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Forest growth in relation to deposition and climate

Forest Growth in Actions IM, D1 and C1-Gro-2(AT)

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a Life+ co-financed project for the "Further Development and Implementation of an EU-level Forest Monitoring System".

The project coordination centre is situated at the Institute for World Forestry, Hamburg, Germany.

- Importance of Forest Growth Monitoring
- Aims of the Work
- Periodic Growth on IM Plots
  - Effects of deposition, temperature
- Annual Growth on D1 Core Plots
  - Climate: The extreme summer drought of 2003
- Concluding Remarks

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Forest Growth

The importance of forest growth studies

- Forest growth mitigates the impact of climate change and air pollution
- Forest growth is affected by climate change and air pollution
- Forest growth is a good indicator of environmental changes that affect forests

Forest Growth

Forest growth is changing

- Forest Growth was believed to decline as part of the ‚Waldsterben' (Ulrich 1979)
- Forest growth has increased in recent decades (Spiecker et al. 1996)
- Forests are now considered as substantial carbon sinks (Naburs et al. 2003)

Forest Growth

Effects on forest growth controversial

- Nitrogen deposition thought to cause a large increase in carbon uptake of forests (Magnani et al. 2008)
- Others believed that N deposition will only result in a small C uptake (Nadelhofer et al. 1999)
- Europe-wide reduction in primary productivity of forests during 2003 (Ciais et al. 2005)

- How can measuring forest growth on intensive monitoring plots be used to answer some of the controversial questions?
- What kann it add to the existing national forest inventories?

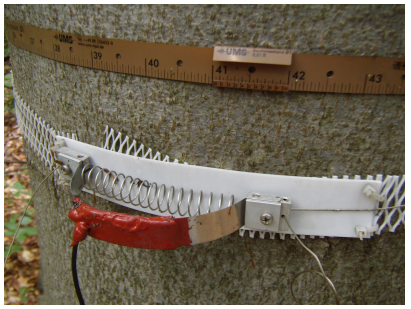
- Harmonised growth assessment with centrally stored data
- Larger plots with known forest management
- Other environmental variables measured on site
- => ideally for cause-effect measures

IM - Periodic measurements on all trees (mean plot size 0.25 ha)

- 5-year diameter growth (mm), height growth (dm),
- => basal area increment, volume increment, including removal and mortality, carbon uptake
- => stand density, top height, standing volume/biomass, species distribution, crown cover, different indices of structural diversity and competition and spatial distribution

D1 – Permanent and continuous stem measurements on selected trees on core plots

- Manually Girth bands
  - Annual stem growth (1/10 mm)
  - Seasonal stem growth
- Electronic dendrometers
  - Daily radius changes (1/100 mm)
  - Temporal swelling and shrinking

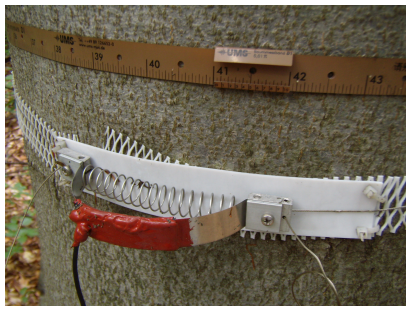


Periodic (5-yr) measurements for effects of

- deposition
- temperature change
- general drought

Annual permanent growth measurements for effects of

- extreme climatic events
- biotic damages (insect outbreak)



