

# Growth deviation and environmental changes



Changes in management, climate and N deposition explain recent deviation from expected growth in mature Spruce and Beech forests in Italy

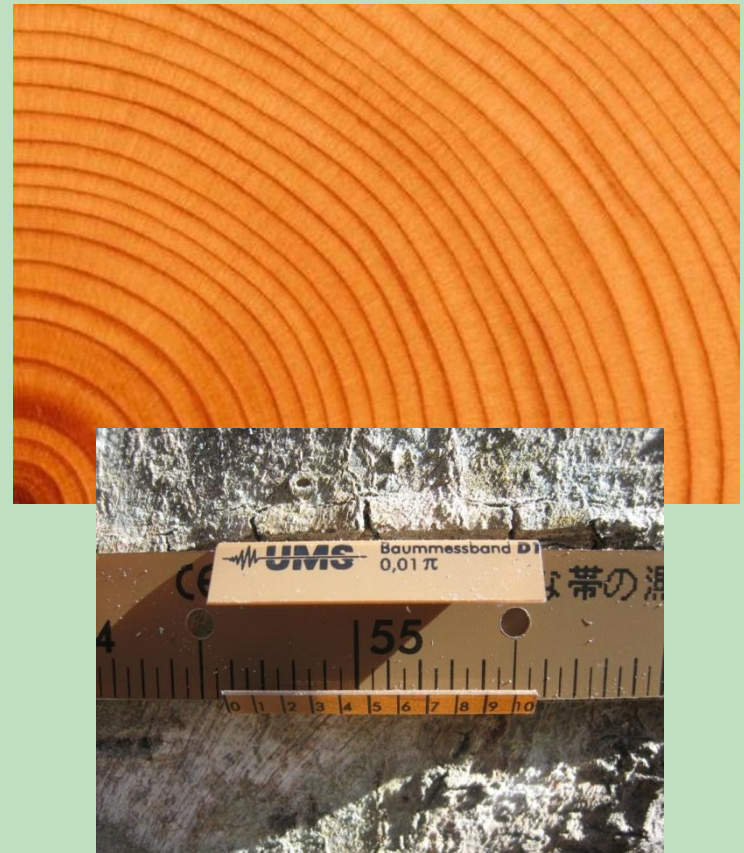
Ferretti M., Bertini G., Calderisi M., Fabbio G., Marchetto A.



# Growth deviation

A preliminary investigation on factors involved in recently measured growth deviation at selected CONECOFOR plots

- Reported changes in tree growth (Spieker et al.1996, Leuzinger et al.2005, Ciais et al. 2005)
- Possible reason: management, increasing AT, changes in precipitation pattern, raising CO<sub>2</sub> level, fertilization by N deposition, increasing O<sub>3</sub> concentration.
- Role of environmental drivers and management



# Talk outline

A preliminary investigation on factors involved in recently measured growth deviation at selected CONECOFOR plots

- Concept and methods
- Variables used in the study
- Results and conclusions





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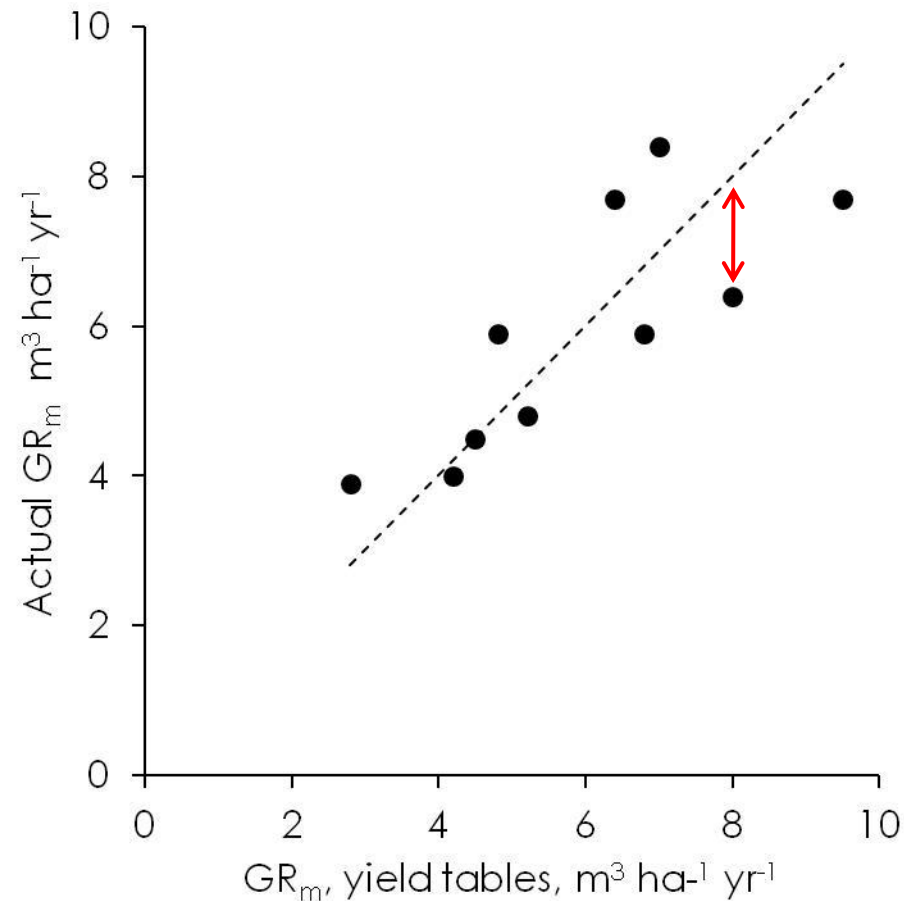
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# Concept and methods

