An analysis of defoliation trends in boreal forests of Finland

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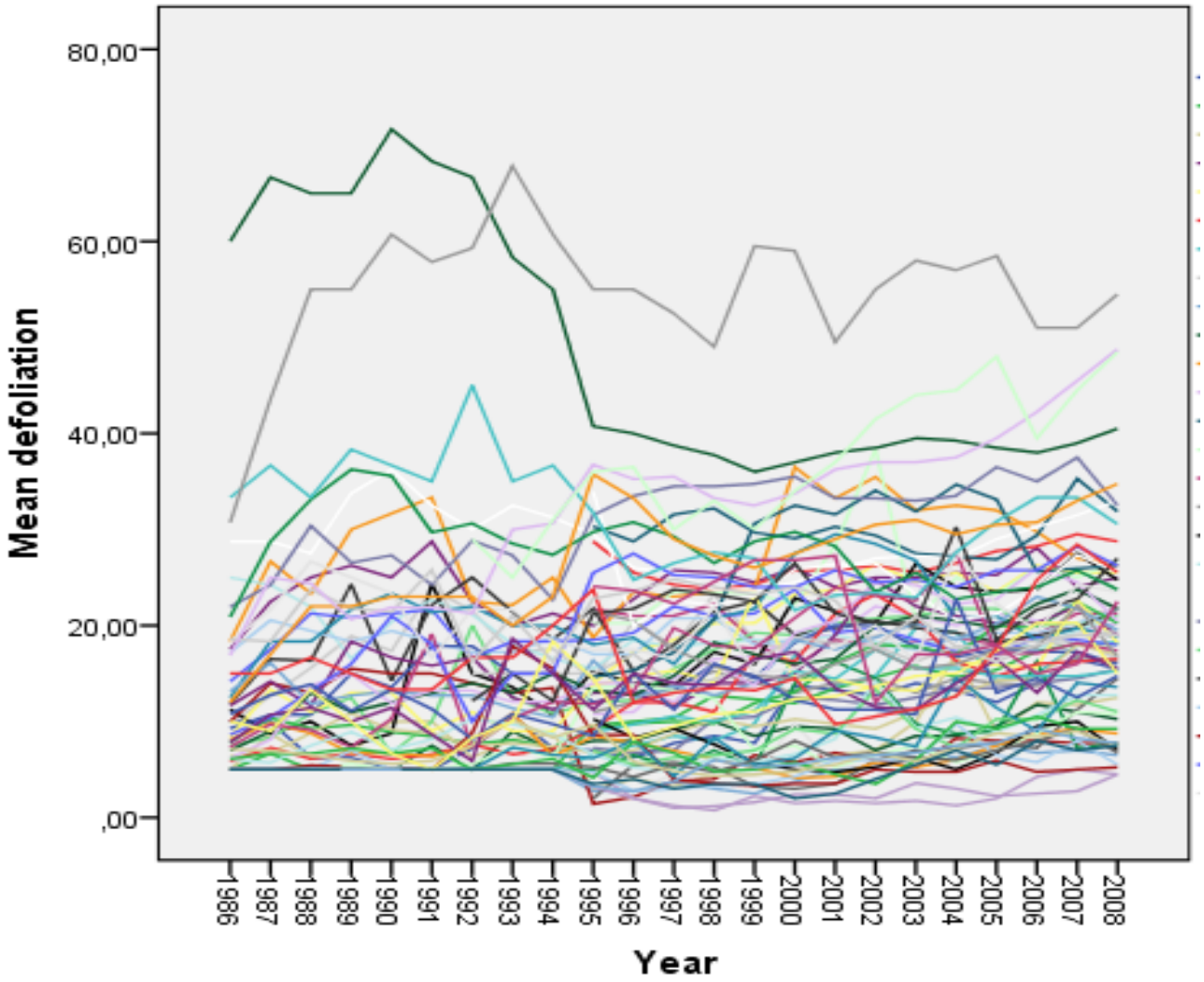
Aims /questions

Defoliation trends in Scots pine and Norway spruce in relation to:

- Properties of the stand: age, site type, soil,
- Climatic variables, elevation,
- Biotic and abiotic damage
- Modelled depositions of S and N_{tot} ,ozone (AOT)

Nevalainen, S.,Sirkiä, S.,Neuvonen, S.& Peltoniemi, M. 2015. Vulnerability to pine sawfly damage decreases with site fertility but the opposite is true with Scleroderris canker damage; results from Finnish ICP Forests and NFI data. Annals of Forest Science November 2014, 9 s

The starting point…



The plots used in this work

Common plots =assessed each year

1996- 2008

126 Scots pine and 76 Norway spruce plots, only!

Nevalainen, S.,Sirkiä, S.,Neuvonen, S.& Peltoniemi, M. 2015. Vulnerability to pine sawfly damage decreases with site fertility but the opposite is true with Scleroderris canker damage; results from Finnish ICP Forests and NFI data. Annals of Forest Science November 2014. 9 s.

Nevalainen, S., Lindgren, M., Pouttu, A., Heinonen, J., Hongisto, M. & Neuvonen, S. 2010. Extensive tree health monitoring networks are useful in revealing the impacts of widespread biotic damage in boreal forests. Environmental Monitoring and Assessment 168: 159-171.

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About the methods

Plot wise means of defoliation (response)
>>Earth Trend Modeler in Idrisi

>>Theil-Sen & Mann-Kendall

>> deviation from the linear trend each year

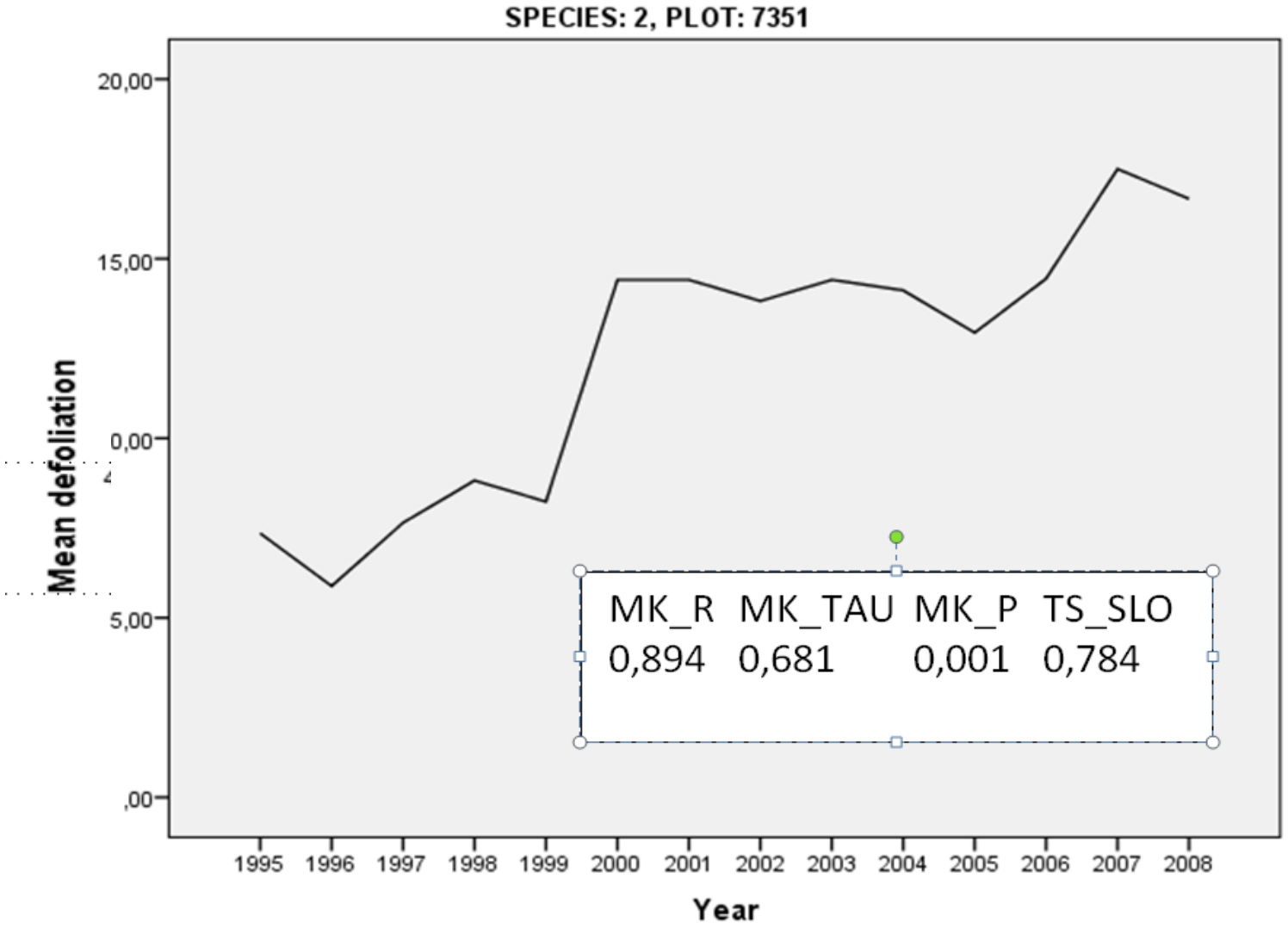
>> correlations

>> Classification & Regression Trees (CART) & Random Forest in R (Rattle GUI)

The trend variables

Theil-Sen Slope	Mann-Kendall R	Mann-Kendall Tau	Mann-Kendall P	Mann-Kendall Z	Intercept linear	Slope linear
Magnitude of the trend	Correlation with linearity	Monotonic trend	The trend by change?	Mann-K Signif.	Used to compute deviance from a linear trend (in annual data)	
	Small values< damage?	-1 …1	>0,05 Significant trend			

Some typical time series in defoliation: inspect your data carefully!