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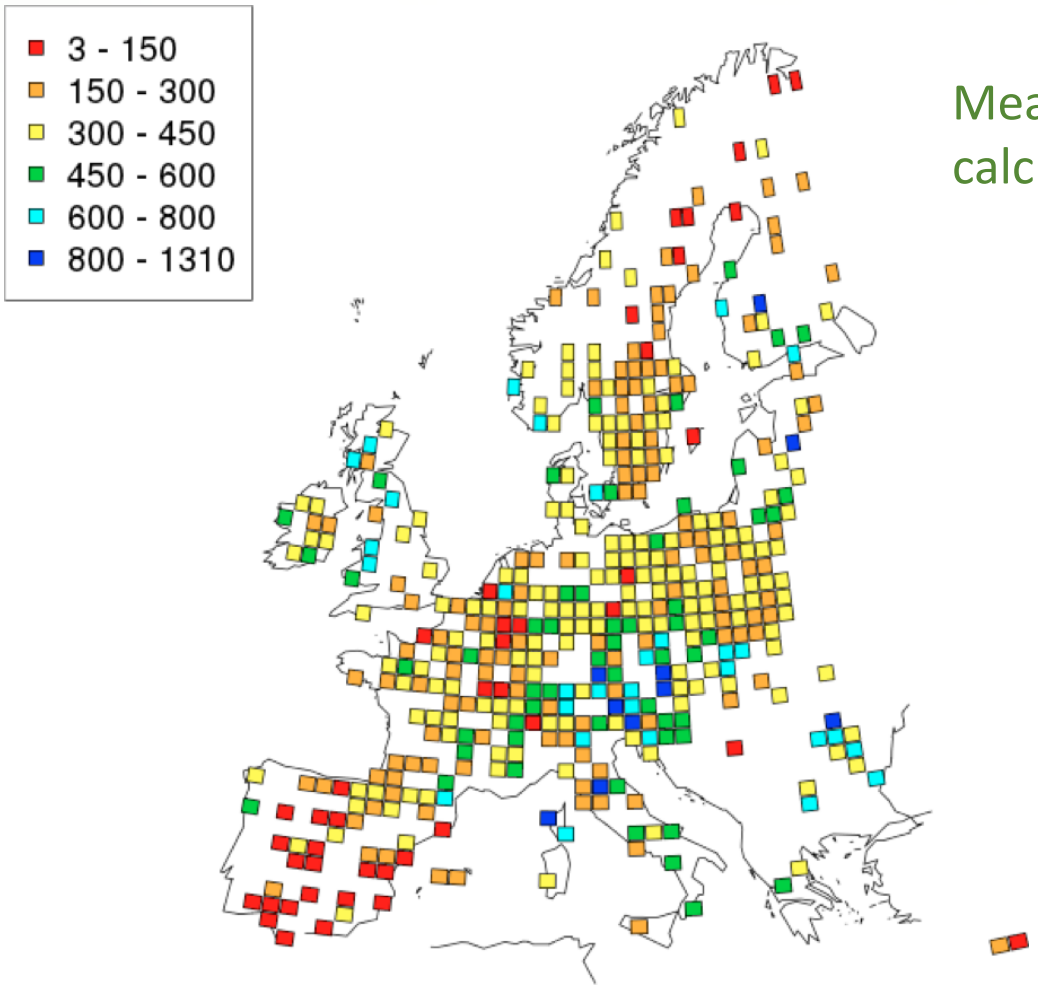
Periodic Forest Growth

Mean stocking stem volume



Mean standing volume calculate for all plots

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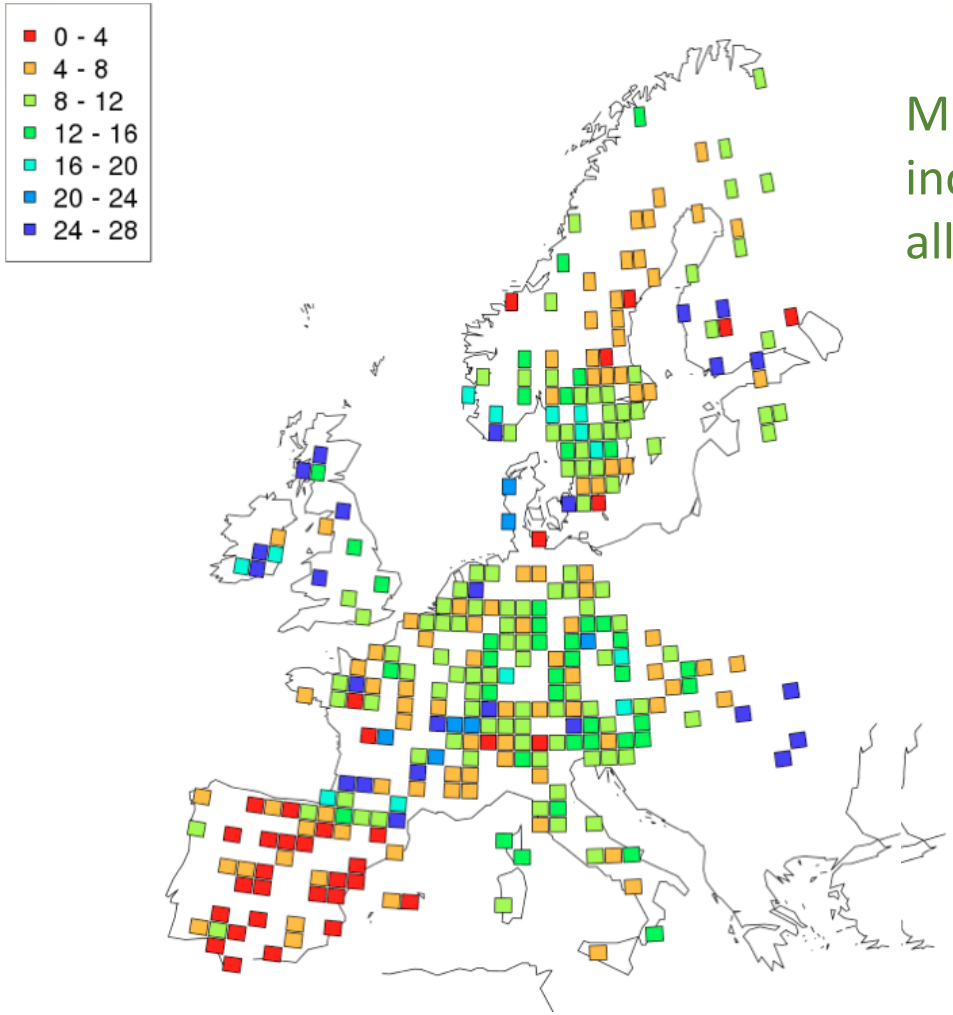
Periodic Forest Growth

