Photosynthetic Carbon Flux In The Tree Canopy

M. Schaub[1] , M. Haeni[1], Y. Salmon[2]

[1]*Swiss Federal Research Institute WSL*
[2]*University of Edinburgh*

OBJECTIVES

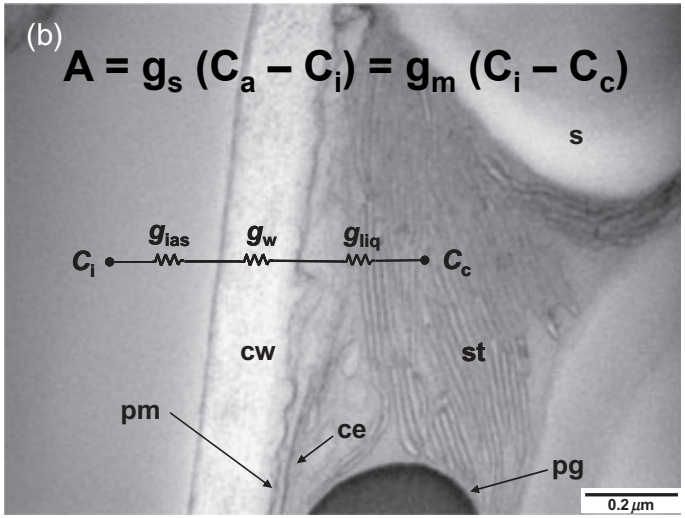
Leaf level – mechanistic questions:

- diurnal course of leaf gas exchange (A, g_s, E, WUE, SLA)
- potential leaf gas exchange (A/C_i, A_{light})
- stomatal *vs*. sub-stomatal regulation of A (V_{cmax}, J_{max}, g_m)

for *Pinus sylvestris* under elevated soil water availability (irrigation of 100% ambient precip.) *vs.* natural drought conditions (ambient = control).

Canopy level – system-relevant question:

How does the whole-tree CO_2 assimilation rate (A_{tree}) perform under elevated soil water availability *vs*. natural drought conditions?



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METHODS PARAMETERS

Approach

Estimate whole-tree CO_2 assimilation rate (A_{Tree}) based on photosynthetic water-use-efficiency (WUE) (Farquhar *et al*., 1989; Hu *et al*. 2010)

Parameters

Measured (LiCor 6400XT): δH_2O, δCO_2, $Temp_{air}$, $Temp_{leaf}$, PAR

Calculated: A, g_s, E, A/C_i, A_{light}, $A_{diurnal}$, V_{cmax}, J_{max}, $A_{diurnal}$, Ψ_w, WUE

Whole-tree CO_2 assimilation rate (A_{Tree} = WUE * $E_{sap\ flow}$)

$WUE = f(\delta^{13}C)$

E_{Tree} = f (sap flow)

METHODS SAMPLES

Dates
2013 June, July, Aug / 2014 May, June, July, Aug

A/C_i curves
18 trees x 1 branch x 7 dates = 126 curves

A_{light} curves
18 trees x 1 branch x 2 dates = 36 curves

Diurnal gas exchange samples
6 trees x 5 branches x 3-4 times/date x 7 dates = 630

Treatments
control & irrigated (+100% ambient)