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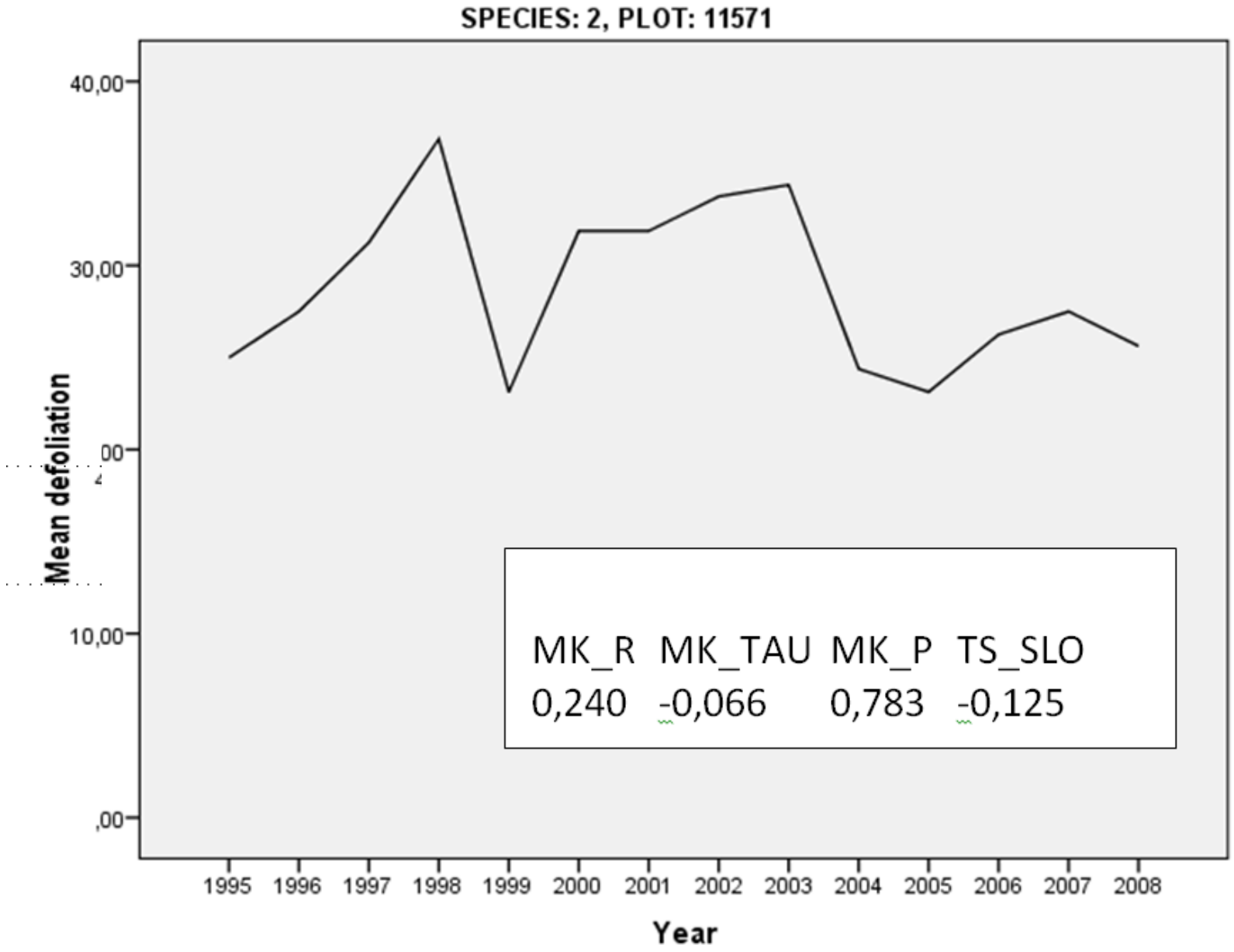
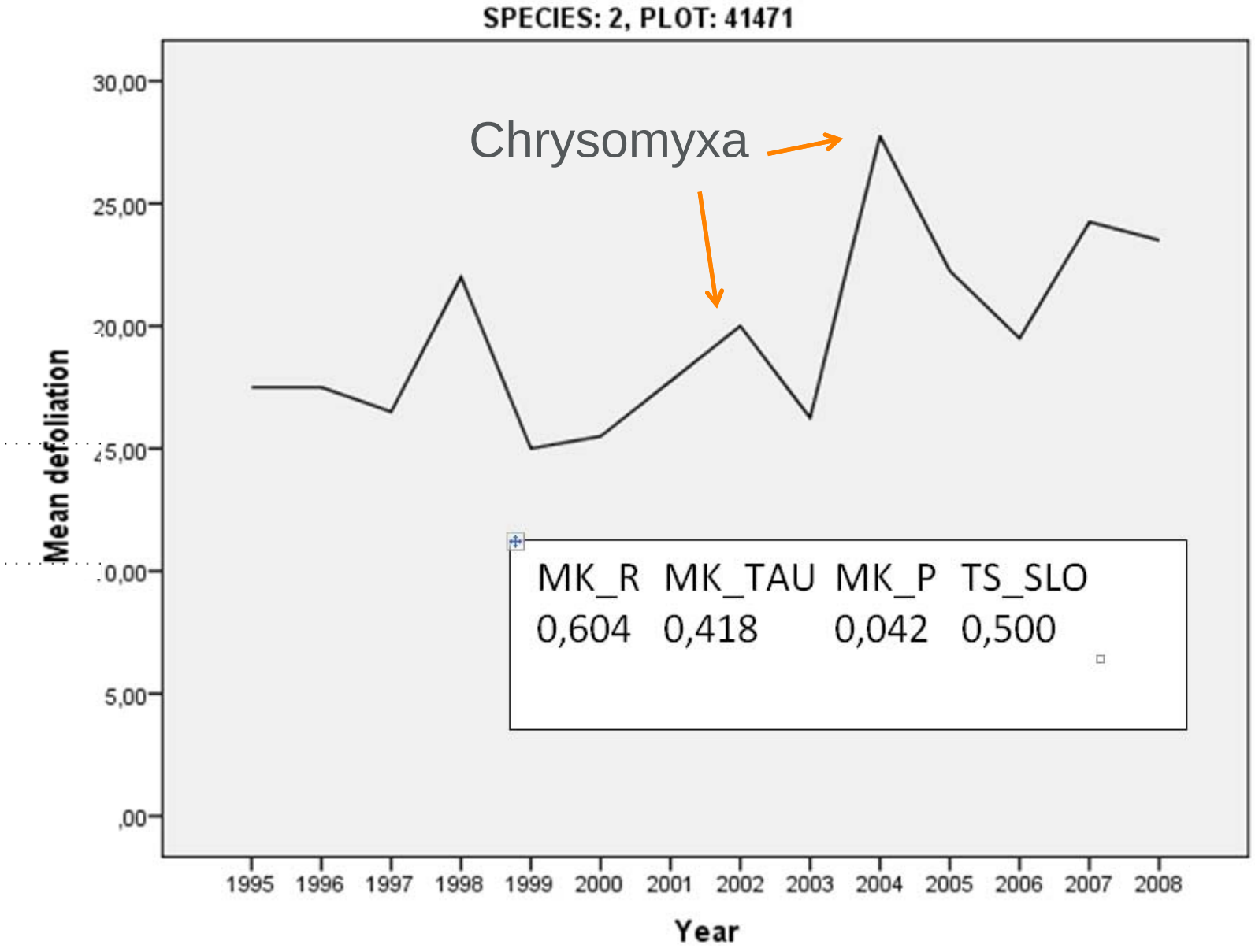
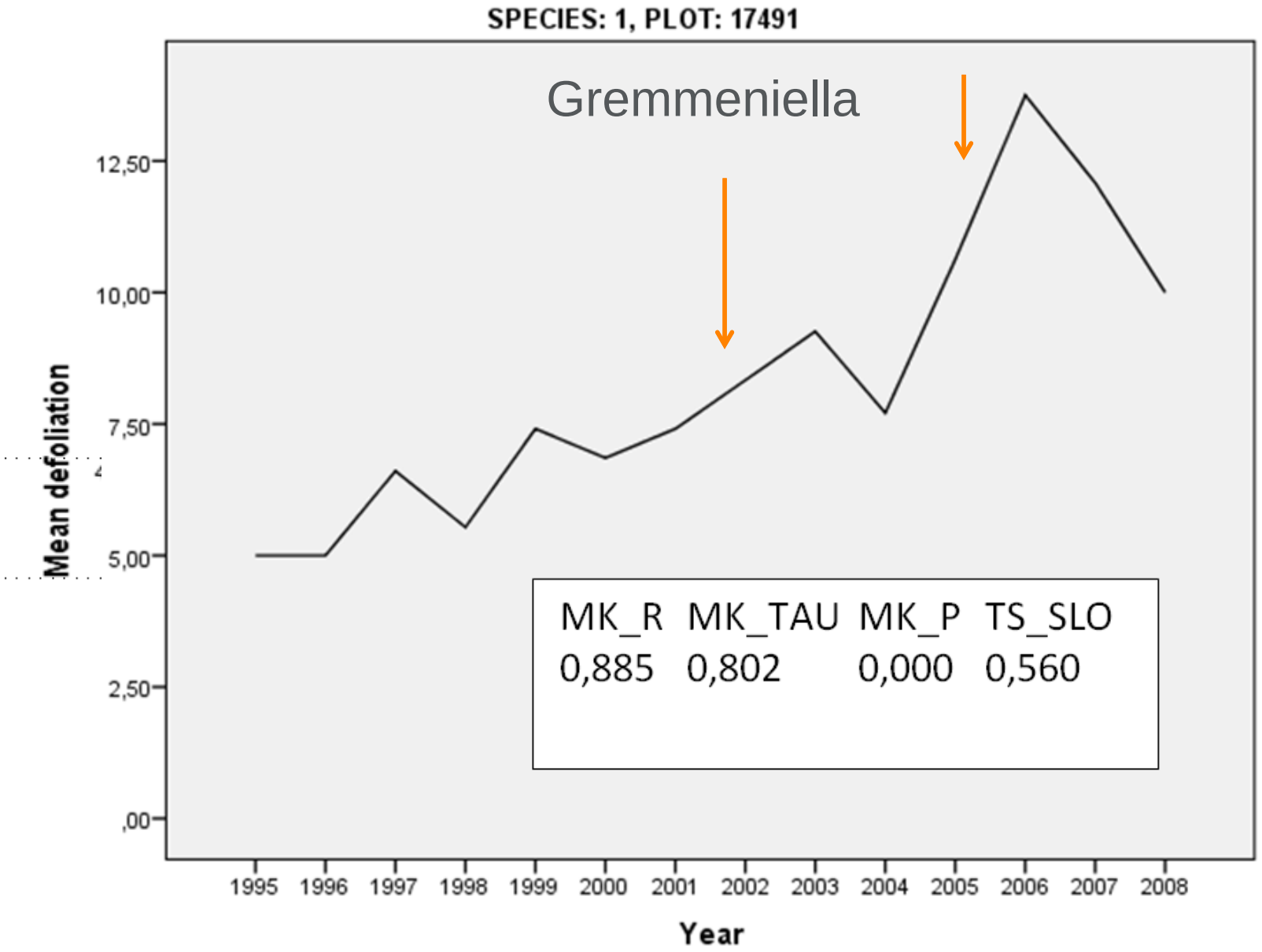
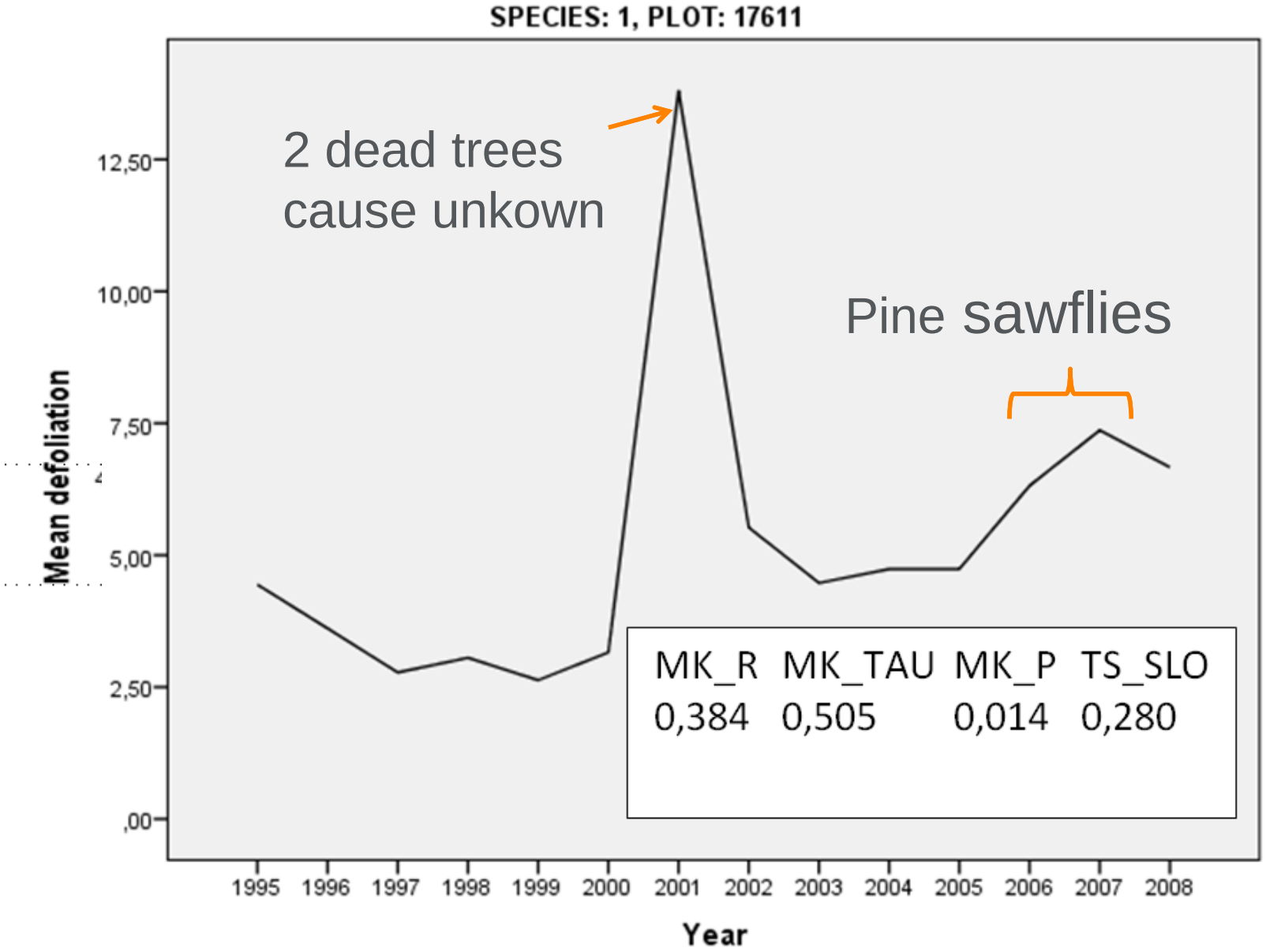




