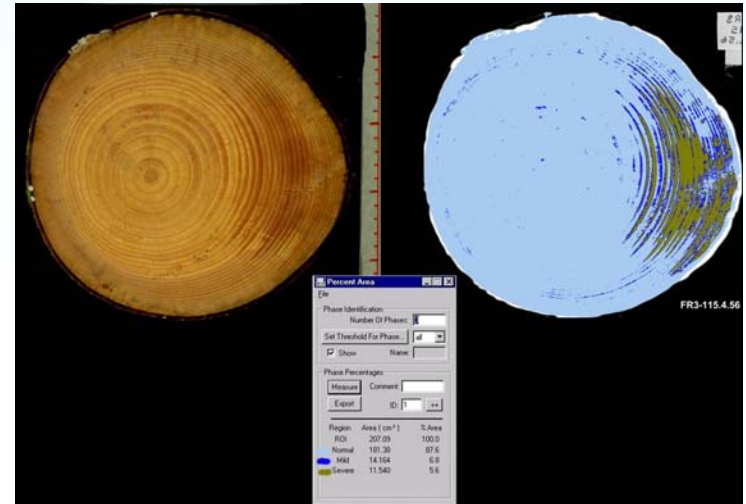


Factors Affecting Compression Wood Formation in Sitka Spruce and Scots Pine



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François



Problems with utilisation

- High longitudinal shrinkage results in increased drying distortion
- Reduced stiffness and a tendency to fail in a brash manner
- High lignin content and short fibres less suitable for pulp



Problems with utilisation: Brash failure

Fibrous Break



Brash Fracture



Problems with utilisation: bow



(Courtesy Mats Warensjö, SLU)

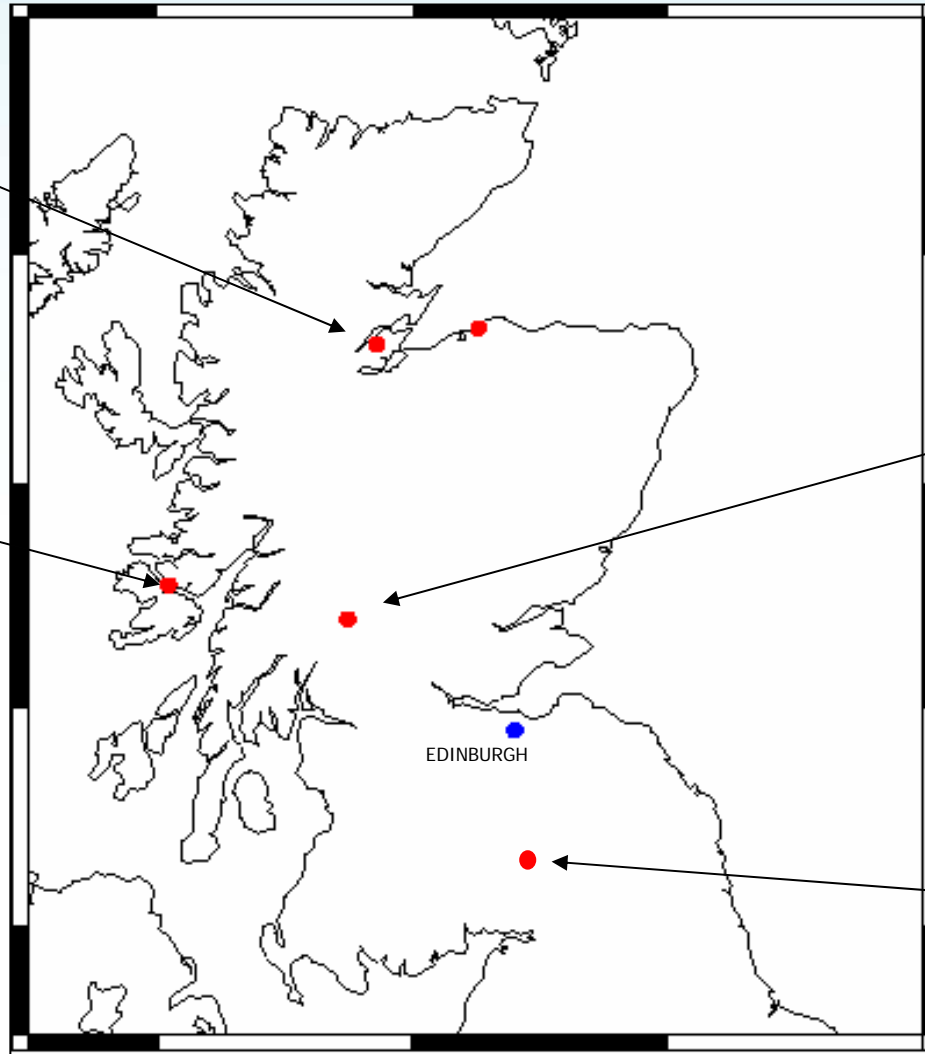
Field sites

Findon

Scots pine, spacing experiment

Lochaline

Sitka spruce, exposed, steep and level sites.



