



UNIVERSITY OF  
EASTERN FINLAND



**Applied Period Presentation:**

**Growth Response of Douglas-firs (*Pseudotsuga menziessii*) to Temperature in Southwestern Germany**

by

Jaspar Albers

(M.Sc. European Forestry 2009)

Supervisor: Bela Bender

Freiburg, 15.12.2009

# Introduction

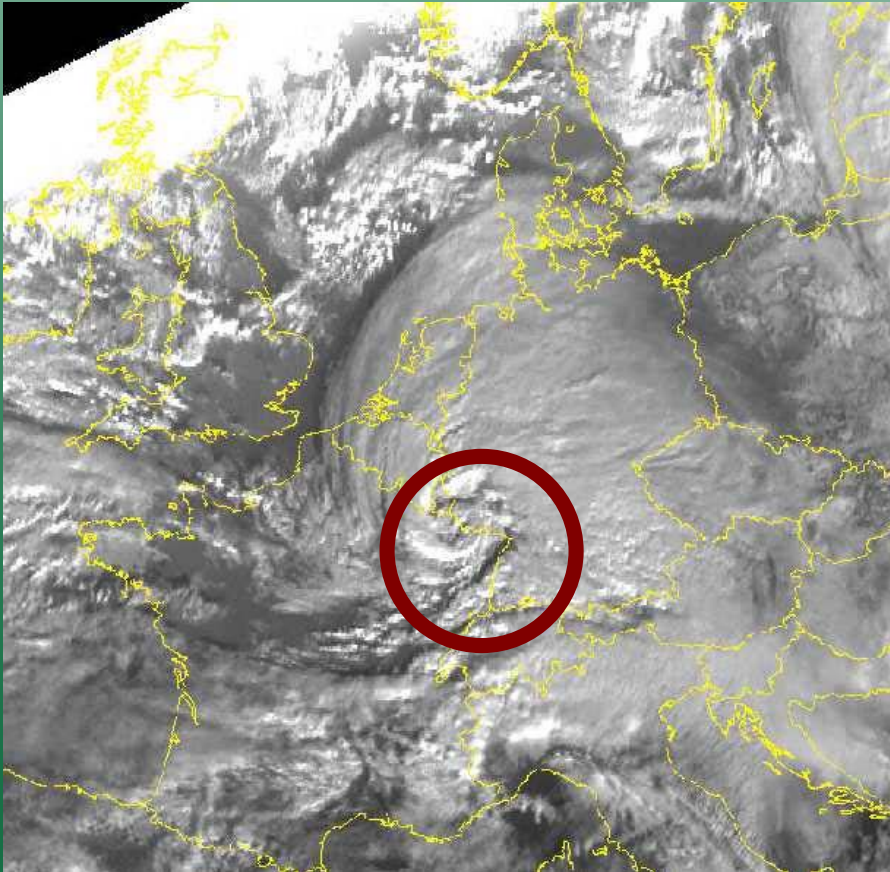
- an initial study to prepare the implementation of a dendroecological research project: „***Drought resistance of various Douglas-fir provenances***“
- effects of climatic variations on radial growth, especially intra-annual wood formation (wood density)
- different Douglas-fir provenances with differing reactions when exposed to stress (drought/heat) → elasticity!

# Study area: Uhlberg



- close to Freiburg
- planted ~ 1933
- experimental plot of the FVA since 1953
- 3 different thinning intensities on 3 plots (1-2-3) since 1961

# Study area: Uhlberg



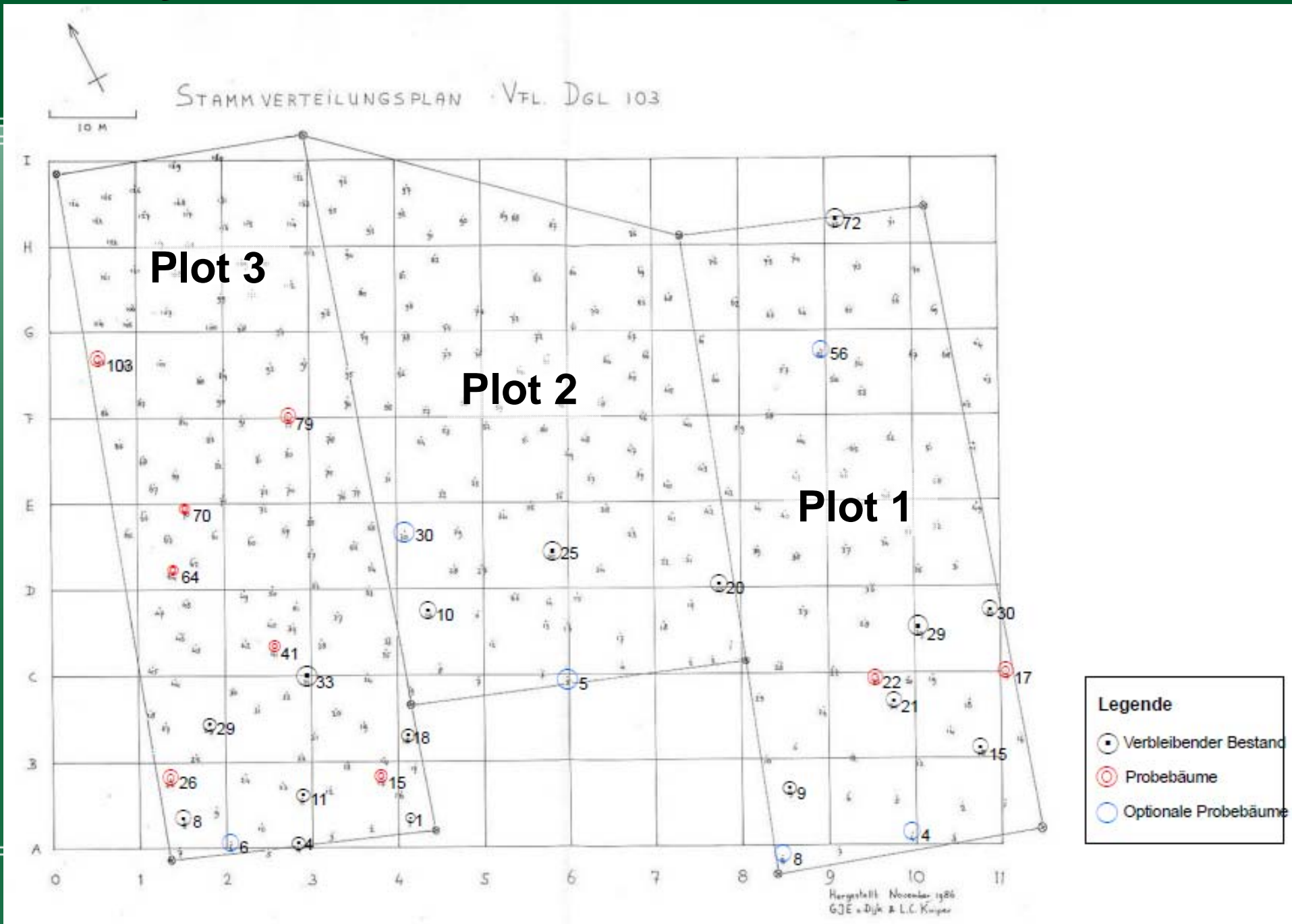
December 1999: „Lothar“!