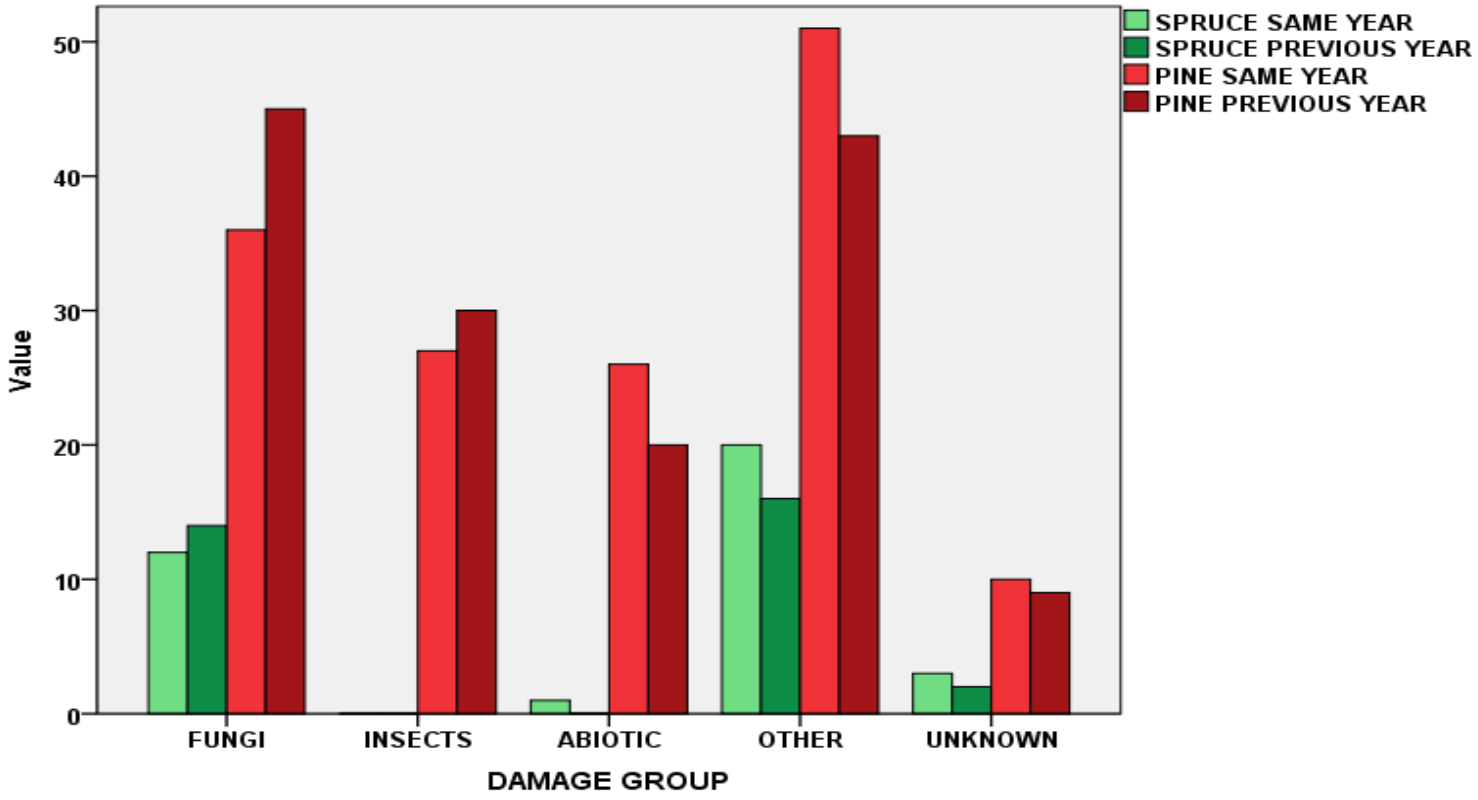




How often is abiotic/damage related to signicant deviation from the linear trend?

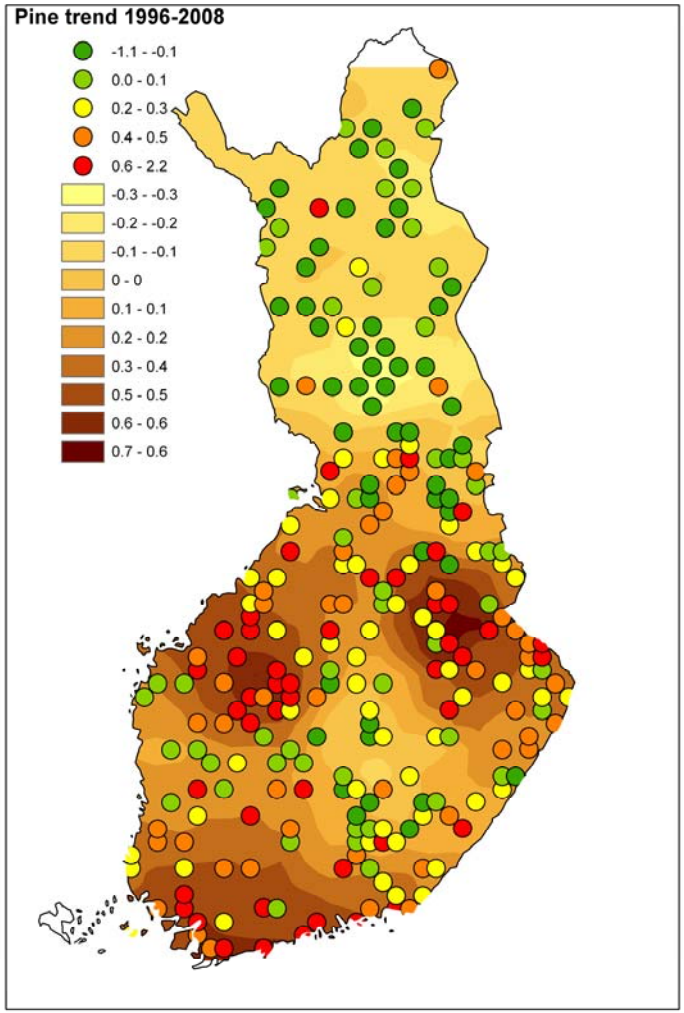
- Needs annual data
- 25 % deviation from linear=significant
- 5 or more damaged trees in a plot= a damage year