Mean annual stem volume growth



Mean annual volume increment calculated for all plots

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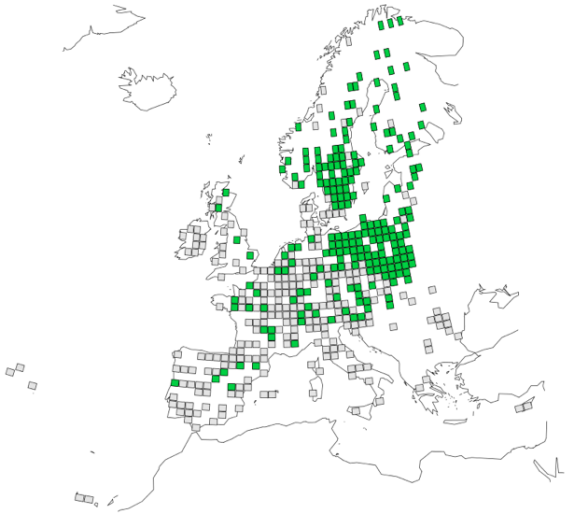
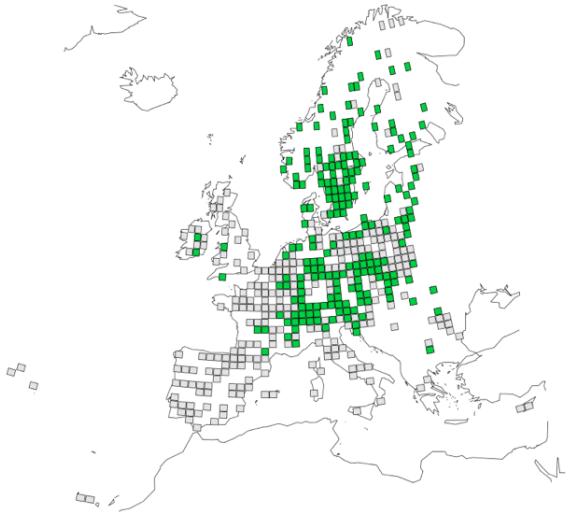
Periodic Forest Growth

