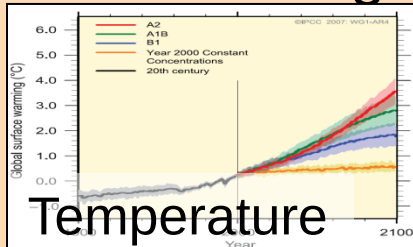


Simulated forest productivity and biomass changes under global change

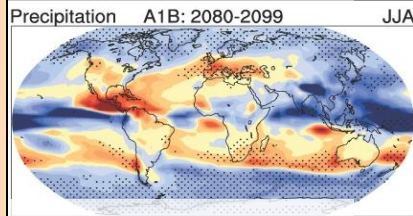


Christopher Reyer, Petra Lasch, Martin Gutsch
Potsdam Institute for Climate Impact Research

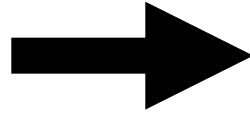
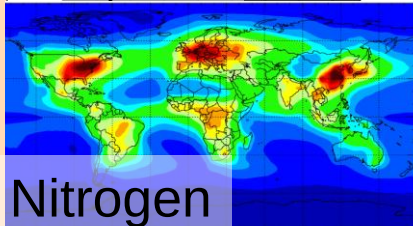
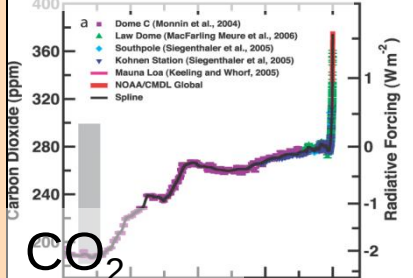
Global Change



Temperature



Precipitation (mm day⁻¹)



Process-based Model

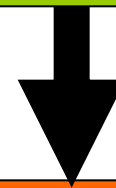
Photosynthesis

Respiration

Evapotranspiration

Allocation

Mortality



Forest Productivity & Biomass

Dentener et al. 2006, IPCC 2007

Objective

To review forest productivity changes simulated by process-based forest stand models under global change scenarios

Methods: Data compilation

AND

A

- forest*
- tree*
- stand*

B

- model*
- simul*
- process*
- mechan*

AND

C

- grow*
- producti*
- NPP

AND

D

- climat* chang*
- global change
- environmental change

→dec 2011: 7,642 paper in WoS

→title & abstracts: simulate productivity under global change?

→~550 papers: process-based (tree, stand, grid), gap, hybrid or statistical models

