Leaf nutrients and leaf morphological traits in European beech stands across a water availability gradient in Switzerland

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Introduction

Material and Methods

Results

Discussion

- Forest productivity
- Water availability
- Leaf traits
- Research questions

- Study area
- Sampling
- Chemical analysis
- Data analysis

- Foliage
- Climatic
- Soil

- Discussion
- Conclusion
- Suggestion

Nutrient cycling

Global change

Forest productivity

Drought

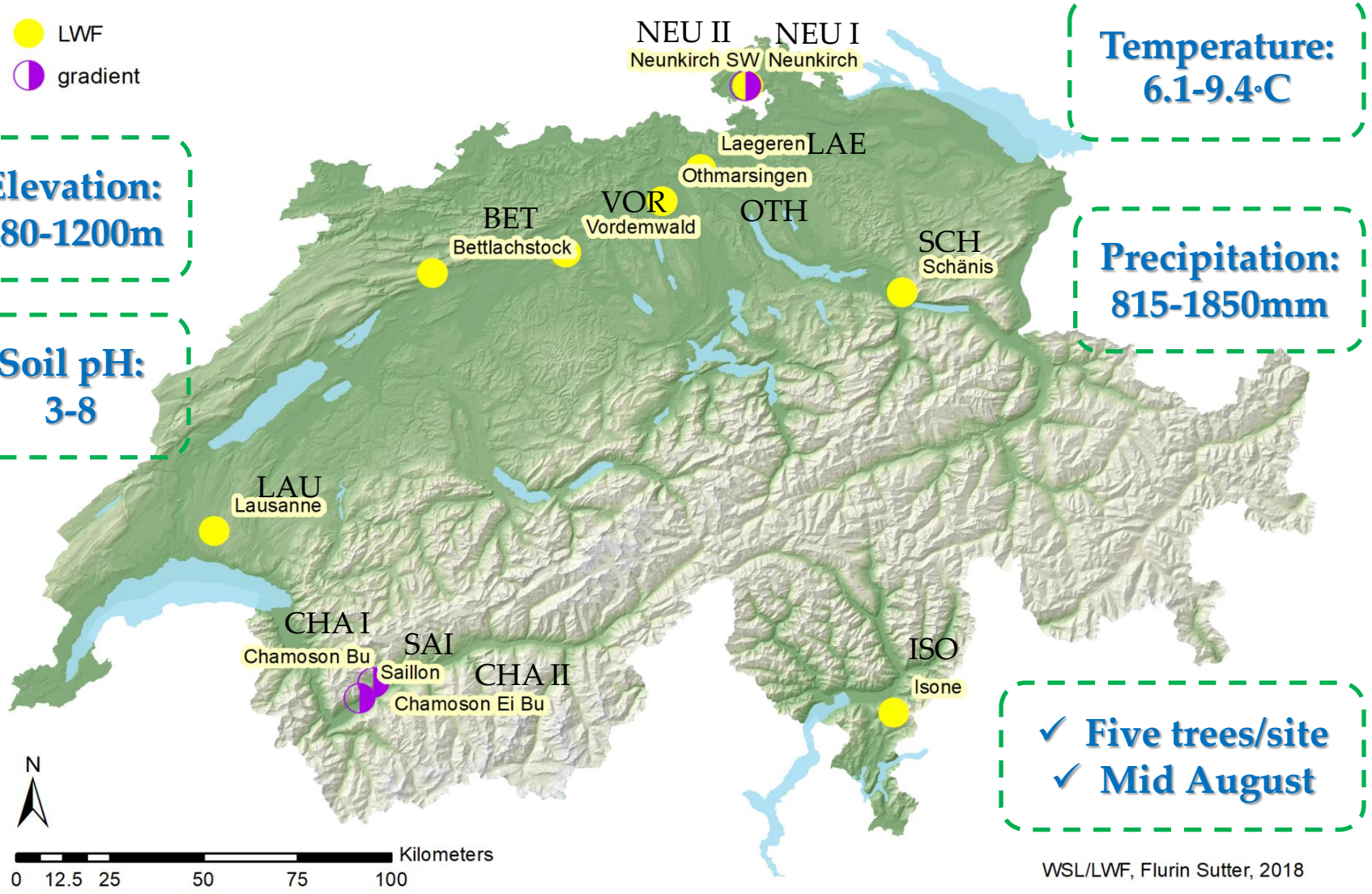
Leaf traits

photo: Markus Gysin

Research questions

Does lower water availability have significant effects on the foliar morphological traits?

How are the nutrient concentrations in the leaves affected by water availability?



Elevation: 480-1200m

Soil pH: 3-8

Temperature: 6.1-9.4°C

Precipitation: 815-1850mm

- ✓ Five trees/site
- ✓ Mid August

- Leaf area, leaf weight,
  specific leaf area SLA
- Macronutrients: N, P, K, Ca, Mg, S
- Micronutrients: Al, B, Ba, Cu, Fe, Mn, Ni, Zn
- Carbon and C isotope : C, $d^{13}C$
- Lignin, phenol
- Gradient of water availability:
  - Annual precipitation
  - Drought index: mean ratio between actual and potential transpiration June to August (1981-2010) AT/PT

