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UNIVERSITÄT FREIBURG

Applied period report:

Dendroecological Analysis of the Radial Increment of Trees at Different Stem Heights; with Respect to Age, Species, Aspect and Altitude

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Content

- Objectives and hypotheses
- Discription of the study area
- Material and field methods
- Data analysis
- Results
- Conclusion

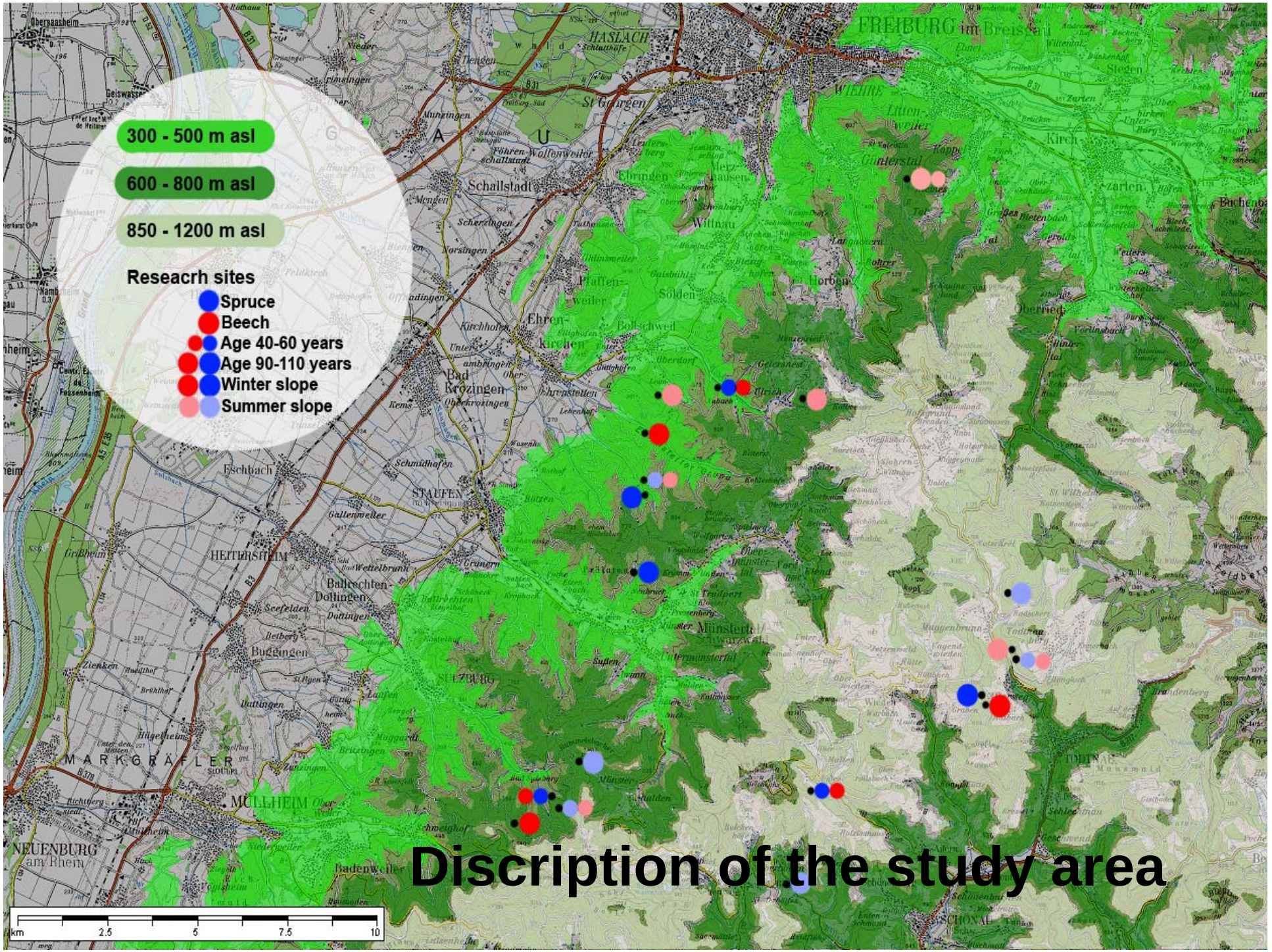
Objectives and Hypotheses

Objectives:

- To see the general radial increment trend through time, across the different stem heights of a tree; in different site conditions, species and age
- To see whether there is a common signal among the different sites, species and age
- To indicate some special years which need emphasis for further studies

Hypotheses:

- The radial increment of trees is influenced by climatic factors, hence regardless of their variability, trees under similar climatic environment, must have some common signal as a result of the response to climate
- There is larger radial increment in the upper part of a tree due to longer growing period since growing starts at the top and cessation starts at the bottom
- Younger trees should have larger more radial increment because through time older trees have a physical problem to grow more