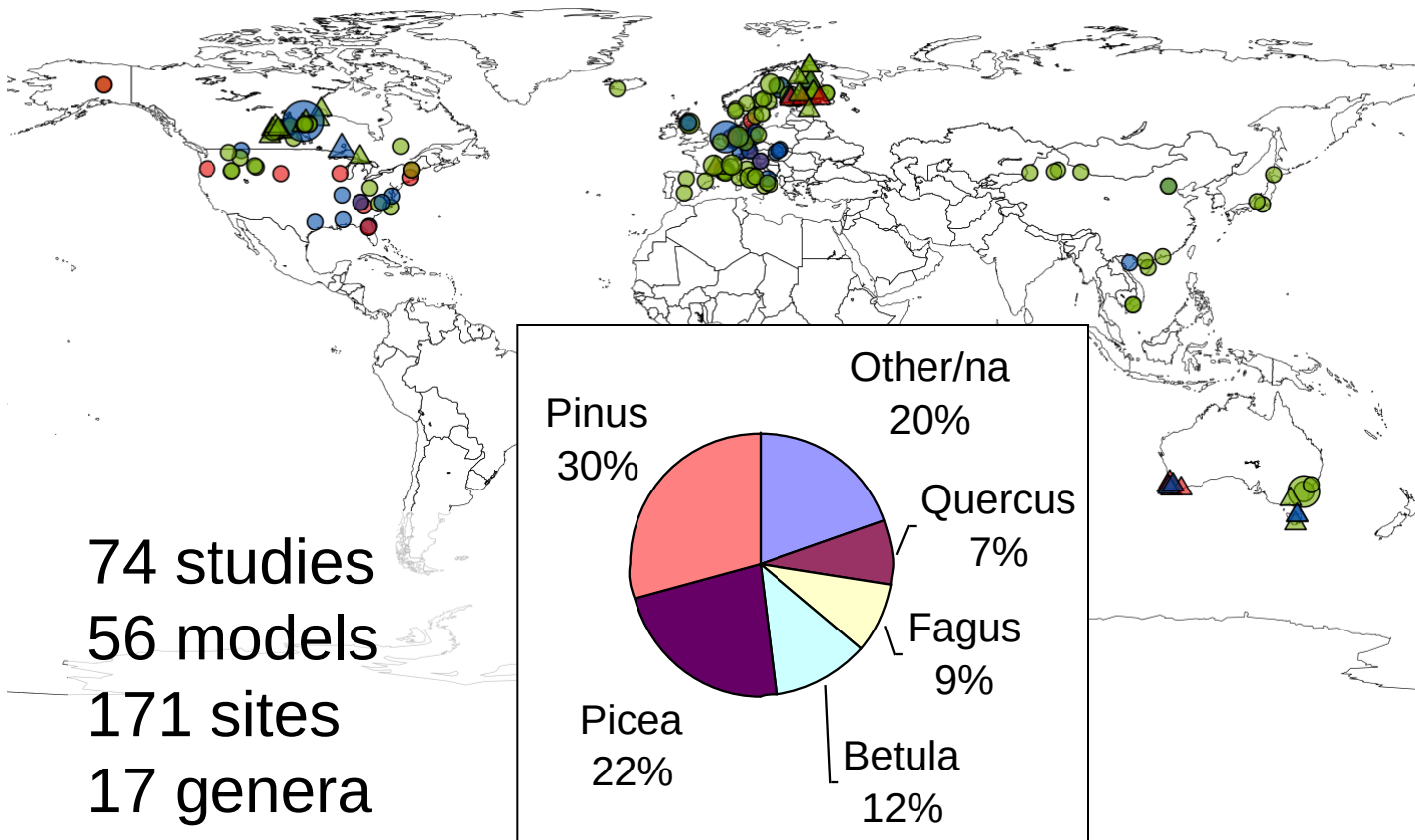
→focus: **stand-level PBMs**

Methods: Data preparation

- Changes in carbon/biomass fluxes (NPP...) & stocks (biomass, volume, stem wood)
- Change in drivers
- Other metadata (transient, step changes, “experiments“...)
- Change relative to baseline conditions

Qualitative changes

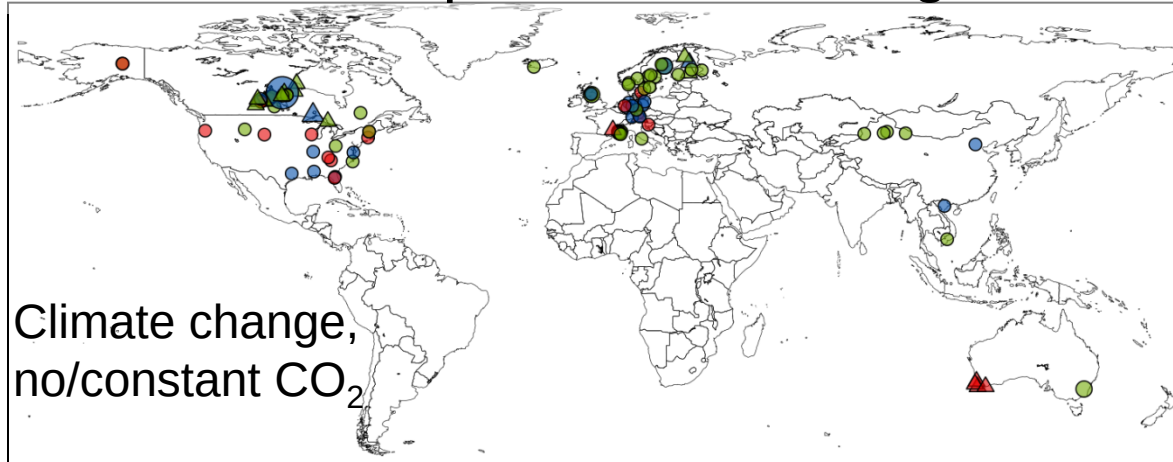
1209 simulations: 79% positive, 19% negative, 2% zero



