

Swedish Clean Air and Climate Research Program Frisk luft och Klimat



## Swedish Clean Air and Climate Research Program

WP 4. Climate and carbon cycle impacts of short lived climate forcers.

## Forest ozone exposure and effects on carbon sequestration

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Per Erik Karlsson, Håkan Pleijel\*, Hans Linderholm\*\*

IVL Swedish Environmental Research Institute

- \* Dept Biol & Env Sciences, University of Gothenburg
- \*\* Dept of Earth Sciences, University of Gothenburg



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### Background.

- The carbon stocks in Swedish forests increase 30-40 M t  $CO_2e/yr$  and the main sink is the living biomass
- Depends on the gap between growth and fellings
- A small decline in the growth rates may substantially reduce forest carbon sequestration







### Aims and approach



#### Aims

- To further quantify the ozone impacts on the growth of Swedish forests
- To quantify the impacts of other air pollution and climate elements on the growth of Swedish forests

#### Approach

- Dendrochronology investigations of >20 years of historic forest growth at approximately 25 different sites with Norway spruce, Scots pine and European beech across Sweden
- Explanatory variables include:

Yearly ozone exposure; Yearly temp sum/VPD; precipitation sum; radiation; Yearly drought days (modelling soil moisture); Yearly nitrogen deposition; Yearly basecation deposition; Soil, and stand characteristics etc. etc.



## **Research plots**

- Plots within the Swedish Throughfall monitoring network (SWETHRO) with estimates for air pollution concentrations, deposition and soil water chemistry
- Some of the plots are co-located with forest observation plots run by the Swedish Forest Agency, with regular monitoring of stem DBH; needle nutrients; soil structure and chemistry; crown thinning
- Some plots are part of a research project with modelling of growth and soil water chemistry with the FORSAFE model (Salim Belyazid & Cecilia Akselsson, Lund University)











### **Research plots**

 Plots, 17 with Norway spruce, 4 with Scots pine, 4 with European beech)





[ppbv hours]

5000

2000

10000 15000 20000 30000

40000 60000



## The methodology of dendrochronology



## Are there methodology problems in interpreting tree-rings vs. yearly growth rates ?

Possibilities

 At Asa research station DBH has been monitored weekly since 1993 and ongoing

 Tree-ring analysis of the same trees would give an insight into the relations between tree-rings and manual growth assessments



### The time-step



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#### Yearly

Advantages

Can use the between-year variation in both the dependent- and explanatory variables

Dis-advantages

 there might be complications with "memory effects" between years, which however might be handled with the statistical models



## The dependent variable



The yearly, relative stem basal area increment (%/ yr)

Advantages 

– A rate parameter, strongly coupled to forestry assessments

- **Dis-advantages** 
  - biased by stem shape changes, c.f. Kranzberg



Karlsson, unpublished

#### Pretzsch et al., 2010.





## The explanatory variables – ozone exposure



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#### **AOT40**

- Advantages
  - relatively easy to estimate, compared to ozone flux
  - has been demonstrated useful for Swedish conditions, both in experiments and epidemiology
- Dis-advantages
  - may ignore the dose-modifying impacts of VPD and soil moisture



## The role of soil moisture for the ozone exposure



A severe drought treatment during 3 out of 4 ozone exposure seasons did not result in a better correlation between reductions in RGR and ozone exposure based on ozone flux as compared to AOT40.



Karlsson et al. Environmental Pollution 128 (2004) 405–417 415



# The explanatory variables – ozone exposure



AOT40, apr-sep

20000

15000

ppb timmar 2000 2000

#### How to estimate plot AOT40 ?

- The national rural ozone monitoring
  - few sites, most available > 20 years
- The southern Swedish Ozone Monitoring Network
  - more sites, only few years
  - based on monthly passive sampling in combination with hourly air temperature measurements
- The MATCH model
  - as yet not available for 20 years





2014



# The explanatory variables – ozone exposure



#### How to estimate plot AOT40 ?

 The monthly ozone passive sampling/ air temperature methodology at 10 "critical" plots





## The explanatory variables – soil moisture



#### How to estimate historic soil moisture during >20 years?

- Buecker et al, 2012?
- Monitoring soil moisture at 10 and 50 cm depth with gypsum blocks at three sites as a transect across southern Sweden





### **Statistical methods**



#### XXX

Advantages

- xxx

Dis-advantages

– ууу