# Study area: Uhlberg



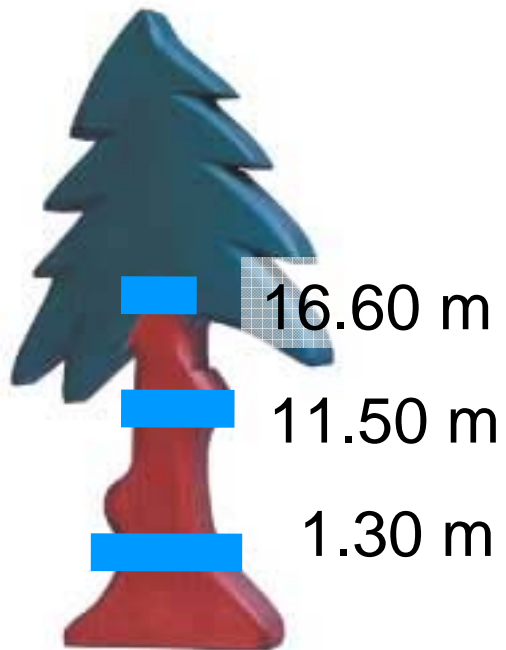
- many trees were uprooted
- few single trees were left undamaged
- experiment was stopped in spring 2000

# Study area: Distribution of surviving trees



# Material

*Pseudotsuga holzklotzii*



- 3 stem disks / tree

- **Plot 1:** 5 trees

- **Plot 2:** 2 trees

- **Plot 3:** 9 trees

- 16 trees

==> 48 samples taken in July 2009

# Preparation



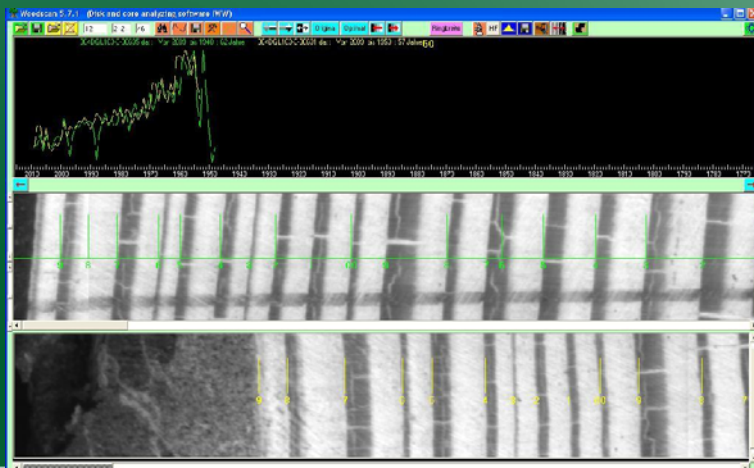
- sanding
- marking 8 radii





# Measurement

## Overview



Scanning the discs...

P l o t	Tree Nr.	Tree- rings (1.30 m)	Tree- rings (11.50 m)	Tree- rings (16.60 m)	First date
1	004	74	62	54	1936
1	008	68	56	49	1942
1	017	74	59	48	1936
1	022	73	60	50	1937
1	056	73	58	51	1937
2	005	74	61	53	1936
2	030	74	62	54	1936
3	006	75	64	57	1935
3	015	69	55	47	1941
3	026	75	63	55	1935
3	033	74	60	54	1936
3	041	74	59	50	1936

# Analysis

As the overall aim of this AP study was to prepare the implementation of a larger research project, it was tailored specifically to influence the methods of sample collection.

Two practical questions were of interest:

- 1. From which part of the stand should the samples be taken?**  
(Social classes?)
- 2. From which tree height should the samples be taken?**

# Social classes (1)

**Dominant**



Difficulties:

- how to distinguish? (16 trees!)
- period after 1999?

VS.

**Suppressed**



Which social class delivers higher correlations with climatic data?