74 studies
56 models
171 sites
17 genera

Qualitative changes

333 simulations: 60% positive, 35% negative, 3% zero



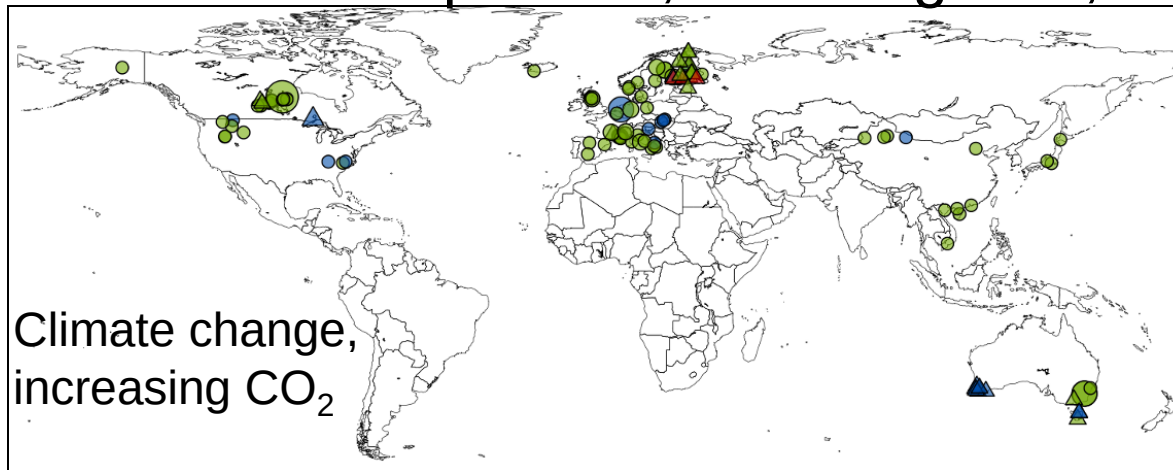
Carbon Stocks / Fluxes