- 41 % and 72 % (spruce and pine): a signigicant deviation
- In 17 % and 27 % of these cases a ’damage year’ (spruce and pine)

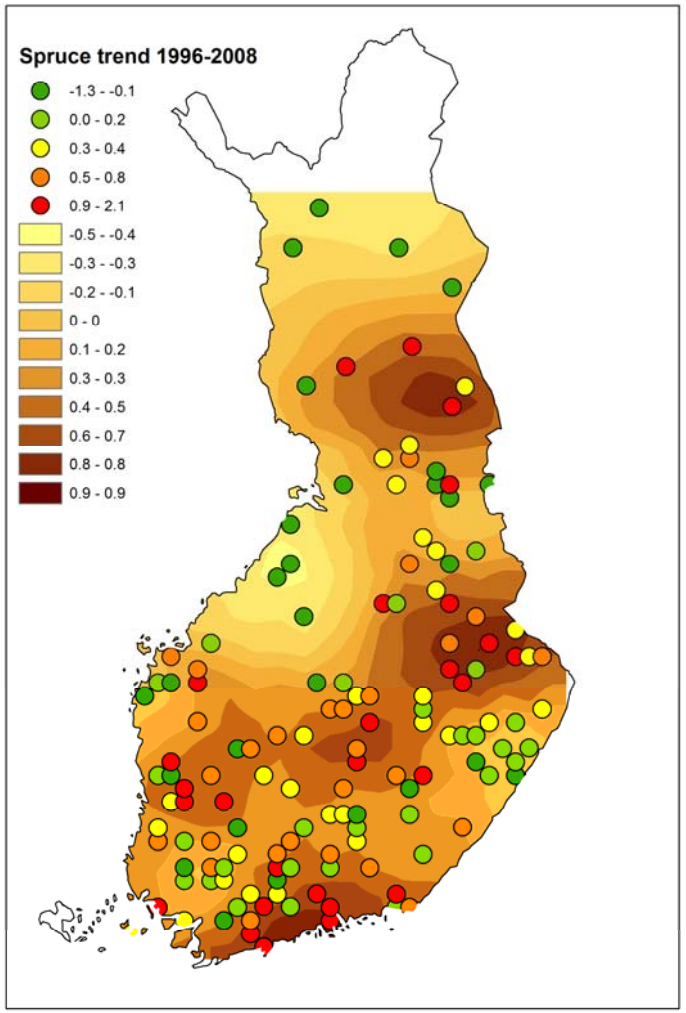


Theil- Sen slopes

Scots pine



Norway spruce



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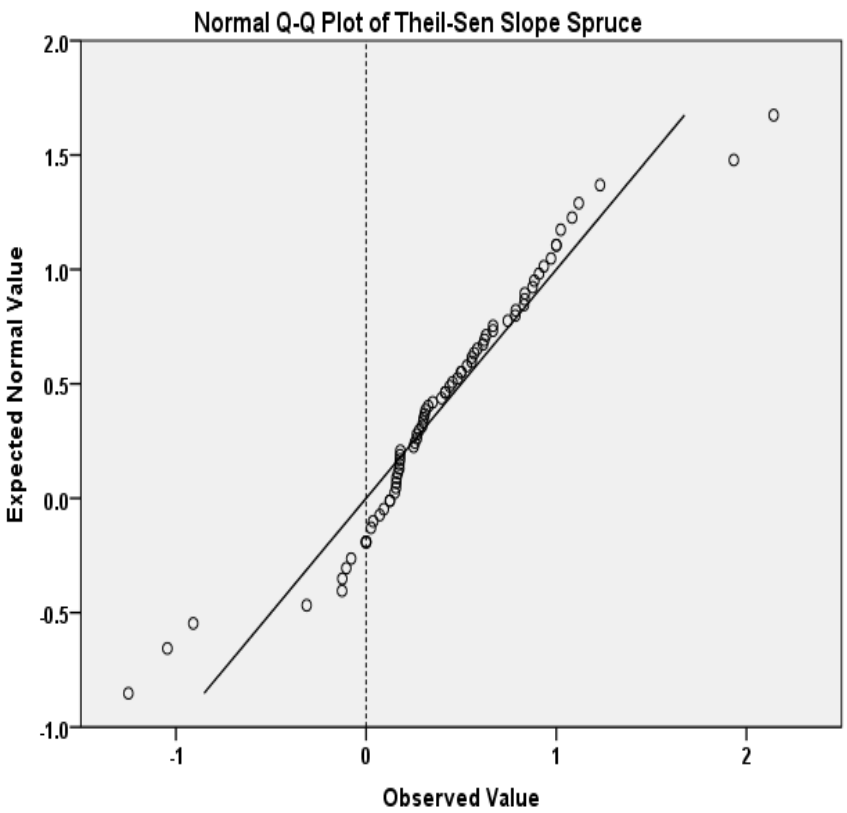
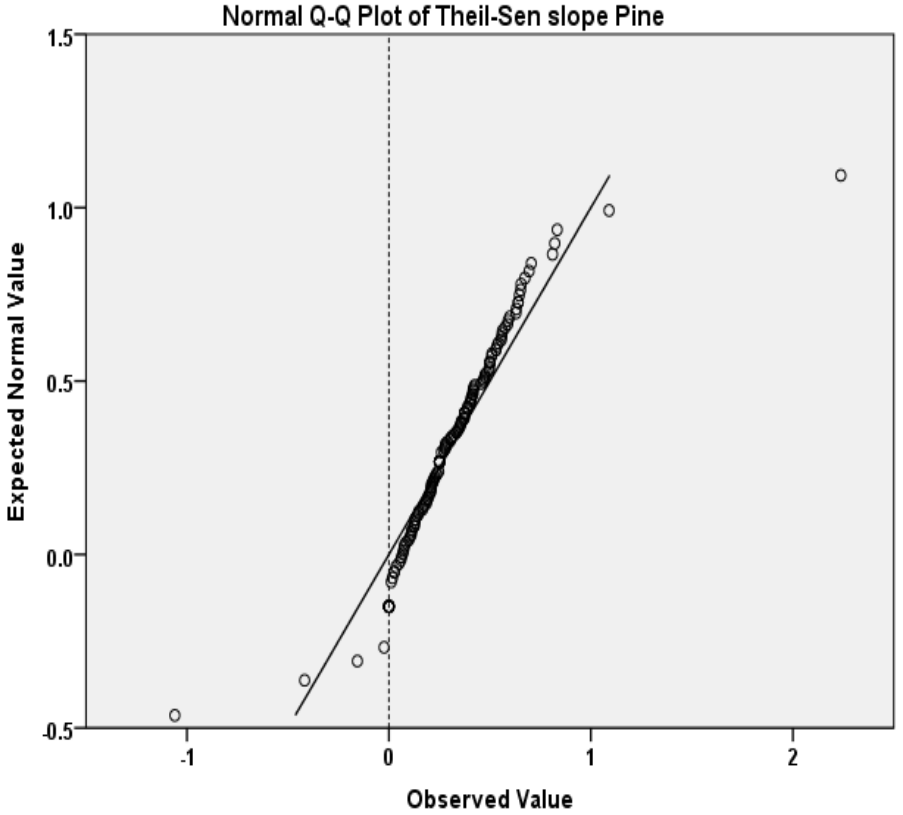
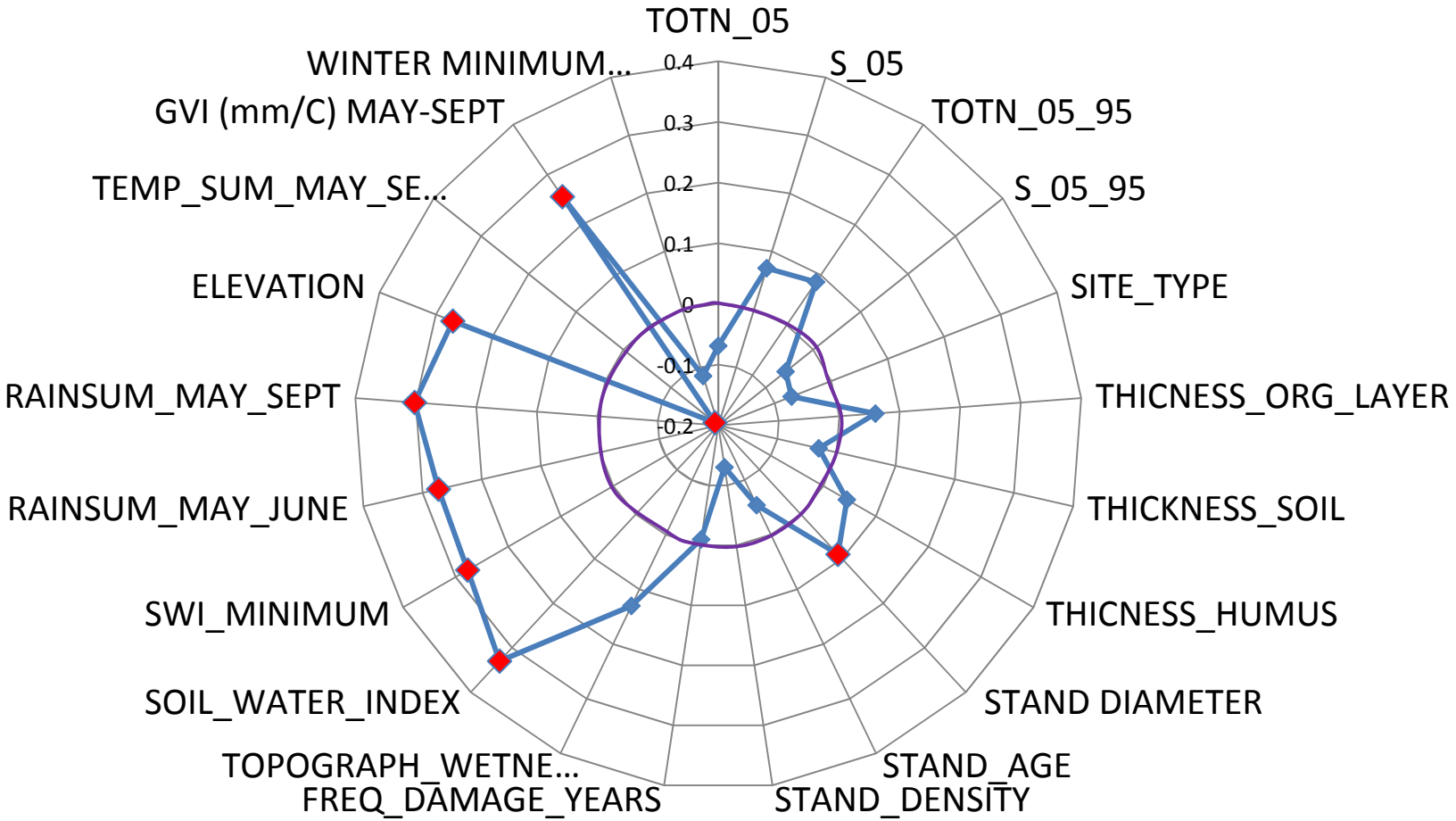
Only a few negative Theil-Sen slope values