Discription of the study area

Material and field methods

Sample selection:		Beech (Fagus sylvatica)		Spruce (Picea abies)	
		Young (40-60) yrs	Old (90-110)yrs	Young (40-60)yrs	Old (90-60)yrs
NE	Montane (850-1200)				
	Kollin (300-500)				
SW	Montane (850-1200)				
	Kollin (300-500)				

Aspect: North East and South West

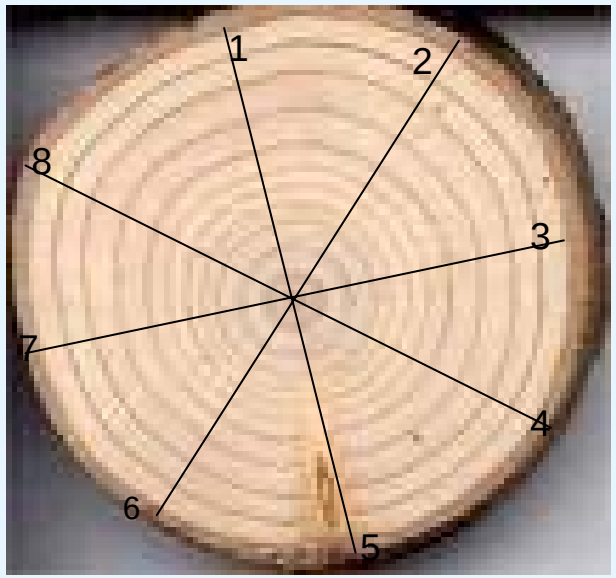
Altitude: Montane s.l)

Species: Spruce (

Age class: Young

Material and field methods

- Five trees per each site were selected
- Nine discs from each tree at heigts: 1.3, 11.5, 14.0, 16.5, 19.0, 21.0, 24.0, 26.5, 29.0 m from the base
- Total number of discs = 2*2*2*2*5*9=720
- Each disc was then given a code, the radial increment series was measured in eight/four directions and averaged.



Data analysis

Raw data:

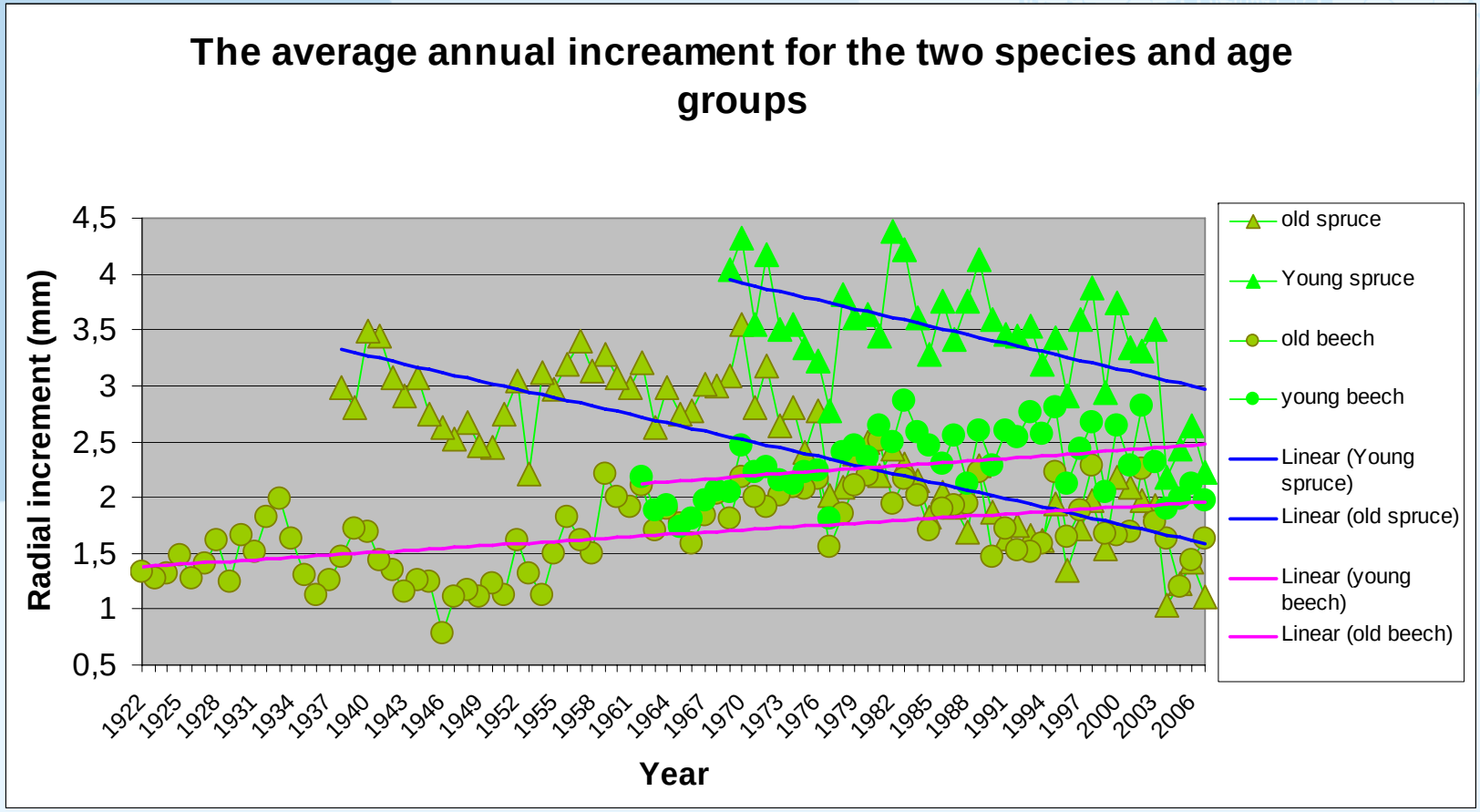
The raw data was analysed by drawing graphs, calculating the correlation and anova for different stem heights within a site and taking averages across the sites,