## Tree height (2)



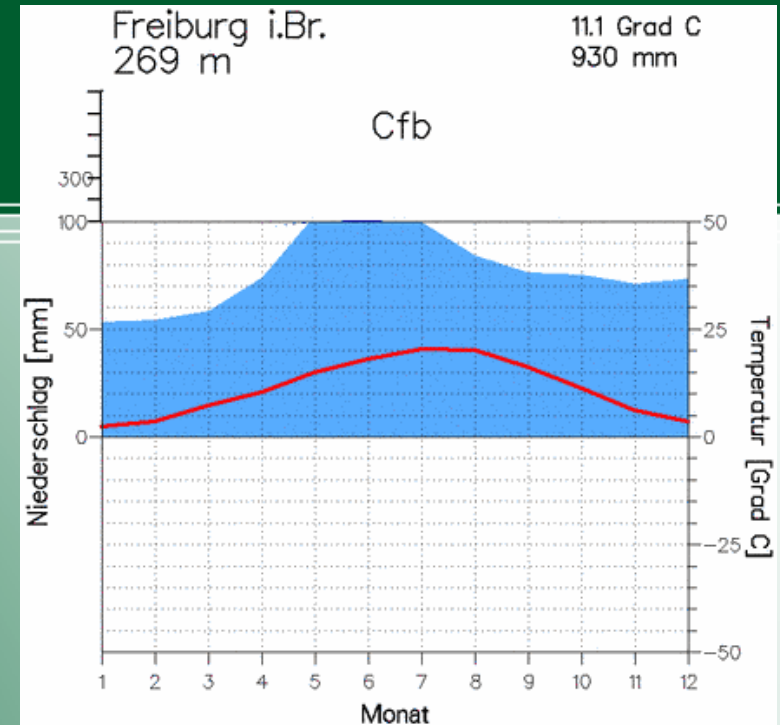
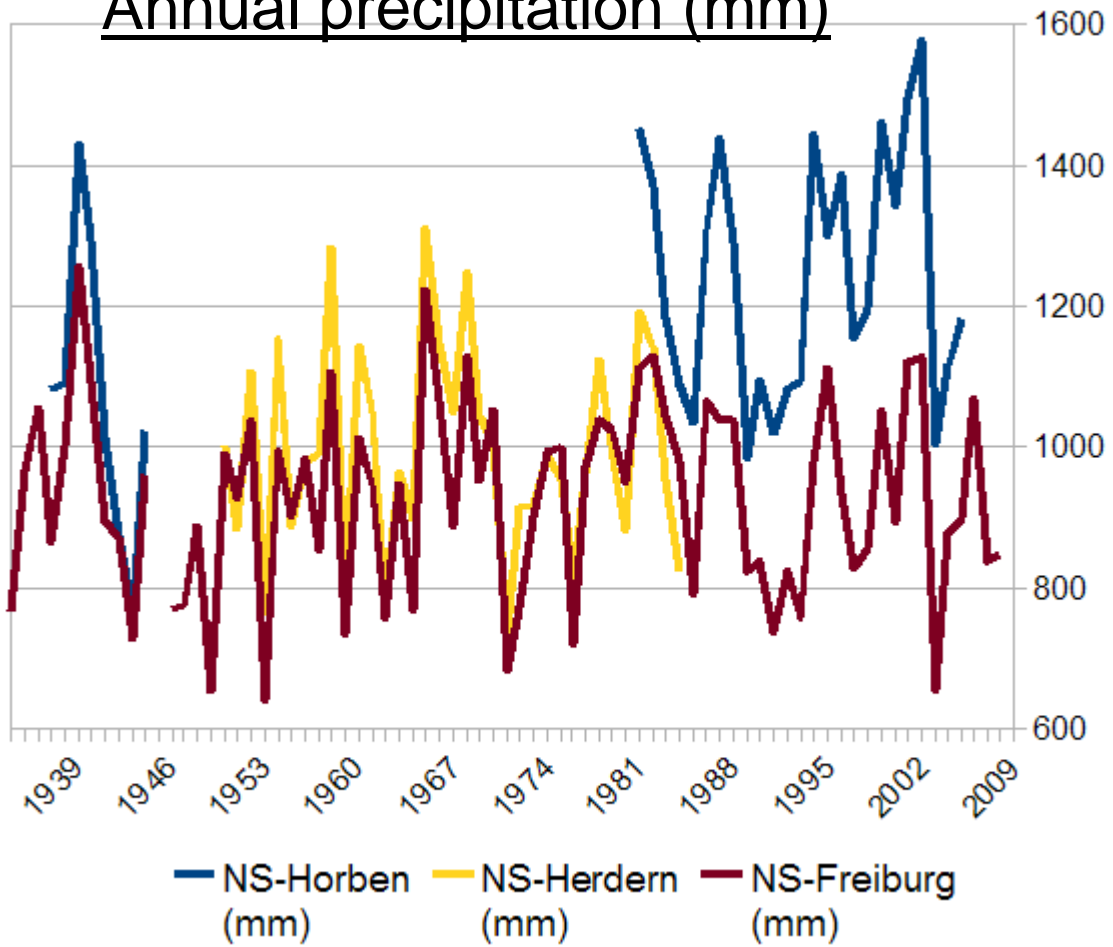
From which tree height should the samples be taken?

Difficulties:

- higher disks with lesser tree-rings
- biologic/cambial age of samples (different increment rate)

# Climatic data

## Annual precipitation (mm)



## Temperature (°C)

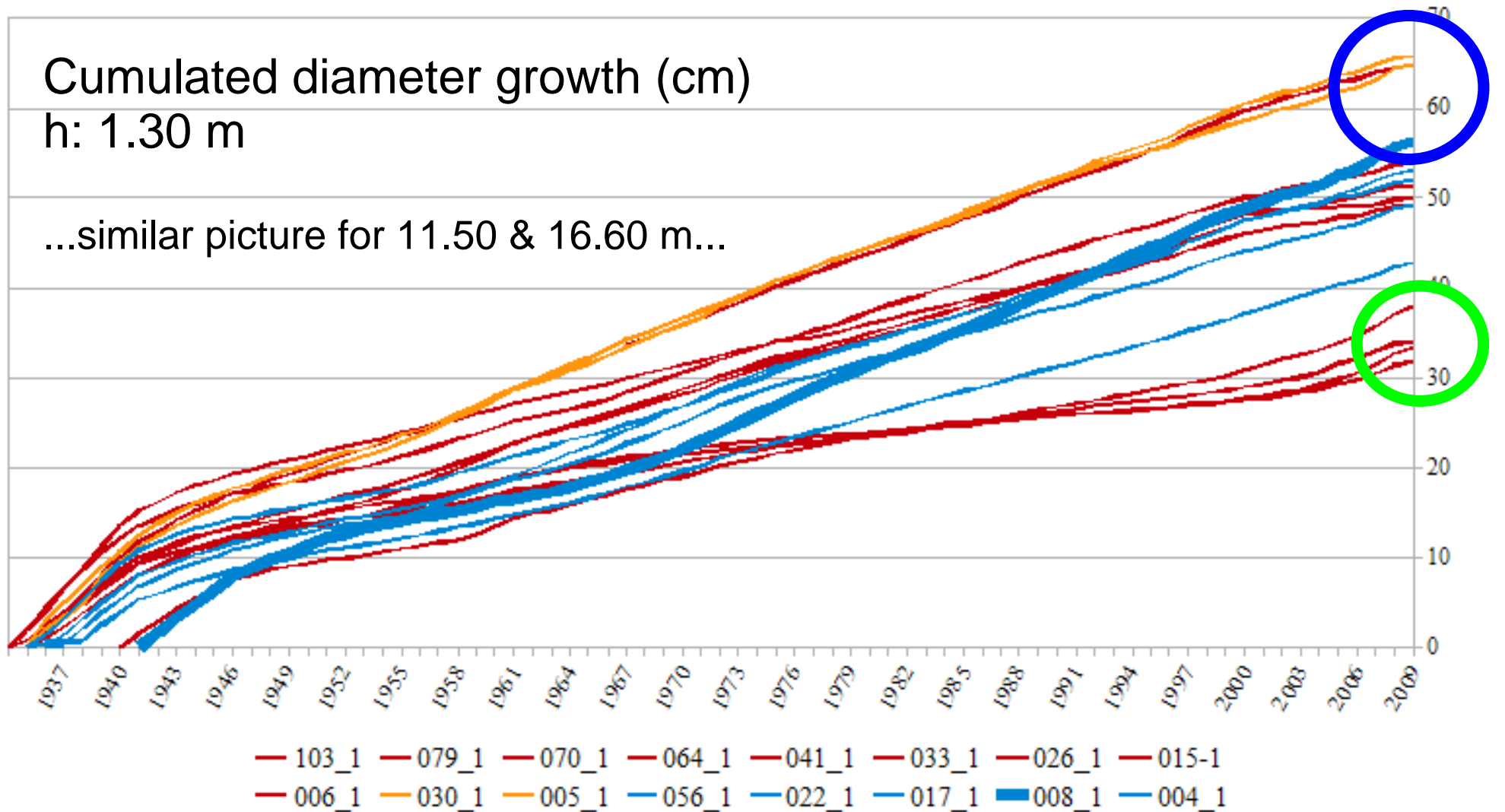
- Annual mean (Freiburg)
- Annual max. (Freiburg & Herdern)

# (1) Classifying: By growth curves I

Cumulated diameter growth (cm)

h: 1.30 m

...similar picture for 11.50 & 16.60 m...