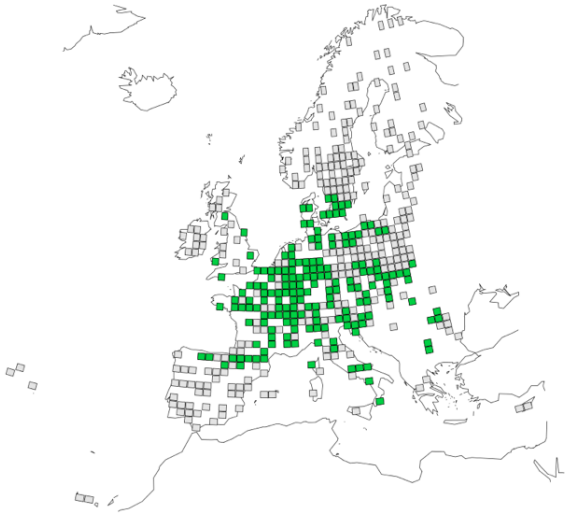
Species distribution in plots



Pinus sylvestris



Picea abies

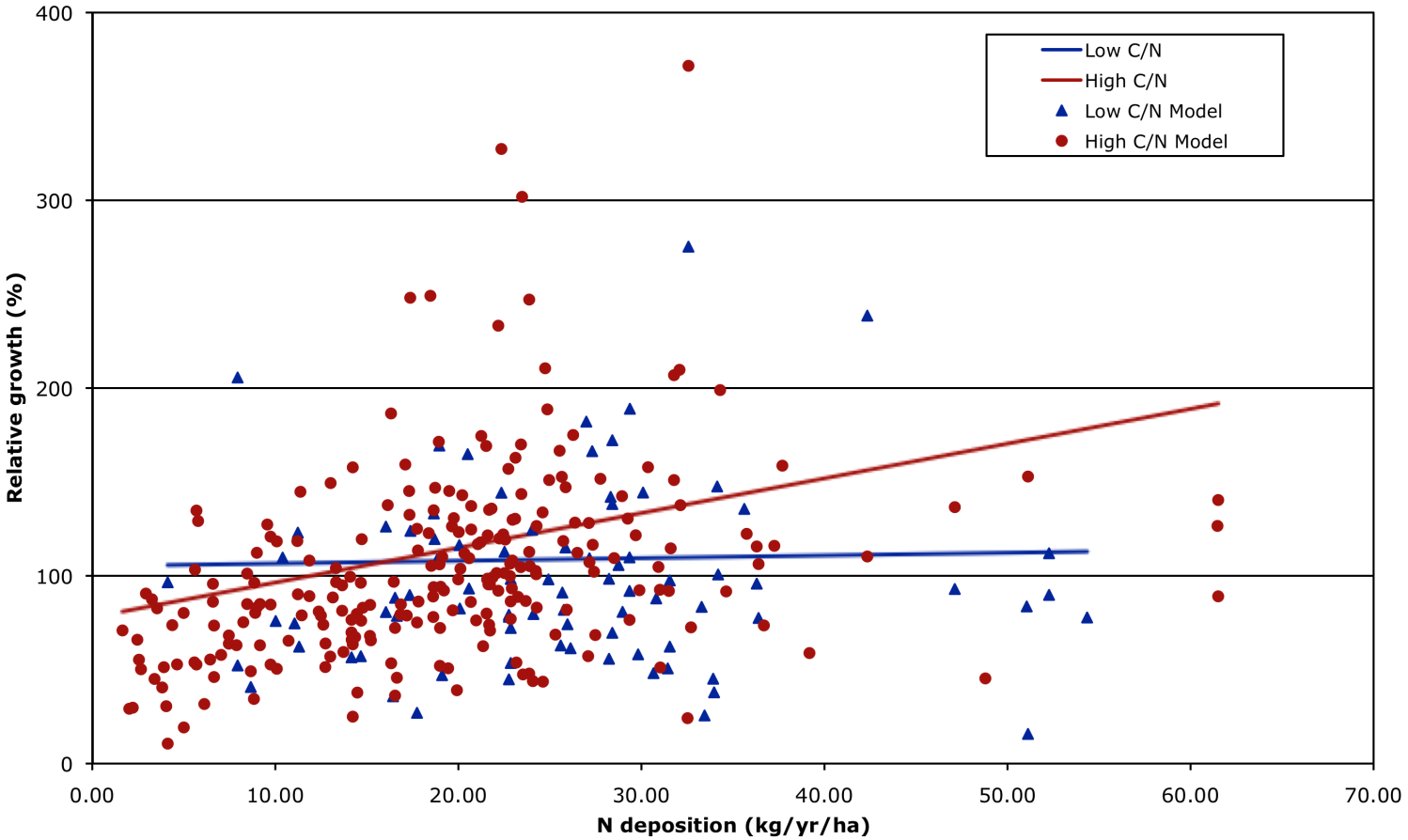


Fagus sylvatica

Assessment of the effect of environmental changes on growth (1st growth period):

- Use stand productivity (height at age 50), tree age and stand density to model potental volume growth with the help of yield tables
- Compare expected growth with actual 5 year growth and relate the difference to environmental factors
  - N and acidic deposition
  - Temperature deviation
  - Drought index