Detrended data:

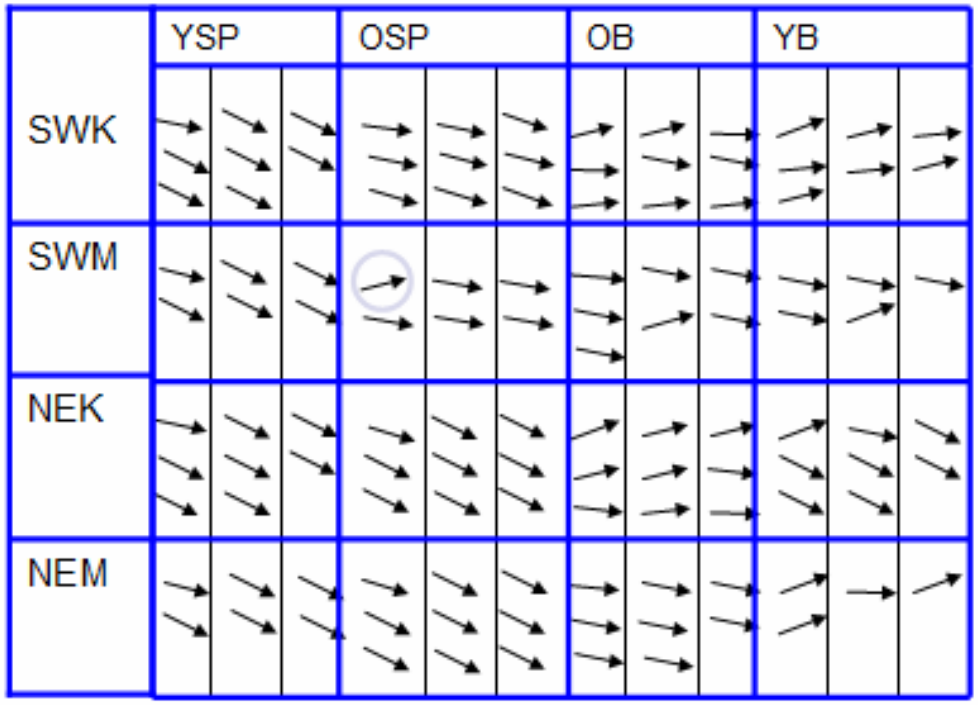
In order to remove the long-term growth trend, the raw data was detrended by ARSTAN using a spline function with 50% variance at 30 year wave length, and the IR index (proportion of measured value to estimated) was used to see the high frequency variation caused by the climate.

Results

Radial increment trend through time



Results- The IR trend general direction



d1	d2	d3
d4	d5	d6
d7	d8	d9

Key:

Highly declining

Moderately declining

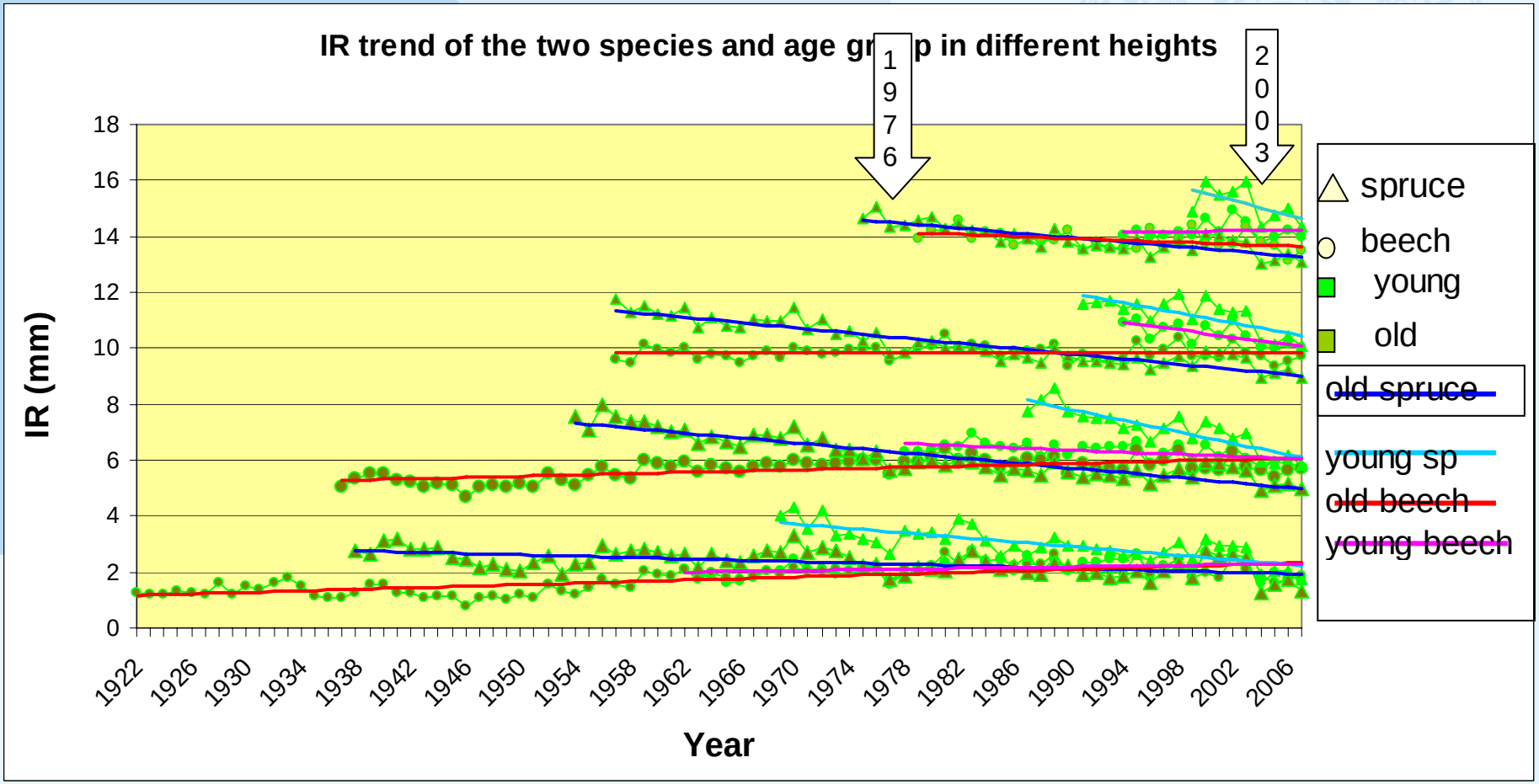
Uniform/constant

Moderately inclining

Highly inclining

YSP	young spruce
OSP	old spruce
OB	old beech
YB	young beech
SWK	south west kollin
SWM	south west montane
NEK	north east kollin
NEM	north east montane

Results- Radial increment trend in the different heights



Results- Synchrony among the different heights

Correlation matrix of the different heights in young beech

	d1	*d2*	*d3*	*d4*	*d5*	*d6*	*d7*
d1	1						
d2	0,898242	1					
d3	0,911217	0,968518	1				
d4	0,910425	0,928849	0,955579	1			
d5	0,664086	0,582658	0,551442	0,732106	1		
d6	0,791824	0,834939	0,913214	0,937151	0,577566	1	
d7	0,314976	0,26558	0,229185	0,387881	0,609292	0,293984	1

r > 0.95

0.8 < r < 0.95

0.5 < r < 0.8

r < 0.5

Results- Synchrony among the different heights

Correlation matrix of the different heights in old beech

	d1	*d2*	*d3*	*d4*	*d5*	*d6*	*d7*	*d8*	*d9*
d1	1,00								
d2	0,97	1,00							
d3	0,84	0,96	1,00						
d4	0,84	0,95	0,98	1,00					
d5	0,85	0,95	0,97	0,99	1,00				
d6	0,88	0,94	0,98	0,98	0,99	1,00			
d7	0,86	0,93	0,96	0,96	0,98	0,98	1,00		
d8	0,80	0,86	0,91	0,88	0,91	0,92	0,93	1,00	
d9	0,65	0,73	0,80	0,75	0,78	0,80	0,84	0,96	1