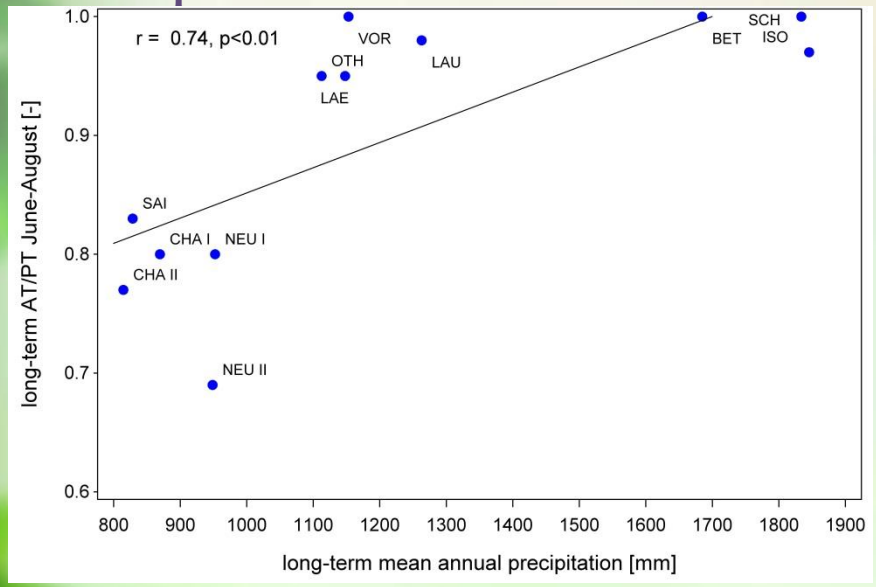
Other variables: soil chemistry

Data analysis: Pearson correlation

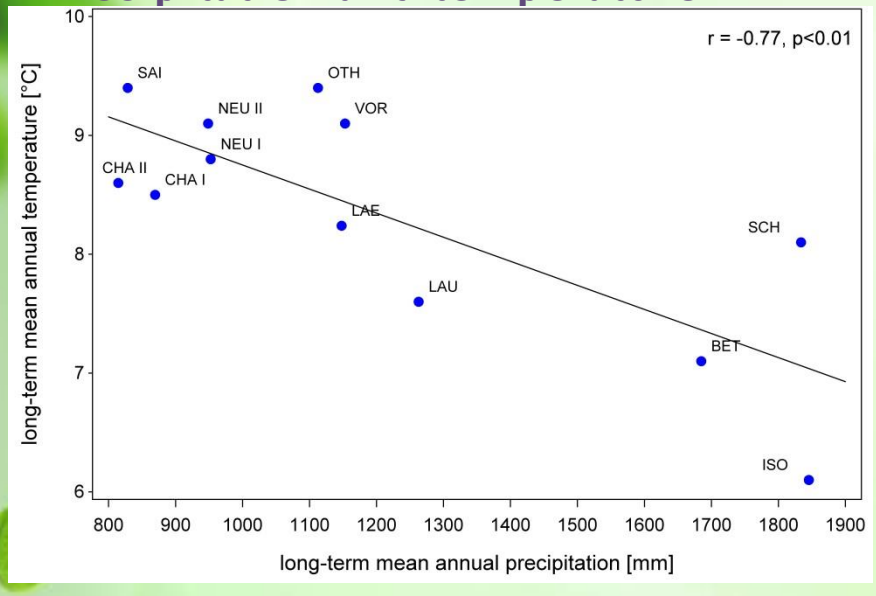

Results

Relationships between climatic factors / drought index

Precipitation and AT/PT

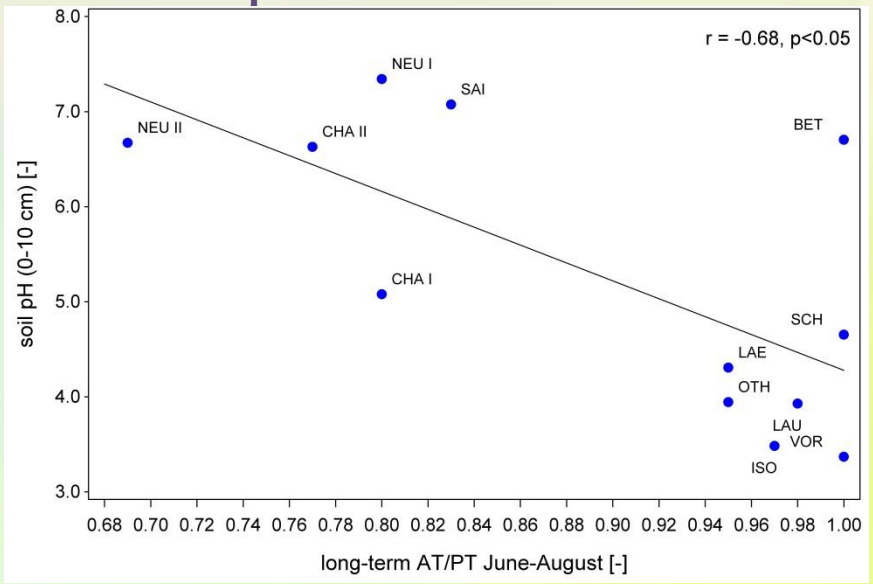


Precipitation and temperature



Relationships between drought index and soil acidity

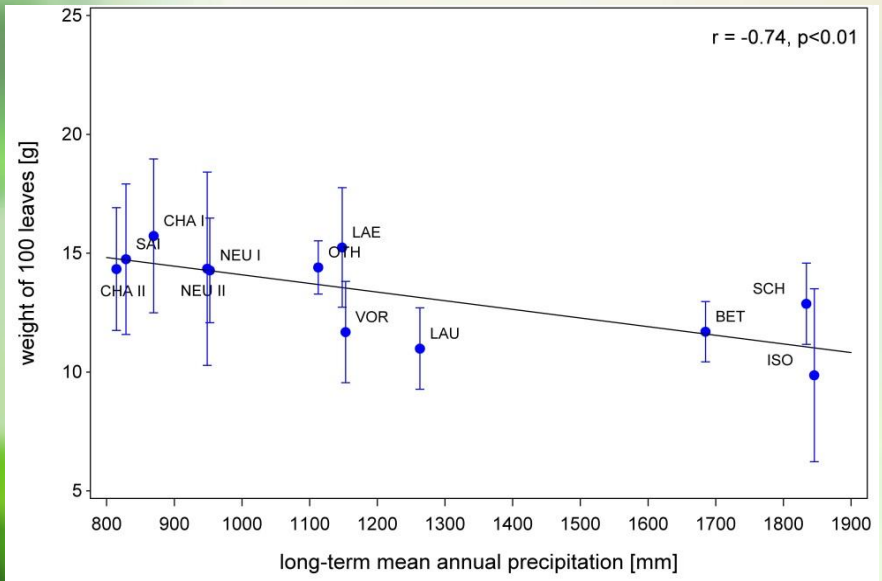
Soil pH and AT/PT

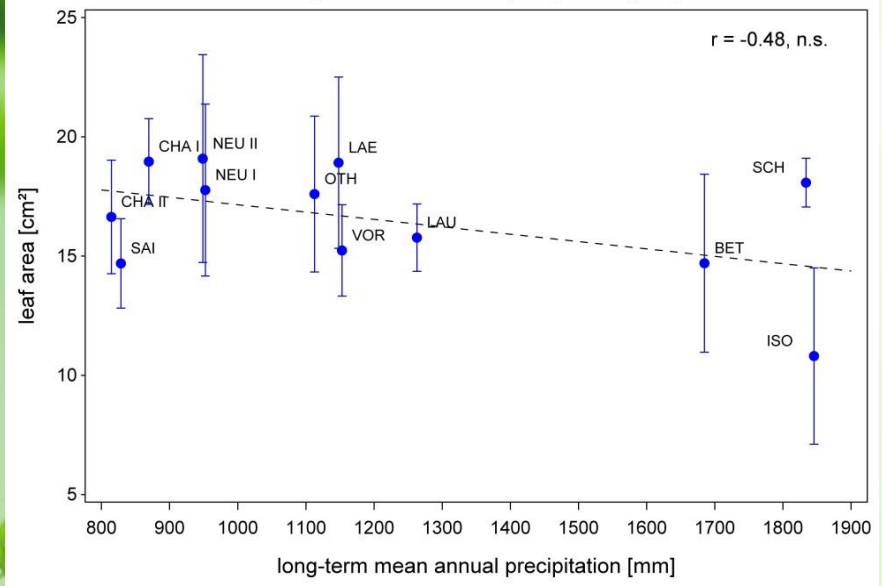