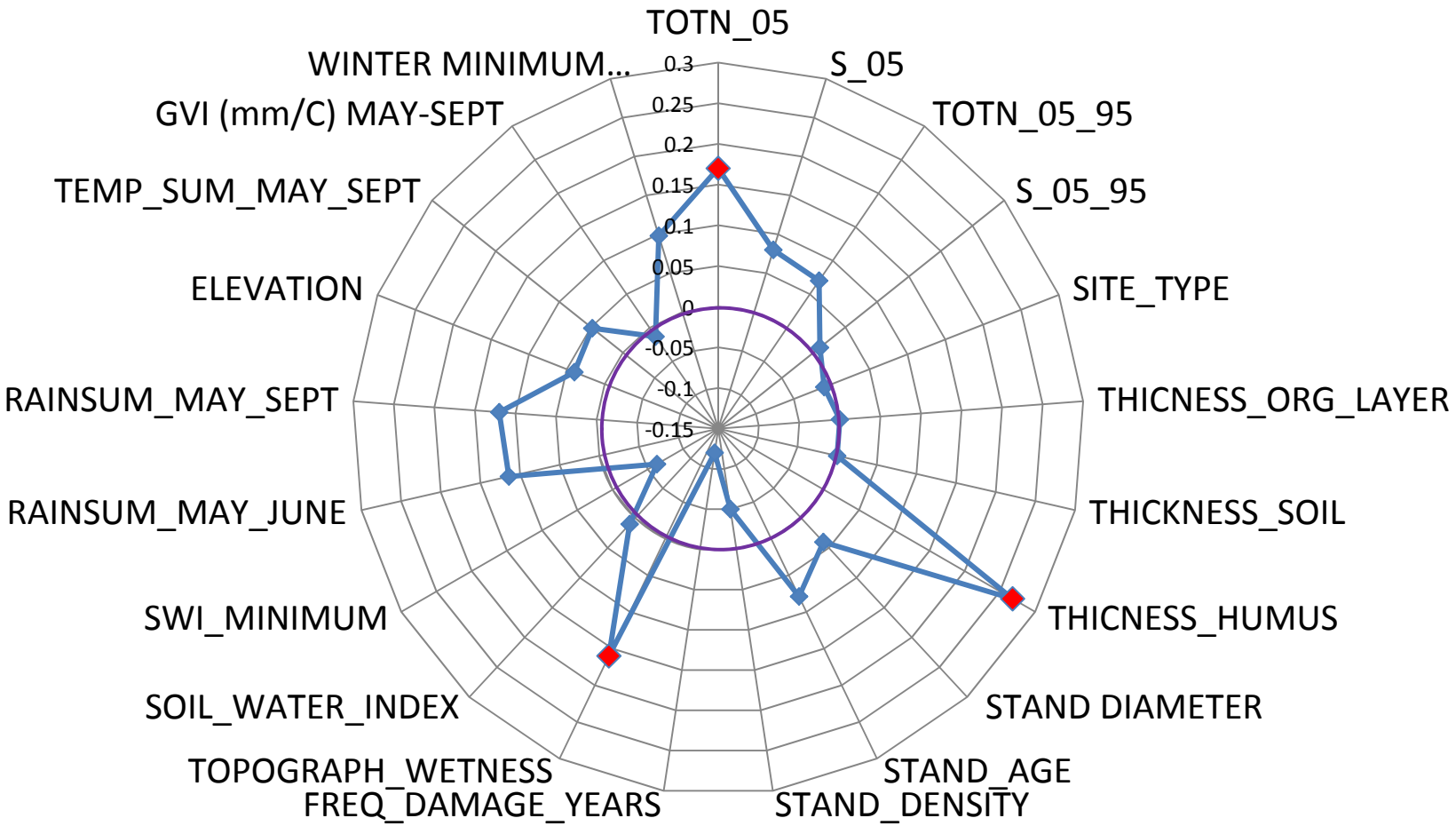


	Scots pine	Norway spruce
Increasing tend	91 %	85 %
Significant trend	53 %	56 %
-of which increasing	93 %	98 %
Linear trend	57 %	48 %
Monotonic trend	32 %	49 %
N of plots	126	76

