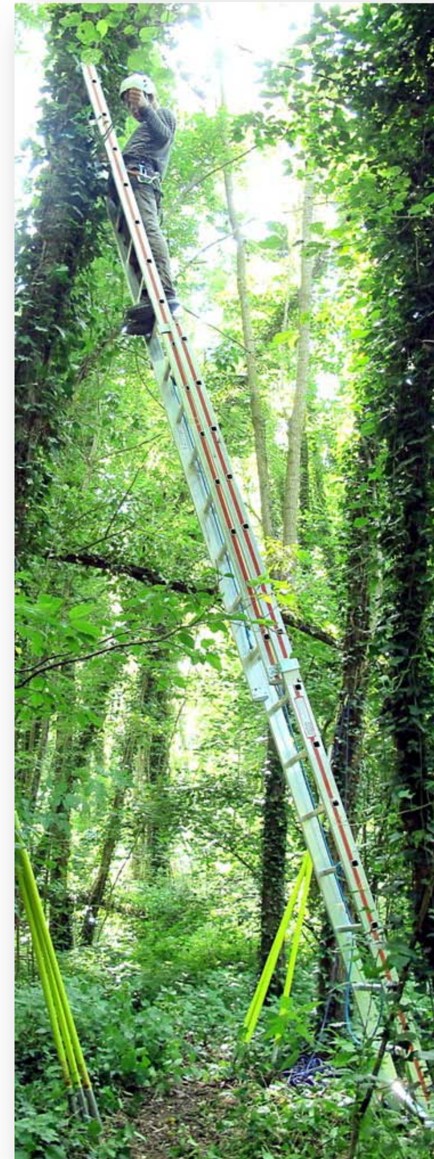

BG5.1: Biospheric Feedbacks on the Earth System

Temporal & Spatial Variability of Photosynthetic Potentials of Riparian Trees in the Mediterranean.

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Marie-Curie Initial Training Network GREENCYCLESII

CREAF Centre de Recerca Ecològica i Aplicacions Forestals

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Background

BG.5.1 statement:

- Biospheric feedbacks are a significant uncertainty in our current understanding of the Earth system.
- Biochemical processes are likely to affect the Earth system in the coming decades.

What does it mean?

- Global environmental changes leading to drought, vegetation shifts etc.

Relevance for the Mediterranean?

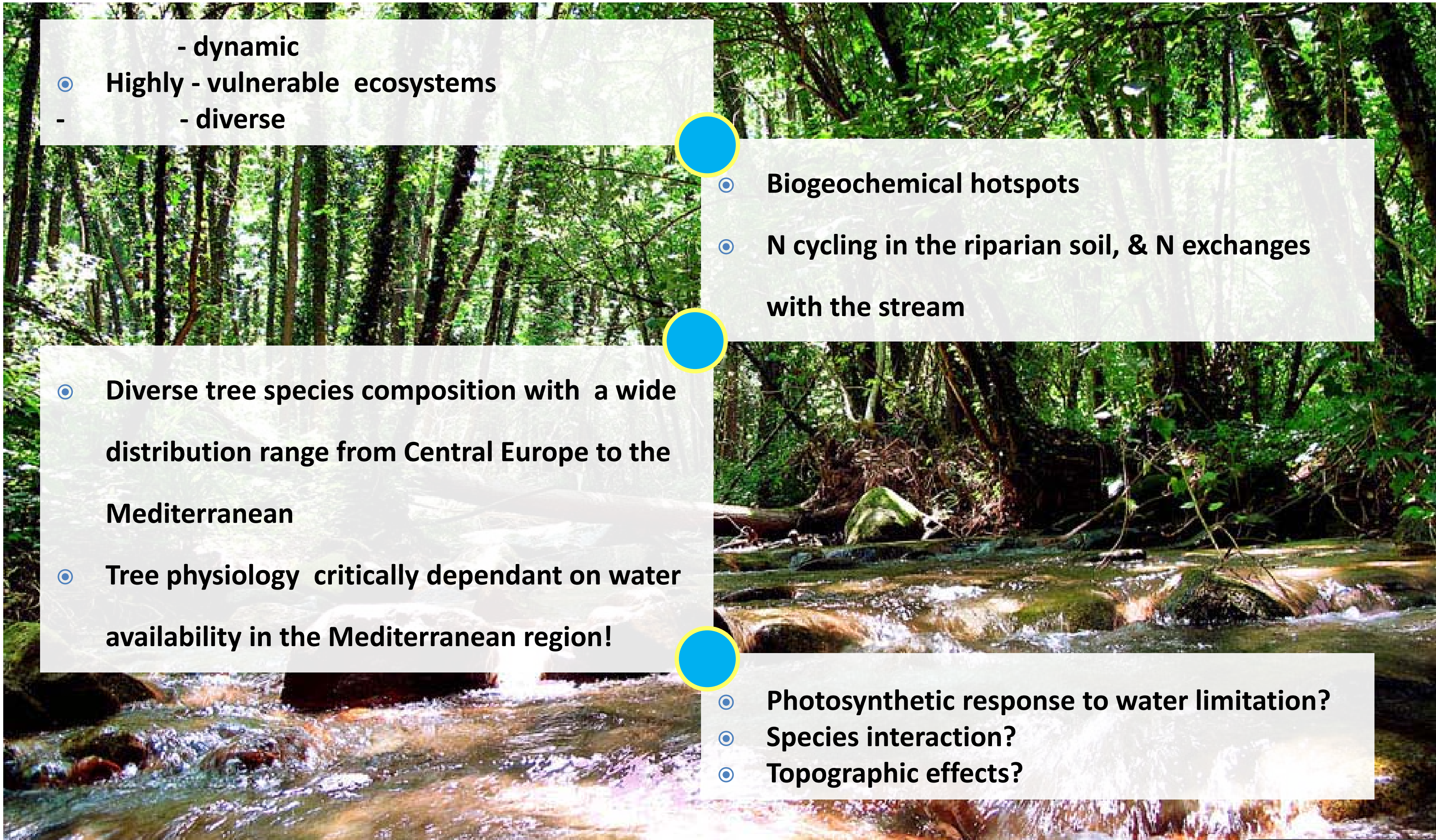
- Mediterranean region particularly vulnerable to climate change induced drought stress

Conclusion!

- Need to improve the ecophysiological understanding when modelling from the chloroplast to the globe!

Objectives

Riparian Ecosystems

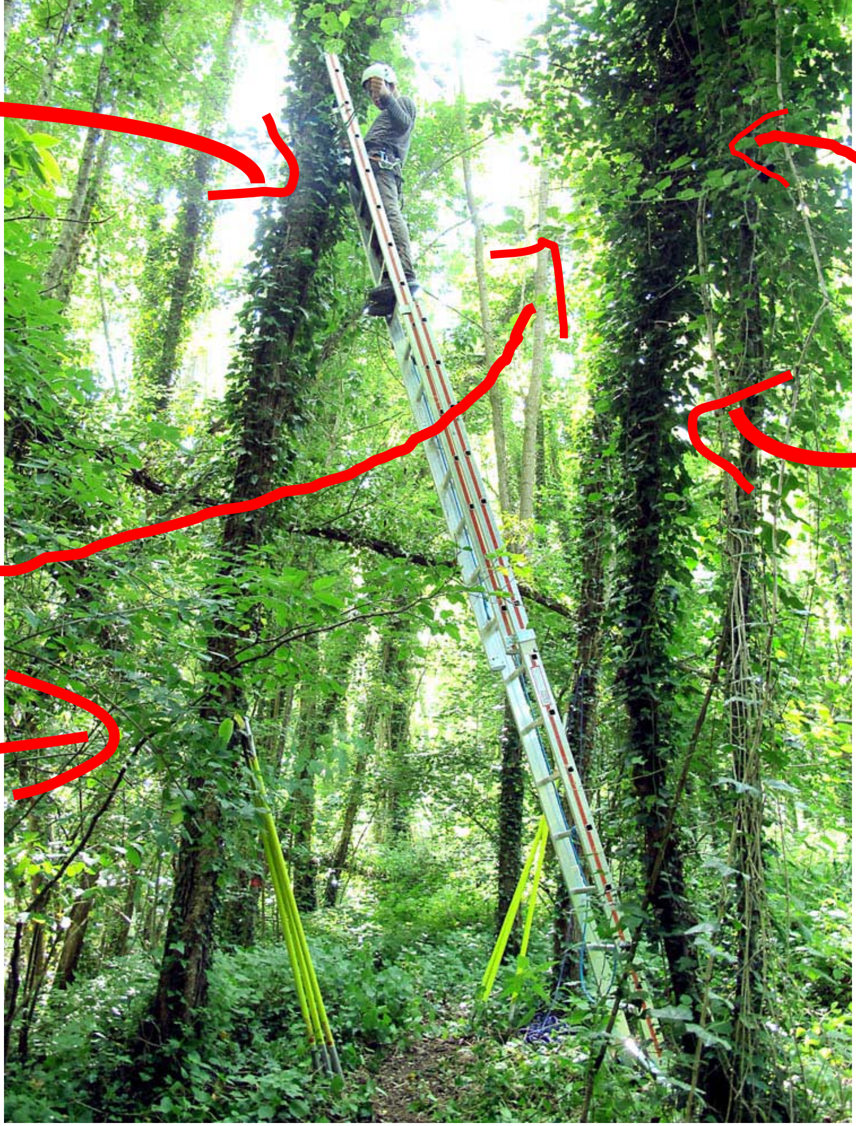


- dynamic
- Highly - vulnerable ecosystems
- - diverse

- Biogeochemical hotspots
- N cycling in the riparian soil, & N exchanges with the stream

- Diverse tree species composition with a wide distribution range from Central Europe to the Mediterranean
- Tree physiology critically dependant on water availability in the Mediterranean region!