- Significant (positive) correlation between annual precipitation and AT/PT
- Significant (negative) correlation between annual precipitation and temperature
- The AT/PT gradient is also a soil acidity gradient (all dry sites are on calcareous substrate)

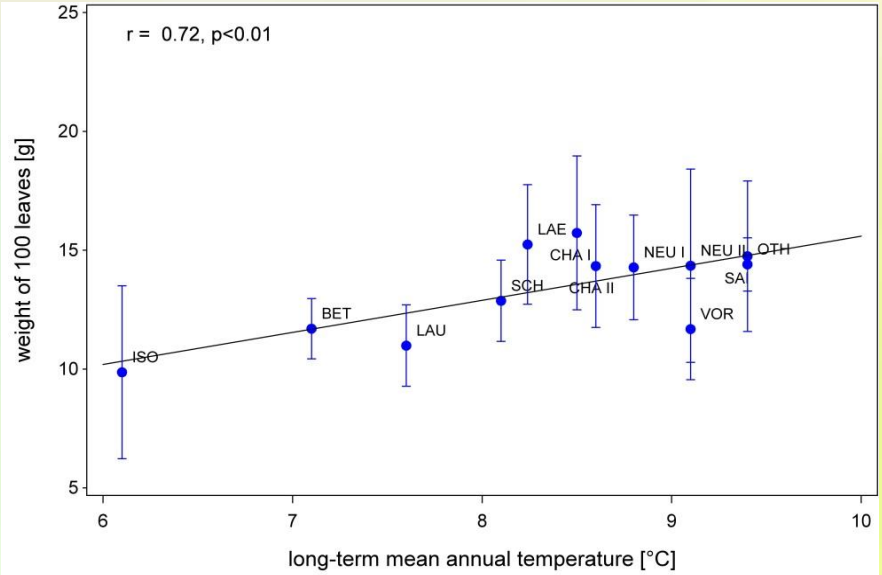
Relationship between leaf size (weight, area) and annual precipitation and temperature

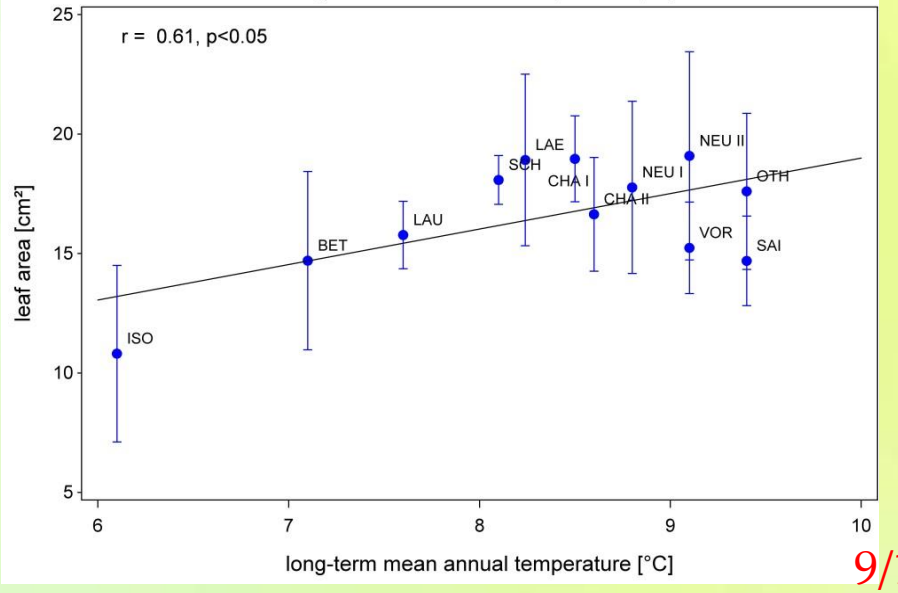
Precipitation (mm)