N deposition increases growth when N in the soil is limited



Environmental change and growth

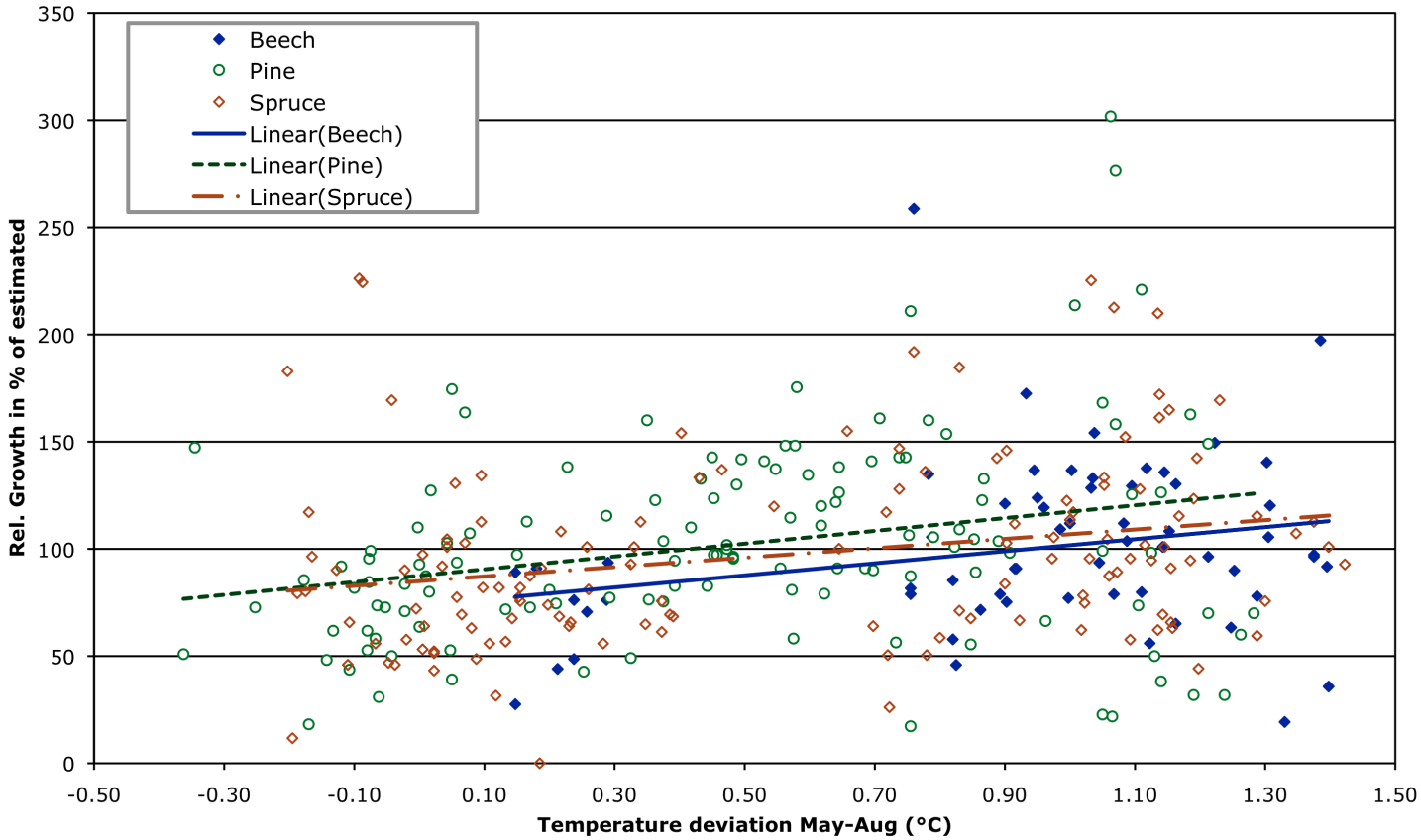
The effect of N deposition

Tree species	Growth increase per 1 kg N
Norway spruce	+ 0.9 - 2.0 %
Scots pine	+ 1.0 - 1.1 %
Common beech	(+0.5 - 1.0%)
Oak spec.	(-0.4 - 1.6%)
All combined	+ 1.2 %

Environmental change and growth

The effect of temperature

Increased temperature during the growth period increased growth!



Periodic volume growth on IM plots for first 5-year period

- increased with N deposition when N was not limited in the soil
- for 1 Kg N deposition per year on average growth increased by 1% or 15 - 30 kg C uptake per year
- increased when temperature during the vegetation period was above average
- did not show a negative trend with acidic deposition
- did not show a clear trend with calculated drought index

The problem with periodic growth data is that specific extreme events cannot be identifed or quantified!

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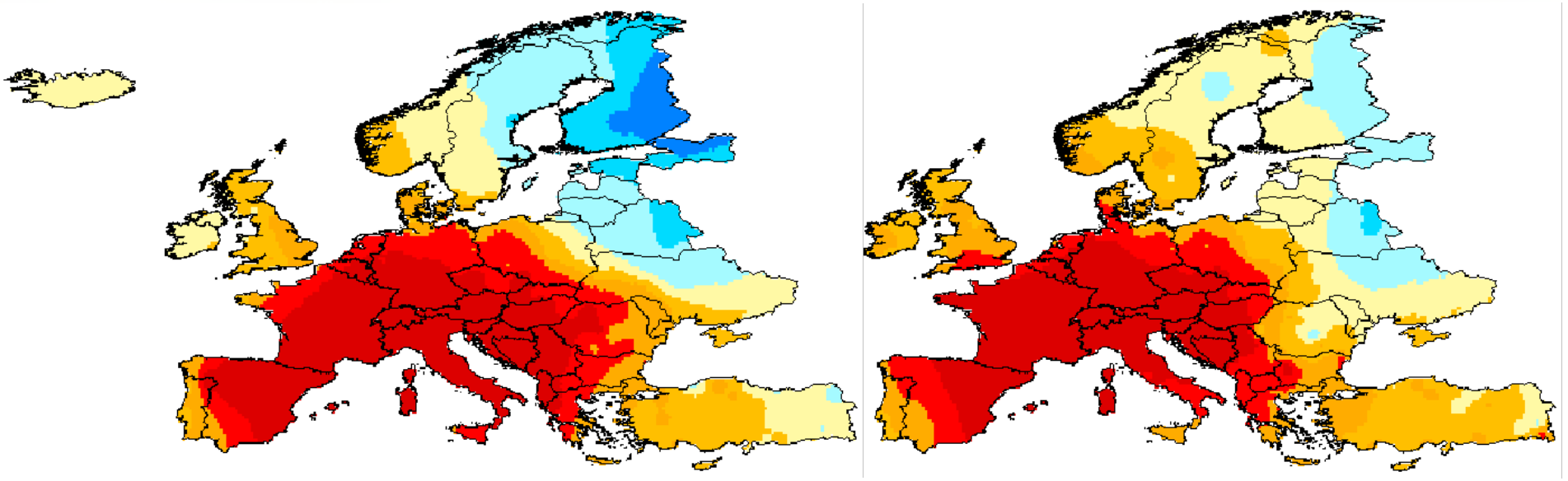
Effects of Extreme Climate