A preliminary investigation on factors involved in recently measured growth deviation at selected CONECOFOR plots

- Concept: by comparing measured growth data and data from yield tables, investigate the role of environmental drivers in explaining recent growth deviation
- Data: measured growth on 10 CONECOFOR plots compared to yield tables for same or similar forests (1915-1974)
- Statistical methods: subsequent MLR models, starting from a reference model (only management related variables)



# Predictor variables environmental changes

## Differences between present and past condition

### 1. Meteorology

### 3. Environmental pollution:

- $O_3$  concentration
- $CO_2$  level
- N deposition



### 2. Management

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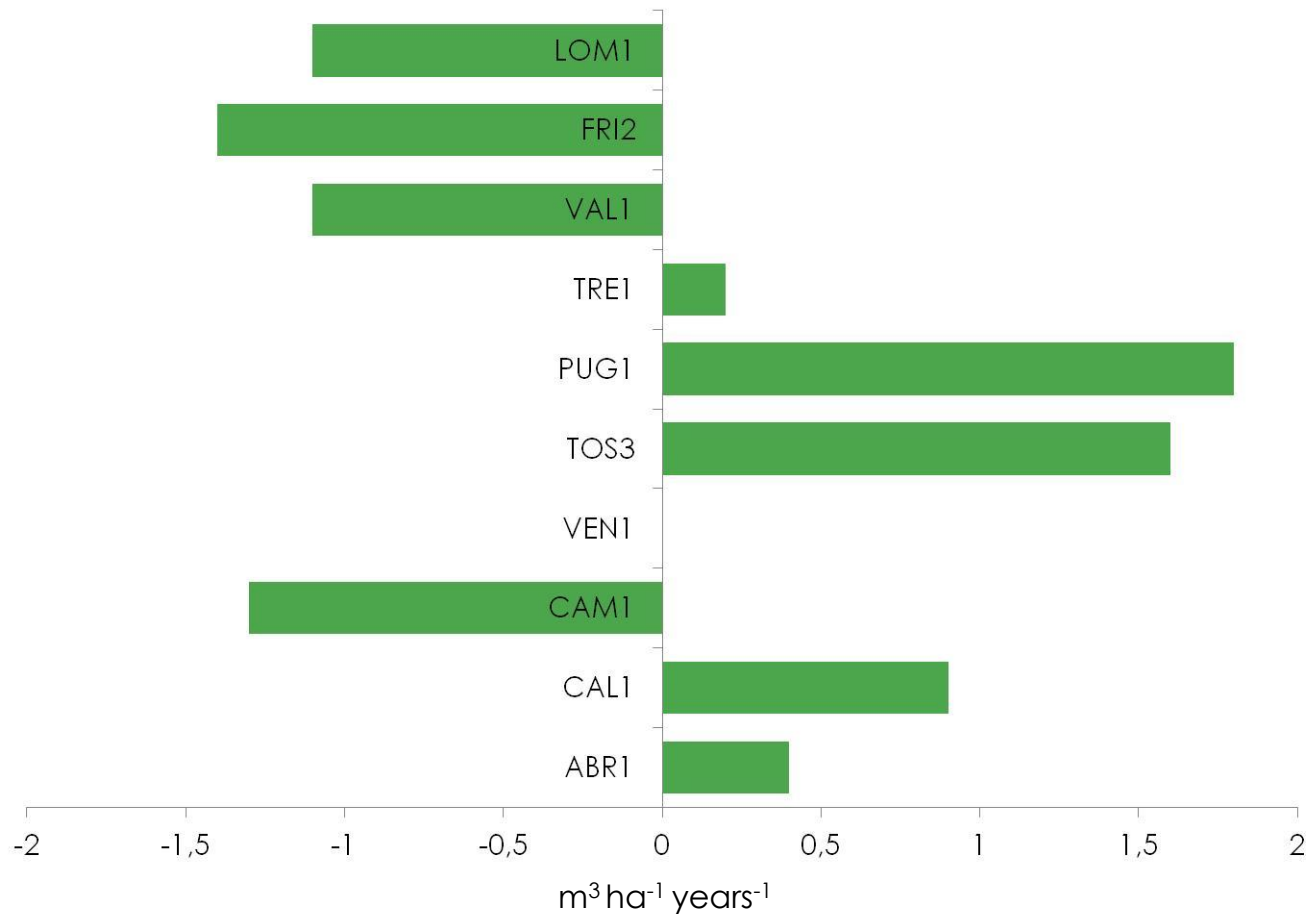
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# Response variable