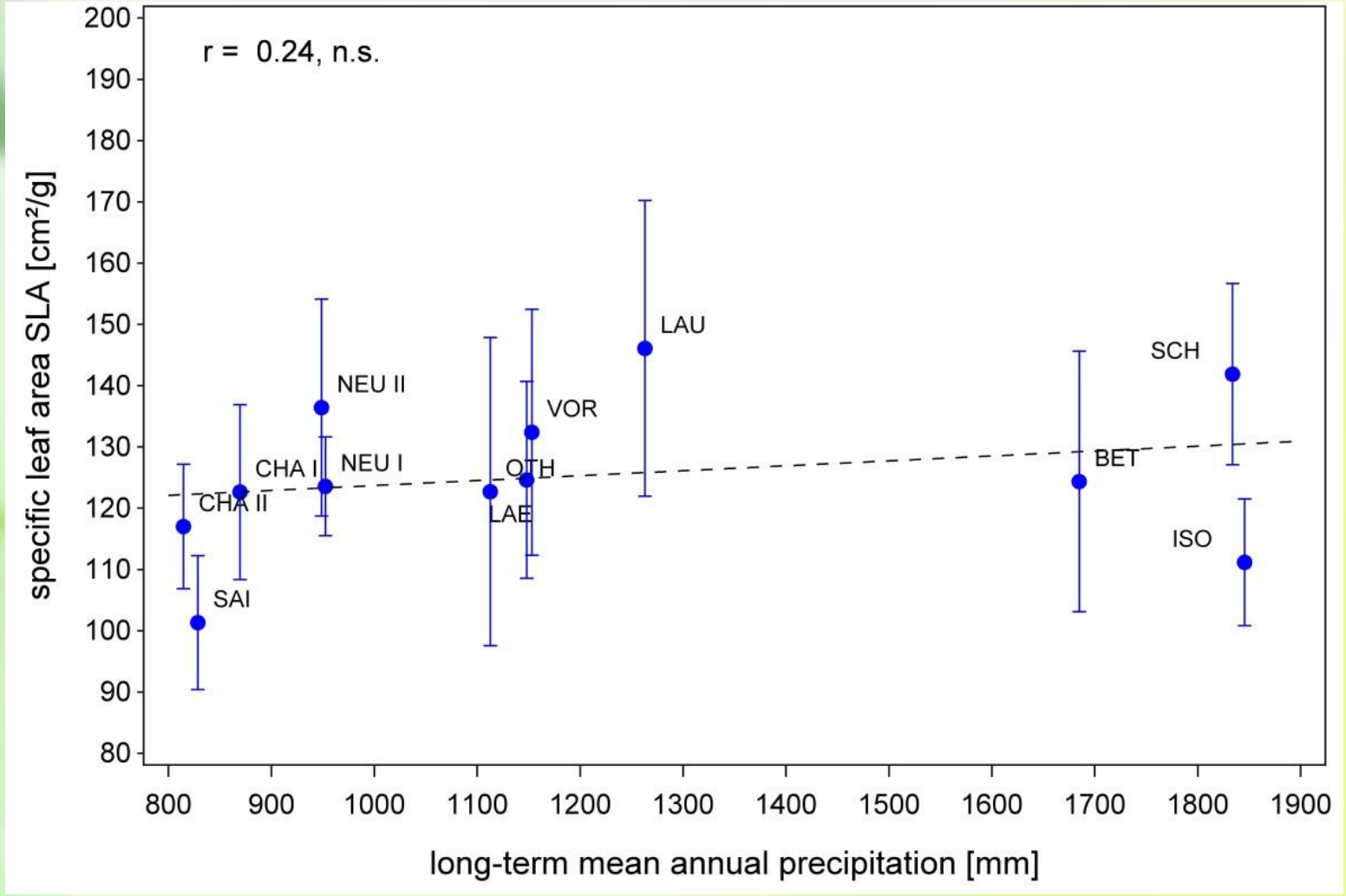


Temperature (°C)



