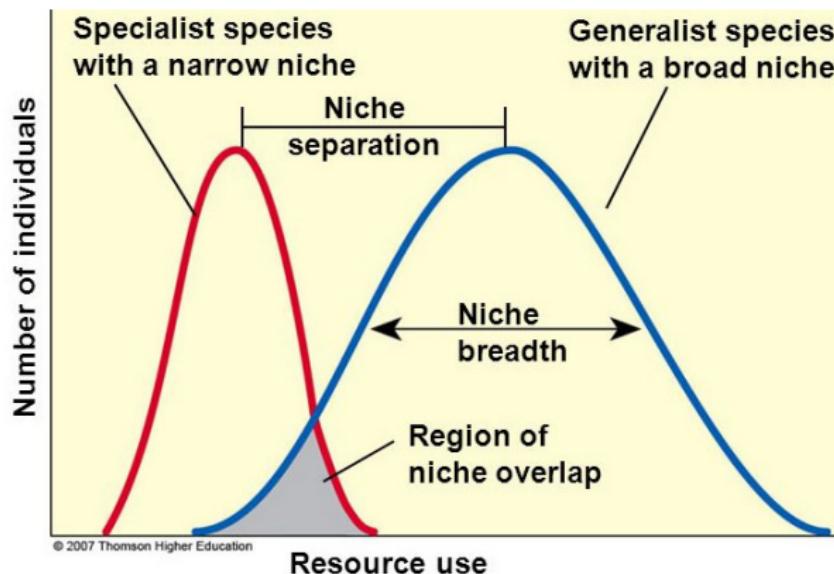
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## Additional remark

- Intra-specific variability and adaptation to change





... Thank you for attention ...

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<https://ecology.ghislainv.fr>



Presentation available at :

<https://ecology.ghislainv.fr/presentations>