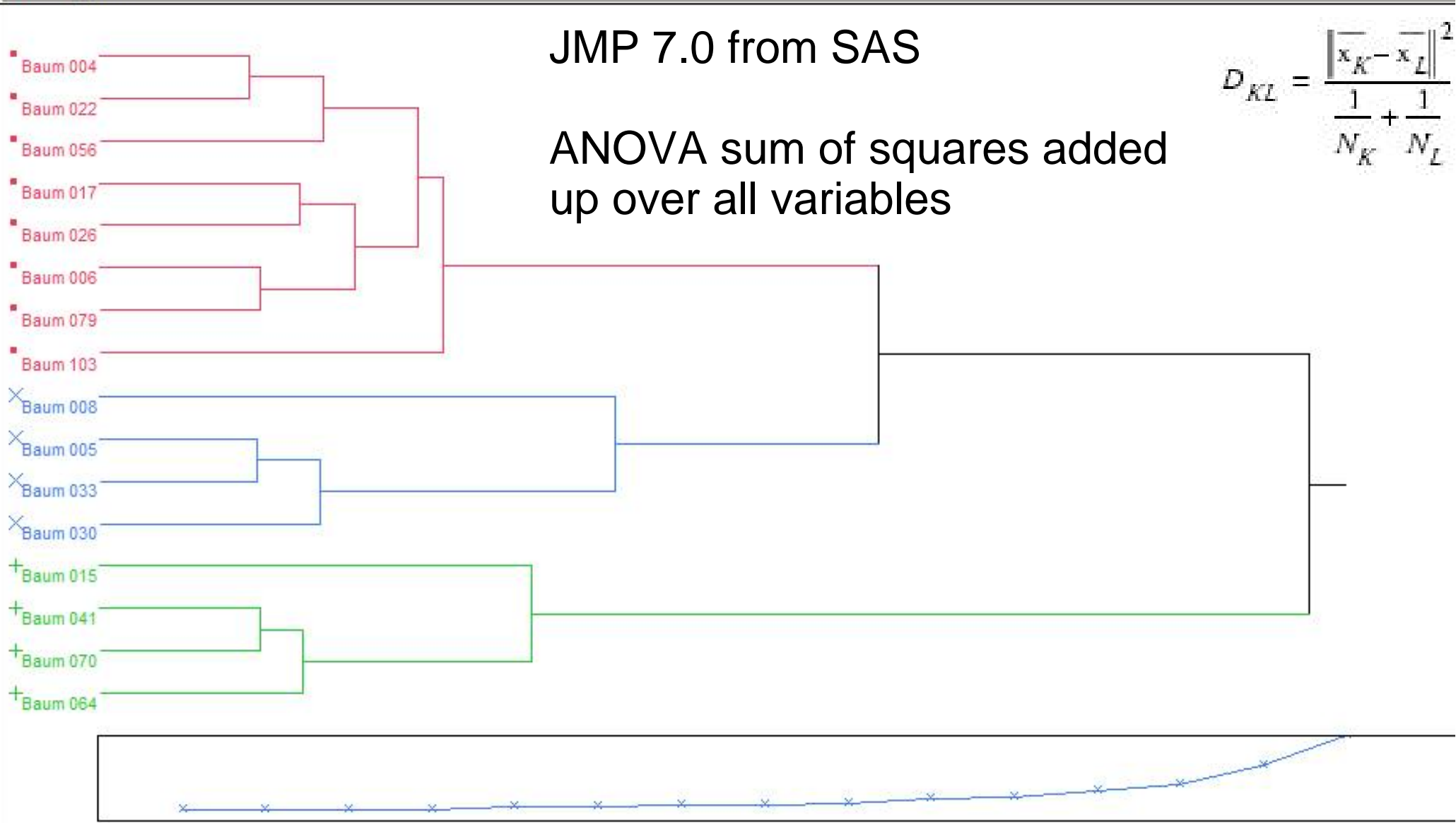


# (1) Classifying: By clustering II

## Hierarchical Clustering

Method = Ward

### Dendrogram



# (1) Classifying: By history III

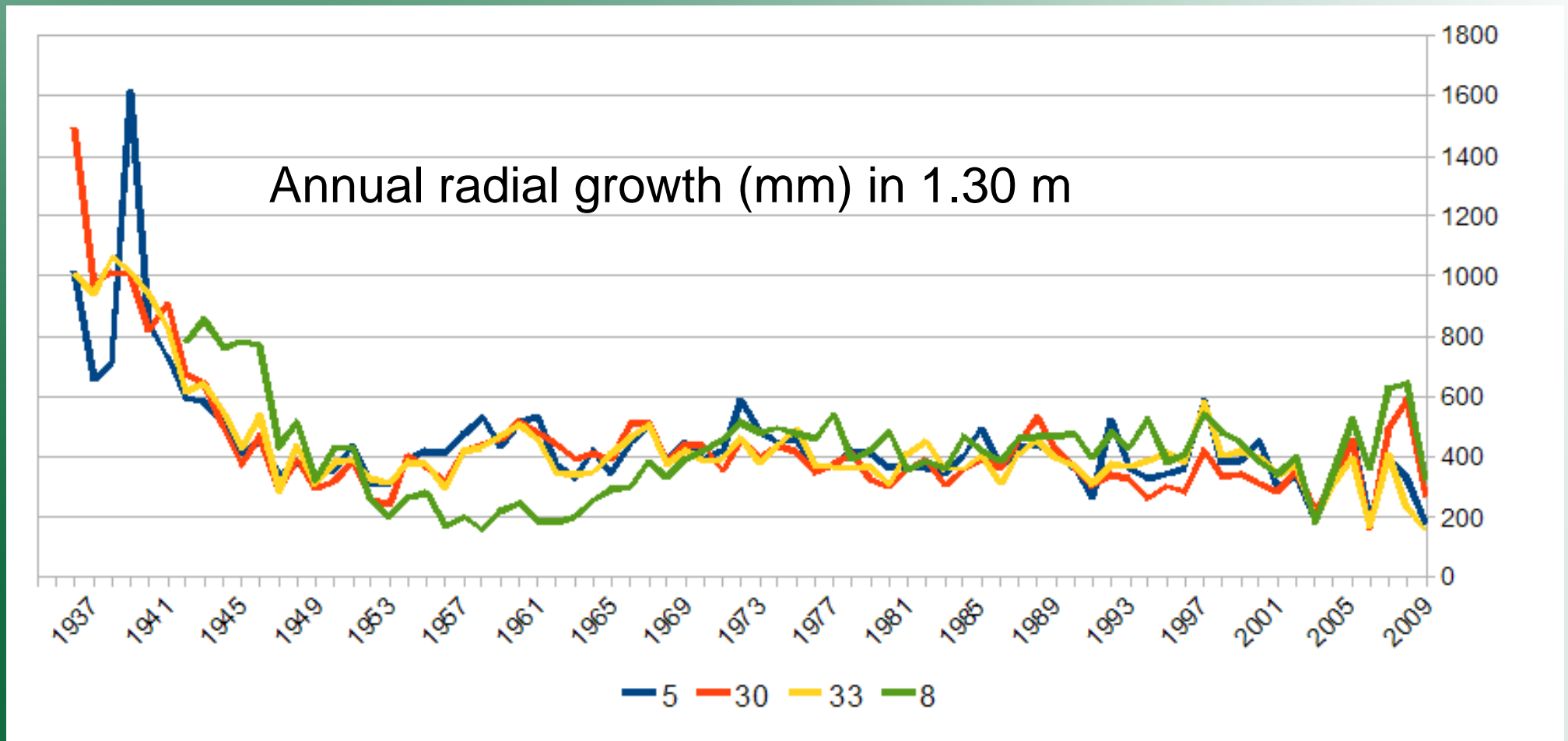
	1965	1976	1979	1982
<b>d +</b>	<b>25,0</b>	<b>35,0</b>	<b>37,4</b>	<b>39,8</b>
<b>d m</b>	<b>20,3</b>	<b>30,1</b>	<b>32,0</b>	<b>34,1</b>
<b>d -</b>	<b>15,4</b>	<b>24,2</b>	<b>25,7</b>	<b>27,5</b>
1_004	23,6	31,8	33,5	35,4
1_008	18,4	27,8	30,5	32,9
1_017	16,6	23,4	25,1	26,8
1_022	21,0	29,6	31,4	33,3
1_056	22,3	31,4	33,3	35,3
<b>d +</b>	<b>23,7</b>	<b>35,1</b>	<b>37,4</b>	<b>40,1</b>
<b>d m</b>	<b>18,5</b>	<b>28,2</b>	<b>30,2</b>	<b>32,2</b>
<b>d -</b>	<b>12,5</b>	<b>20,2</b>	<b>22,0</b>	<b>23,3</b>