Correlation profile- Norway spruce

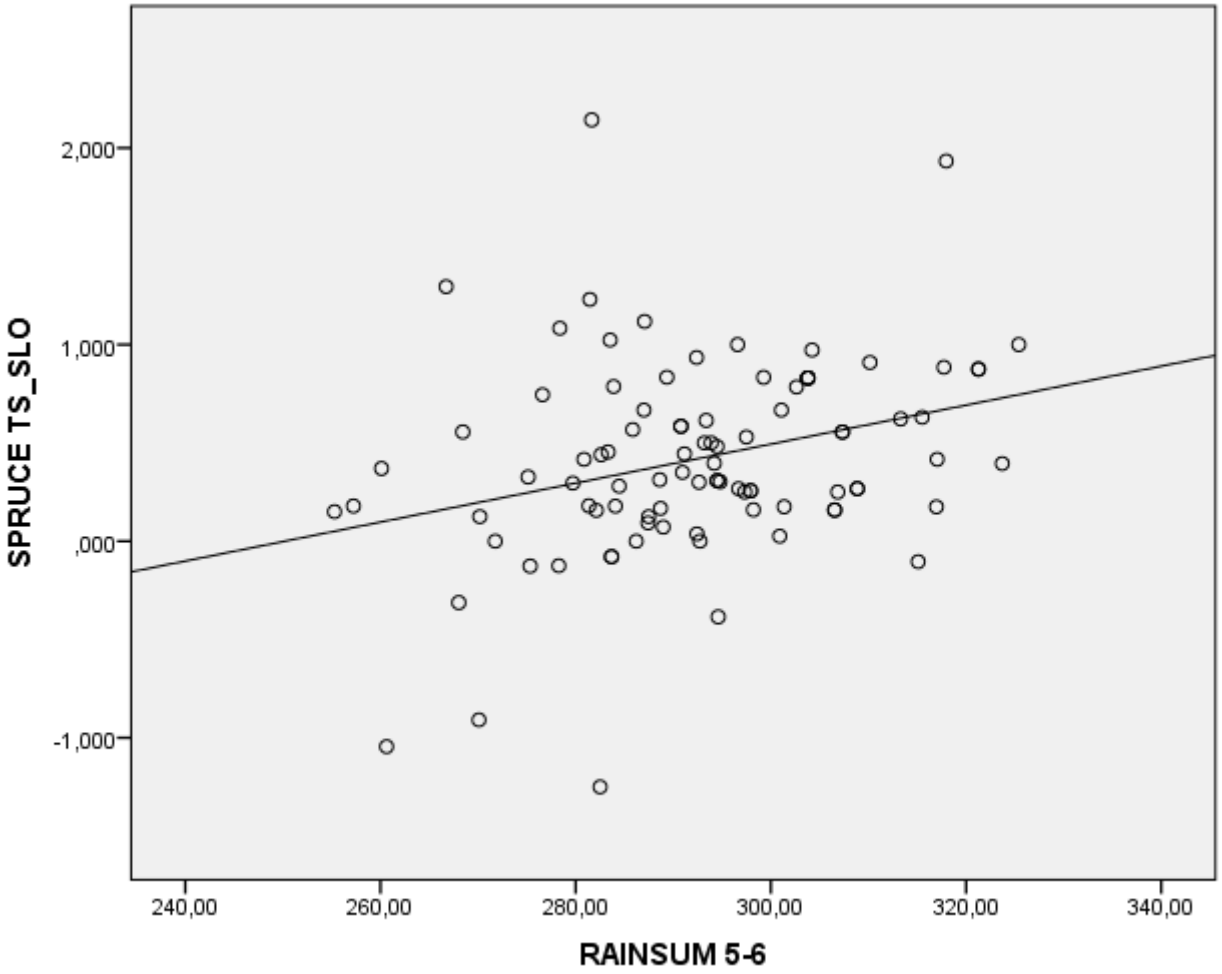


Correlation profile- Scots pine: differs from that of Norway spruce



Even with the 'best' correlations there is a large variation

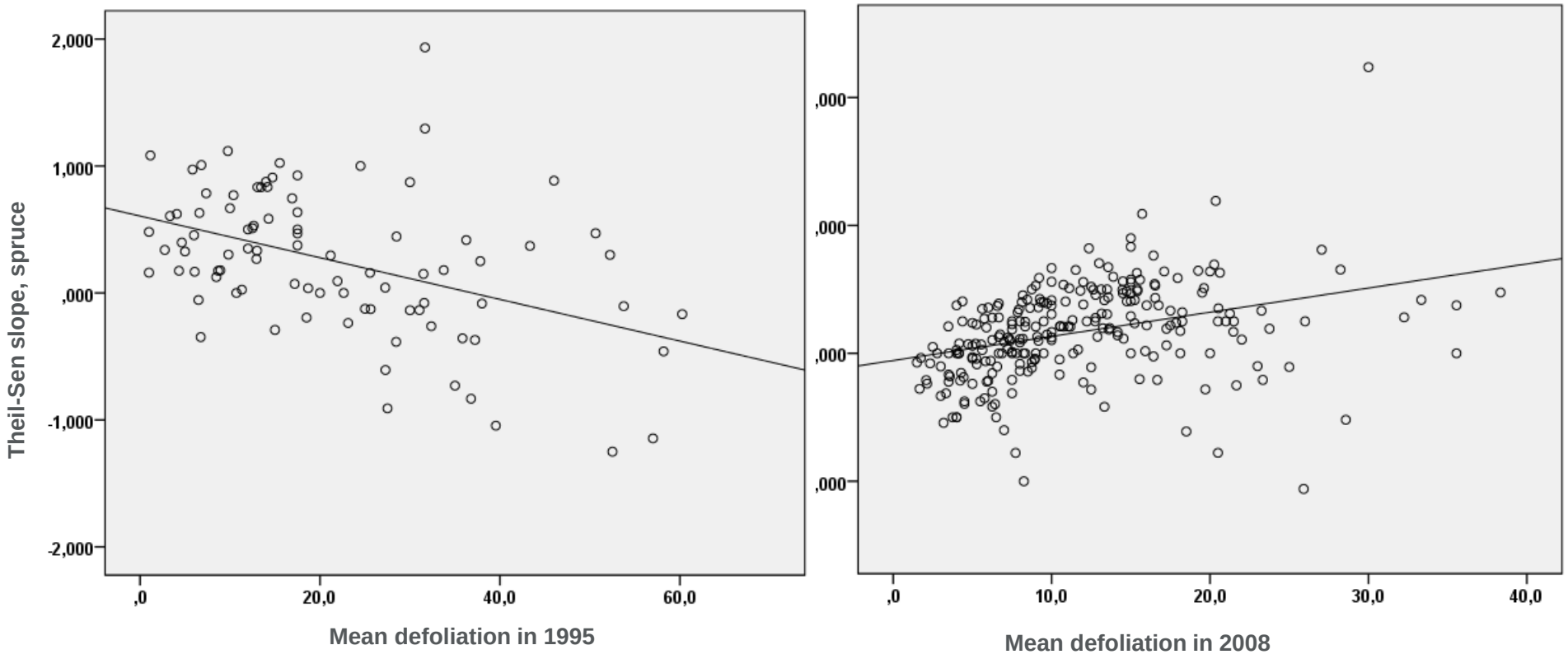
Here: Modelled rainsum during May-June, vs T-S slope, Norway spruce plots



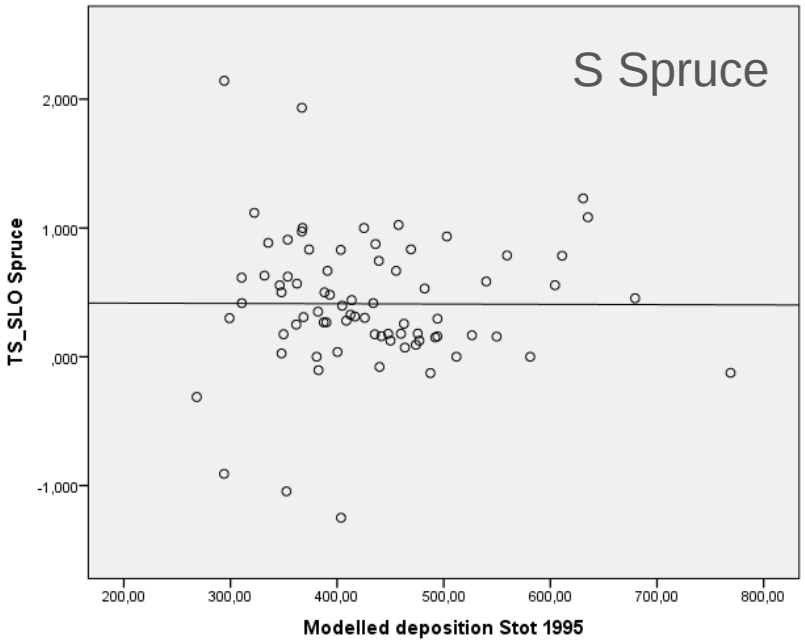
Theil-Sen slope was somewhat related to

-Defoliation in 1995 (Norway spruce)

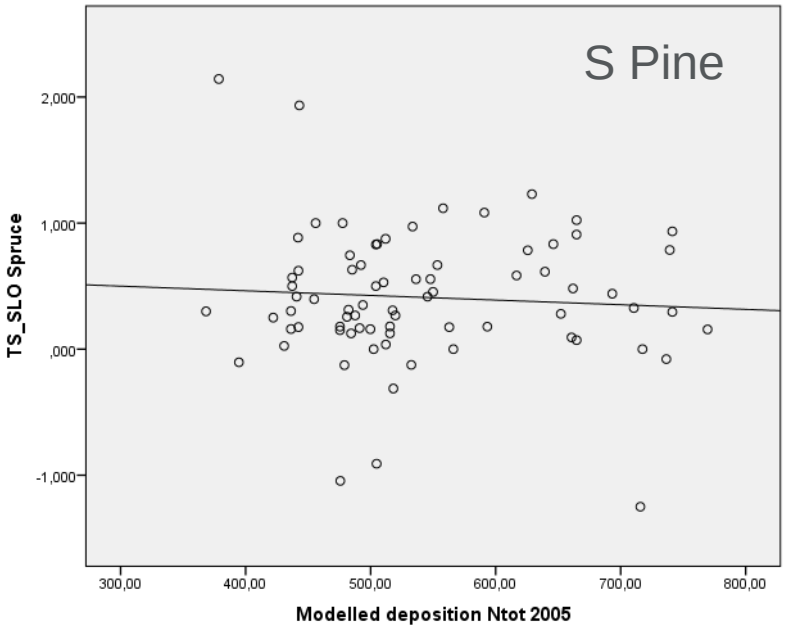
-Defoliation in 2008 (Scots pine)