- Fluxes
- ▲ Stocks

NPP Change

- positive
- positive / negative
- negative

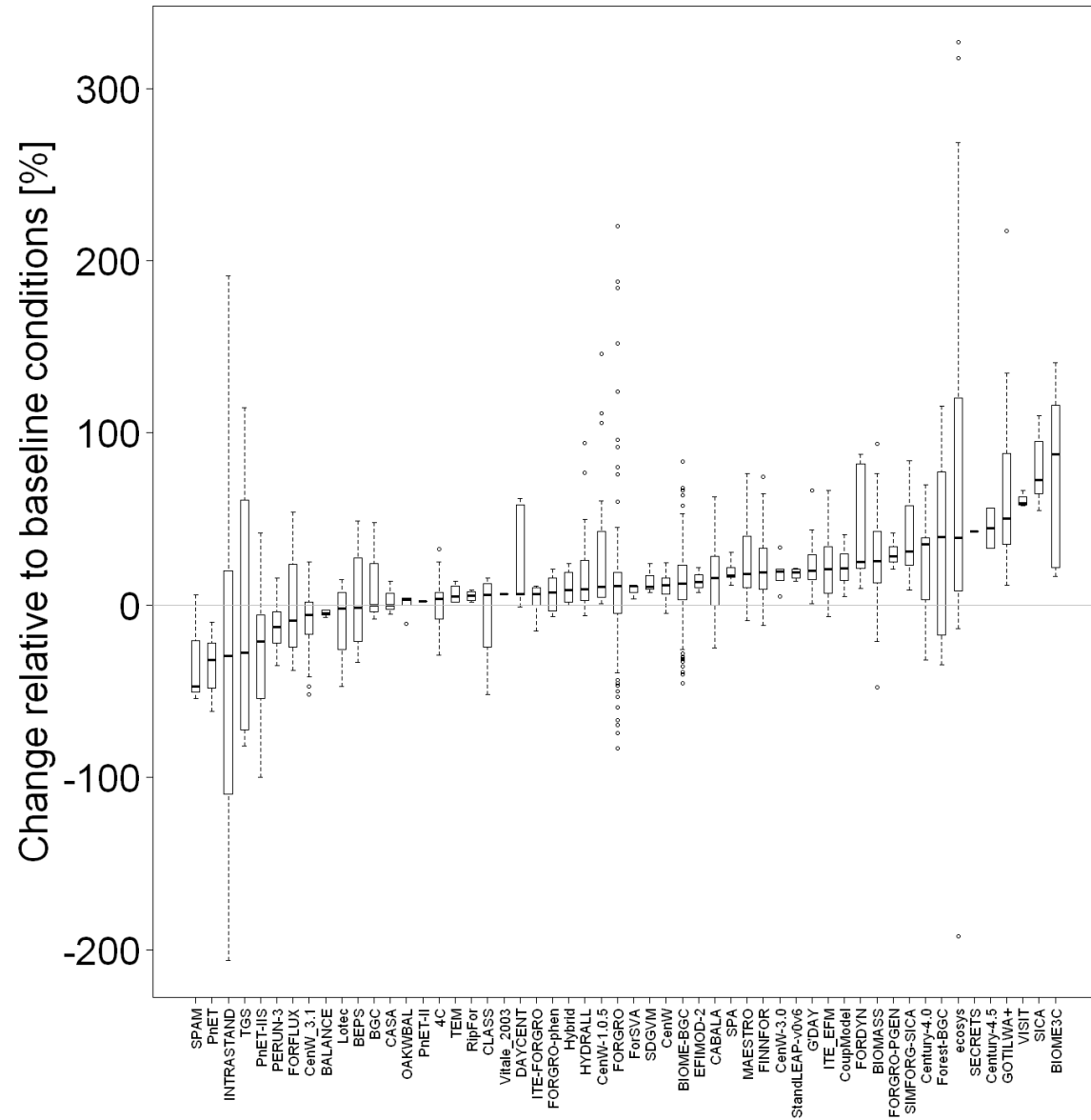
870 simulations: 87% positive, 12% negative, 1% zero