Benmore

Sitka spruce, sheltered, steep and level sites.

Eskdalemuir

Sitka spruce spacing experiments



Treatment structure

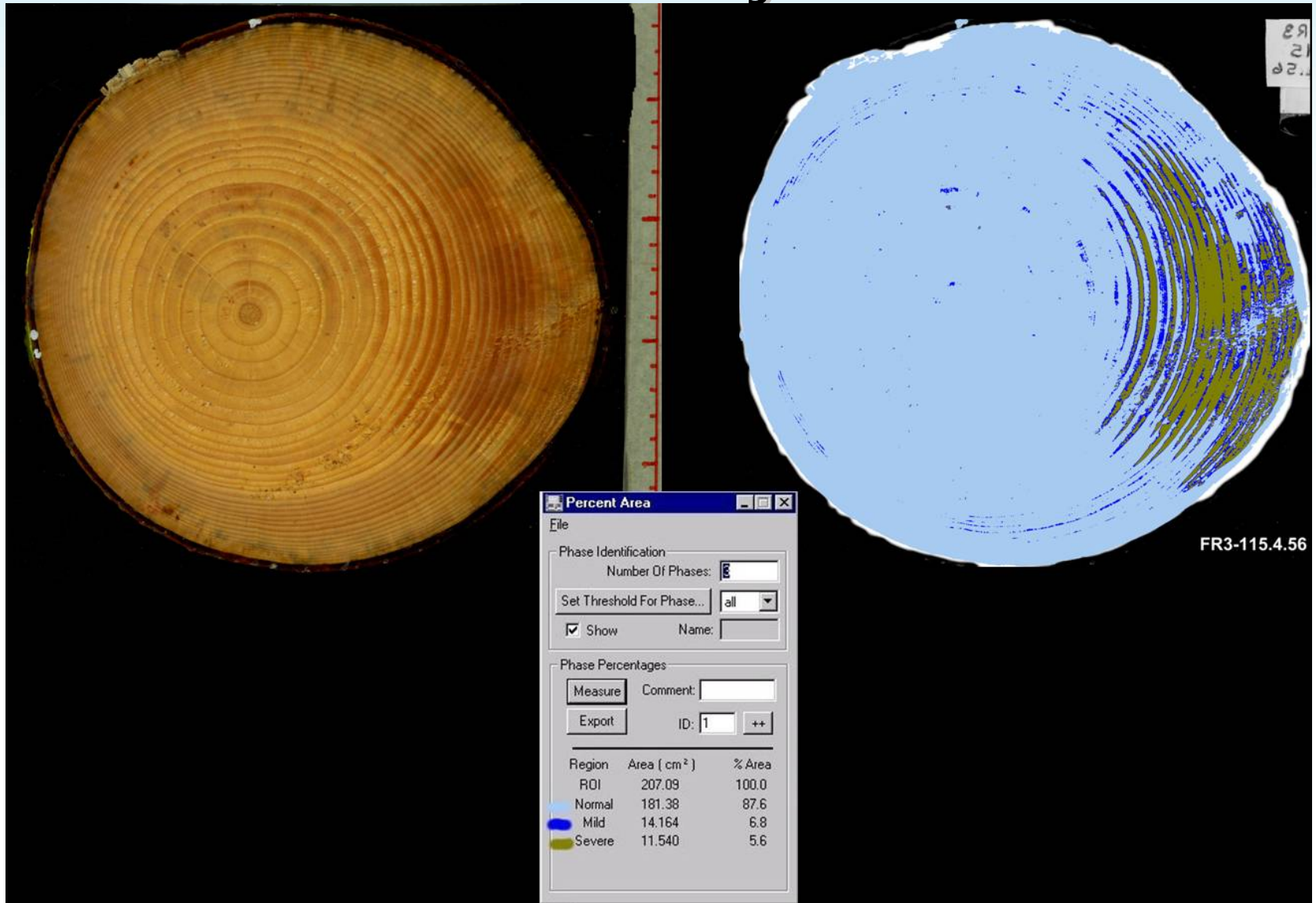


Site	Species	Exposure	Slope
FR1	SS	Sheltered	Flat
FR2	SS	Sheltered	Steep
FR3	SS	Exposed	Steep
FR4	SS	Exposed	Flat