PRELIMINARY RESULTS

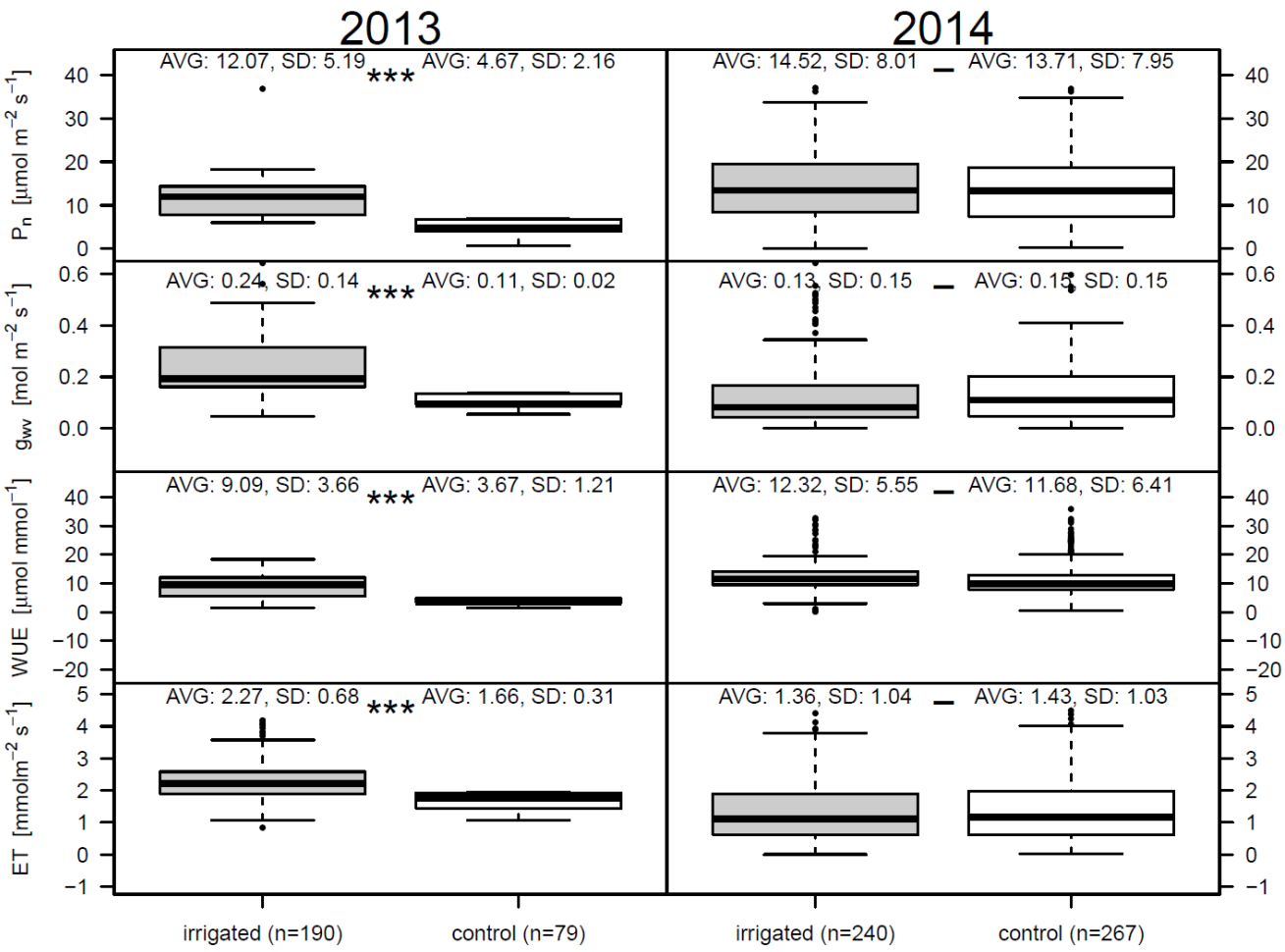


Figure 1. Box plots for diurnal leaf gas exchange (P_n, g_w, WUE, ET).