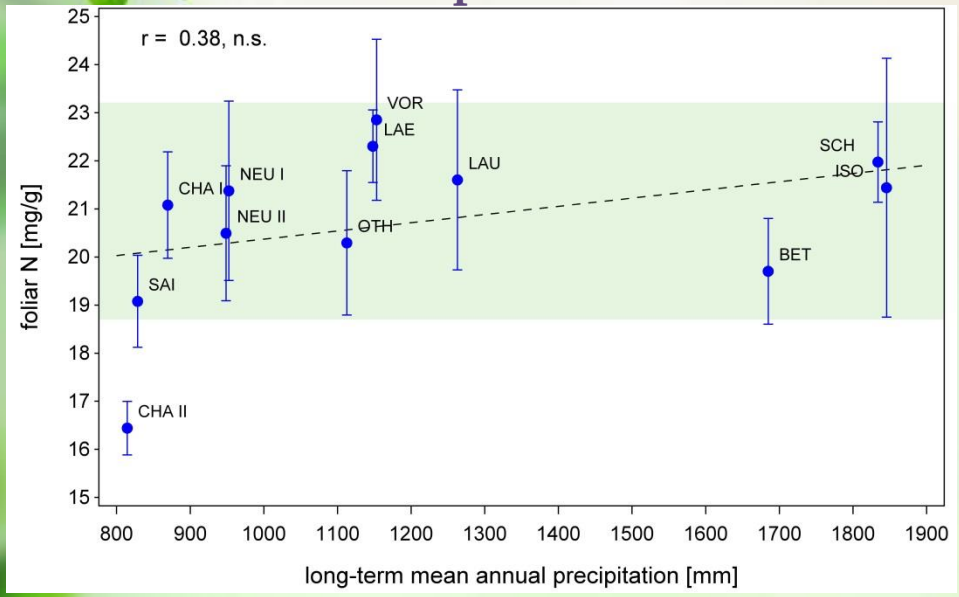


- **No significant relationship between SLA and precipitation (or AT/PT)**

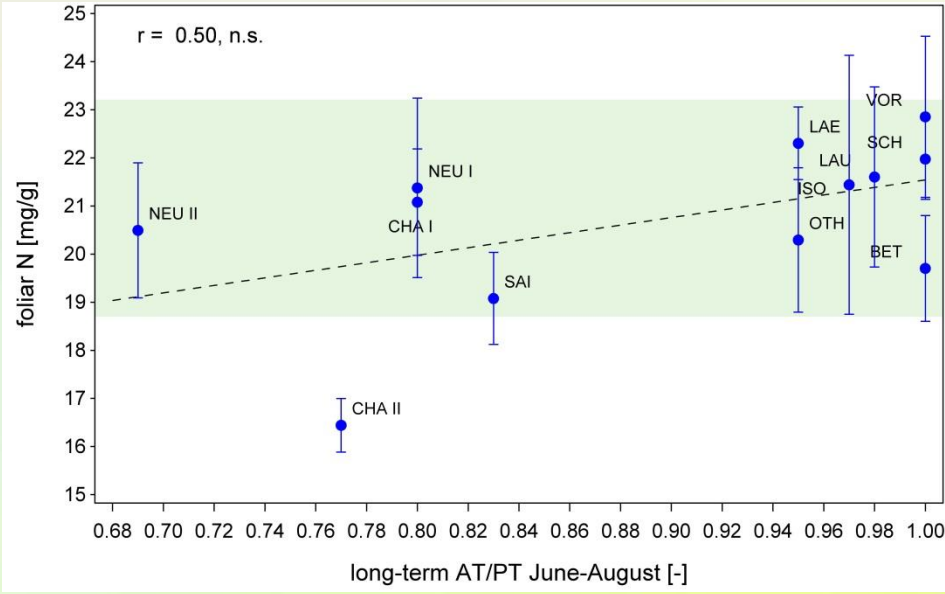


N concentrations in foliage

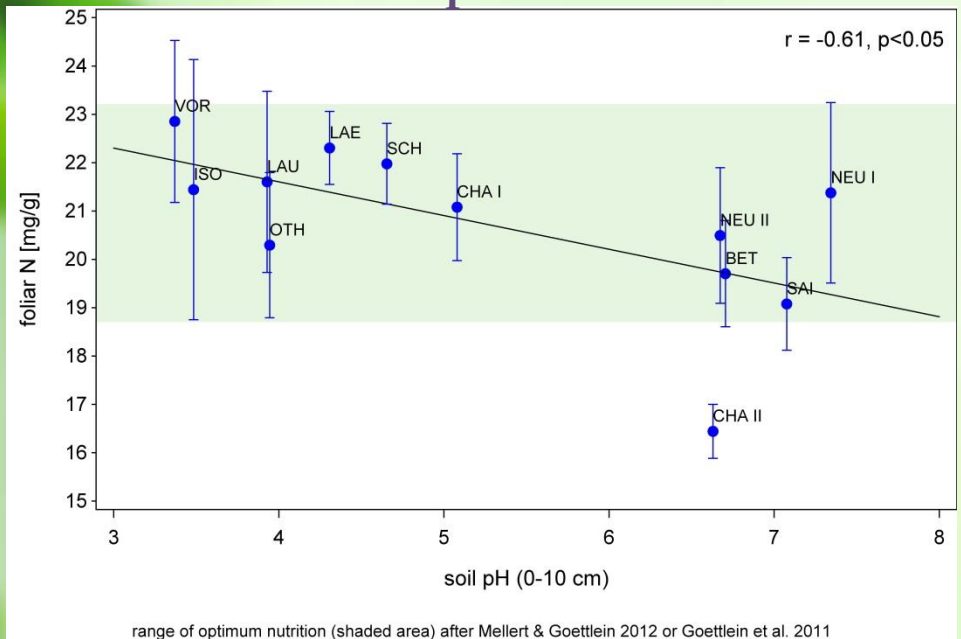
Precipitation (mm)



AT/PT



Soil pH

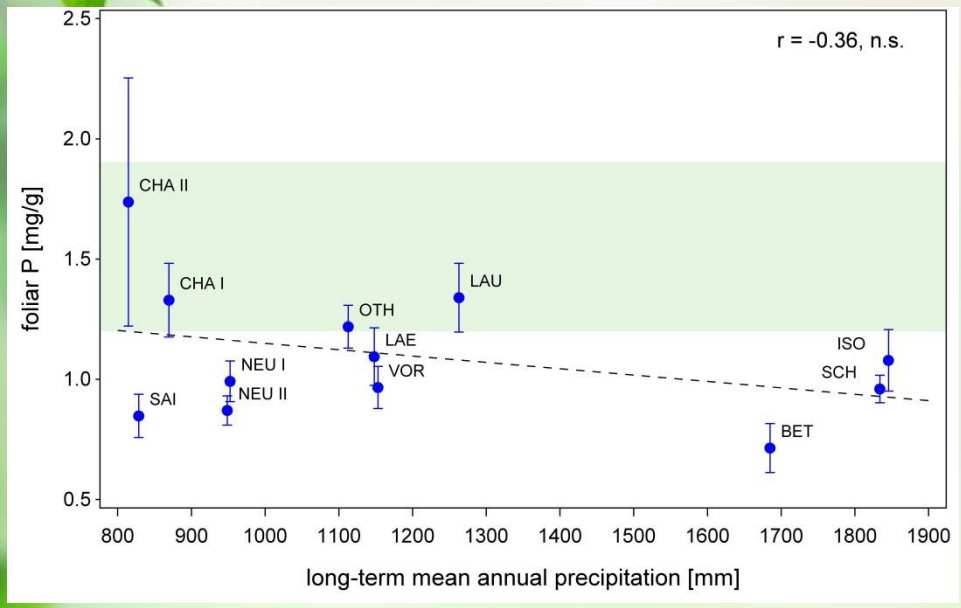


range of optimum nutrition (shaded area) after Mellert & Goettlein 2012 or Goettlein et al. 2011

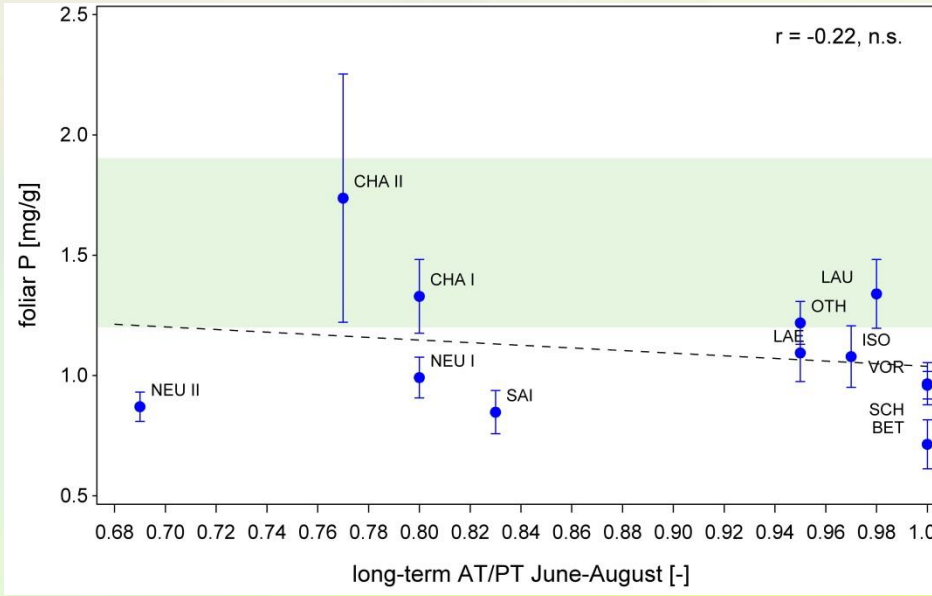
- No significant correlation between foliar N and annual precipitation or AT/PT
- All sites within the range of optimum nutrition for N except CHA II
- Significant correlation between foliar N and soil pH (but not with N pools in soil or soil C:N)