2_005	31,5	41,4	43,8	45,9
2_030	32,1	41,5	43,7	45,8
<b>d +</b>	<b>24,5</b>	<b>30,6</b>	<b>33,3</b>	<b>34,7</b>
<b>d m</b>	<b>19,7</b>	<b>23,1</b>	<b>26,2</b>	<b>28,2</b>
<b>d -</b>	<b>14,5</b>	<b>16,6</b>	<b>19,2</b>	<b>20,7</b>
3_006	27,0	34,6	36,5	38,8
3_015	16,4	21,9	23,0	24,0
3_026	28,8	34,3	35,5	37,0
3_033	31,6	40,9	43,1	45,4
3_041	20,2	22,7	23,5	24,3
3_064	18,8	22,5	23,3	24,1
3_070	20,5	23,3	23,7	24,1
3_079	25,0	32,1	33,8	35,4
3_103	25,4	32,7	34,3	36,1

## Mean diameter

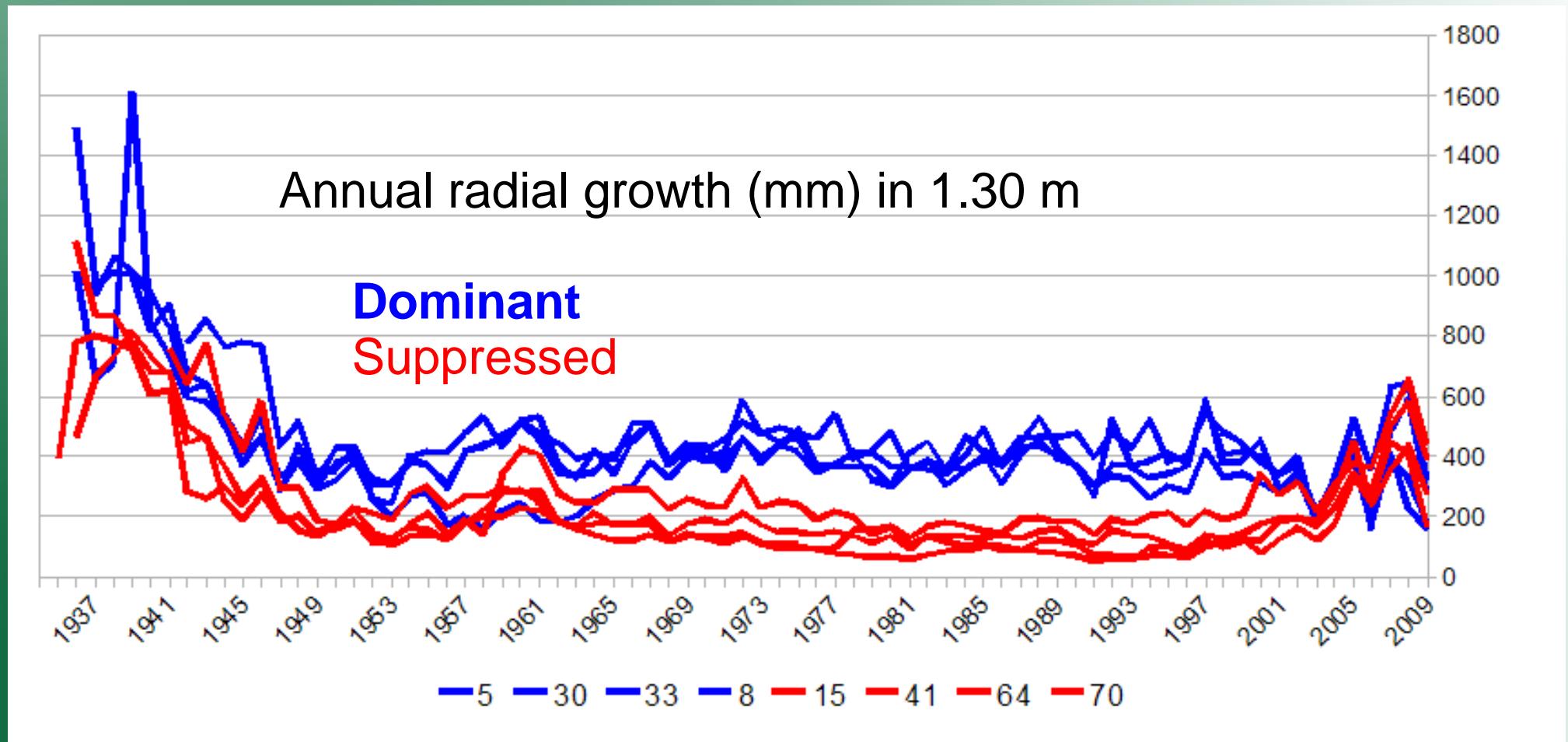
- 1965 calculated by FVA
- 1976, '79, '82 complete measurements (initially > 500 trees)
- range (d+; d-) deducted by standard deviation
- rough bark deduction!