Results- Synchrony among the different heights

Correlation matrix of young spruce

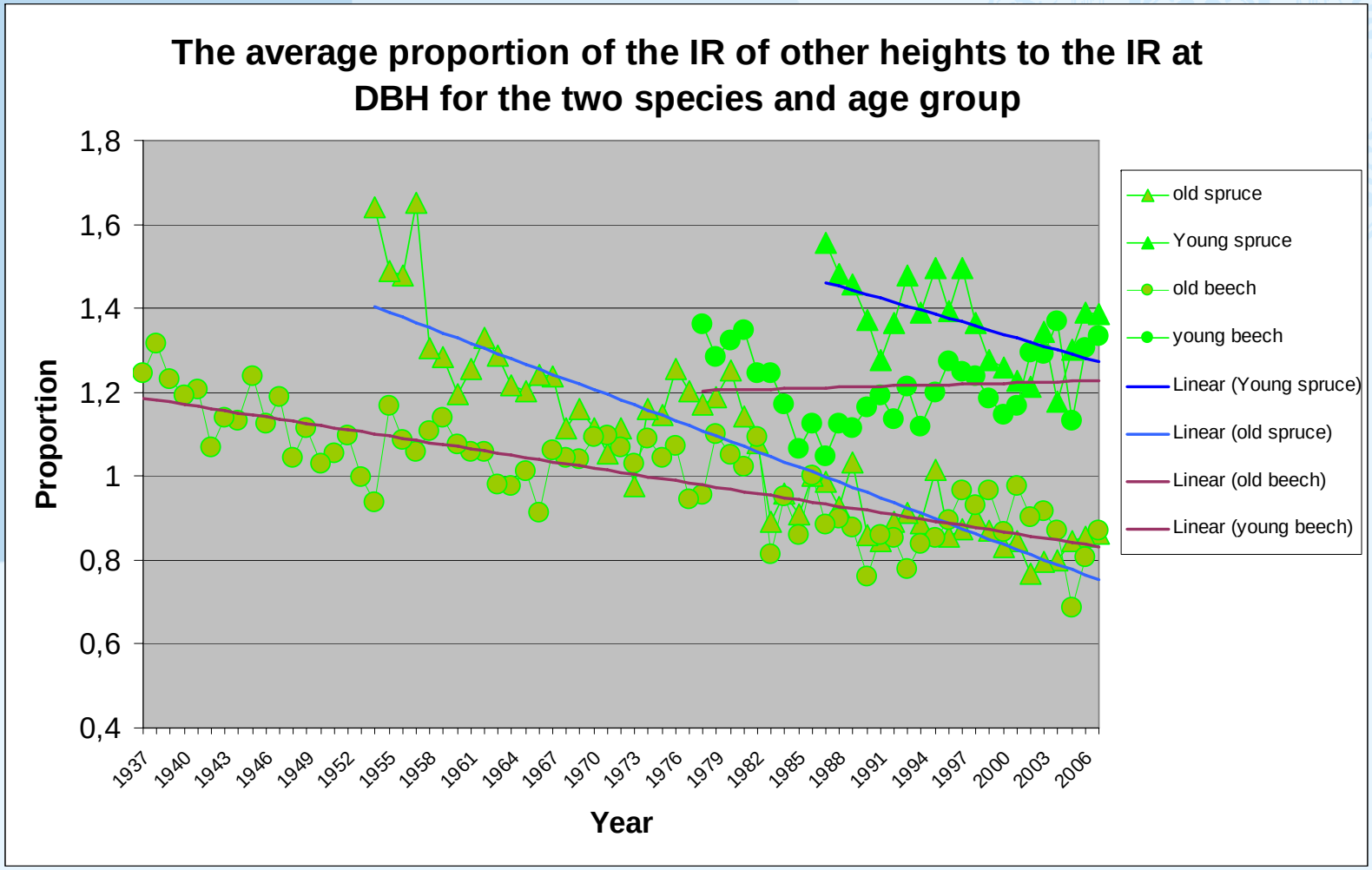
	d1	*d2*	*d3*	*d4*	*d5*	*d6*
d1	1					
d2	0,85368	1				
d3	0,935233	0,980968	1			
d4	0,938152	0,967296	0,982289	1		
d5	0,933719	0,886752	0,912679	0,96259	1	
d6	0,886079	0,868075	0,88977	0,95809	0,962467	1