P concentrations in foliage

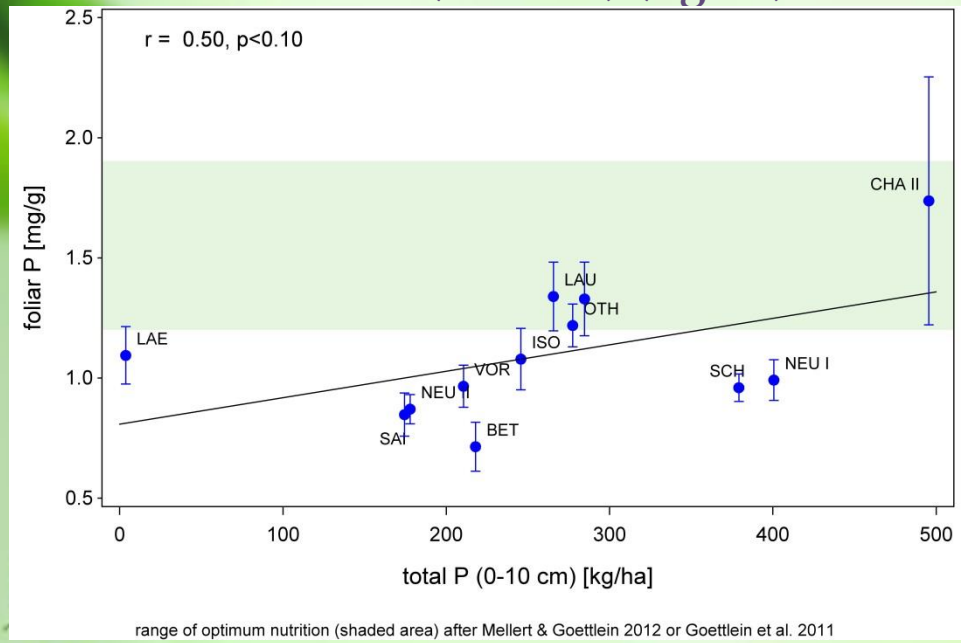
Precipitation (mm)



AT/PT



Total P in soil (0-10 cm) (kg/ha)

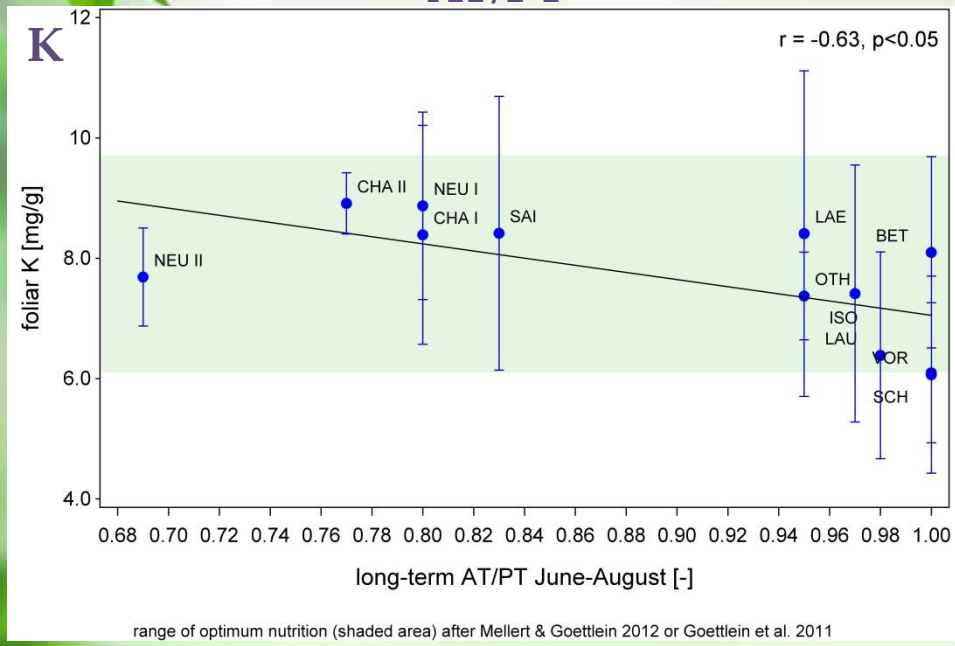


- No significant correlation between foliar P and annual precipitation or AT/PT
- Majority of sites with low P levels
- Significant correlation between foliar P (and foliar N:P) and total P in soil

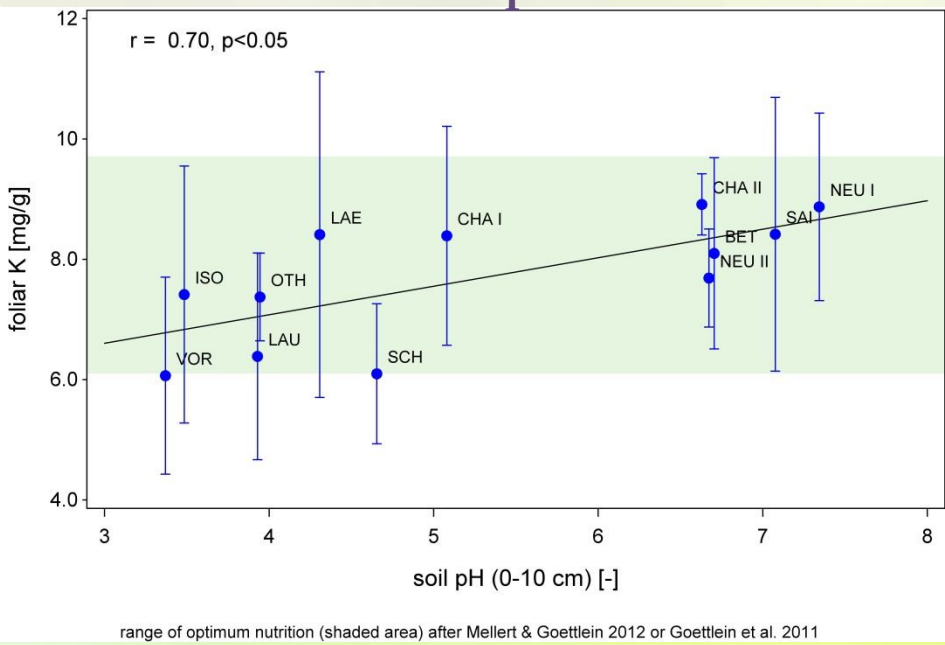
K and Ca concentrations in foliage

AT/PT

soil pH



range of optimum nutrition (shaded area) after Mellert & Goettlein 2012 or Goettlein et al. 2011