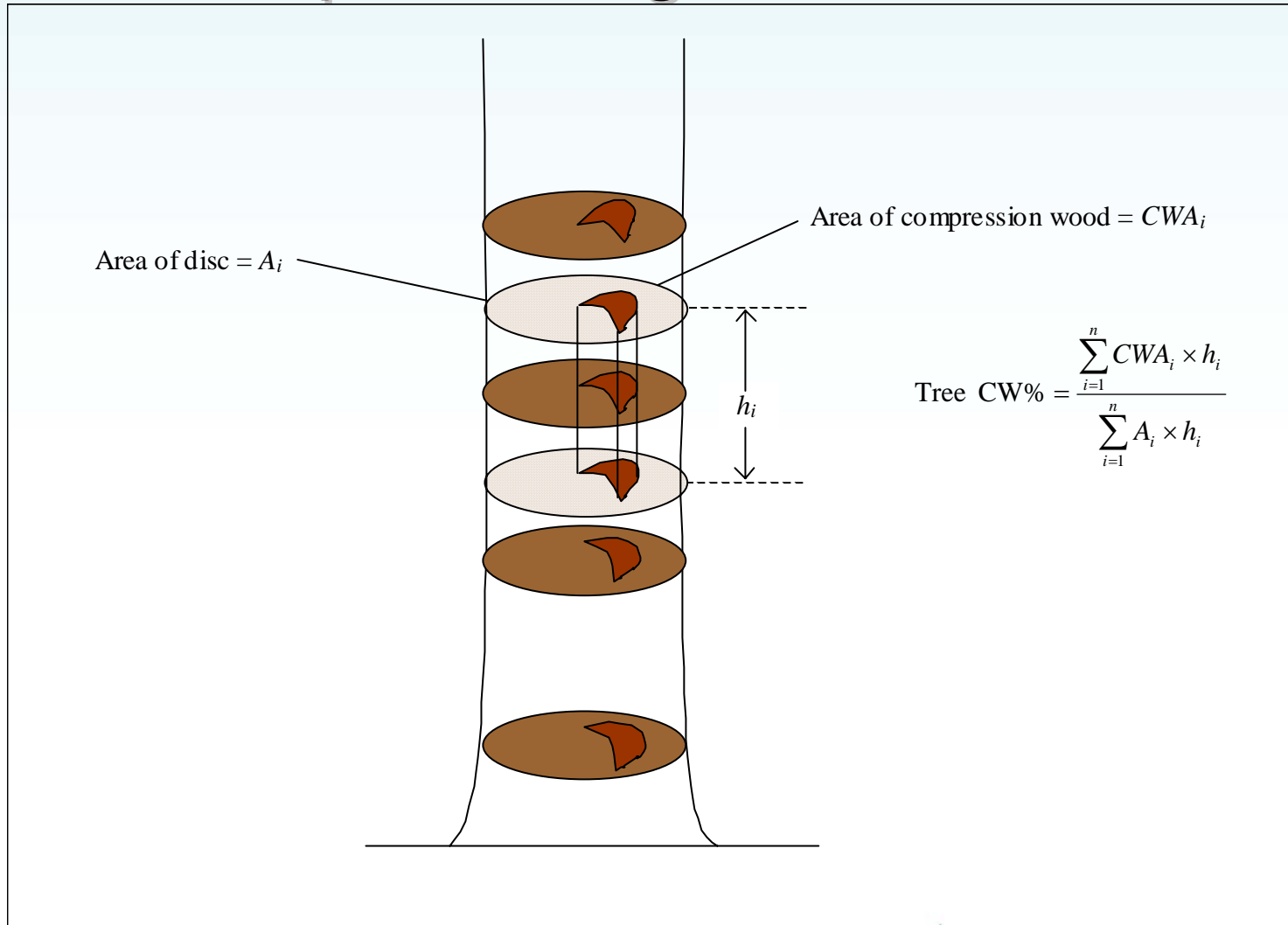


Site	Species	Exposure	Slope
FR5	SP	Sheltered	Flat
FR6	SP	Sheltered	Flat

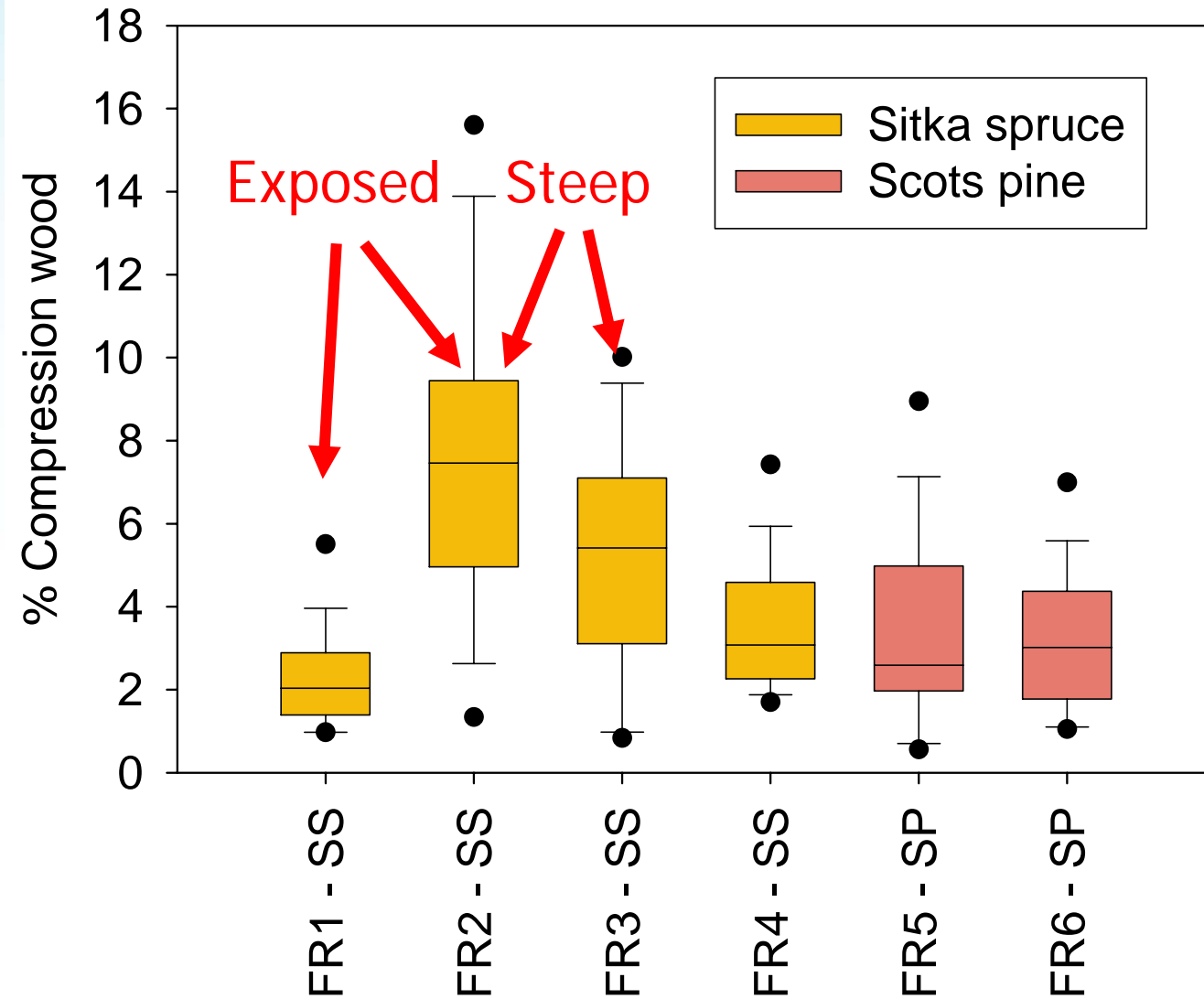
Disc analysis



Calculation of compression wood percentage in tree