Results- Synchrony among the different heights

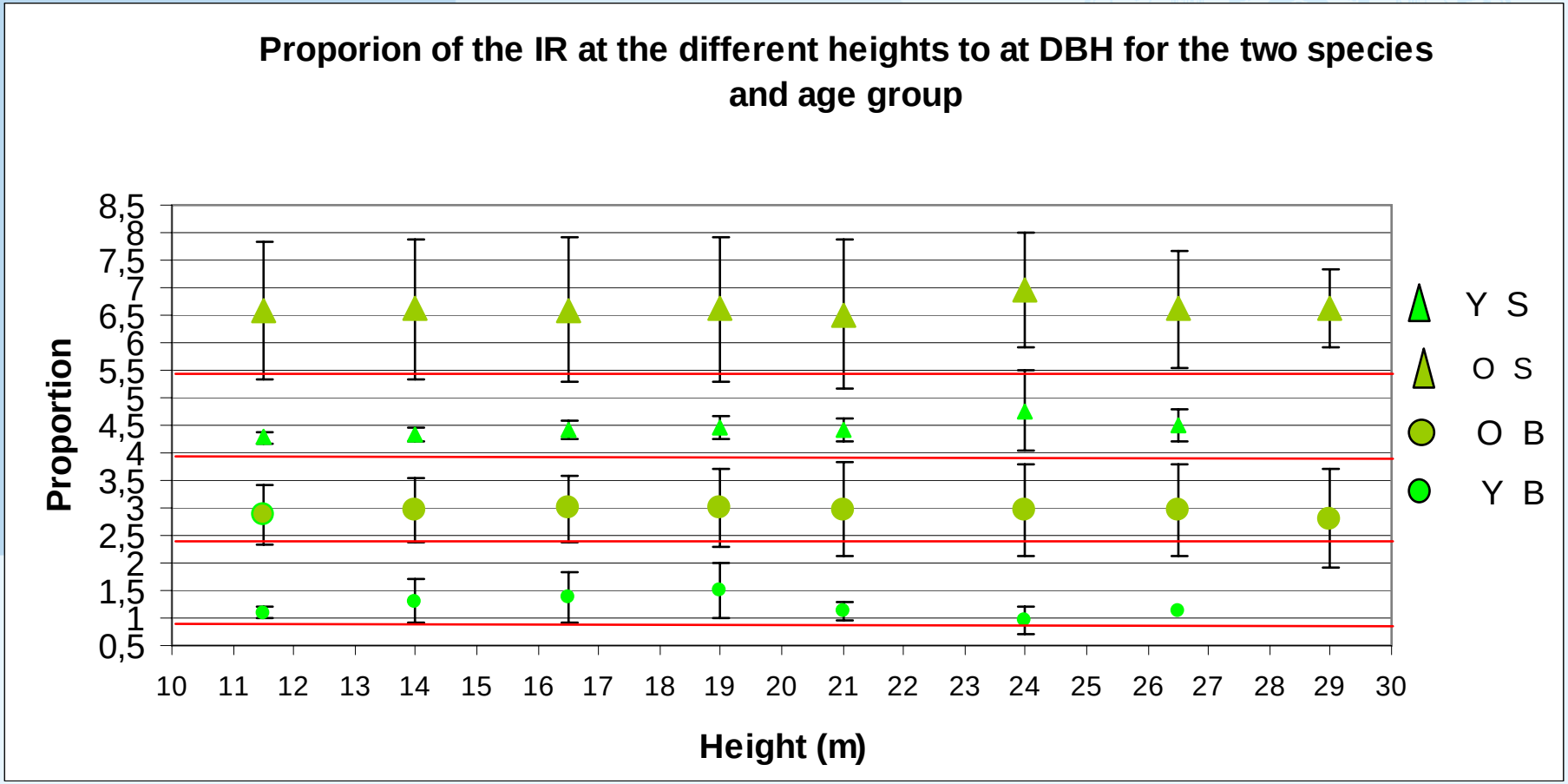
Correlation matrix old spruce

	d1	*d2*	*d3*	*d4*	*d5*	*d6*	*d7*	*d8*	*d9*
d1	1								
d2	0,789134	1							
d3	0,808946	0,993872	1						
d4	0,815893	0,979229	0,992037	1					
d5	0,60465	0,944227	0,976239	0,991612	1				
d6	0,557082	0,916648	0,960265	0,983953	0,98585	1			
d7	0,561148	0,881756	0,927649	0,956606	0,952865	0,97701	1		
d8	0,748692	0,879313	0,892254	0,922263	0,932206	0,968544	0,984555	1	
d9	0,758166	0,863832	0,876329	0,896009	0,90028	0,949484	0,997948	0,996285	1