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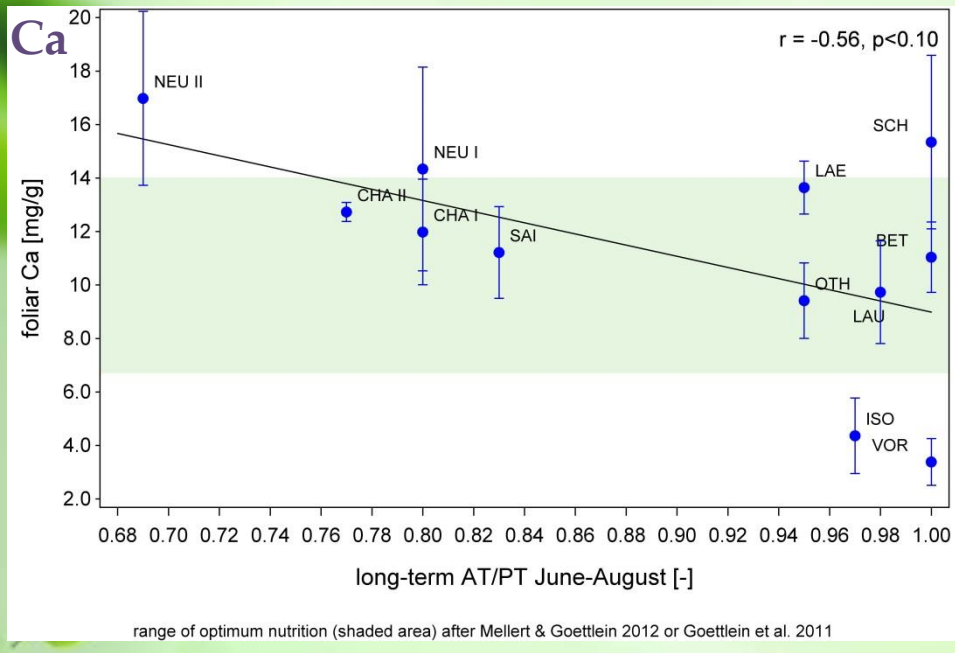

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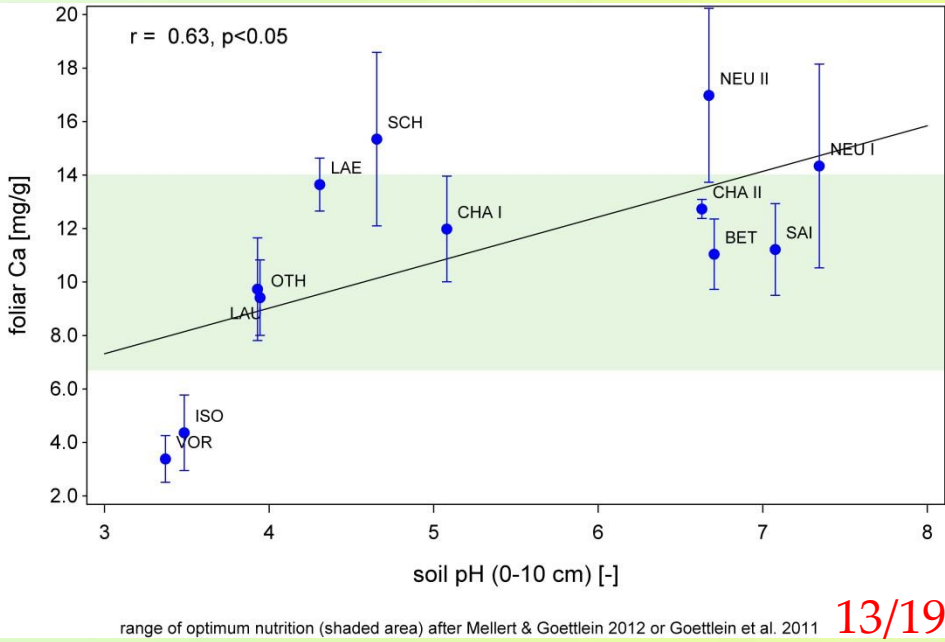
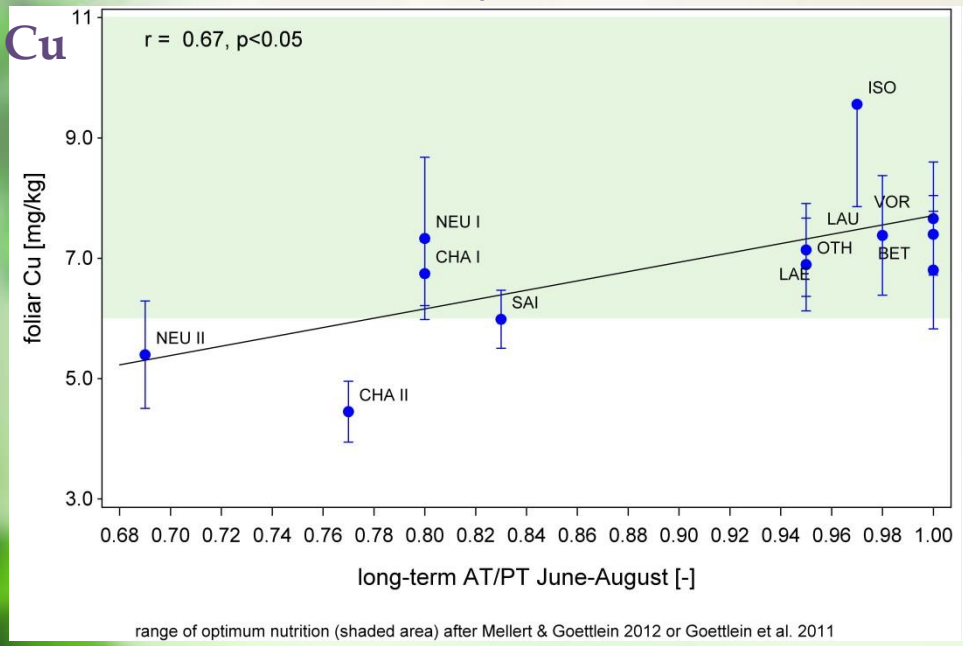


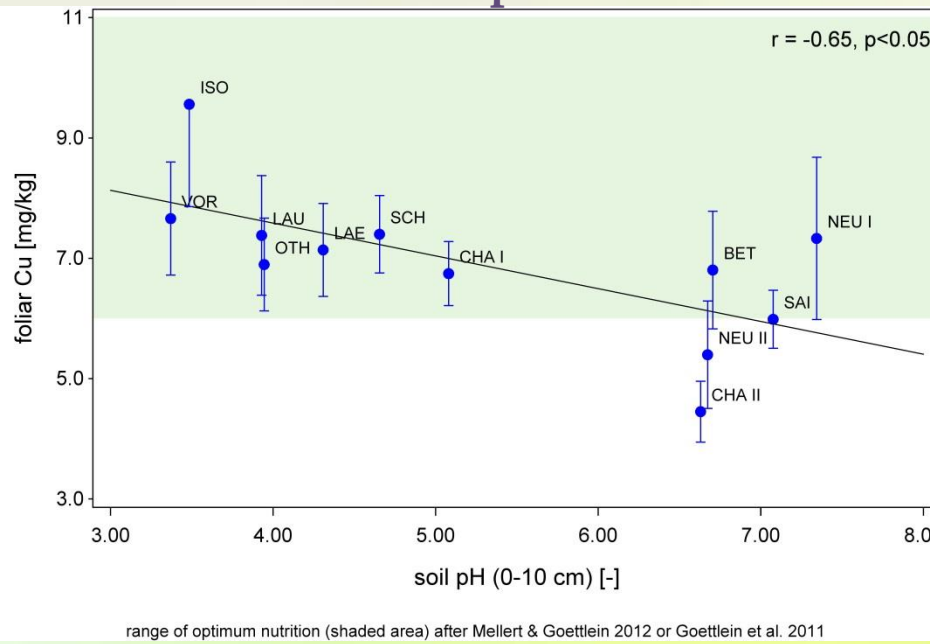
range of optimum nutrition (shaded area) after Mellert & Goettlein 2012 or Goettlein et al. 2011