- Photosynthetic response to water limitation?
- Species interaction?
- Topographic effects?



Objectives:

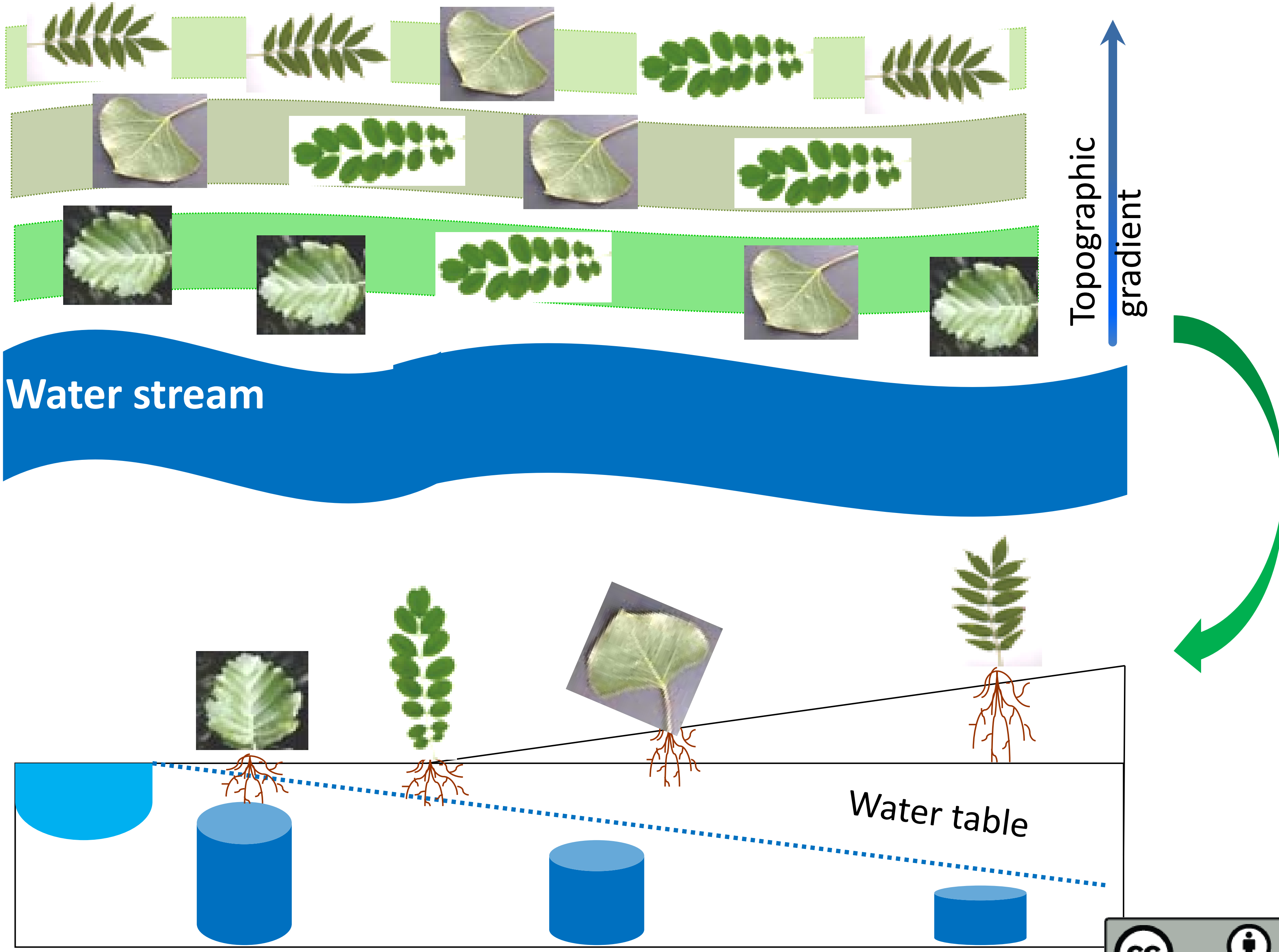
1) Diagnose the state of the photosynthetic machinery in Spring & Summer in sunlit & shaded leaves

2) Investigate the effect of drought on the photosynthetic potentials & carry out a species inter-comparison

3) Study the effect of changing water tables on the photosynthetic potentials along a topographic gradient

Methodology

Sampling design & gas exchange analyses


Topographic
gradient
Water stream
Water table

Methodolgy

Sample size

- 4 tree species
- 3-5 individuals per tree species
- 2 leaves per individual (sunlit & shaded)

Sampling

- Twigs are cut from sunlit and shaded crown, immediately re-ut submerged under water and brought to the lab.
- Pre-conditioning of twigs in controlled conditions overnight in the lab; twigs re-cut under water in the morning.

Gas exchange analyses

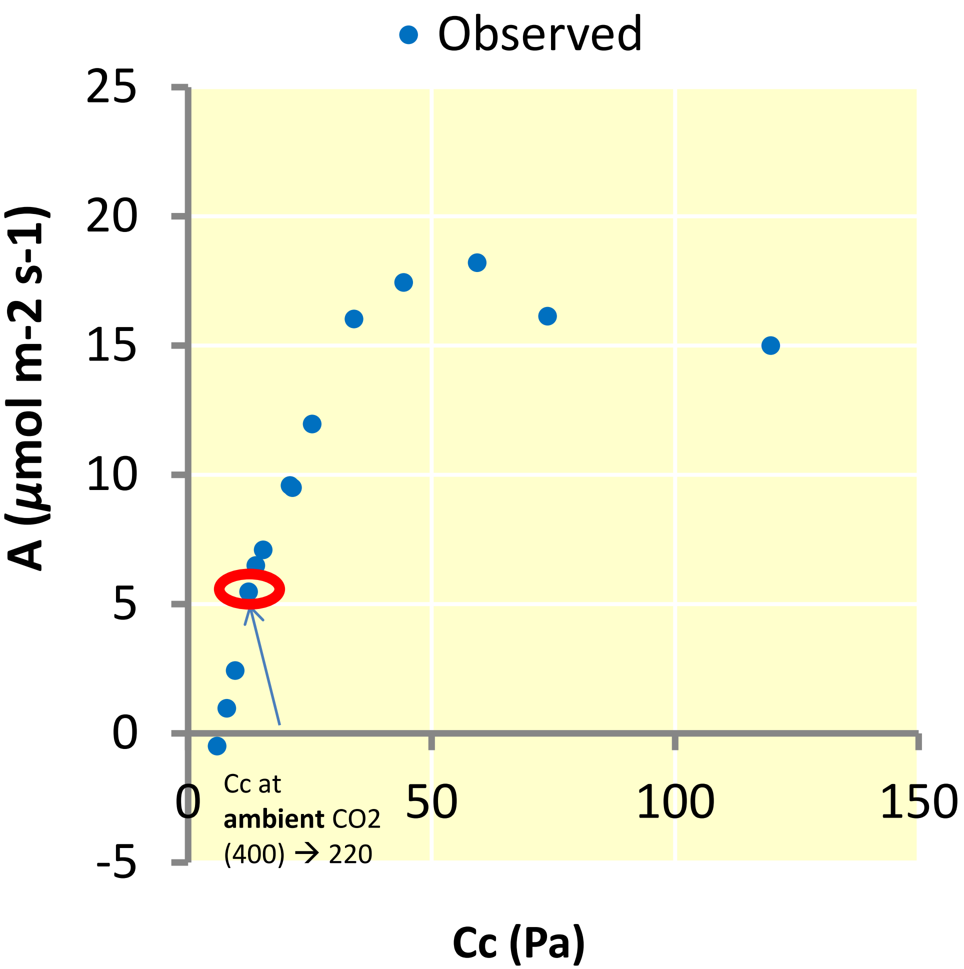
- Using Li-6400 portable photosynthesis system with an fluorescence head[1].
- Creation of A/C_i response curves to analyse the limitations to photosynthesis at light saturation
- Non-linear curve fitting routine to derive photosynthetic parameters following Sharkey *et al.* (2007).