The Heat Summer of 2003



Juni

August

Rebetez et al. 2006

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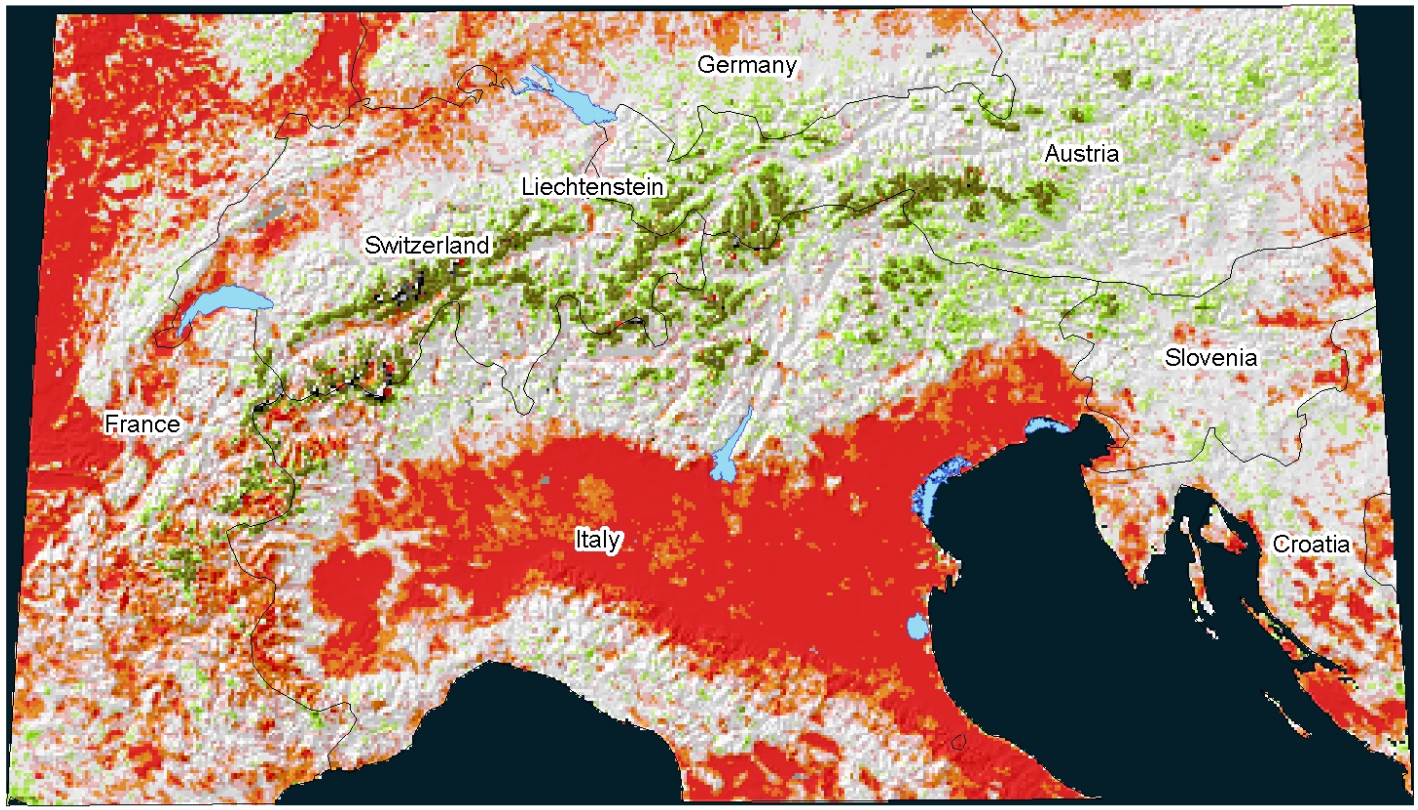
The Summer of 2003

Vegetation Development in 2003!