Cu concentrations in foliage

AT/PT

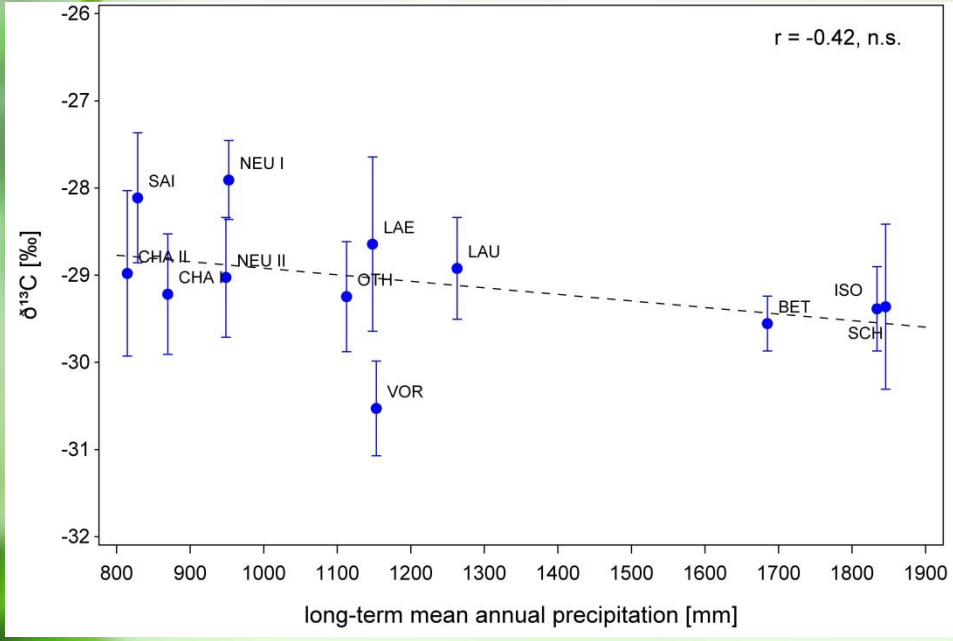


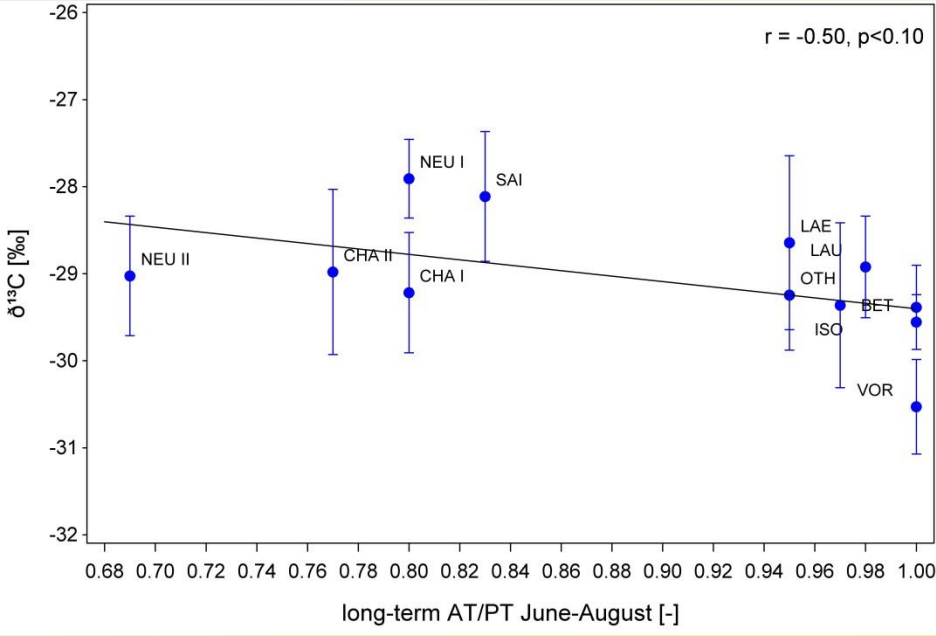
soil pH



- Significant correlation between foliar Cu and AT/PT
- But soil pH most probably the underlying factor of the correlation of AT/PT with foliar Cu (Cu availability decreases with increasing soil pH), as for foliar Ca and K

$\delta^{13}C$ correlation with precipitation, AT/PT





- Negative correlation between $d^{13}C$ and AT/PT (but only slightly significant)

Carbon content, lignin, phenols

- No correlation between C, lignin or phenols and climatic parameters (one site (ISO, with lowest annual temperature) with significantly higher C content in foliage compared to all other sites. Higher leaf thickness as an adaptation to cold?)

Summary of correlations between leaf, soil and climate characteristics

	Precipitation	AT/PT	Temperature	Soil pH
Leaf area	-	-	+	-
Leaf weight	-	-	+	+
SLA	+	+	+	-
d13C	-	-	+	+
Foliar N	+	+	-	-
Foliar P	-	-	+	+
Foliar Ca	-	-	+	+
Foliar K	-	-	+	+

Conclusions

Correlations among factors:

-The AT/PT gradient is also a soil pH gradient in this study (dry sites on calcareous soils)

-Confounding factors, which make the interpretation of the results difficult

Morphological Traits: →

- Yes: leaf size and weight increase with drought, but not the "thickness" (SLA)

Nutrients: →

- Yes: Ca, K in foliage increase with drought,

→ but not for N and P

- Foliage contents indicate that N is not limited, but P seems to be on parts of the sites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Thank you for your attention