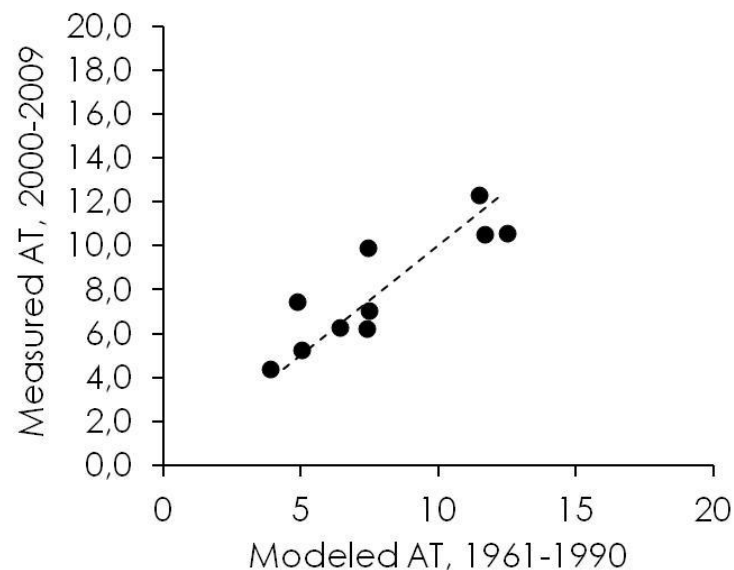
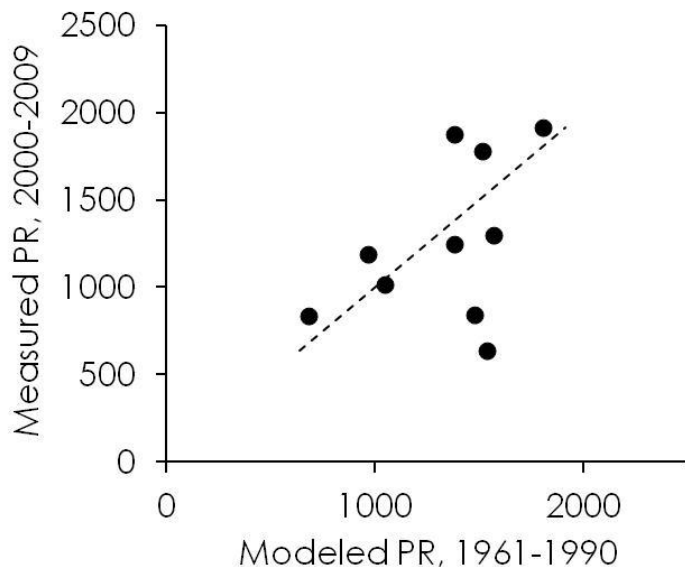
Difference between recently measured tree growth and growth from yield tables (1915-1974) in terms of mean volume increment ( $\text{m}^3 \text{ha}^{-1} \text{years}^{-1}$ )