PRELIMINARY RESULTS

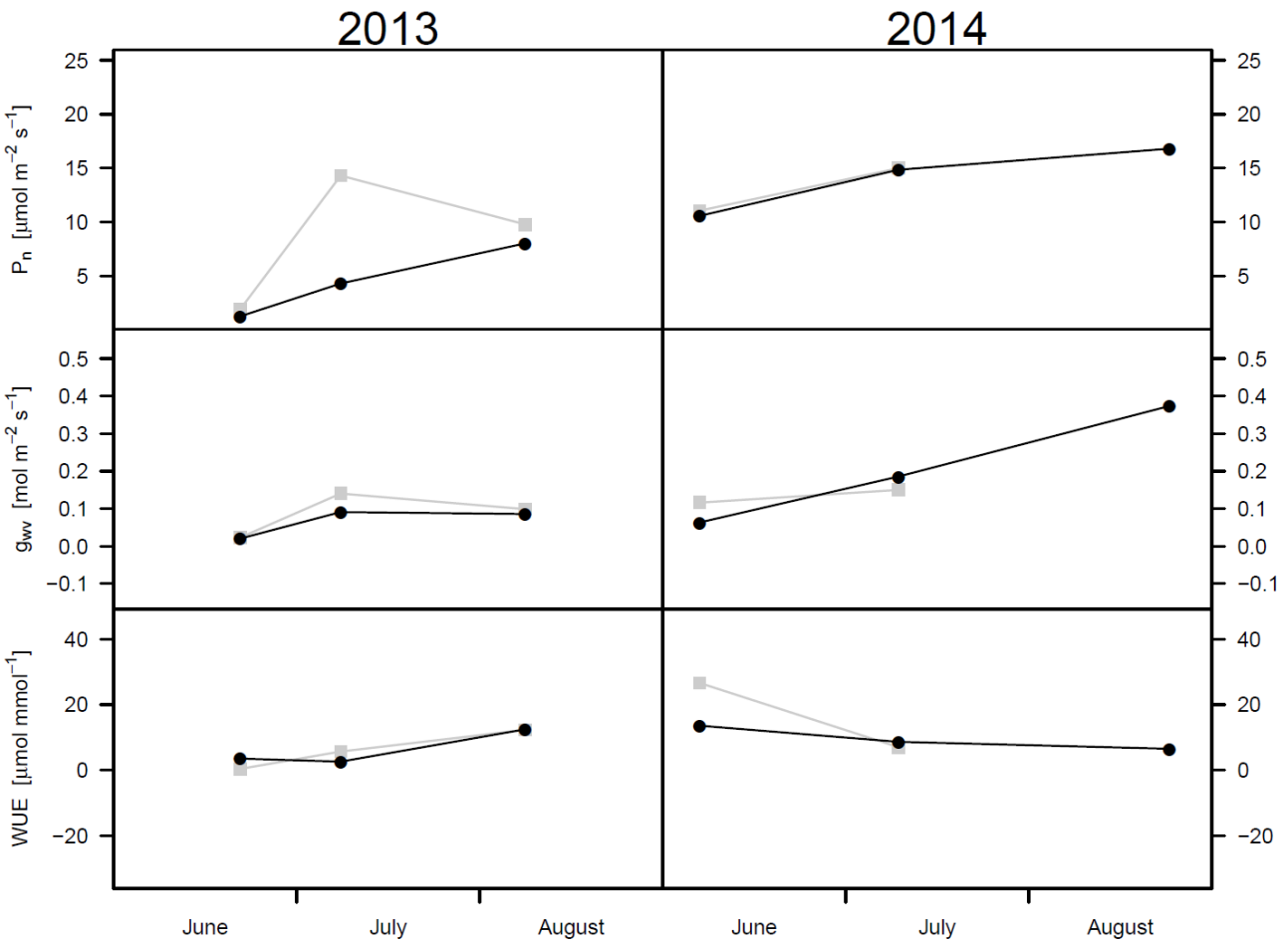


Figure 2. Average & SD for Photosynthesis (P_n; *u*mol m^{-2} s^{-1}), stomatal conductance (g_w; mol m^{-2} s^{-1}) and water use efficiency (WUE) over the season.