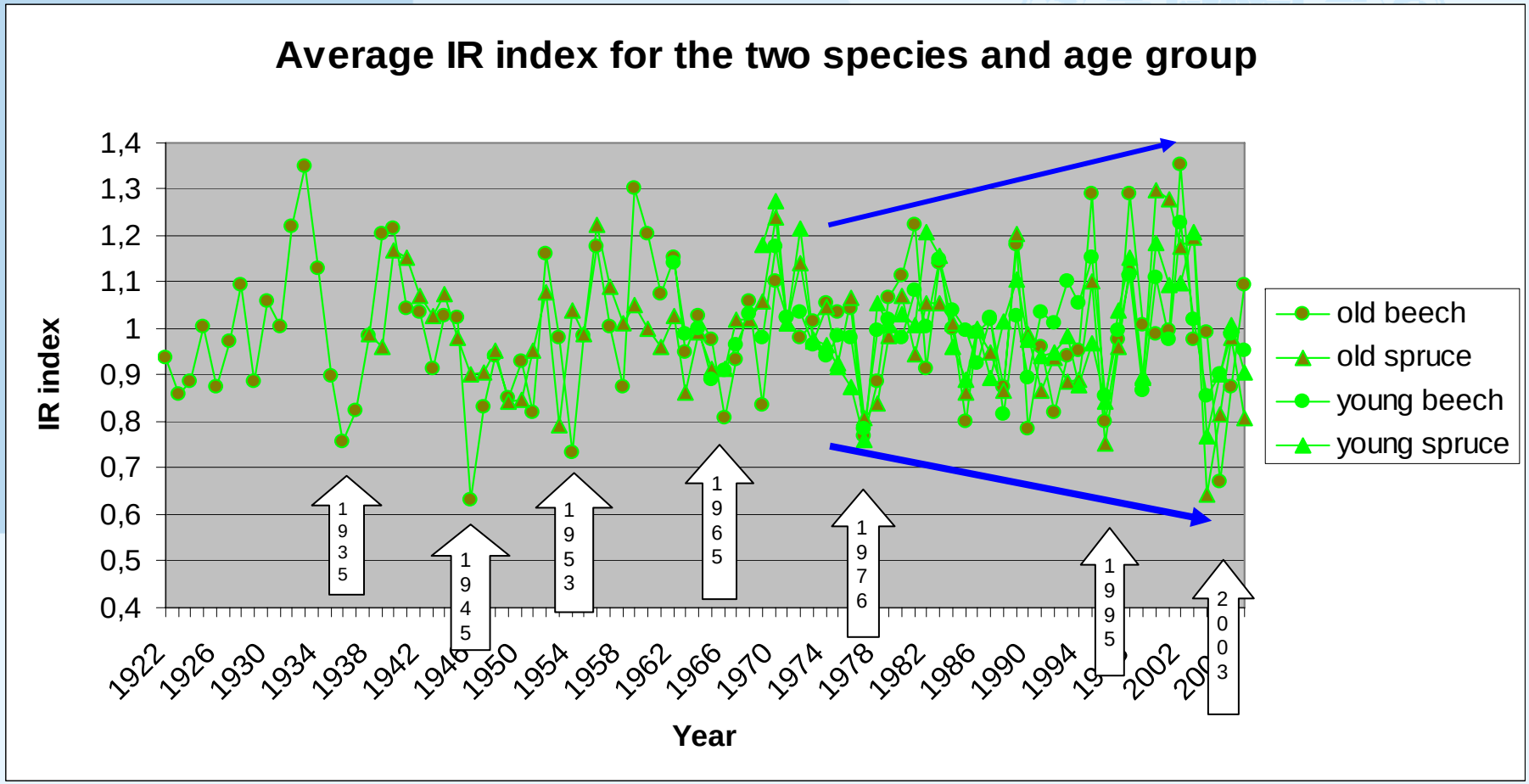
Results-


The average proportion of the IR of other heights to the IR at DBH for the two species and age group
Proportion
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
Year
old spruce
Young spruce
old beech
young beech
Linear (Young spruce)
Linear (old spruce)
Linear (old beech)
Linear (young beech)

Results


Proporion of the IR at the different heights to at DBH for the two species and age group
Proportion
8,5
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Height (m)
Y S
O S
O B
Y B