# Predictor variables 1

## Meteorology: precipitation and air temperature



### **$\delta$ PR**

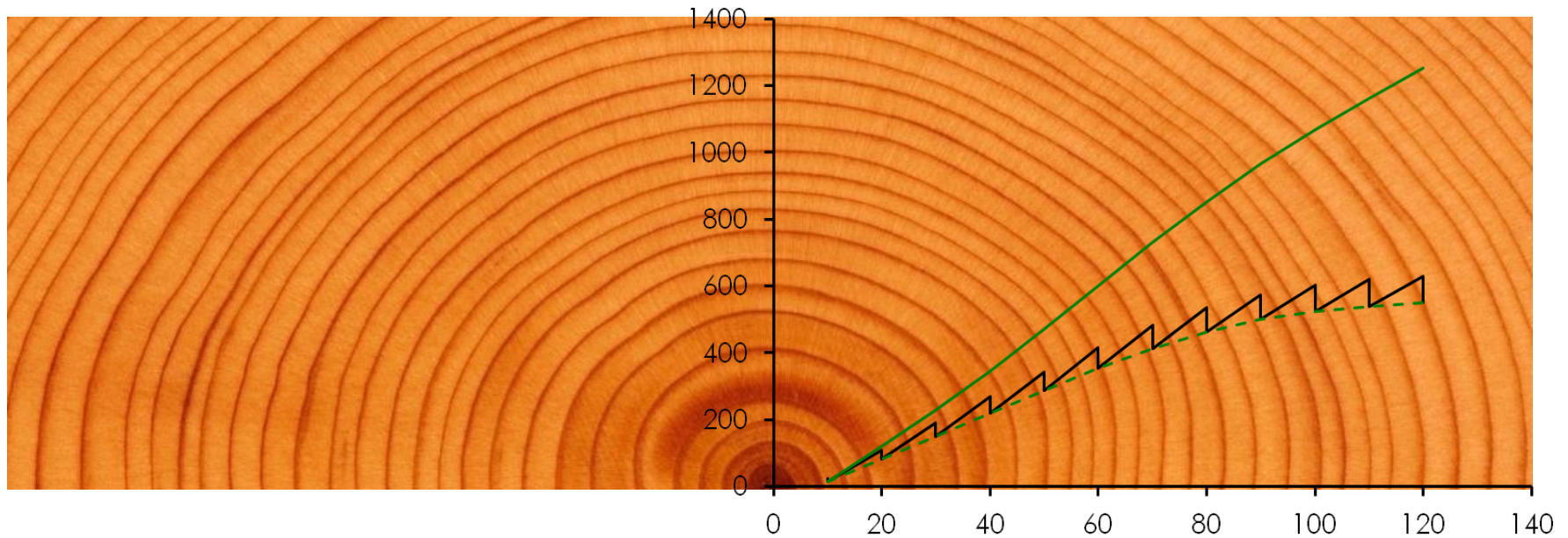
differences between PR (annual, winter, spring, summer, autumn) measured 2000-2009 and modeled 1961-1990 (Attorre et al. 2008)

### **$\delta$ AT**

differences between AT (annual mean, maximum, minimum) measured 2000-2009 and modeled 1961-1990 (Attorre et al. 2008)