Compression wood by site

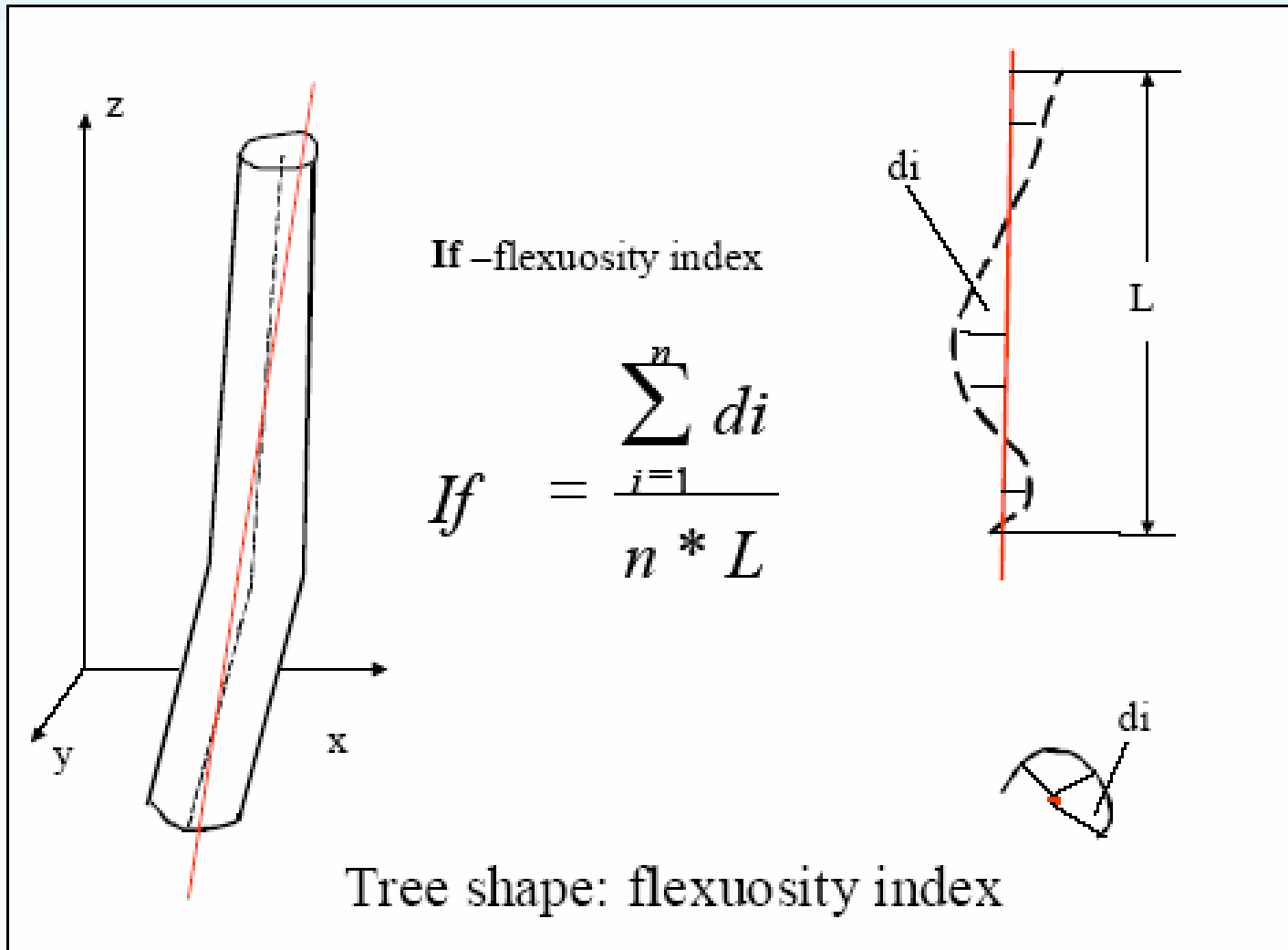


Exploratory analysis

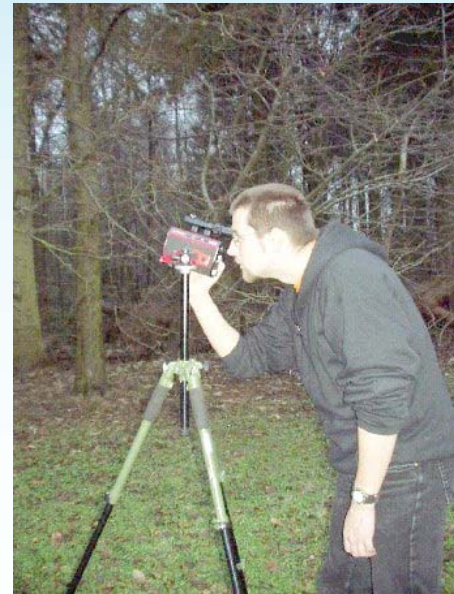
- Hypothesis : We can predict the volume of compression wood in a tree using external tree and site characteristics
- Groups of variables used:
 - Tree lean
 - Tree sinuosity
 - Stem ovality
 - Crown eccentricity
 - Competition indicator
 - Tree size
 - Local slope