# (1) Classifying: Dominant trees



# (1) Comparison of classes



# (1) Social classes – Correlations for 1.30 m

Sample	T mean	T max
Tree 004	0,09	-0,31
Tree 008	0,28	-0,13
Tree 017	0,31	-0,18
Tree 022	0,01	-0,26
Tree 056	0,03	-0,15
Tree 005	-0,10	-0,31
Tree 030	-0,26	-0,31
Tree 006	-0,17	-0,39
Tree 015	0,10	-0,05
Tree 026	0,32	0,00
Tree 033	0,04	-0,30
Tree 041	-0,13	-0,04
Tree 064	0,09	0,00
Tree 070	-0,08	0,03
Tree 079	-0,23	-0,26
Tree 103	-0,23	-0,19
Mean Dom	0,03	-0,35
Mean Sup	-0,01	-0,02

1947 - 2008

Sample	T mean	T max
Tree 004	0,21	-0,22
Tree 008	0,47	-0,06
Tree 017	0,31	-0,24
Tree 022	0,18	-0,23
Tree 056	0,10	-0,10
Tree 005	0,08	-0,18
Tree 030	-0,07	-0,22
Tree 006	0,10	-0,31
Tree 015	0,00	-0,10
Tree 026	0,44	0,13
Tree 033	0,31	-0,20
Tree 041	-0,30	-0,08
Tree 064	-0,10	-0,08
Tree 070	-0,17	0,06
Tree 079	0,07	-0,12
Tree 103	0,15	0,01

1947 - 1999

- positive correlation values for T mean
- lower correlation values for T max

**All correlations were computed with raw measurement values – no standardisation was applied!**

# (1) Social classes – Correlations for 11.50 m

Sample	T mean	T max
Tree 004	-0,38	-0,36
Tree 008	-0,30	-0,29
Tree 017	-0,31	-0,19
Tree 022	-0,52	-0,31
Tree 056	-0,46	-0,26
Tree 005	-0,46	-0,30
Tree 030	-0,49	-0,25
Tree 006	-0,53	-0,39
Tree 015	-0,39	-0,11
Tree 026	-0,38	-0,23
Tree 033	-0,42	-0,24
Tree 041	-0,23	-0,03
Tree 064	-0,25	-0,08
Tree 070	-0,31	-0,10
Tree 079	-0,37	-0,23
Tree 103	-0,43	-0,23
Mean Dom	-0,46	-0,28
Mean Sup	-0,32	-0,08

Sample	T mean	T max
Tree 004	-0,27	-0,24
Tree 008	-0,18	-0,14
Tree 017	-0,34	-0,15
Tree 022	-0,42	-0,22
Tree 056	-0,36	-0,16
Tree 005	-0,37	-0,17
Tree 030	-0,41	-0,15
Tree 006	-0,43	-0,31
Tree 015	-0,38	-0,06
Tree 026	-0,34	-0,16
Tree 033	-0,37	-0,14
Tree 041	-0,41	-0,11
Tree 064	-0,38	-0,10
Tree 070	-0,34	-0,06
Tree 079	-0,29	-0,11
Tree 103	-0,26	-0,06