Vegetation development in 2003 was less at low and more at high altitude!



Legend

MODIS Summer FPAR relative to mean (%)

< 93 | 93.1 - 95 | 95.1 - 97 | 97.1 - 99 | 99.1 - 101 | 101.1 - 103 | 103.1 - 105 | 105.1 - 107 | > 107

Jolly et al. 2005

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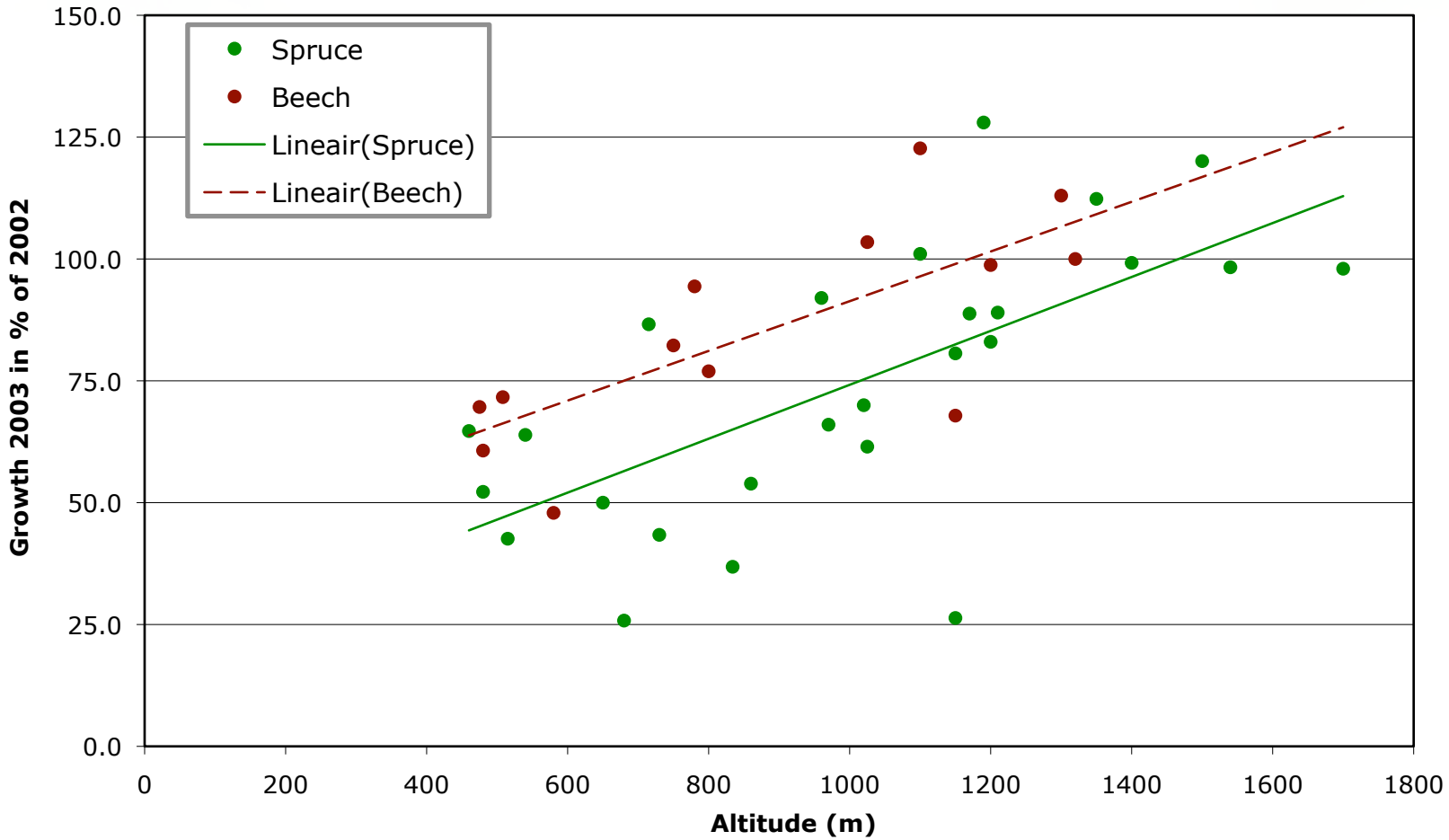
The Summer of 2003

Tree growth on IM and core plots in the Alps in 2003

Tree growth in 2003 increased with altitude in the Alps!