# Predictor variables 2

## Management



### **$\delta$ Age \_Max\_GR**

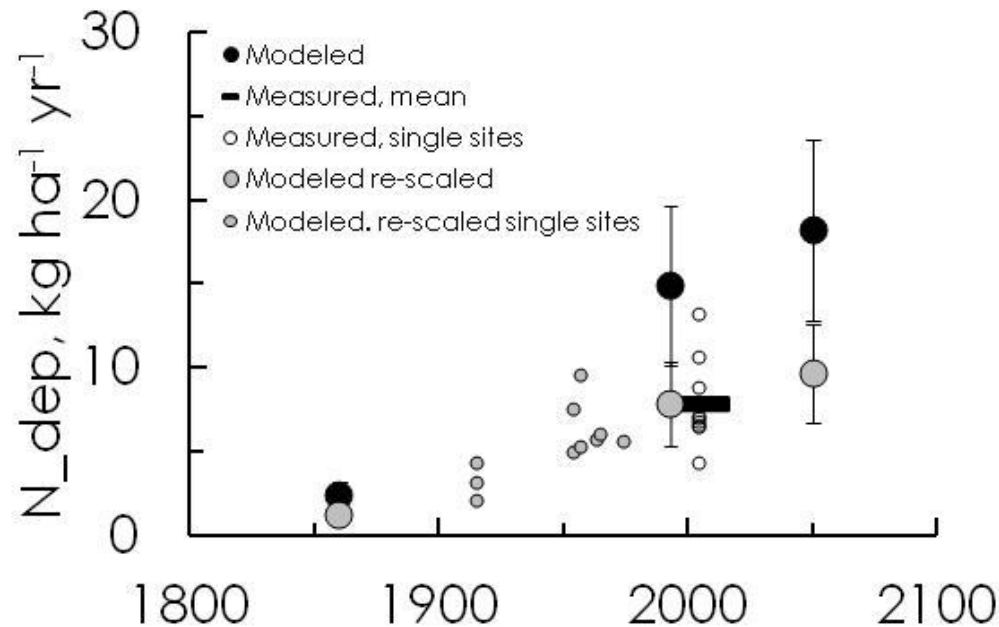
differences between current ages of standing crops and ages of mean volume increment culmination of yield tables

### **$\delta$ Age \_Max**

differences between current ages of standing crops and maximum ages of yield tables

# Predictor variable 3

## N deposition

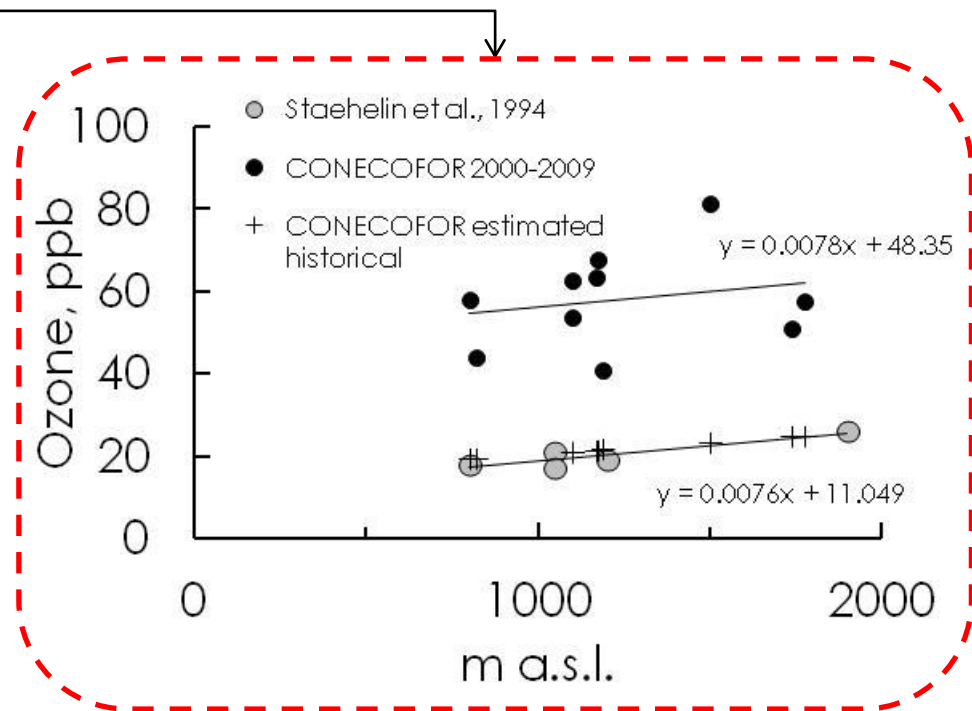
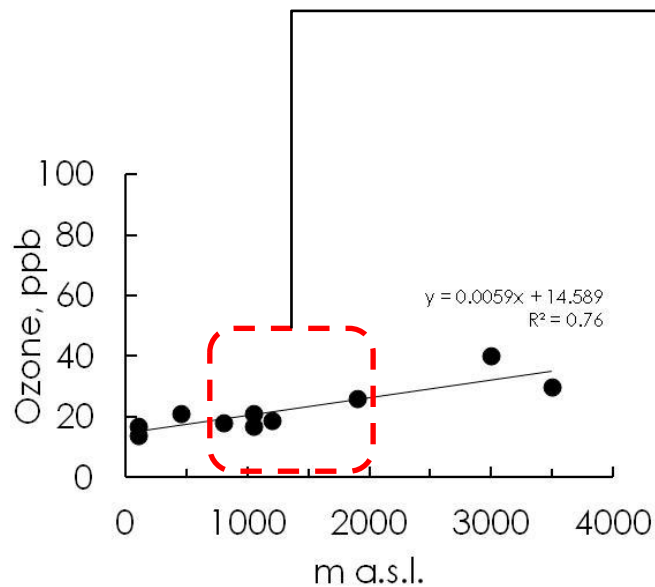