Tree sinuosity

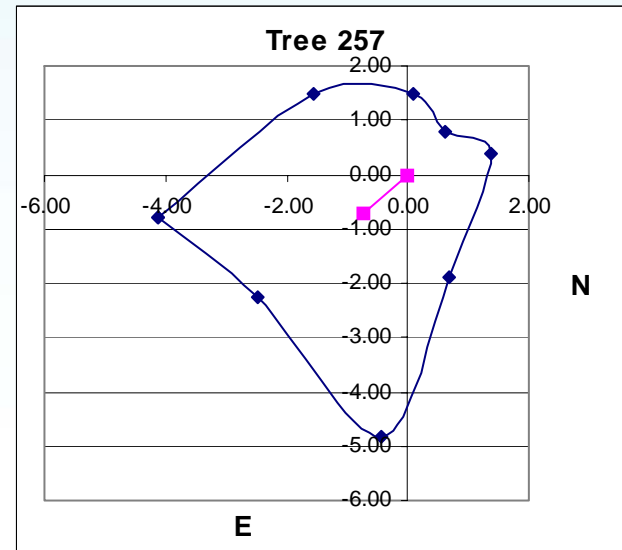
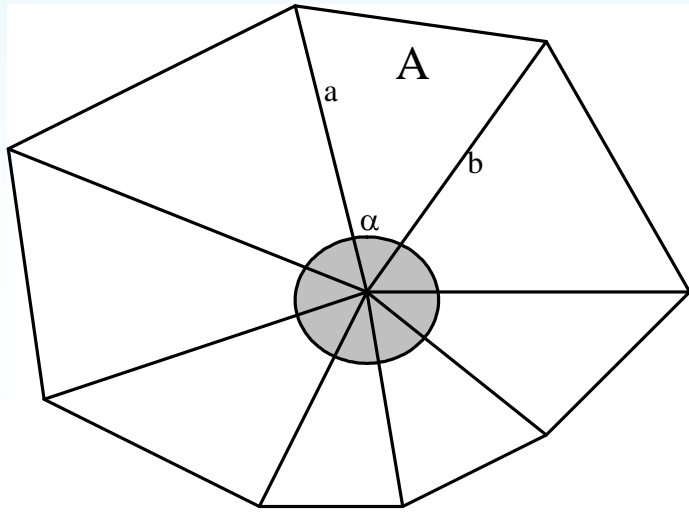