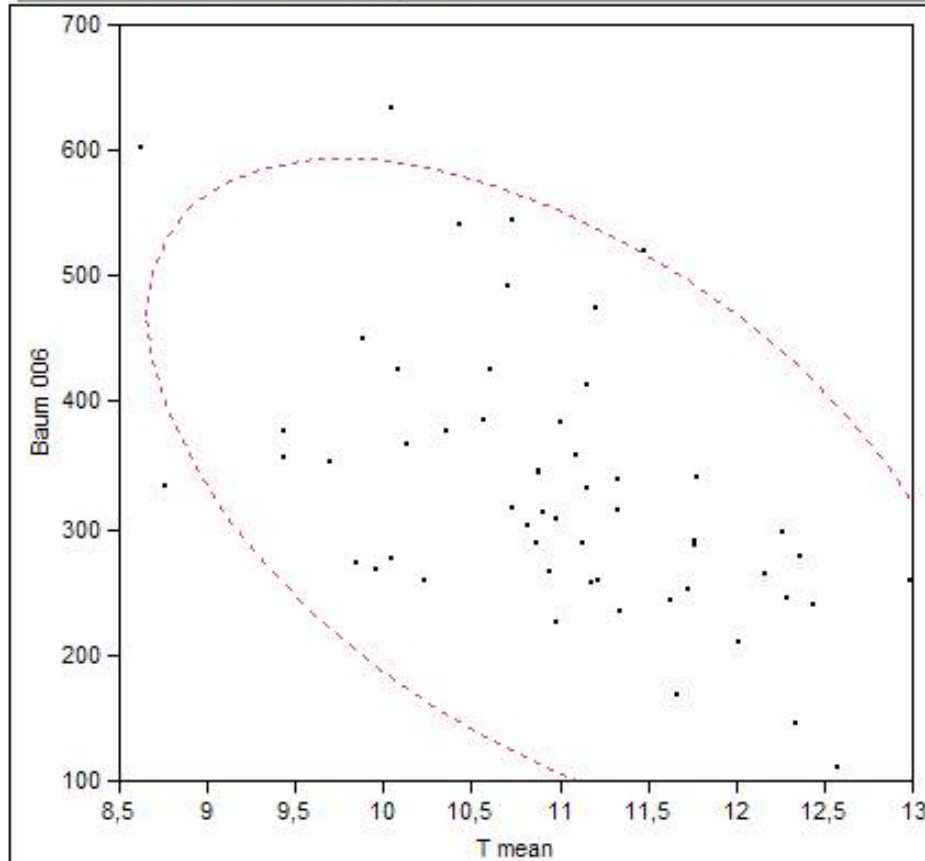
1955 - 2008

1955 - 1999

# (1) Social classes – Correlations for 11.50 m (cont.)

## Fit Y by X Group

### Bivariate Fit of Baum 006 By T mean

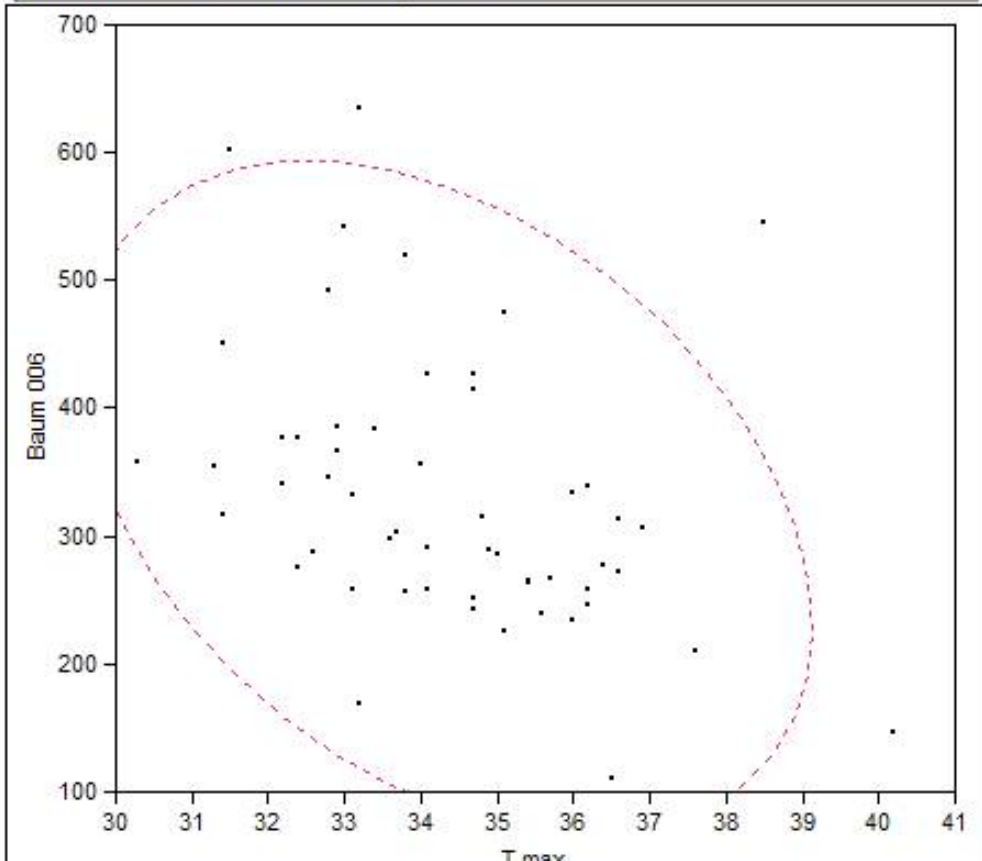


---- Bivariate Normal Ellipse P=0,950

### Correlation

Variable	Mean	Std Dev	Correlation	Signif. Prob	Number
T mean	10,98222	0,950902	-0,53034	<,0001*	54
Baum 006	329,963	107,7476			

### Bivariate Fit of Baum 006 By T max



---- Bivariate Normal Ellipse P=0,950

### Correlation

Variable	Mean	Std Dev	Correlation	Signif. Prob	Number
T max	34,35185	1,951559	-0,38622	0,0039*	54
Baum 006	329,963	107,7476			

## (2) Tree heights – Correlations

Sample	T mean	T max
Tree 004	-0,08	-0,36
Tree 008	0,08	-0,22
Tree 017	0,11	-0,23
Tree 022	-0,22	-0,32
Tree 056	-0,12	-0,22
Tree 005	-0,11	-0,30
Tree 030	-0,35	-0,33
Tree 006	-0,33	-0,42
Tree 015	0,02	-0,03
Tree 026	0,37	0,07
Tree 033	-0,02	-0,31
Tree 041	-0,03	-0,02
Tree 064	0,05	0,02
Tree 070	-0,05	0,07
Tree 079	-0,24	-0,28
Tree 103	-0,26	-0,26

1.30 m

Sample	T mean	T max
Tree 004	-0,35	-0,47
Tree 008	-0,20	-0,44
Tree 017	-0,12	-0,37
Tree 022	-0,56	-0,50
Tree 056	-0,40	-0,41
Tree 005	-0,46	-0,45
Tree 030	-0,54	-0,42
Tree 006	-0,59	-0,56
Tree 015	-0,39	-0,15
Tree 026	-0,32	-0,38
Tree 033	-0,39	-0,33
Tree 041	0,05	0,06
Tree 064	0,04	0,02
Tree 070	-0,13	-0,06
Tree 079	-0,33	-0,44
Tree 103	-0,41	-0,35