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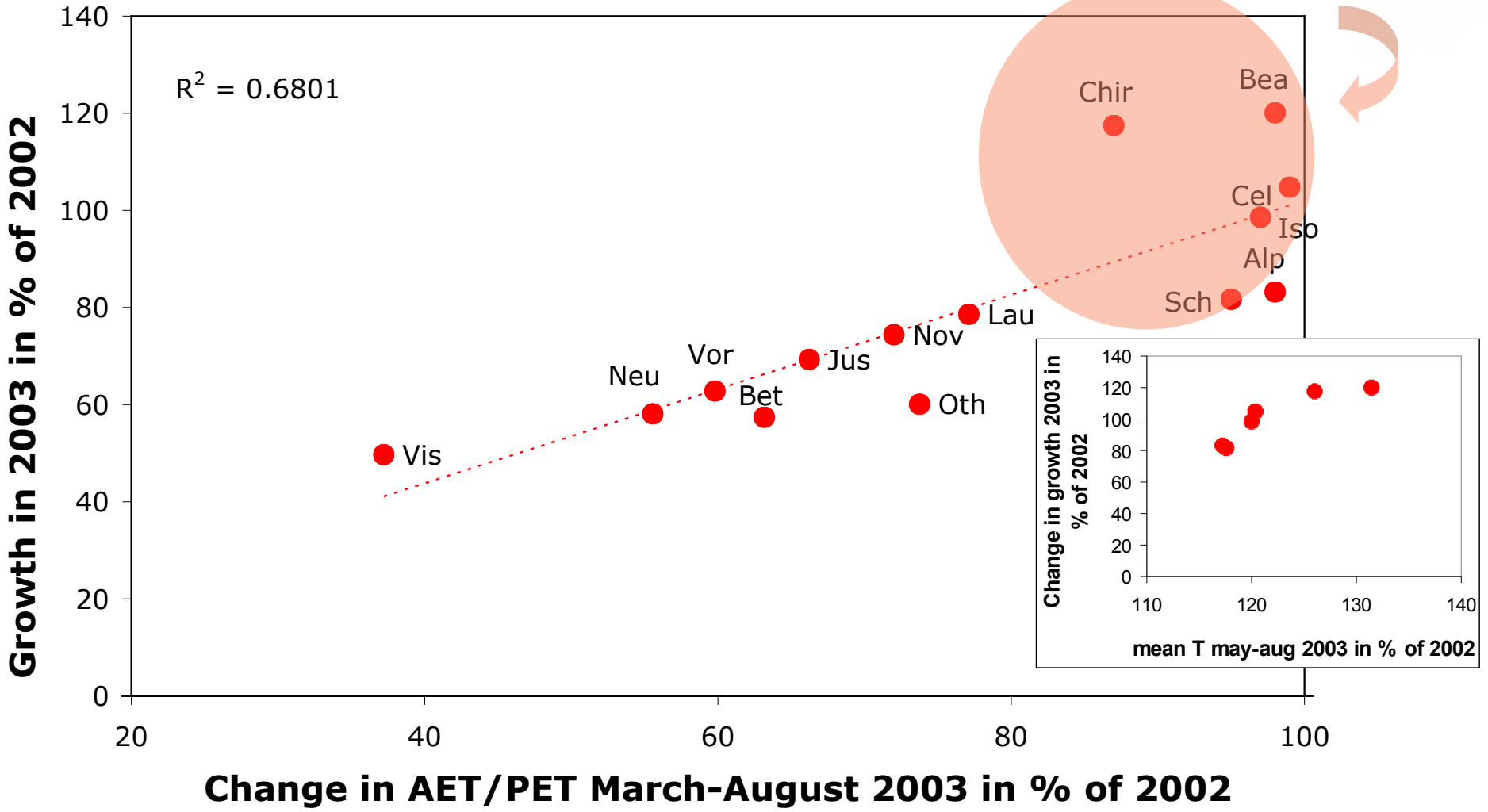
The Summer of 2003

Drought and growth reduction on Swiss plots

T -Effekt?



Graf Pannatier et al., 2007

- The summer 2003 had different effects on tree growth:
- At low altitude growth was reduced in the alps as a result of water limitations
- At high altitude growth increased or remaind the same as a result of warmer temperatures
- Growth reductions were higher for spruce (up to 75%) than for beech (up to 50%)

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Final Conclusions

- Forest growth on intensive monitoring plots can be used to identify which environmental factors are affecting forest growth and to quantify the relative effects
- Periodic plot-level growth and annualy measured tree growth can be used to identify the different underlying processes
- The results obtained can be used to model the effects under future scenarios.

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Thank you for your attention !!