- Obtaining the …

→**Photosynthetic Potential**

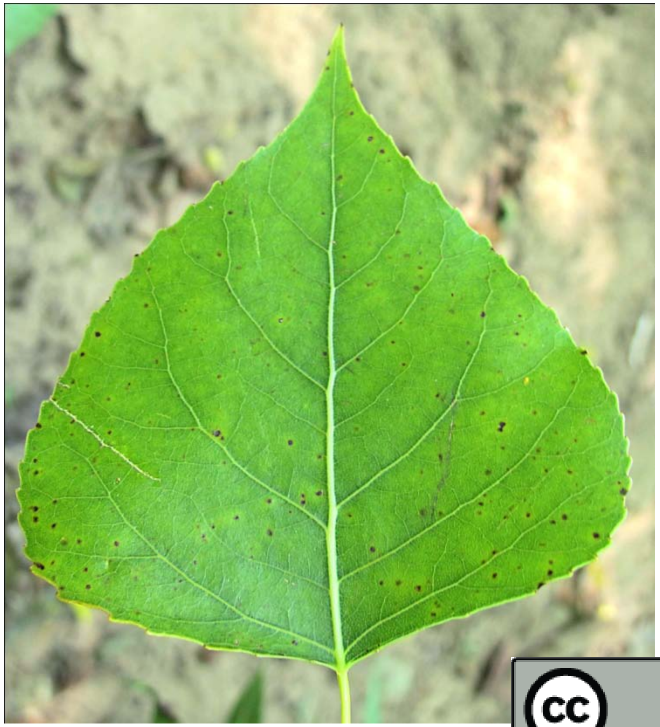
Methodolgy

A/C_c carbon response curve



Conditions:

- Saturating light: 1000 PAR
- Leaf temperature: 25 ° C
- 12 levels of CO_2 concentration (C_a)

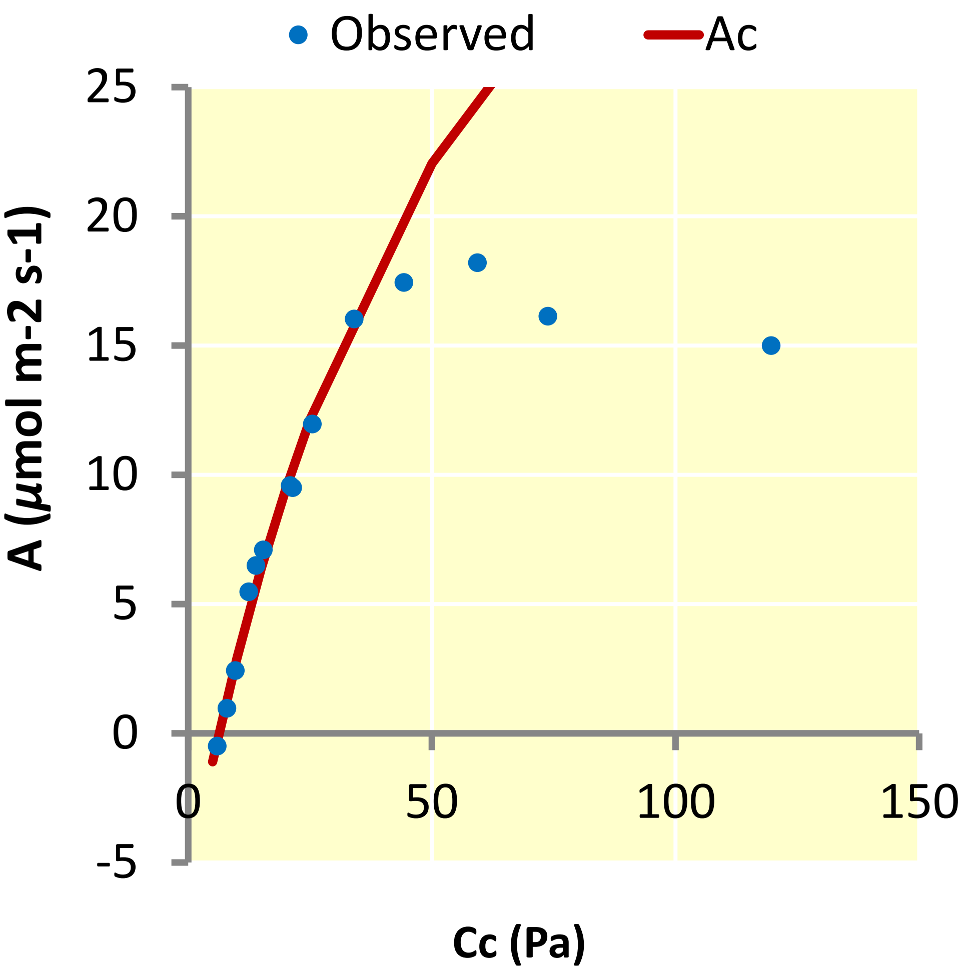


Methodology

Fitting procedure after Sharkey *et al.* (2007)

The Farquhar *et al.* Photosynthesis model* :

Farquhar, von Caemmerer, Berry (1980)



3 disctinct steady states

$$A = V_{\mathrm{cmax}}\left[\frac{C_c - \Gamma^*}{C_c + K_C(1 + O/K_O)}\right] - R_d$$

1)*

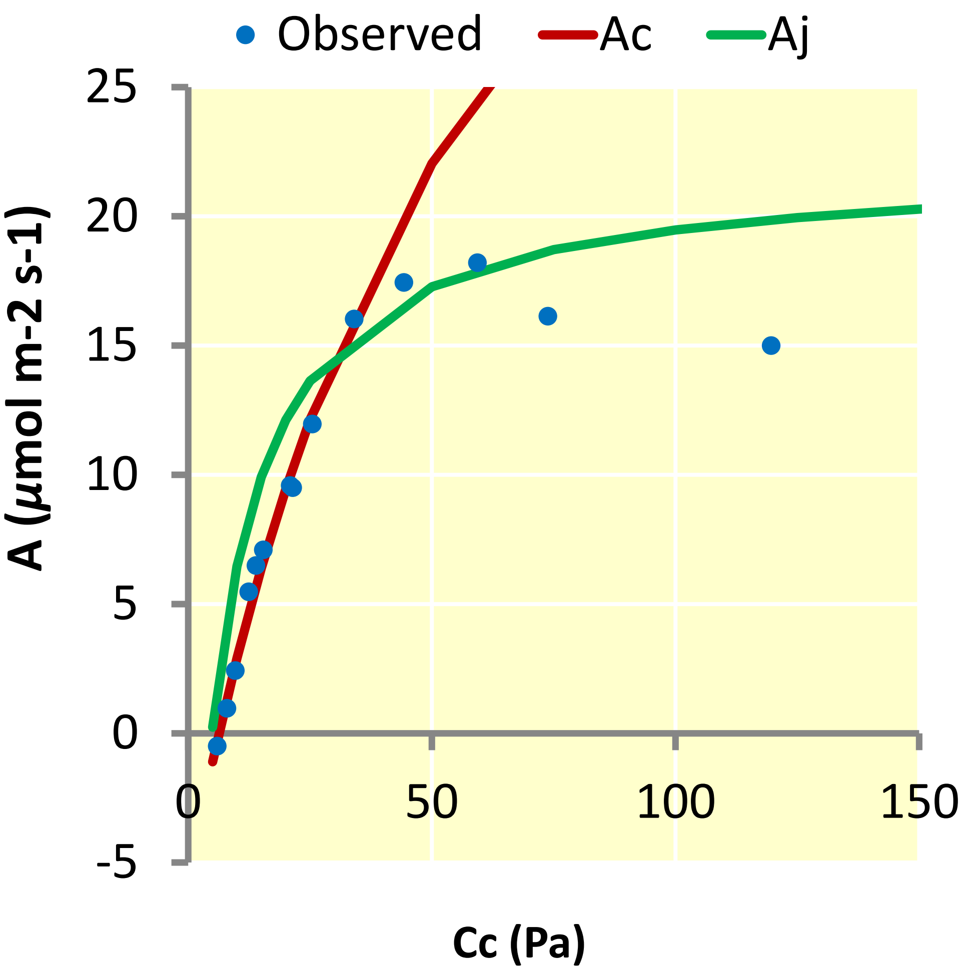
Rubisco-limited photosynthesis (associated with low CO_2)

Methodology

Fitting procedure after Sharkey *et al.* (2007)

The Farquhar *et al.* Photosynthesis model* :

Farquhar, von Caemmerer, Berry (1980)



3 disctinct steady states

$$A = V_{\mathrm{cmax}} \left[\frac{C_c - \Gamma^*}{C_c + K_C(1 + O/K_O)} \right] - R_d$$