PRELIMINARY RESULTS

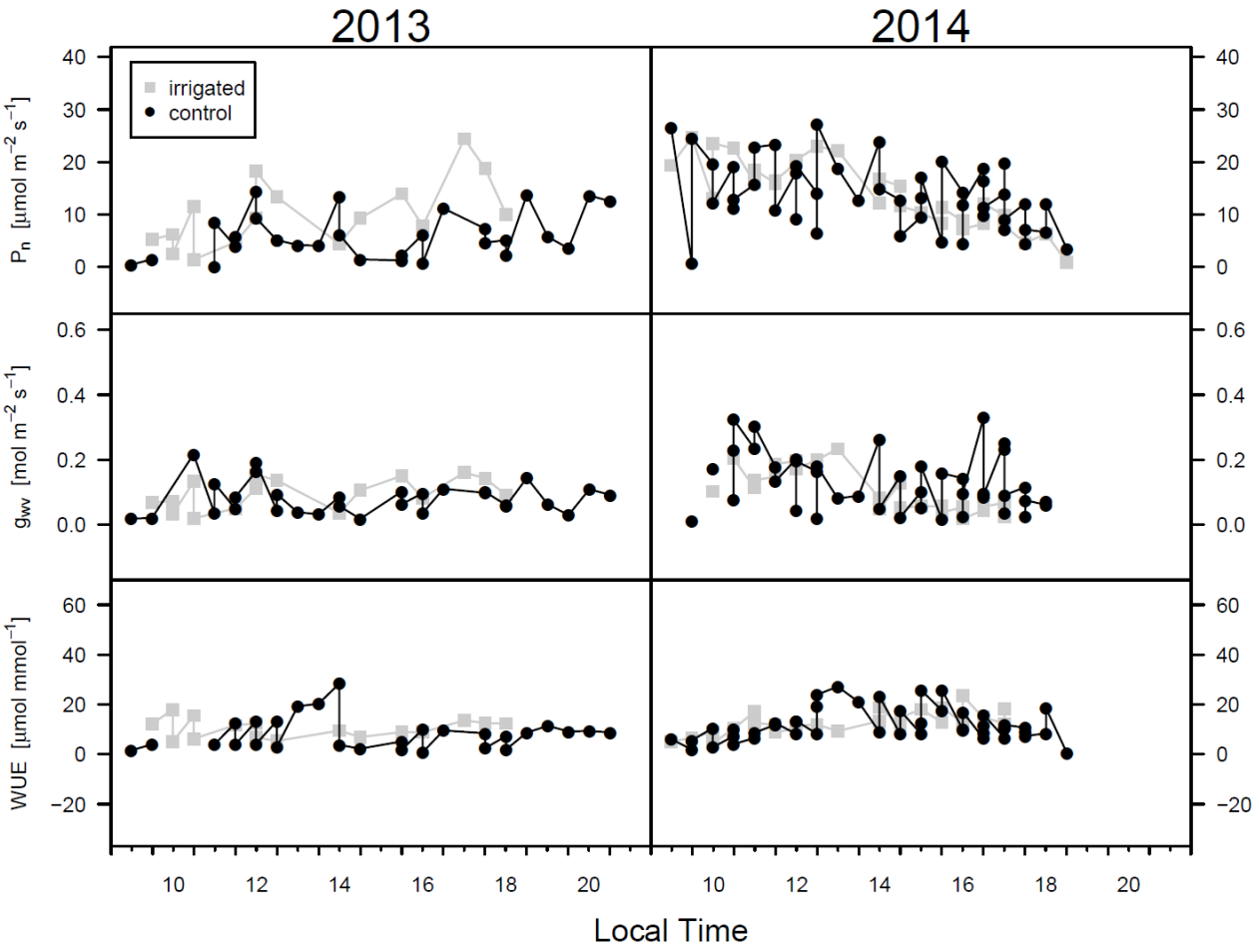


Figure 3. Average & SD for Photosynthesis (P_n; *u*mol m^{-2} s^{-1}), stomatal conductance (g_w; mol m^{-2} s^{-1}) and water use efficiency (WUE) over daytime.