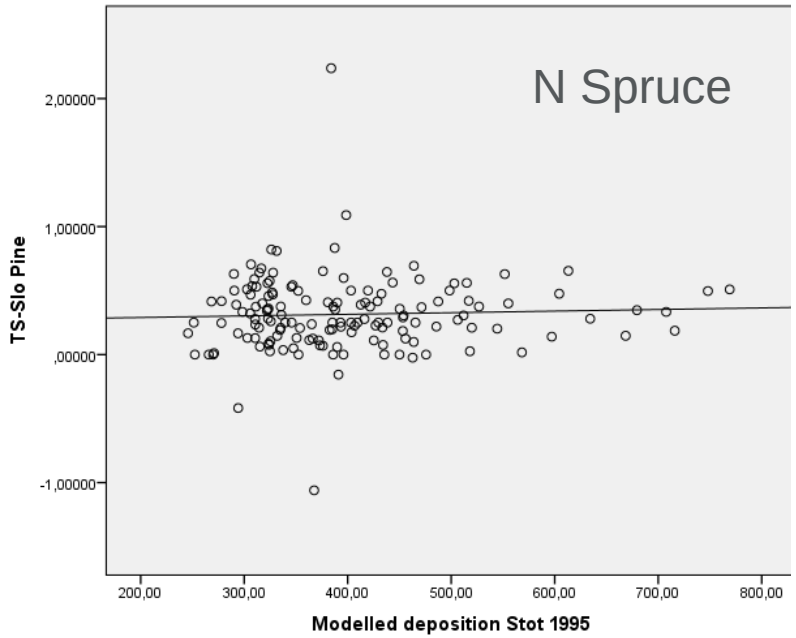


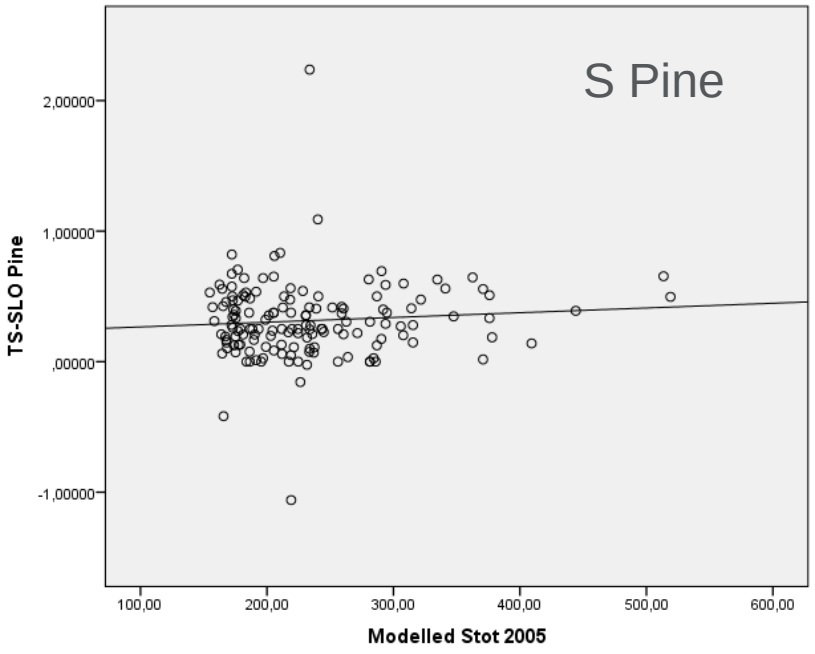
1995



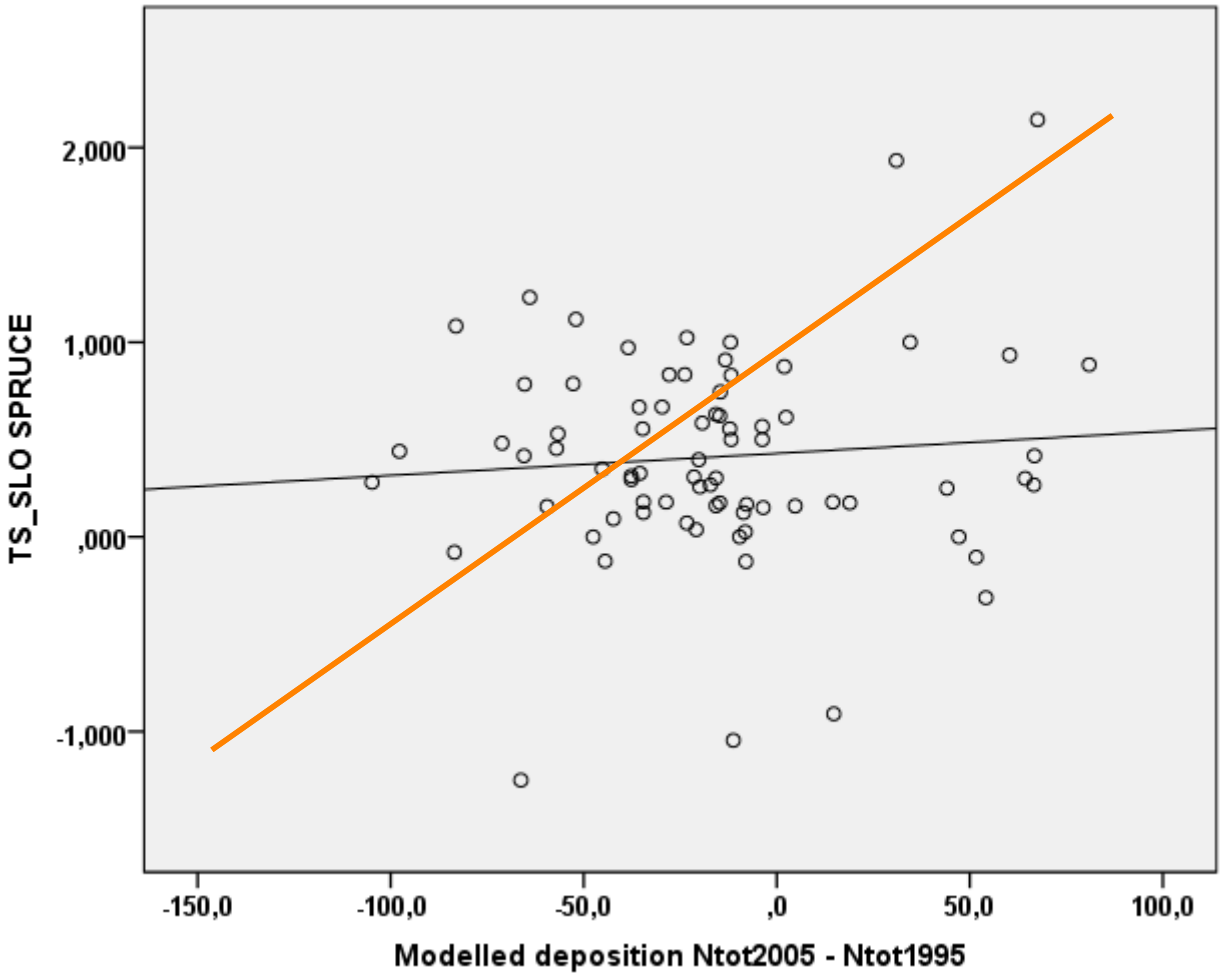
2005

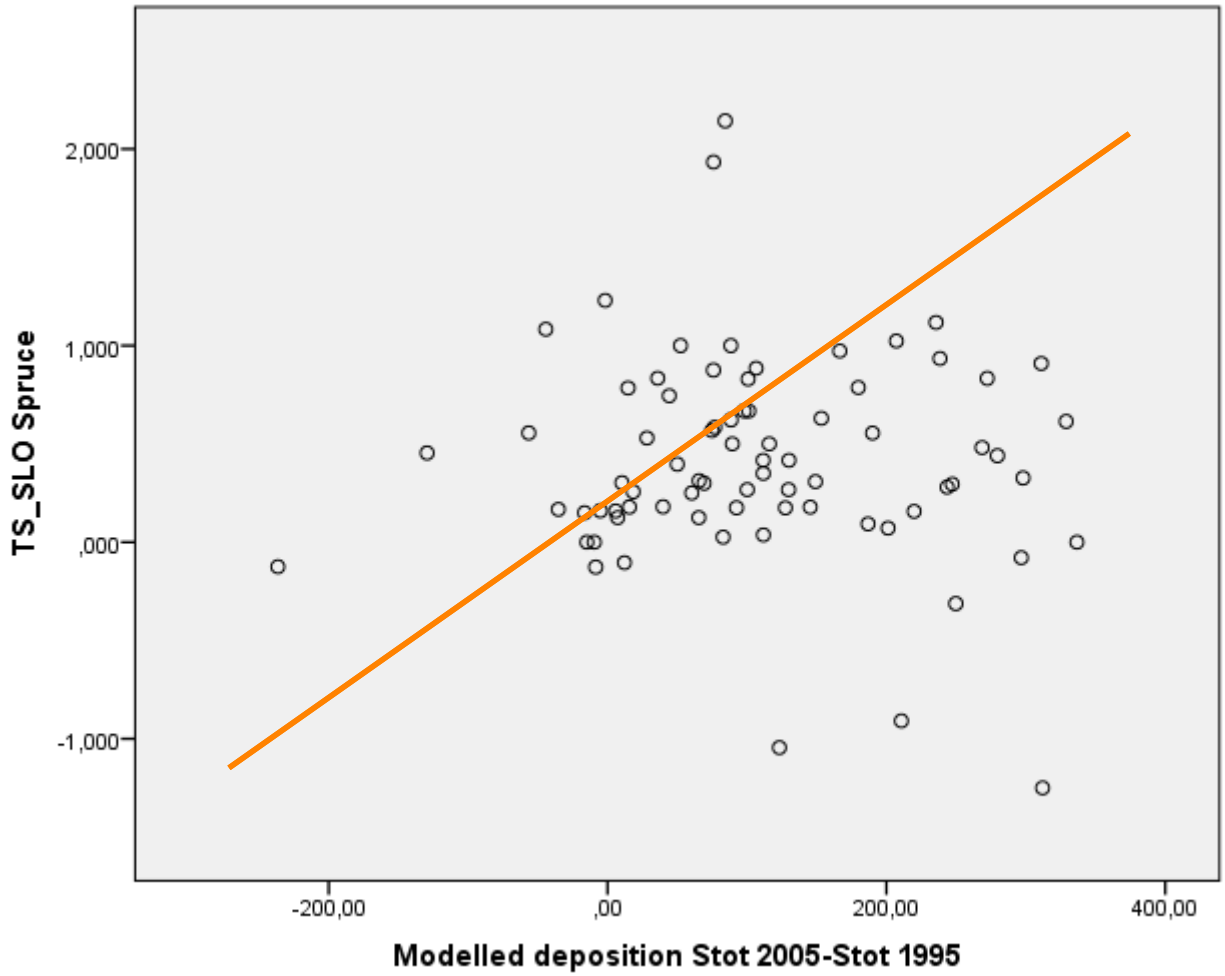




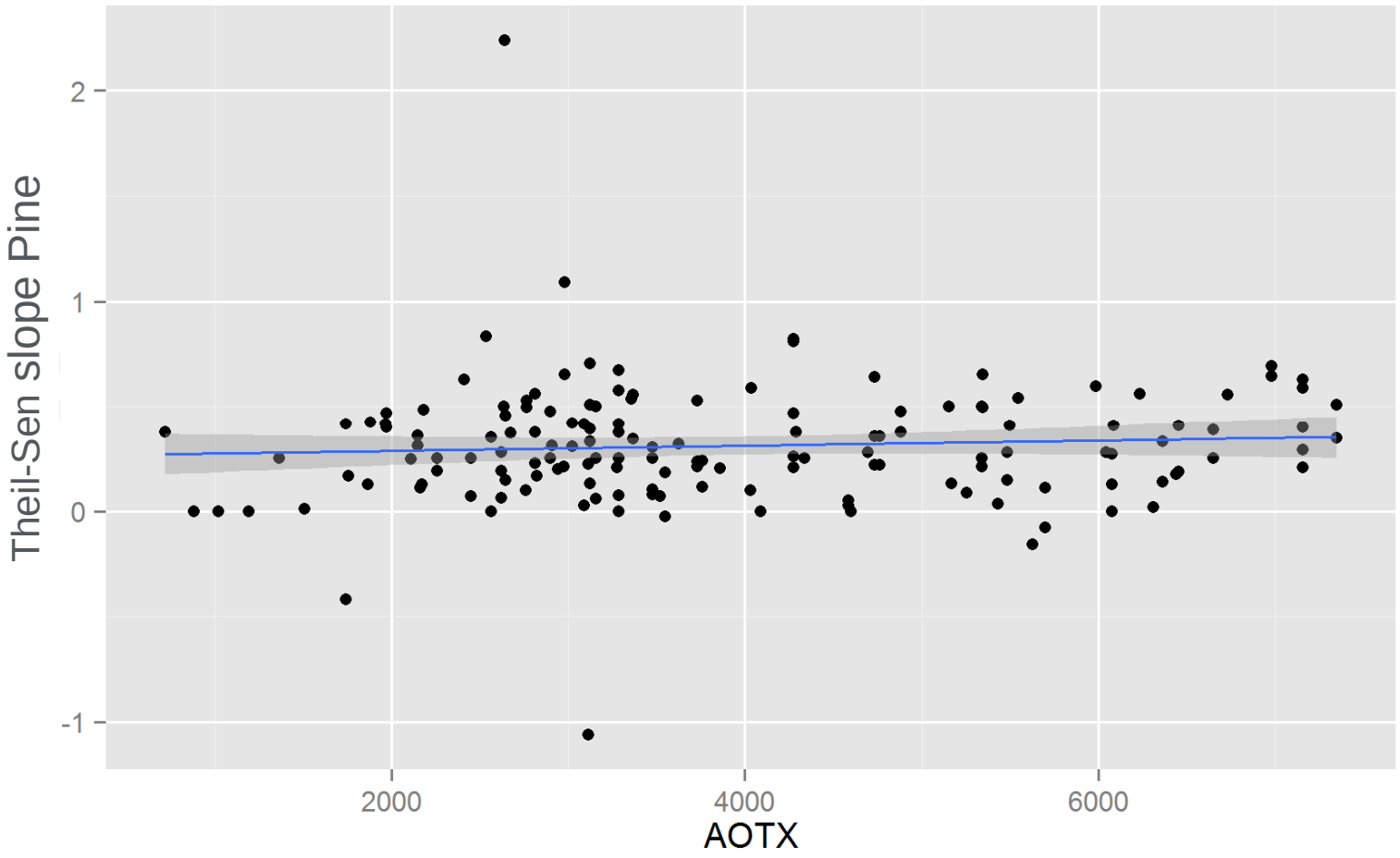


The reduction in N- or S- deposition is not reflected in the magnitude of the defoliation trend!