1)*

Rubisco-limited photosynthesis (associated with low CO_2)

$$A = J \frac{C_c - \Gamma^*}{4C_c + 8\Gamma^*} - R_d$$

2)*

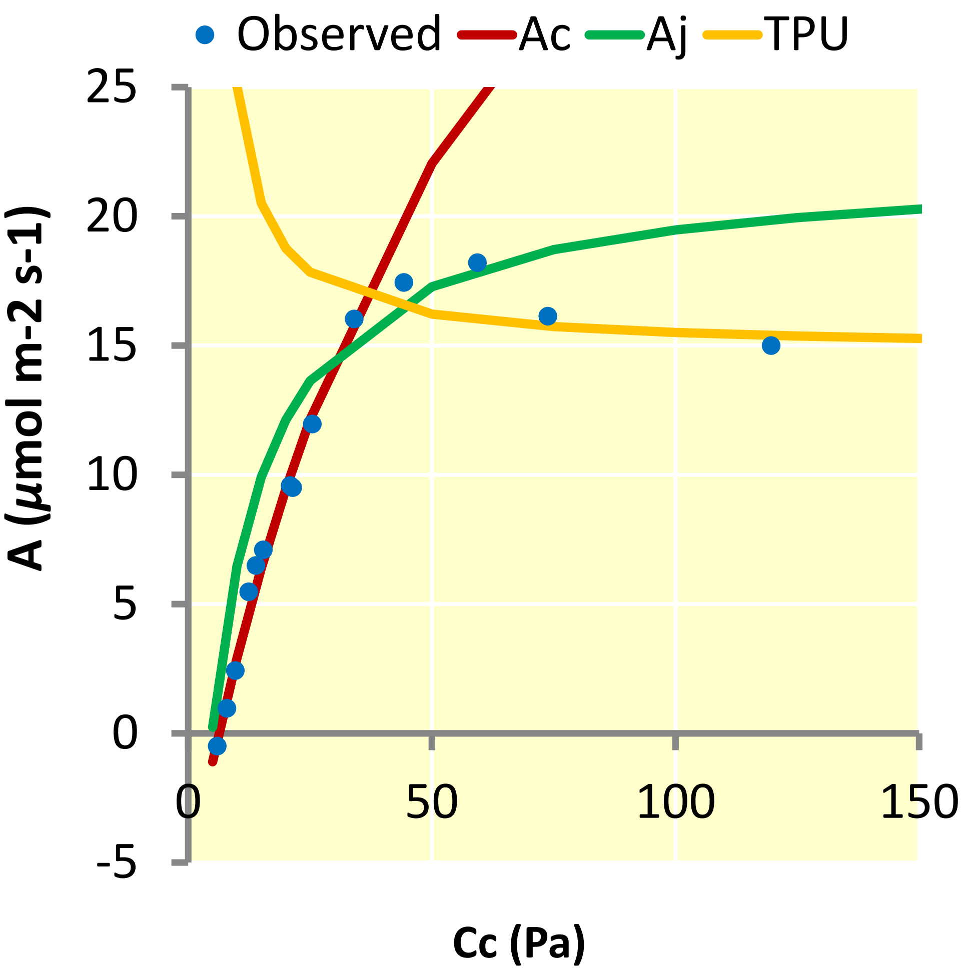
RuPB-regeneration-limited photoynthesis (at higher CO_2 Concentrations)

Methodology

Fitting procedure after Sharkey *et al.* (2007)

The Farquhar *et al.* Photosynthesis model* :

Farquhar, von Caemmerer, Berry (1980)



3 disctinct steady states

$$A = V_{cmax}\left[\frac{C_c - \Gamma^*}{C_c + K_C(1 + O/K_O)}\right] - R_d$$

1)*

Rubisco-limited photosynthesis (associated with low CO_2)

$$A = J\,\frac{C_c - \Gamma^*}{4C_c + 8\Gamma^*} - R_d$$

2)*

RuPB-regeneration-limited photosynthesis (at higher CO_2 Concentrations)

$$A = 3TPU - R_d$$

3)**

Triose phosphate use limitations

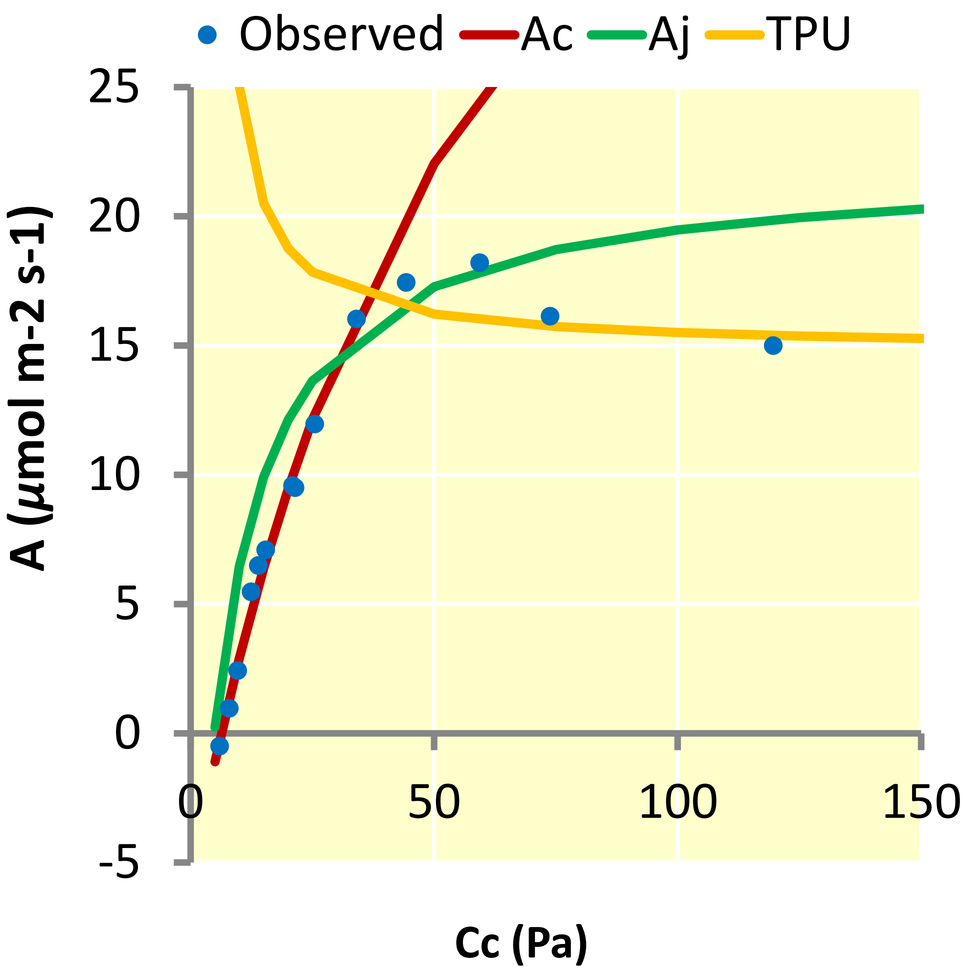
**(Sharkey *et al.* 1985)

Methodology

Fitting procedure after Sharkey *et al.* (2007)

The Farquhar *et al.* Photosynthesis model* :

Farquhar, von Caemmerer, Berry (1980)



3 disctinct steady states

$V_{c,max}$ = 45 (µmol m-2 s-1)

J_{max} = 93 (µmol m-2 s-1)

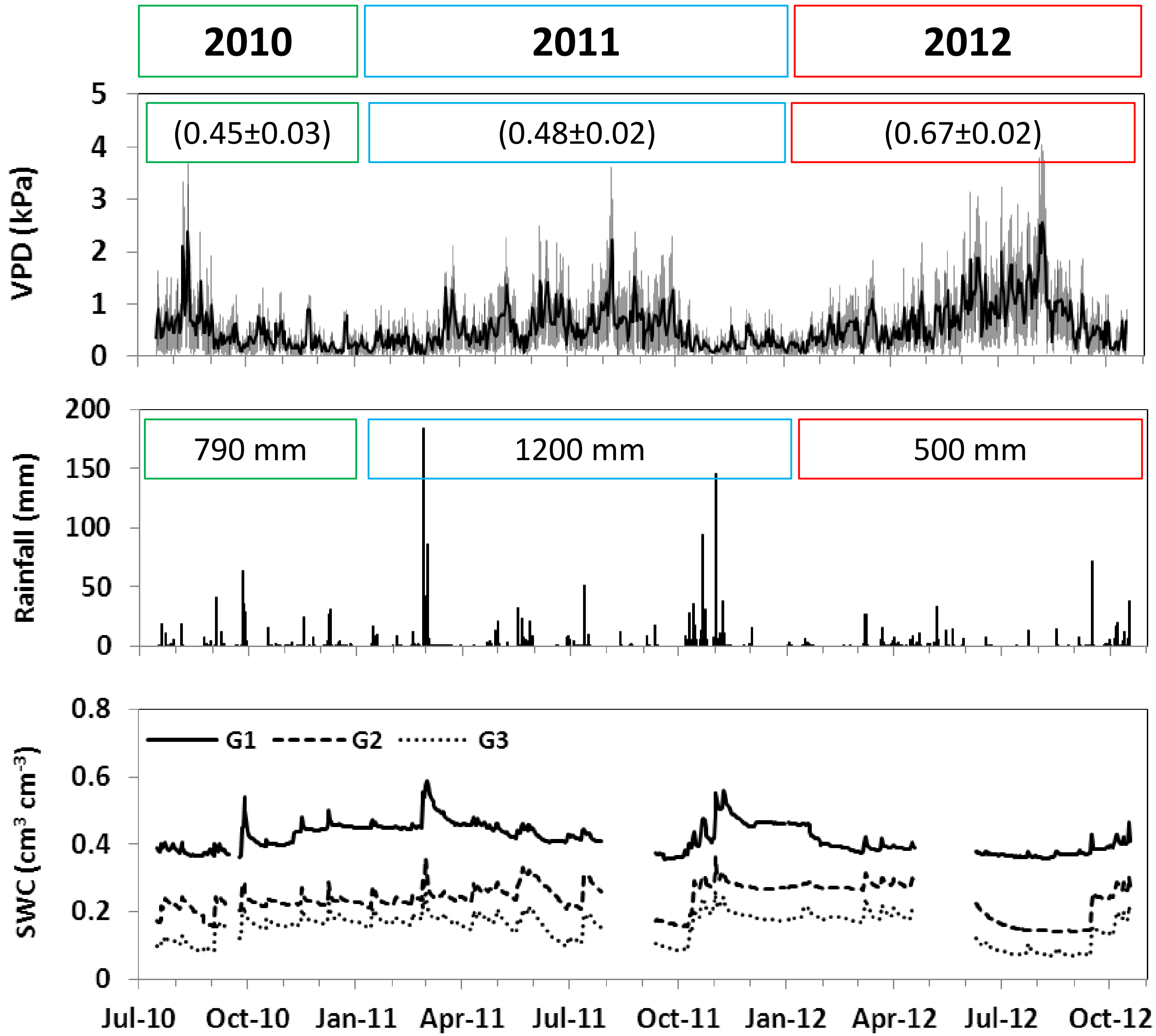
TPU= 5,6 (µmol m-2 s-1)