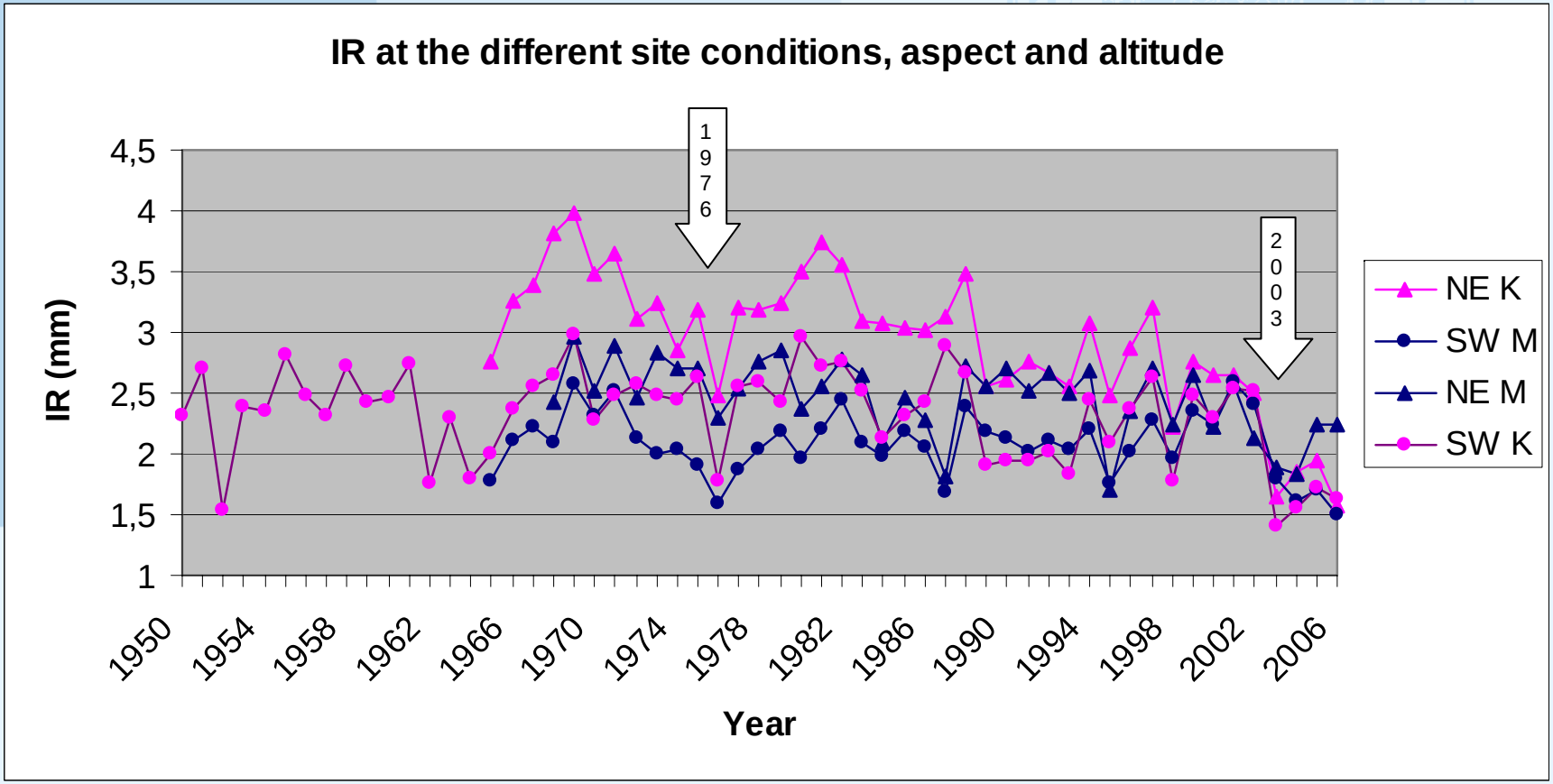
Results- Environmental response (climatic signal) of trees



Results- Correlation matrix of the average IR index among the two species and age groups

	old beech	*old spruce*	*young beech*	*young spruce*
old beech	1			
old spruce	0,477867	1		
young beech	0,654368	0,599027	1	
young spruce	0,312352	0,787096	0,573094	1

Results- Variability of the radial increment in different site conditions



Results- Correlation matrix for the site conditions

	NE K	*SW M*	*NE M*	*SW K*
NE K	**1**			
SW M	**0,583029**	**1**		
NE M	**0,592603**	**0,630572**	**1**	
SW K	**0,859912**	**0,544802**	**0,45623**	**1**

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Altitude	**0,340503**	**1**	**0,340503**	**12,97185**	**0,000547**	**3,960352**
Aspect	**0,090763**	**1**	**0,090763**	**3,457708**	**0,066634**	**3,960352**
Interaction	**2,496812**	**1**	**2,496812**	**95,11899**	**2,93E-15**	**3,960352**
Within	**2,099948**	**80**	**0,026249**			
Total	**5,028026**	**83**				

Summary and Conclusions

The long term radial increment trend is different between Spruce (Picea abies) and Beech (Fagus sylvatica)

The proporions of the different stem heights showed higher radial increment in the higher stem heights than at DBH
Younger trees have a higher radial increment than old trees

There is higher radial increment in the North East Kollin than the other sites

There is high synchrony in radial icrement series across different species, age groups, sites and stem heights

The radial increment index indicated the historical drought years and a trend of increasing high frequency fluctuations

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Wu Jian

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Thank you for your attention!

MARRY CHRISTMAS!