Tree lean



Crown shape and local competition

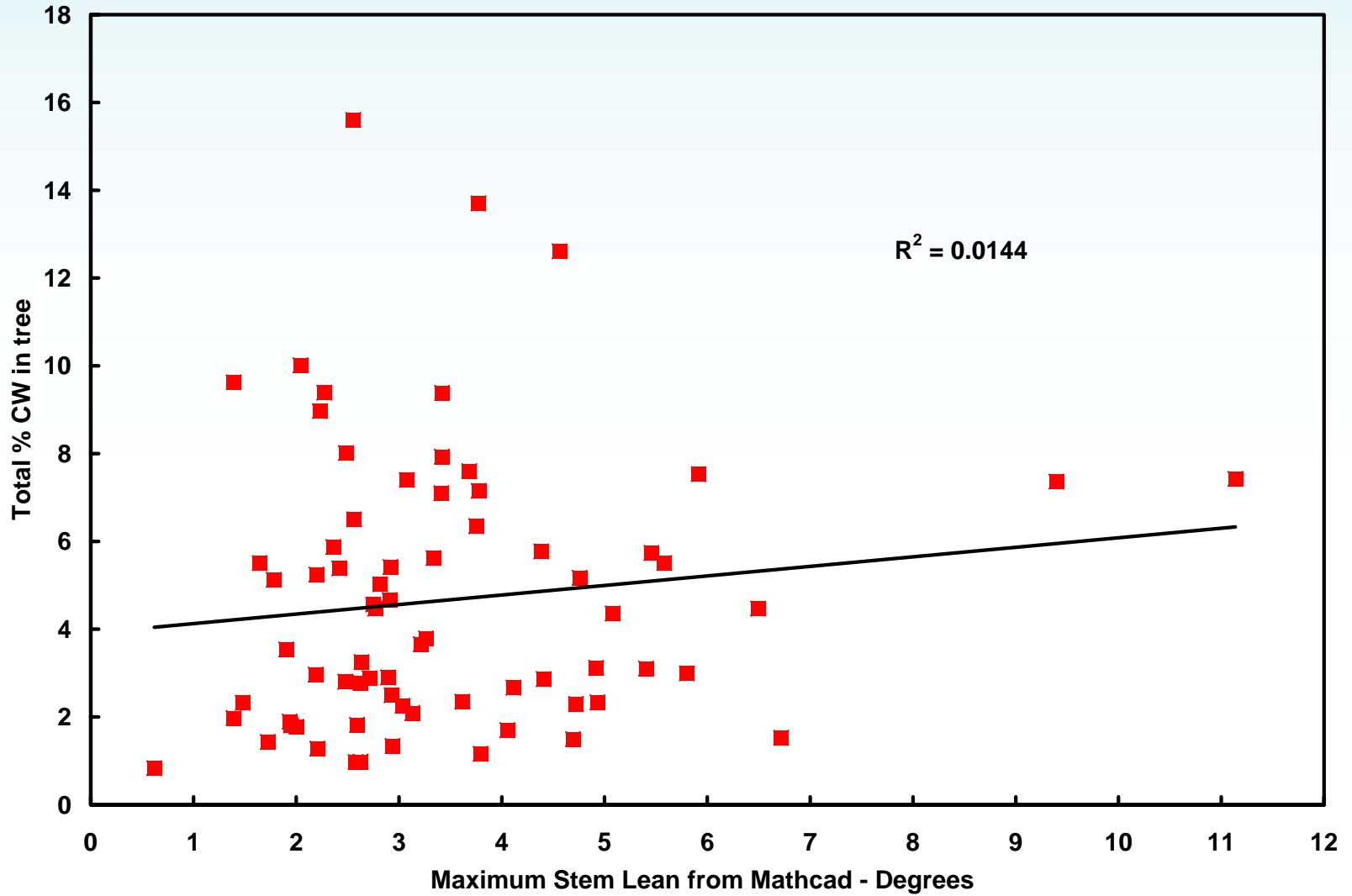
Crown shape and eccentricity



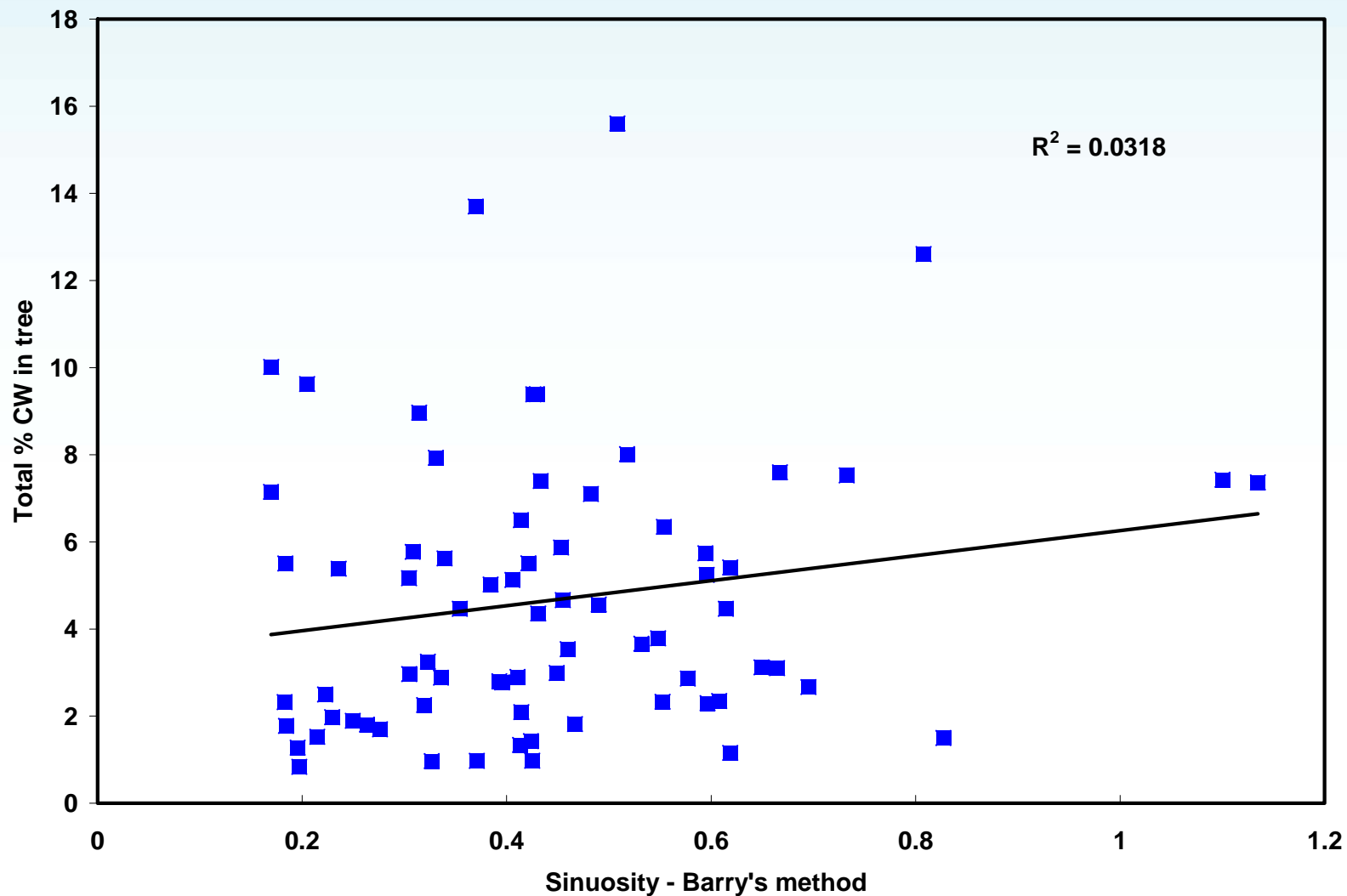
Competition index (based on diameter and distance of neighbours)