### $\delta N_{dep}$

differences between actual bulk N deposition (1998-2009) and potential N deposition estimated at the year of yield tables (Denter 2006)

# Predictor variable 4

## O<sub>3</sub> concentration



### $\delta O_3$

differences between actual O<sub>3</sub> concentration and O<sub>3</sub> concentration modeled for years  $\leq 1950$  by (Staehelin et al 1994)



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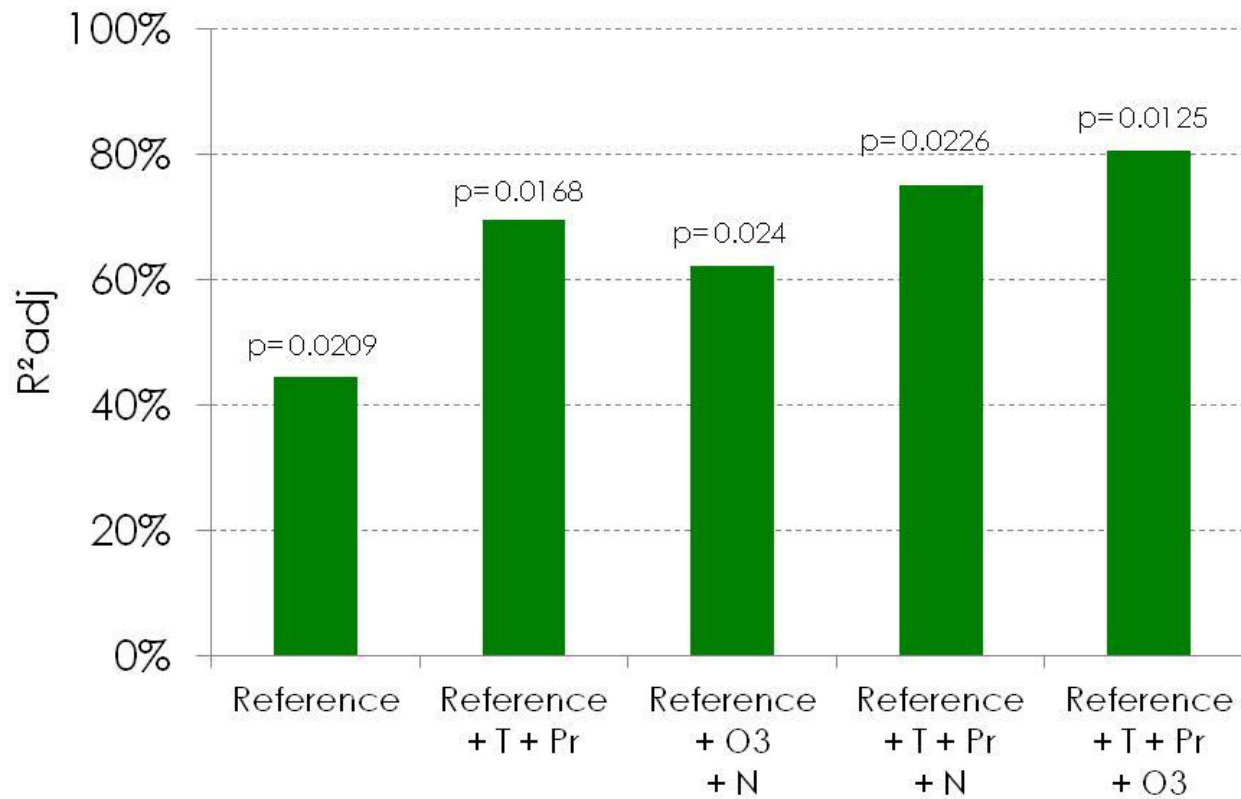
# Variables and final models