**(Sharkey *et al.* 1985)

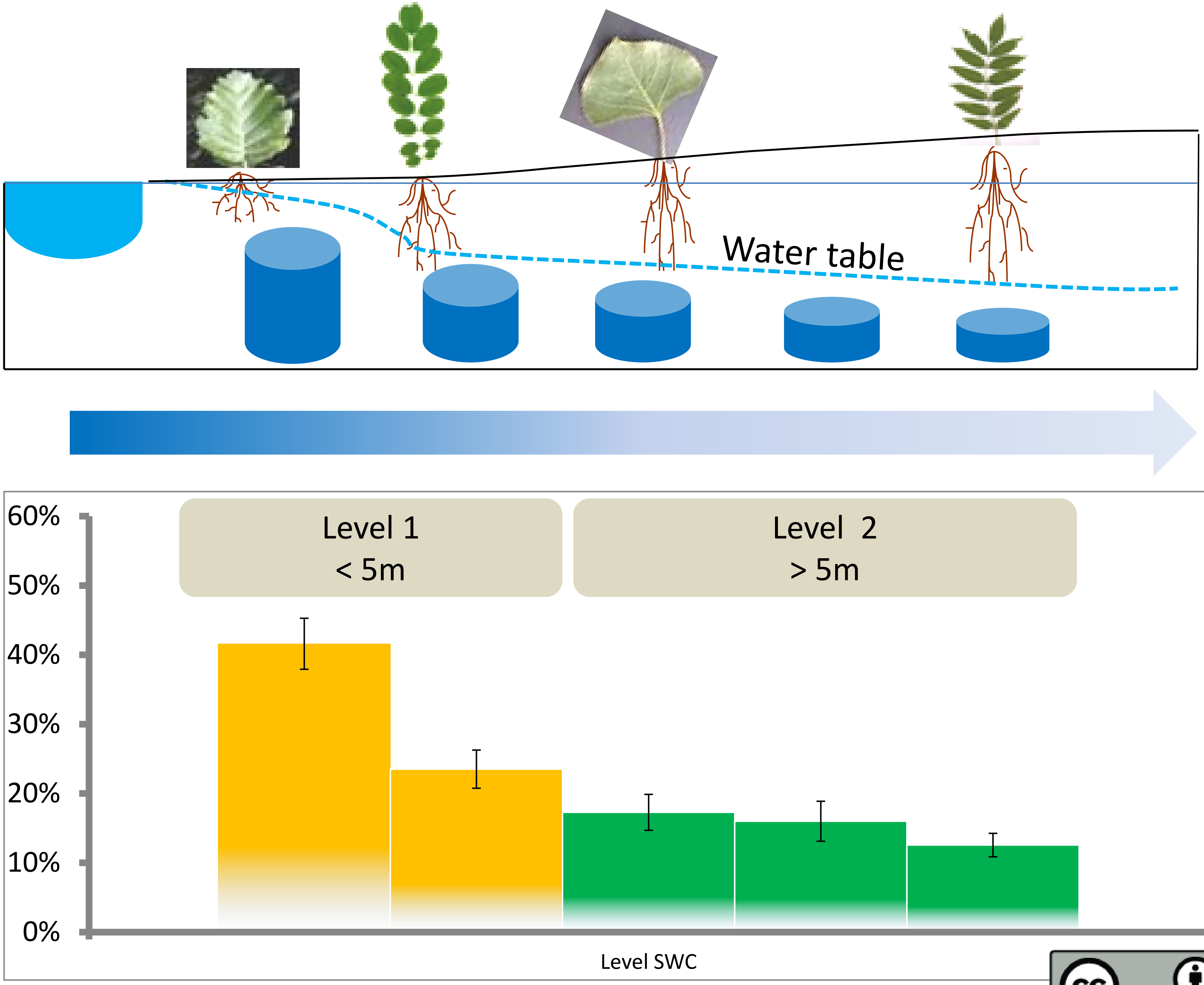
Results

Environmental variables

Seasonal course of VPD, rainfall and soil water content (SWC)



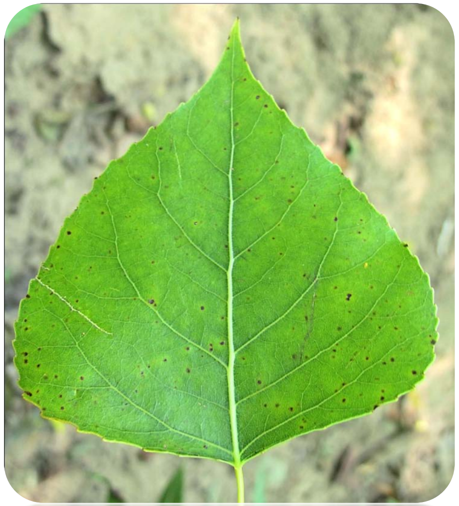
Climatic average
882 mm any^{-1}
(1951-2010)