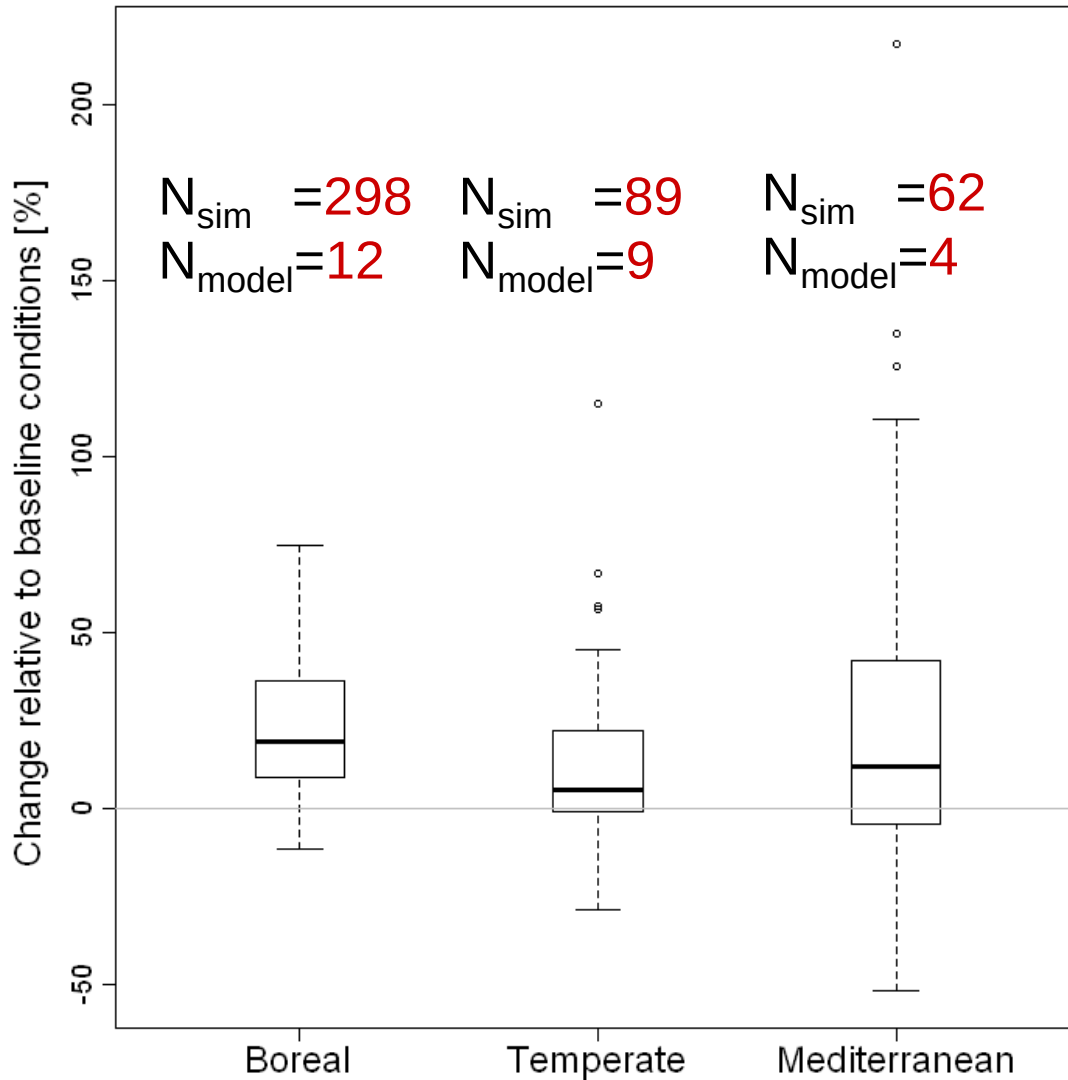
Number of Models

- 1
- 2
- 3
- > 3

Model spread

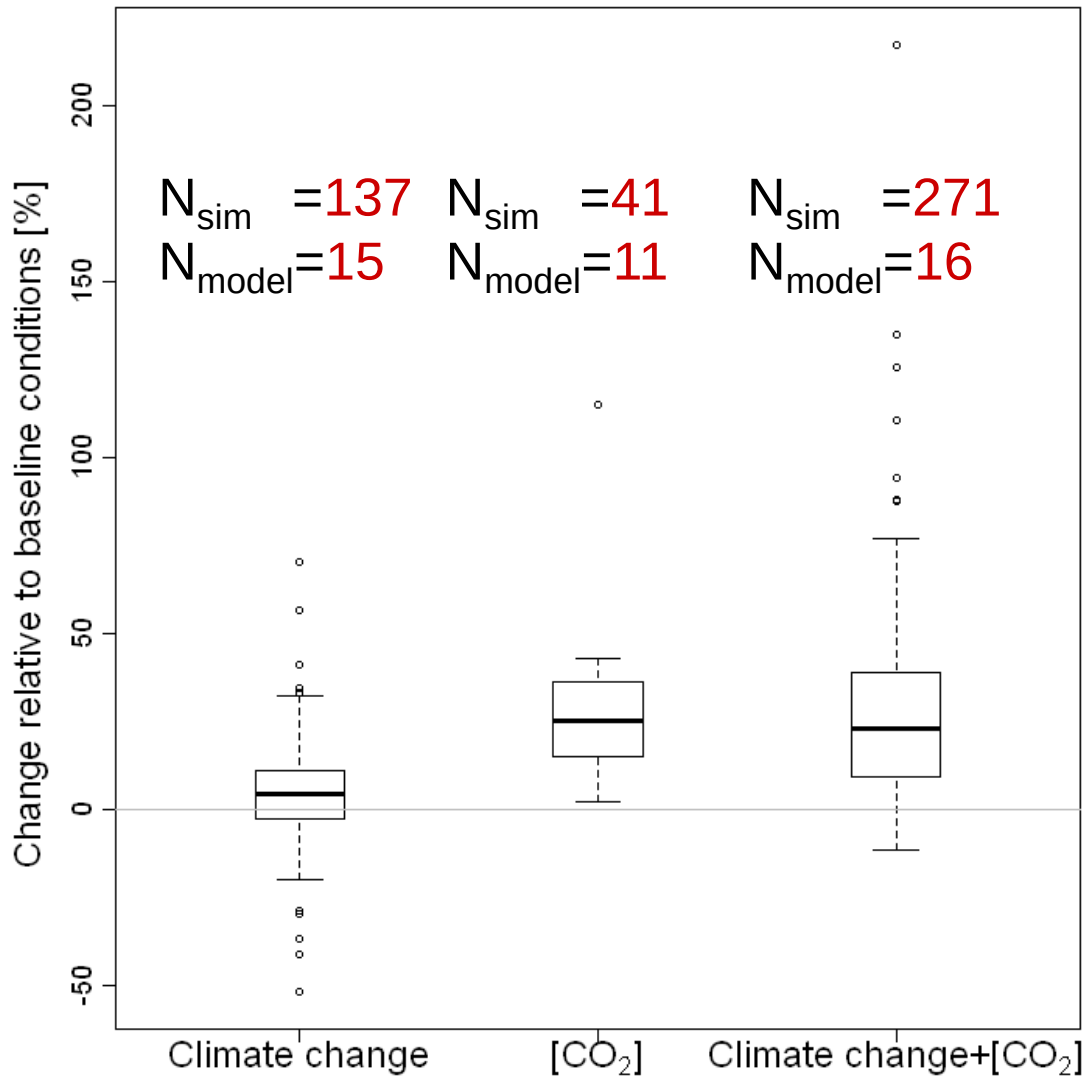


Transient simulations: Biomes



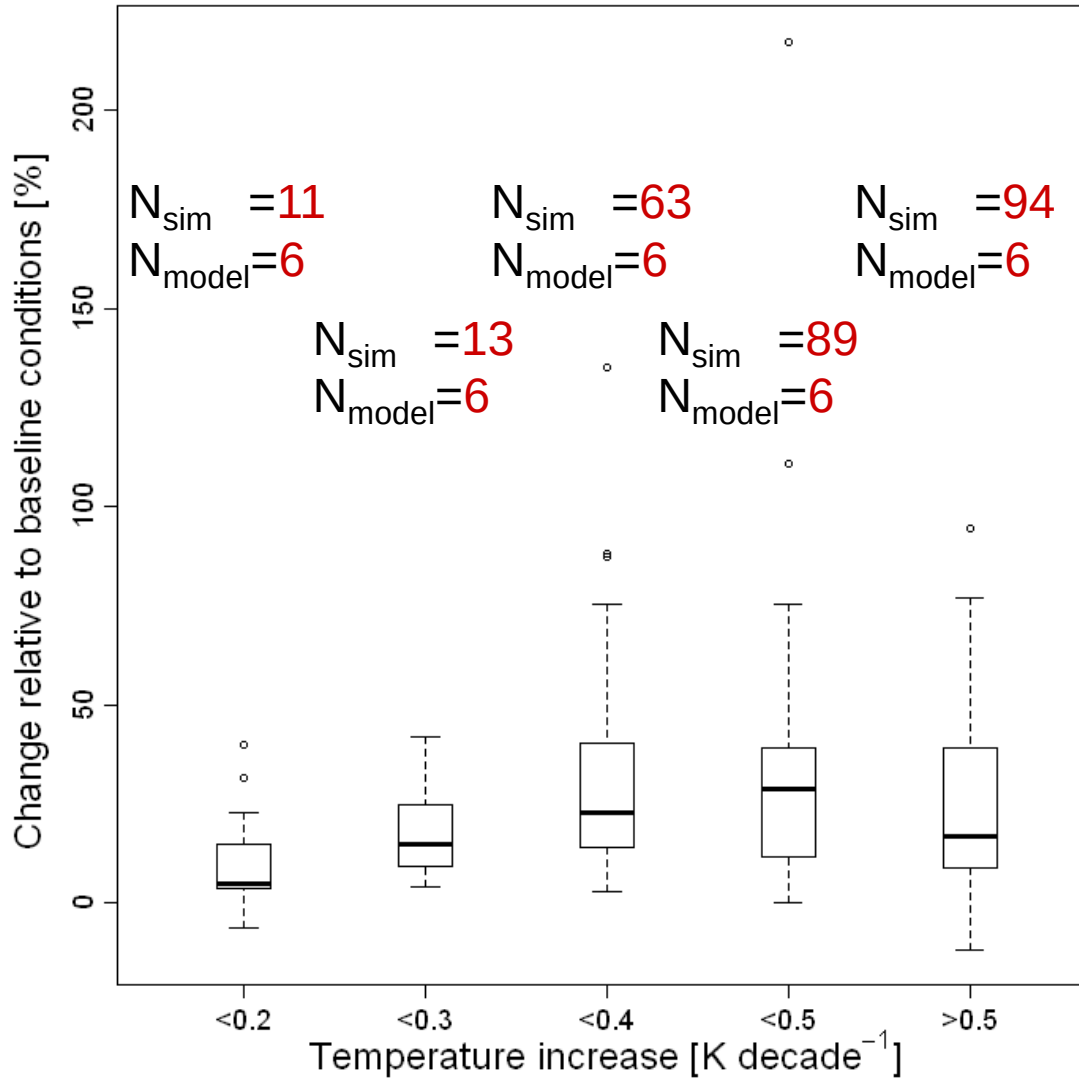
...strong CO₂-effect
(Kirschbaum 2000; Keenan et al. 2011)

Transient simulations: Global Change Driver



...but: drought, N-limitation, acclimation override CO₂-effect?
(Penuelas et al. 2010; Norby et al. 2010)

Combined simulations: Pace of temperature Increase



Around 0.4-0.5K
warming per decade,
physiological response
decreases

Discussion

1. assumptions:

- models equally good & independent (Tebaldi & Knutti 2007; Medlyn et al. 2011)
- model selection criteria (Medlyn et al. 2011)
- relationship biomass & productivity (Keeling & Phillips 2007)

2. mean climate not best predictor of biomass (Stegen et al. 2011) but extremes → e.g. drought (Zhao & Running 2010)

3. synchronized model comparisons (IPCC, COST FP 0603) better to quantify uncertainties

4. publication bias

Conclusions

- strong model effects
- tropics? (Laurance et al. 2004; Lewis et al. 2004 but Feeley et al. 2007)
- many studies available but similar for key processes
- boreal & temperate productivity increase
 - ➔ interactions, feedbacks & disturbances
 - ➔ full carbon cycle

Questions & Comments

Thank you!