Variables	
Metereology	$\delta PR_{winter}$
	<b><math>\delta PR_{spring}</math></b>
	$\delta PR_{summer}$
	$\delta PR_{aut}$
	$\delta PR_{tot}$
	$\delta AT_{min}$
	$\delta AT_{mean}$
	<b><math>\delta AT_{max}</math></b>
Environmental pollution	<b><math>\delta N_{dep}</math></b>
	<b><math>\delta O_3</math></b>
Management	$\delta Age_{Max}$
	<b><math>\delta Age_{Max\_GR}</math></b>

Models
Reference
Reference + T + Pr
Reference + O <sub>3</sub> + N
Reference + T + Pr + N
Reference + T + Pr + O <sub>3</sub>

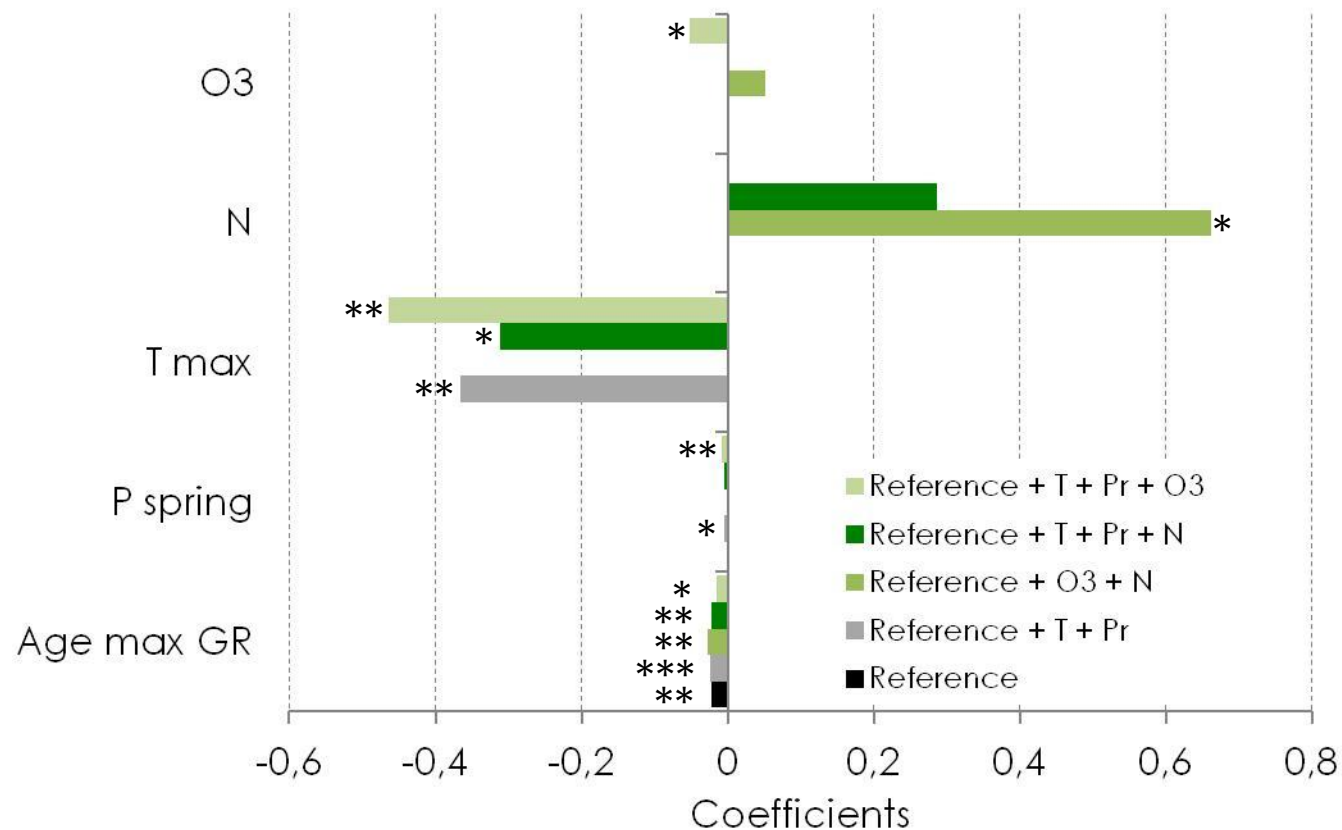
# Models output

## Explained variance



# Models output

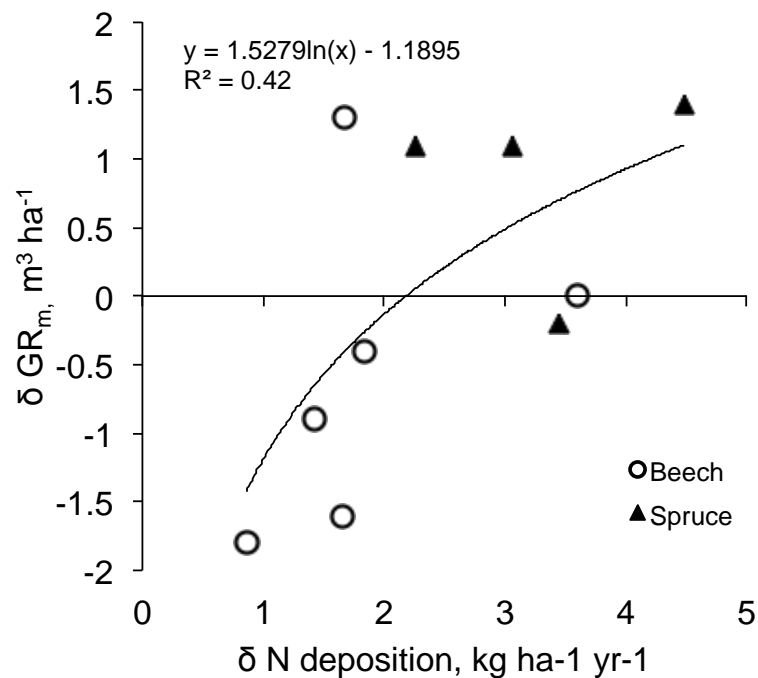
## Estimated variable coefficients per model



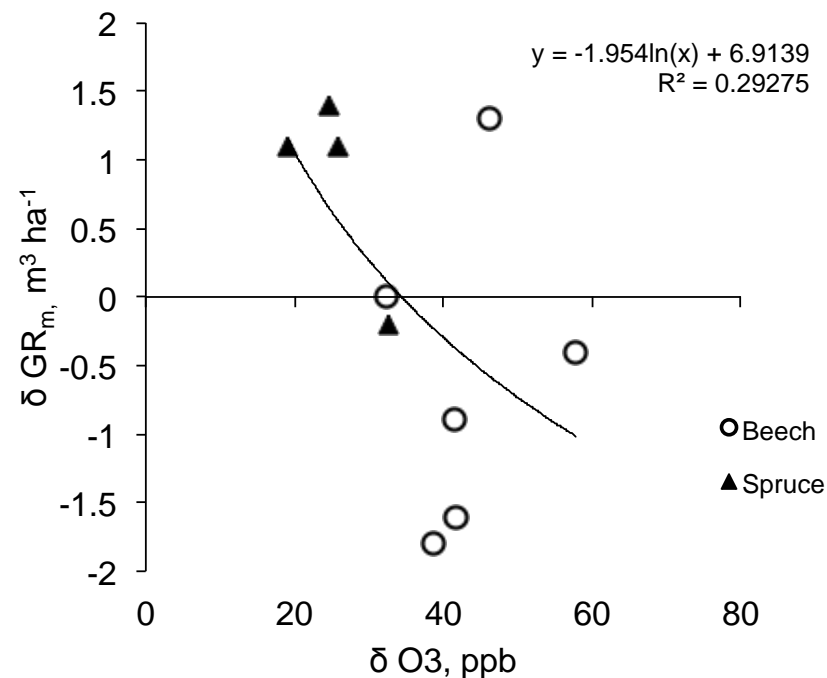


# Relationships between growth deviation and predictor variables

## N deposition



## O<sub>3</sub> concentration



# Conclusions

## N deposition and growth deviation

- Past growth models explained ca. 64% of the average growth as recorded by current measurement
- Deviations from expected growth are explained by changes in several factors related to management (delayed rotation time, negative effect) and meteorology (T max, negative effect)
- Estimated changes in N deposition had a positive effect on reported growth deviation
- Tropospheric ozone, had a negative effect, something that was not obvious from investigation on current growth (Ferretti et al., 2014; 2003; Ferretti and Bussotti, 2009)
- These preliminary results are subject to several uncertainties and needs confirmation by further investigation

# Thanks

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