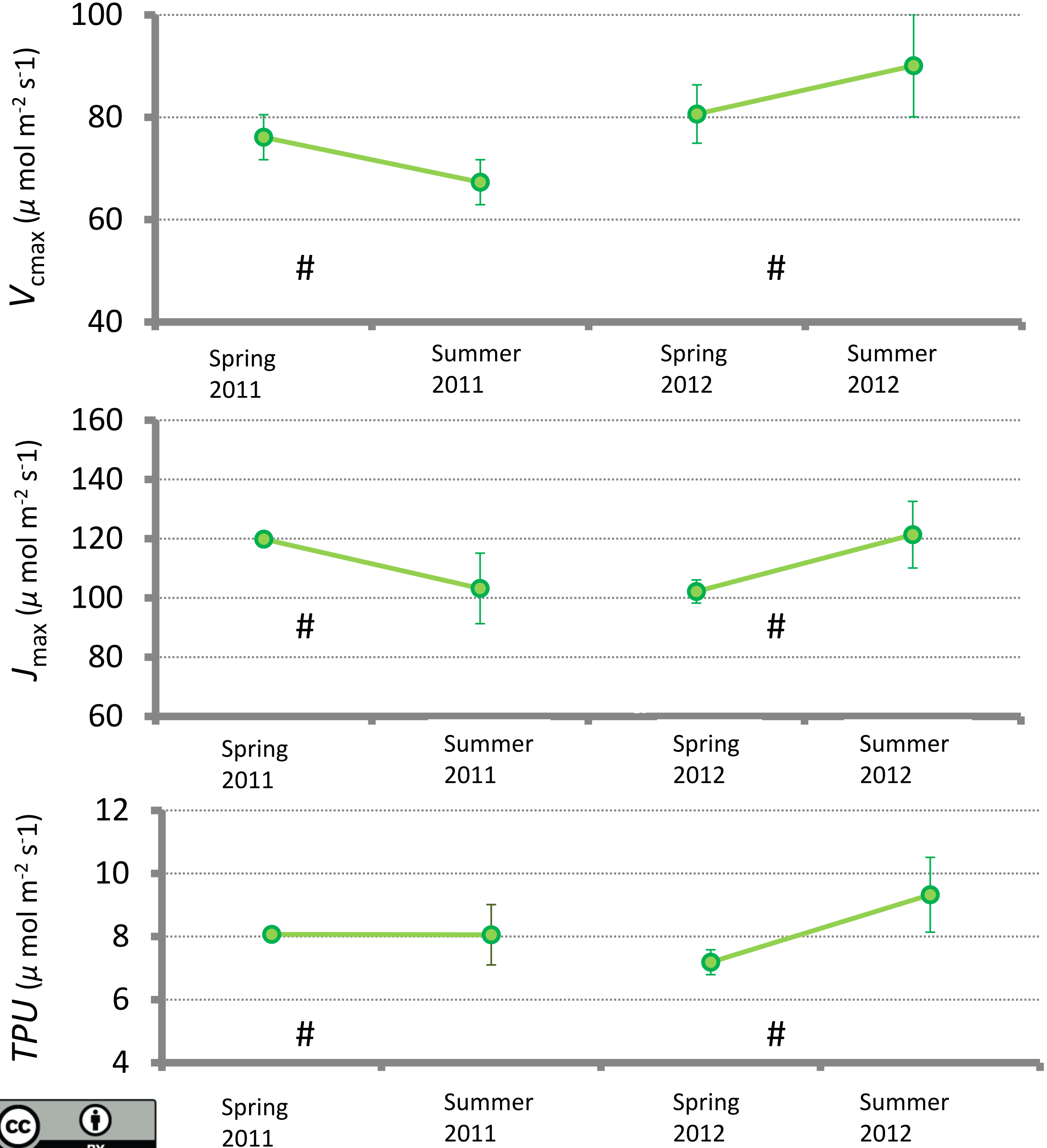
Error bars show standard deviation

Results

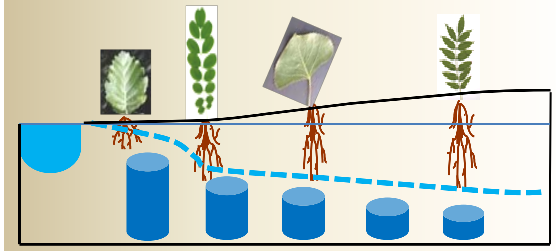
Photosynthetic parameters



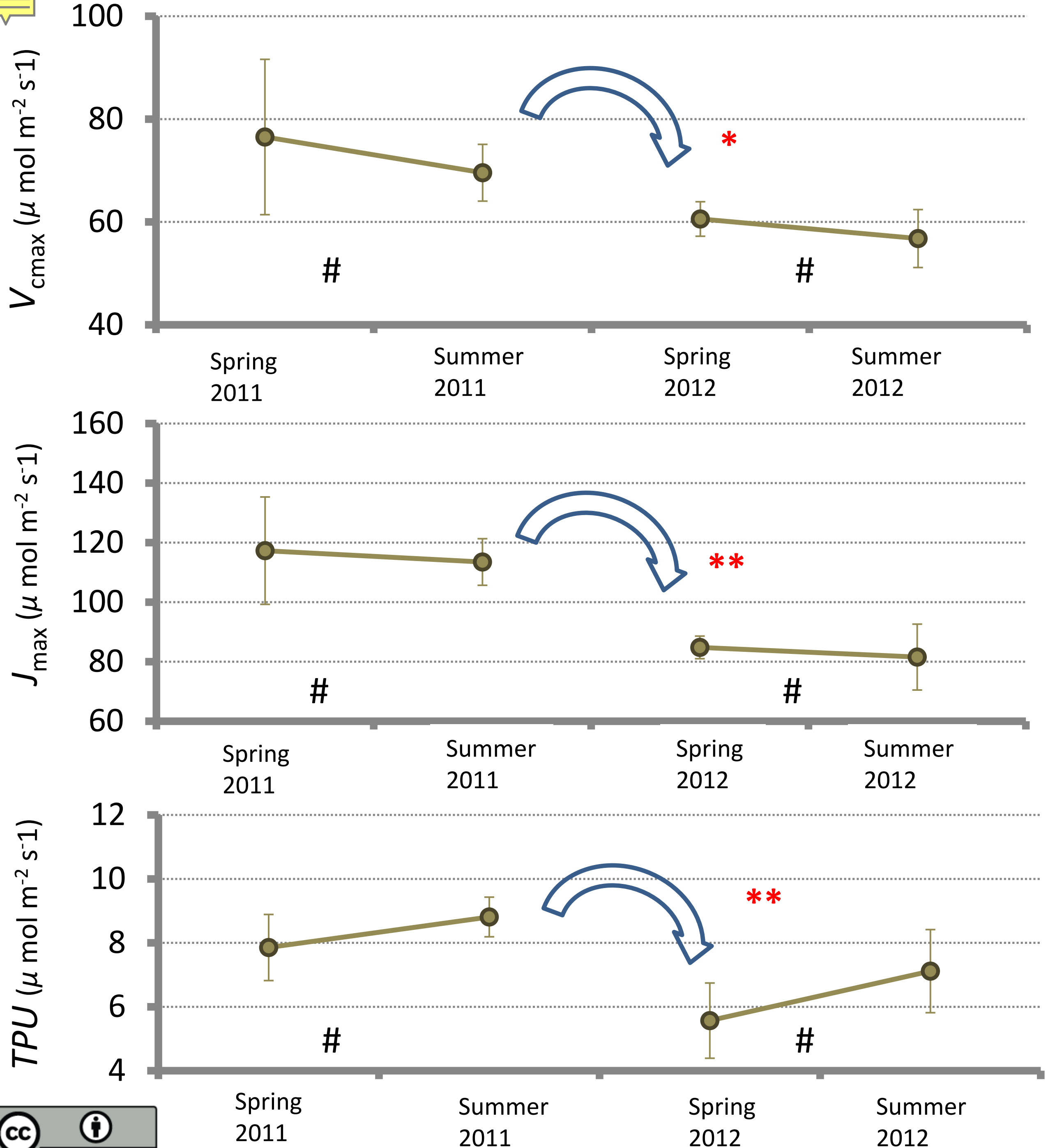
Photosynthetic Potentials



Alnus glutinosa

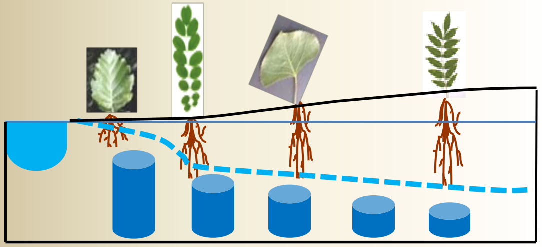


*** highly sign.
** sign.
* low sign.
# non sign.



Photosynthetic Potentials

Fraxinus excelsior



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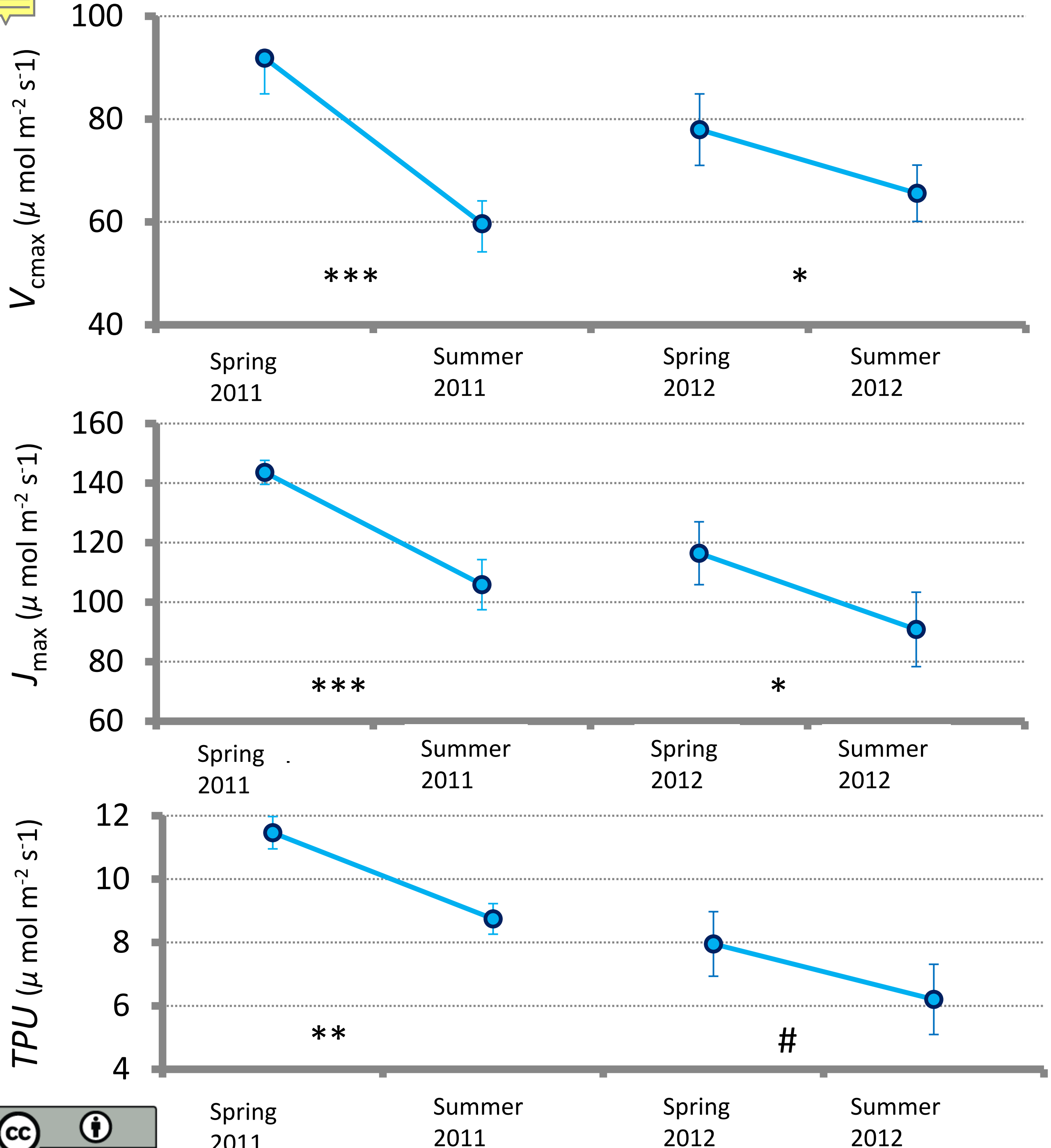
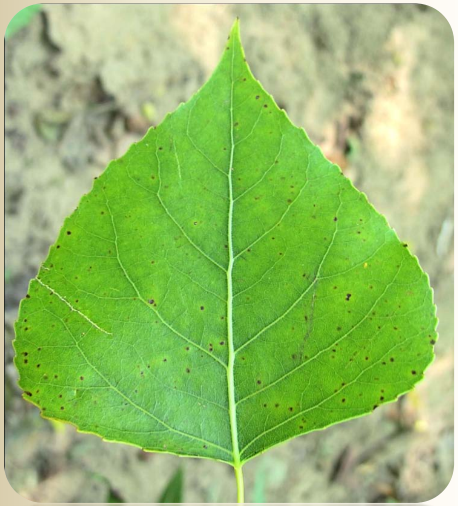
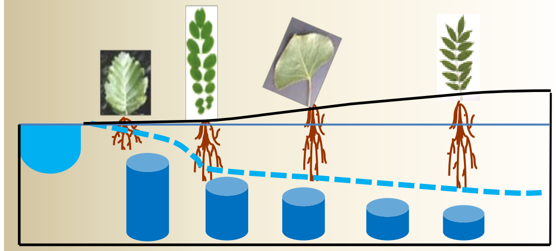