Not even ozone (AOT40) seems to be correlated with the trend…

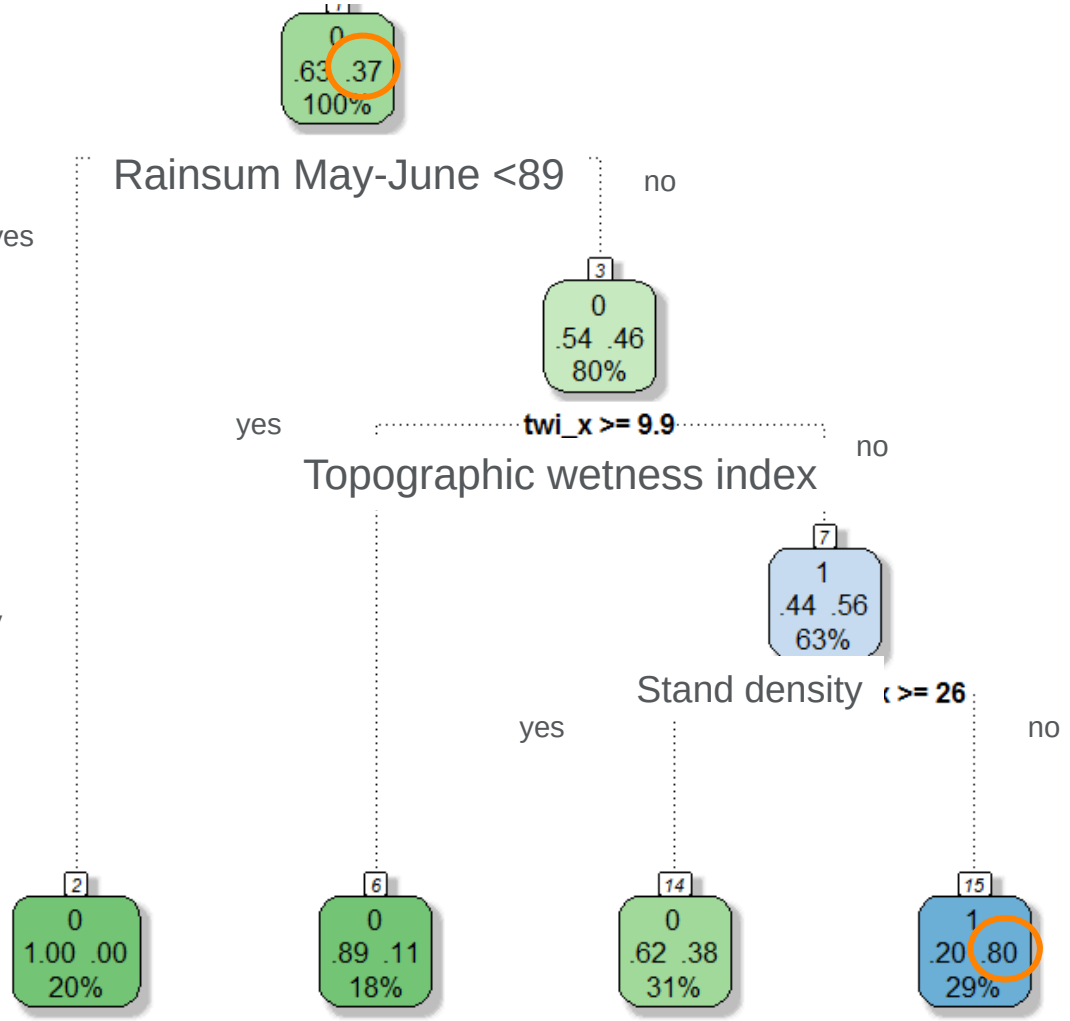


Classification and Regression Trees may show the ”best” way to split the data to groups with different relative risks

Risk for ”high trend” in spruce

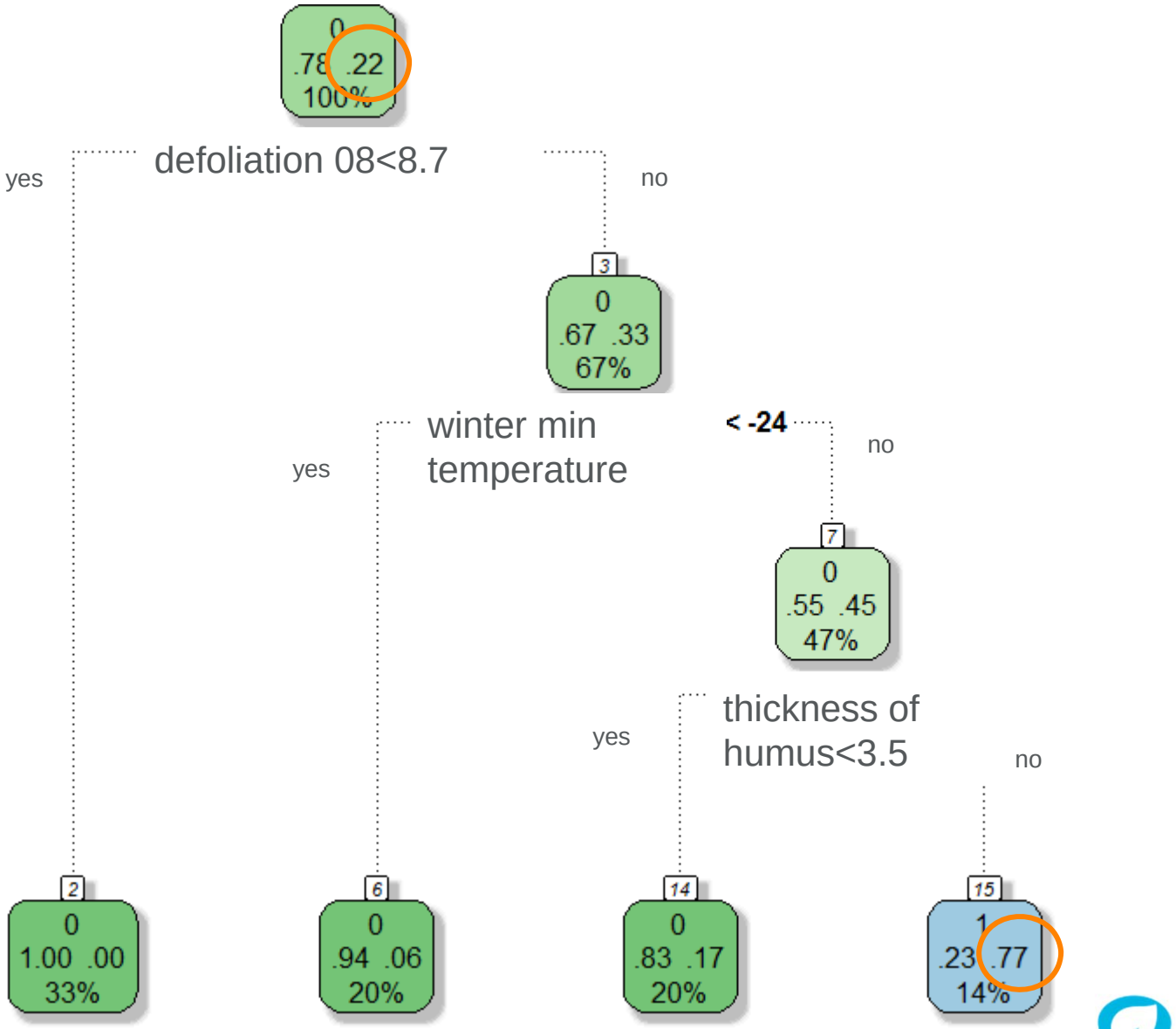
Ts-slope >0,5
&
M-K p <0,05

33 % of the plots correctly classified…



Risk for ”high trend” in pine

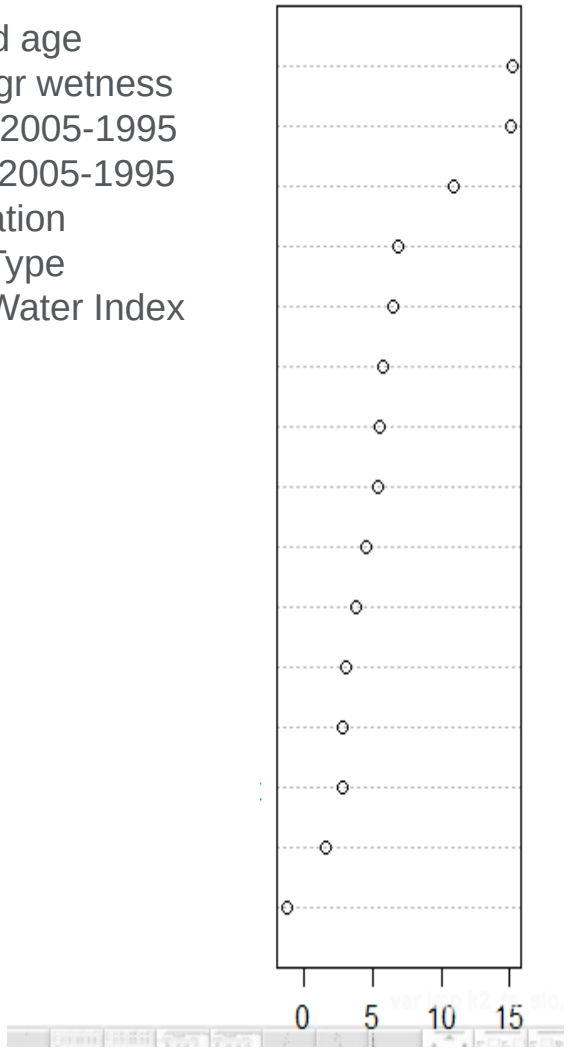
25 % of the plots correctly classified…



”Variable importance” in Random Forest shows the relative importance of the variables for splitting the data

Norway spruce

Stand age
Topogr wetness
TotN 2005-1995
TotS 2005-1995
Elevation
Soil Type
Soil Water Index
etc.



Scots pine

Temperature sum
Pine sawflies, %
Defoliation 2008
Winter temperature
AOT
Stand density
Soil Water index
Total S 1995
etc

Conclusions

- time series too short - as always
- trend analysis is difficult to interprete:
  is the analysis of any value?
- abiotic/biotioc damage may have strong influence in certain years >
  deviation from linear trend useful
- tree species have different sensitivity profiles
- defoliation not a sensitive indicator for deposition or reductions (in low deposition situation)
- models of relative susceptibility are possible

Thank you for your attention!