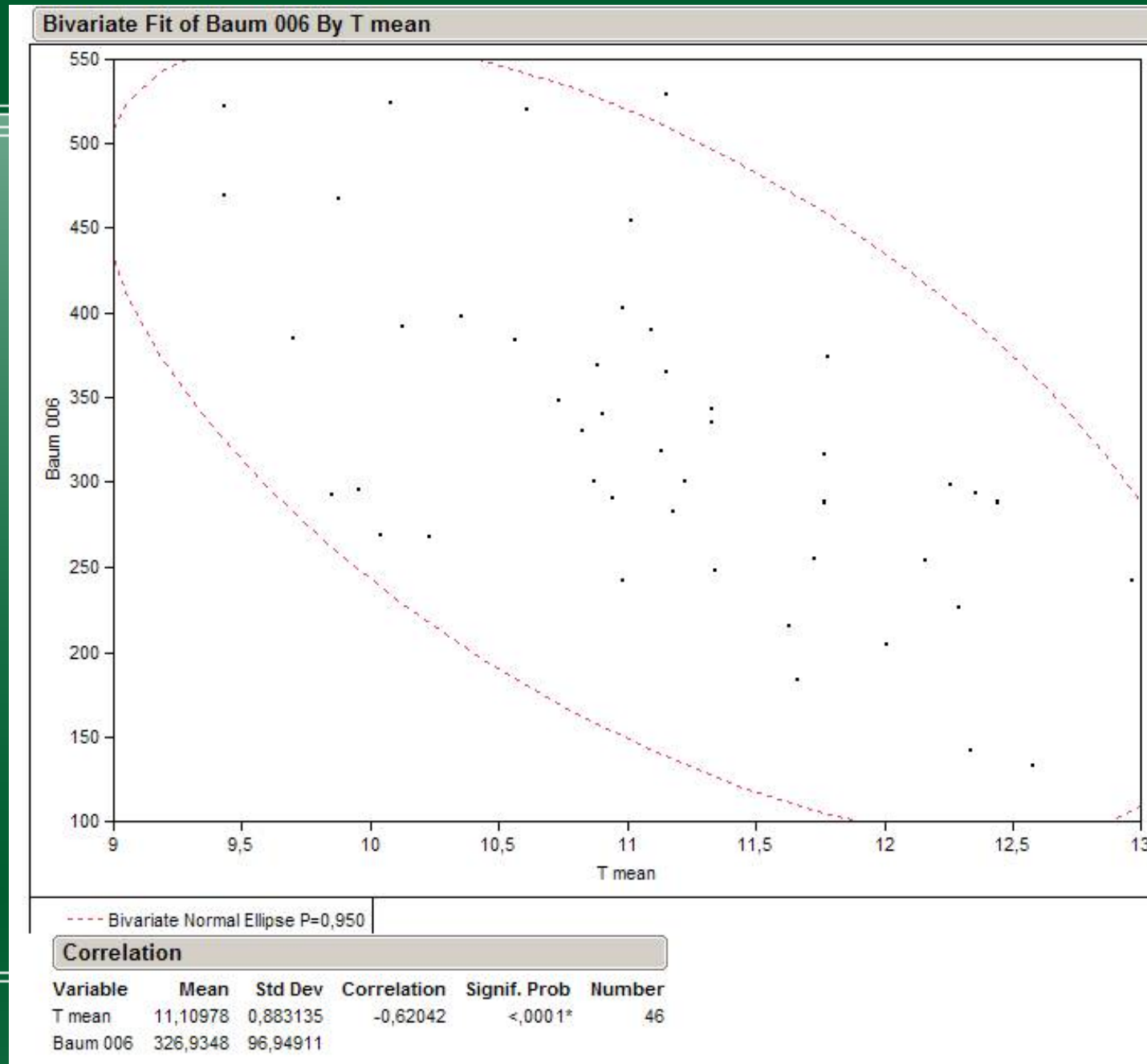
11.50 m

Sample	T mean	T max
Tree 004	-0,49	-0,44
Tree 008	-0,49	-0,61
Tree 017	-0,47	-0,42
Tree 022	-0,55	-0,55
Tree 056	-0,48	-0,44
Tree 005	-0,53	-0,43
Tree 030	-0,51	-0,48
Tree 006	-0,62	-0,47
Tree 015	-0,47	-0,27
Tree 026	-0,45	-0,29
Tree 033	-0,51	-0,37
Tree 041	-0,47	-0,18
Tree 064	-0,45	-0,22
Tree 070	-0,31	-0,10
Tree 079	-0,50	-0,32
Tree 103	-0,49	-0,27

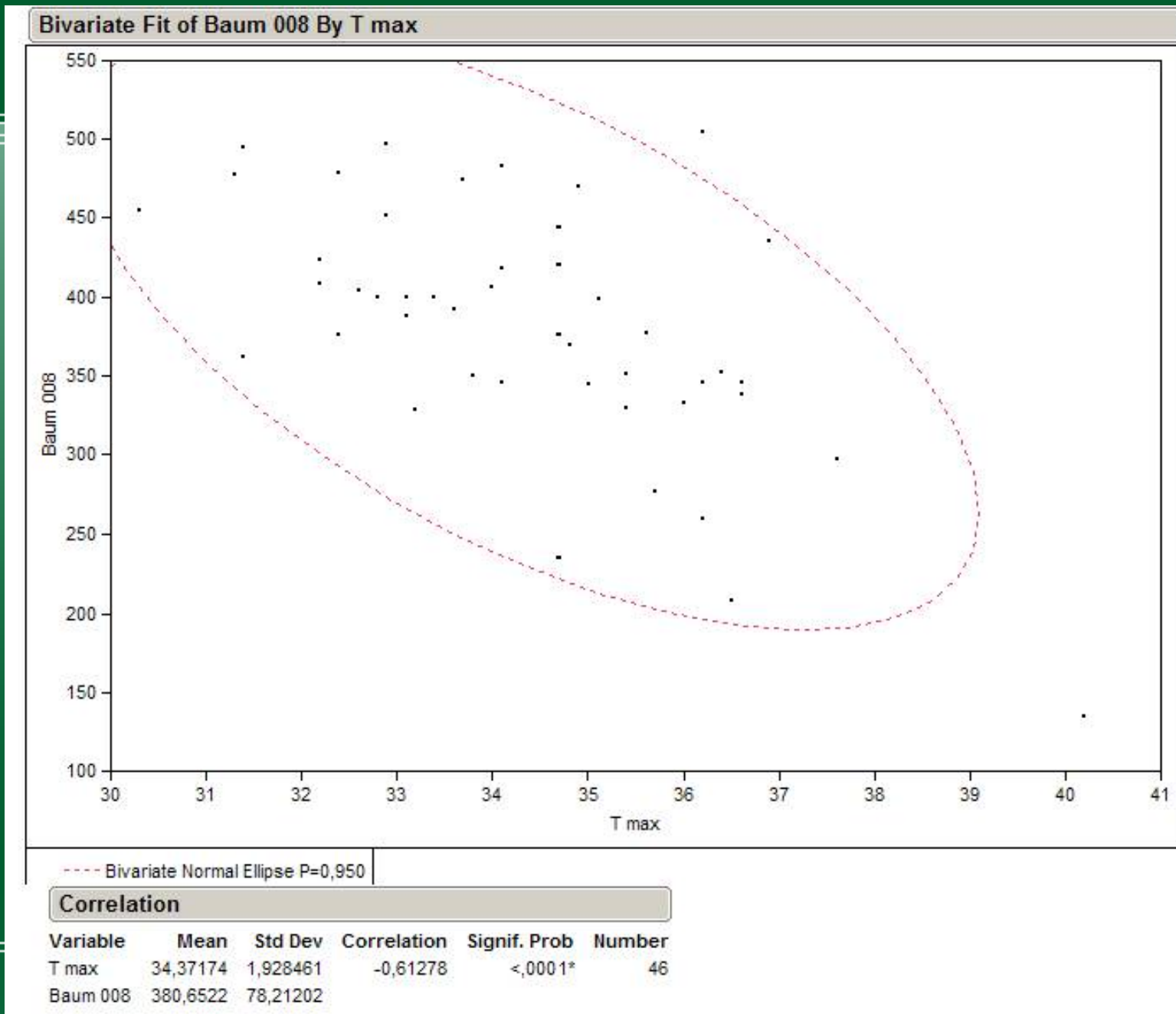
16.60 m

1963 - 2008

# Results: Significant correlations – 16.60 m



# Results: Significant correlations – 16.60 m





# Conclusion

- Dominant trees with better (more significant) values
- Better correlations with increasing sampling height
- The sum of annual precipitation did not have significant influence
- The influence of different thinning intensities could not be examined, Lothar was thorough...

**Thank you for your attention!**