Photosynthetic Potentials



Populus nigra



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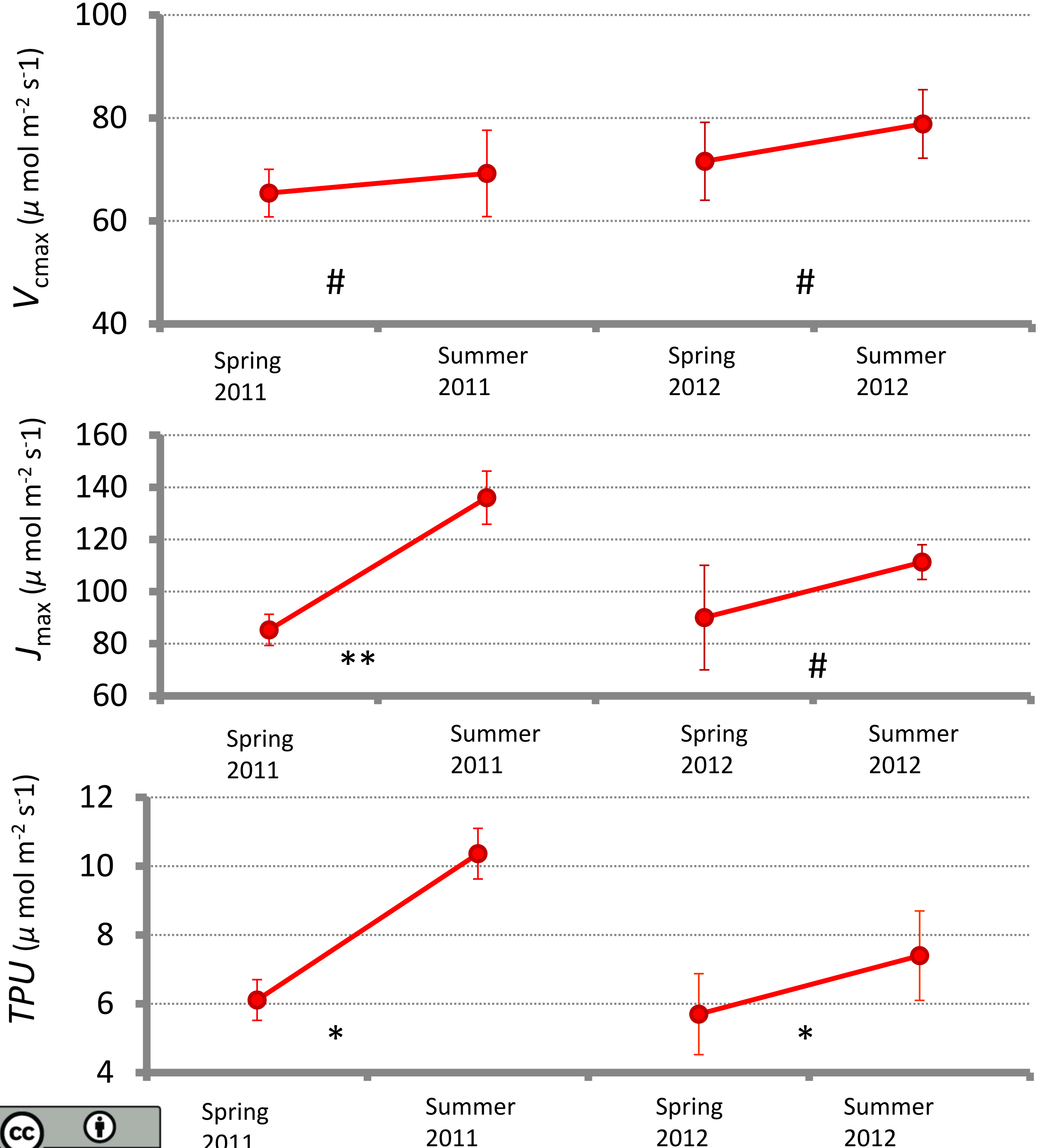
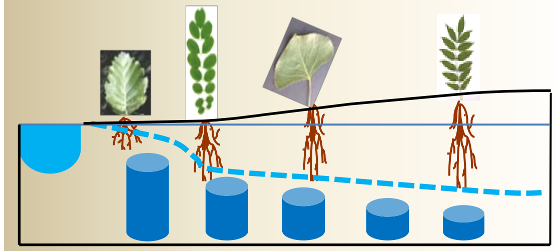