$$CI = \sum_{j=1}^n (dbh_j / dbh_i)^{1.3} / dist_{ij}^{0.4}$$

Single factor regression analysis I



Single factor regression analysis II



Multiple factor regression analysis

Max R ²	parameters						
site	1	2	3	4	5	6	7
FR1	35.0	44.4	51.4	57.5	57.5	55.4	51.3
FR2	17.2	34.7	36.9	39.1	37.9	35.2	28.9
FR3	5.5	8.6	8.6	7.5	3.8		
FR4	47.2	54.7	63.6	63.6	62.9	61.1	57.8
FR5	39.9	52.0	52.0	51.0	48.4	44.3	39.2
FR6	3.1	6.6	17.2	20.1	19.9	17.3	17.8

Max R ²	parameters						
site	1	2	3	4	5	6	7
All Sitka	19.7	28.1	32.0	34.3	36.6	37.1	36.8
All Scots	13.8	18.5	22.6	22.6	21.7	19.7	17.0
All sites	18.7	28.8	30.9	32.6	33.8	35.2	35.4

What factors are most important?

Site	lean	competition	sinuosity	stem ovality	slope	size	crown ecc
FR1	Yellow	Yellow	Yellow	Yellow	Grey	Grey	Grey
FR2	Yellow	Grey	Yellow	Grey	Yellow	Yellow	Grey
FR3	Grey	Yellow	Grey	Grey	Yellow	Grey	Grey
FR4	Yellow	Grey	Yellow	Grey	Grey	Grey	Yellow
FR5	Yellow	Yellow	Grey	Grey	Grey	Grey	Grey
FR6	Yellow	Yellow	Grey	Yellow	Grey	Yellow	Grey

Yellow	Included in model
Grey	Not included in model

Site	lean	competition	sinuosity	stem ovality	slope	size	crown ecc
All Sitka	Yellow	Yellow	Yellow	Yellow	Yellow	Grey	Grey
All Scots	Yellow	Yellow	Yellow	Grey	Grey	Grey	Grey
All sites	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Grey

Choice of variables

- Best variables within each group differed between each site
- But they were consistent for multi-site analyses:
 - Lean : Torpedo Boy
 - Sinuosity : Renaud Daquitaine's method
 - Competition : Crown projected area (or DBH)



Discussion I

- Proportion of the variation explained varied greatly between the sites
- Proportion of the variation explained was relatively low in the multi-site analysis
- Variables that affect the level of CW most significantly are lean, competition (or social status in the stand) and sinuosity



Discussion II

- Tentative explanation for the low levels of variability explained:
 - Sinuosity might be the result of two processes

1.



2.



What's next?

- A within-tree analysis of compression wood location at ring level
- Further emphasis on measuring wood properties as early as possible in the forestry woodchain



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France, Germany and Italy)

www.forestry.gov.uk/compressionwood