Photosynthetic Potentials

Robinia pseudoacacia



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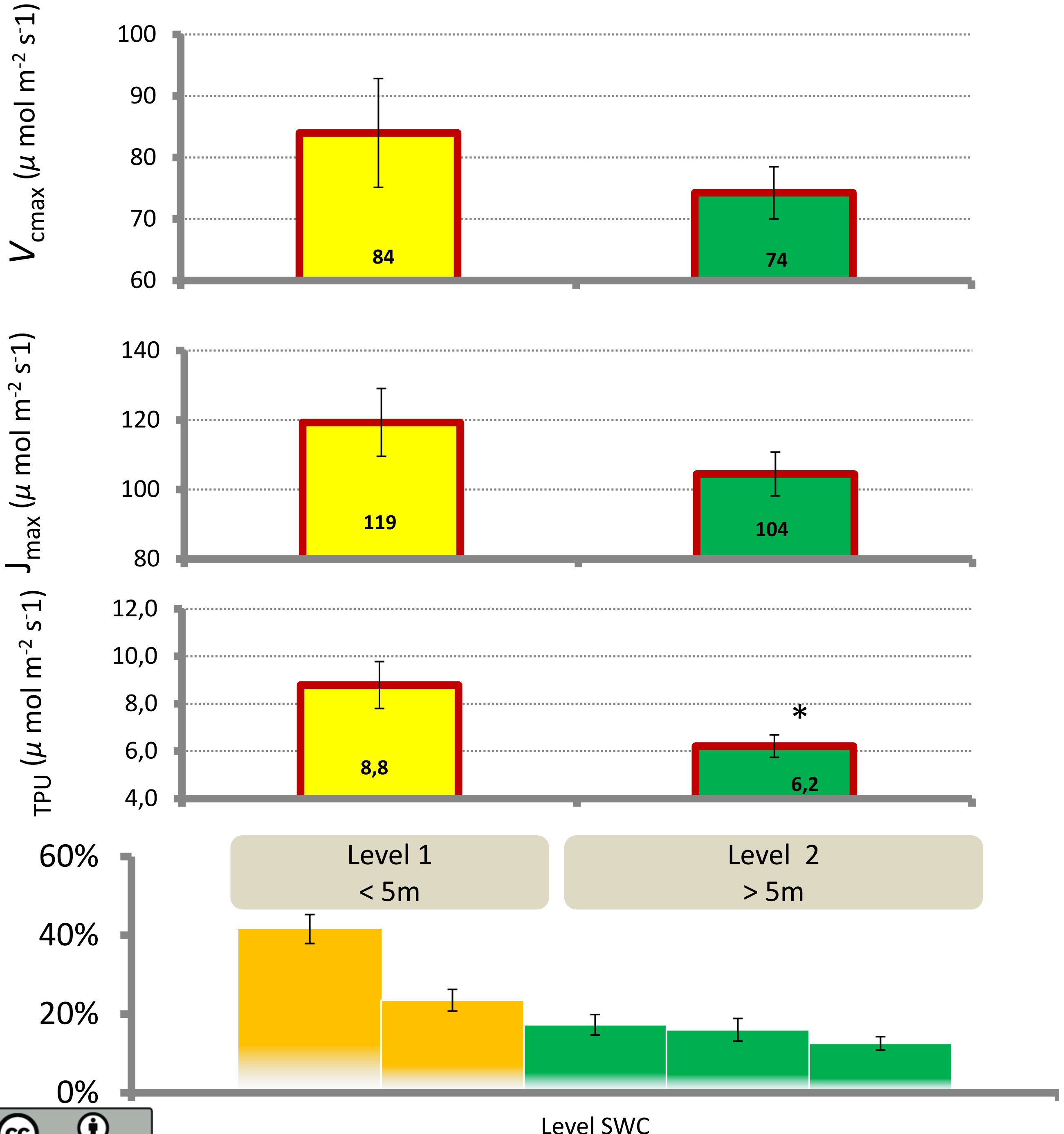
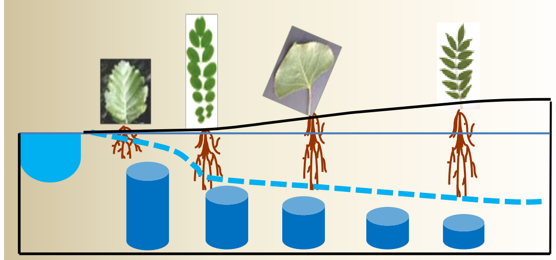
Photosynthetic Potentials

Robinia pseudoacacia

Summer drought 2012





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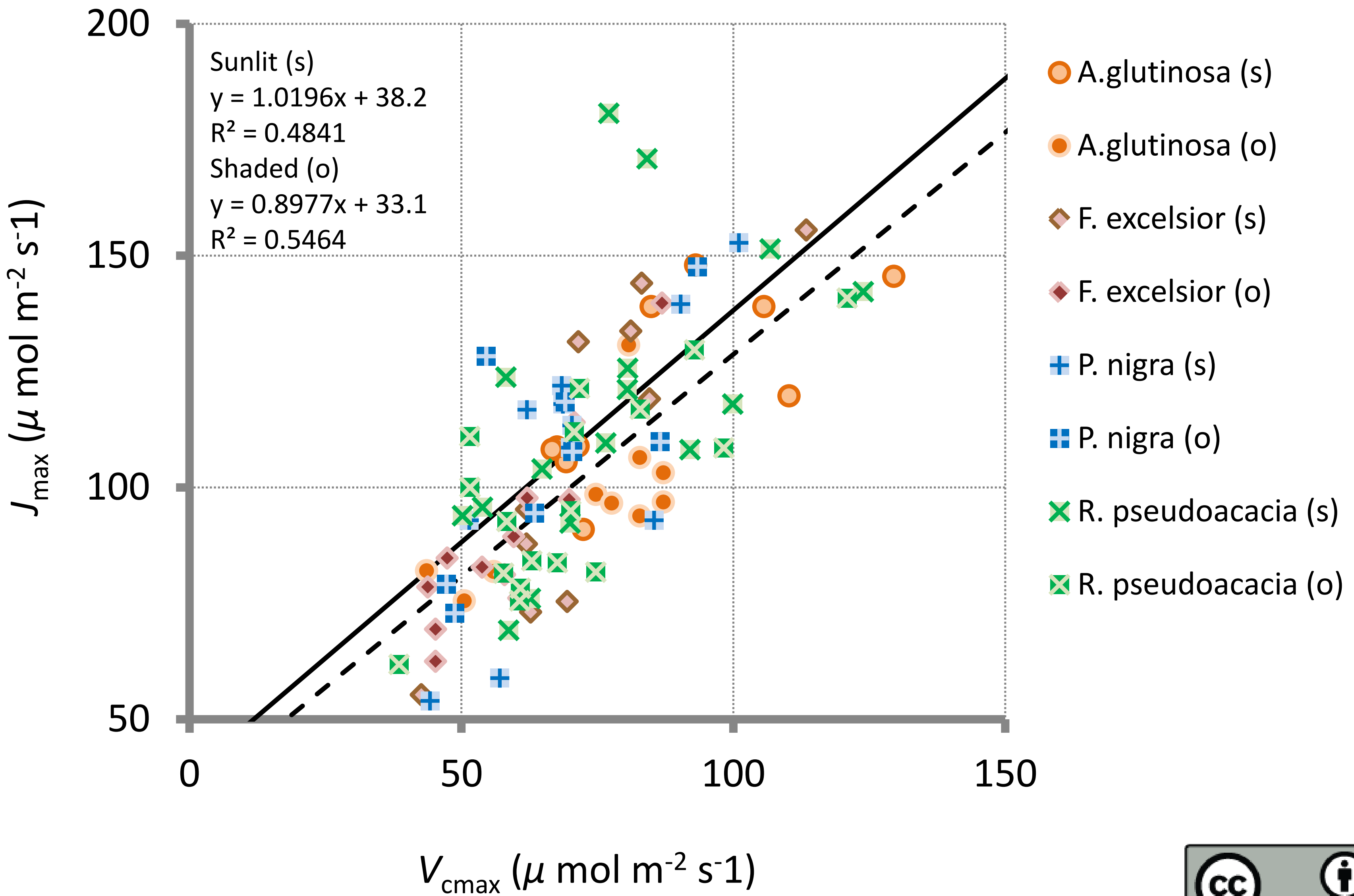
Relationship V_{cmax} & J_{max} for sunlit and shaded leaves

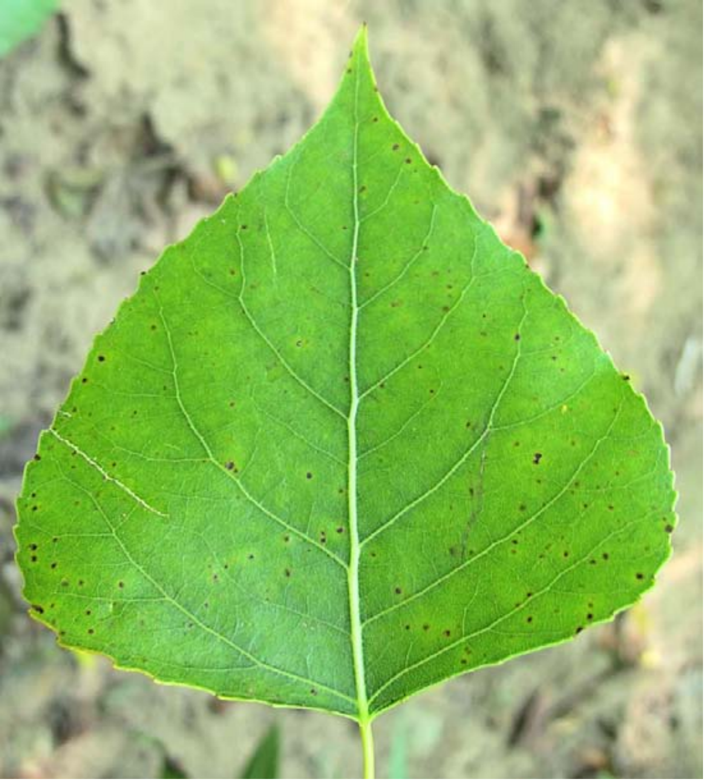


Conclusion

- When I reached the sunlit crown, leaves showed higher photosynthetic potentials
- Strong relationship between J_{max} / V_{cmax} ; Ratio increased in shaded leaves due to lower V_{cmax} (→lower leaf nitrogen content in shaded leaves)
- Highly species specific photosynthetic responses:
  - *P. nigra* most sensitive to summer drought
  - *A. glutinosa* which shows highest performance, *F. excelsior* lowest
- Despite strong drought situation, riparian tree species were able to keep photosynthetic potentials relatively high.
- Topographic gradient of H20 availability not strongly reflected in photos. potentials *R. pseudoacacia* (Phreatocphytic spp!)
- Very difficult to depict the seasonal of photosynthetic changes in such a forest!

Conclusion!

- **Need to improve the ecophysiological understanding when modelling from the chloroplast to the globe!**



Thanks