PRELIMINARY RESULTS

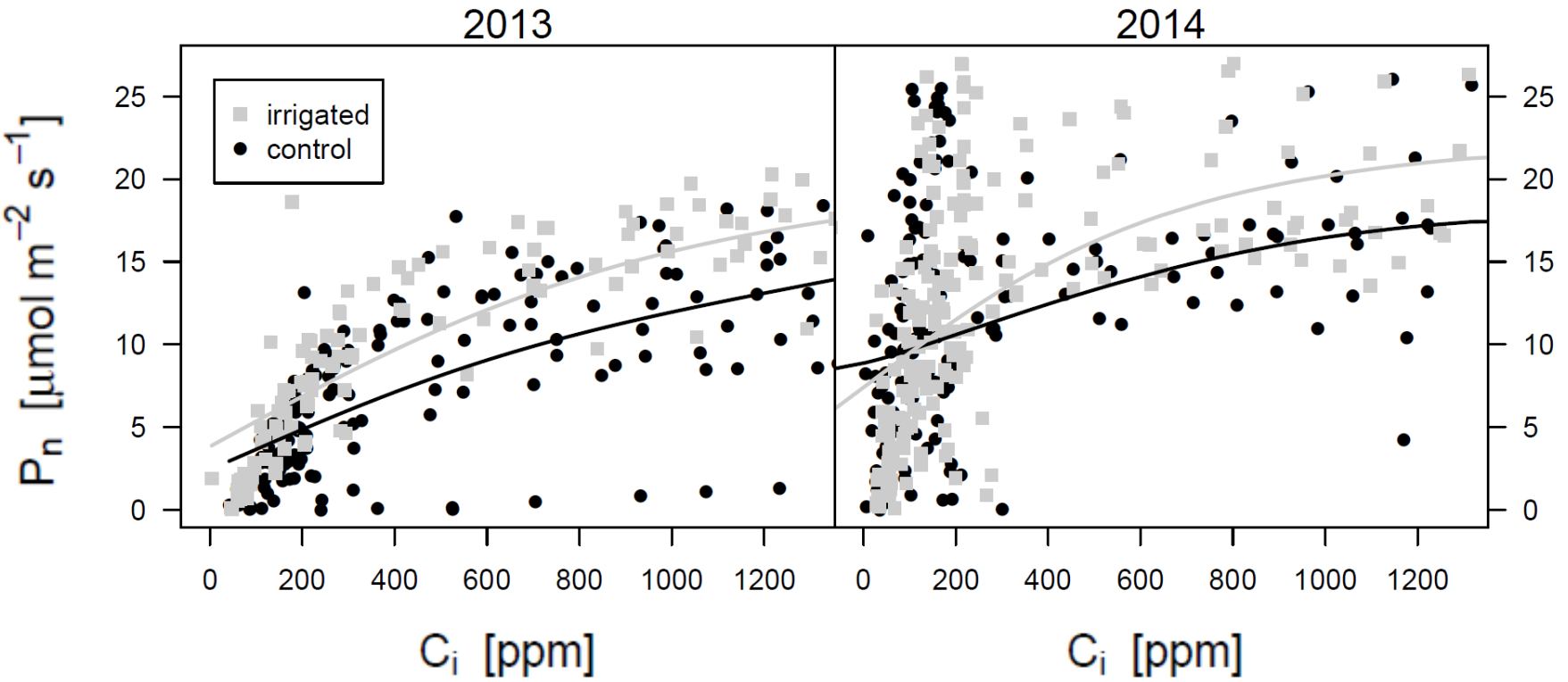


Figure 4. Average & SD for the ratio of Photosynthesis (P_n; *u*mol m^{-2} s^{-1}) over internal CO2 concentration (C_i; Pa).

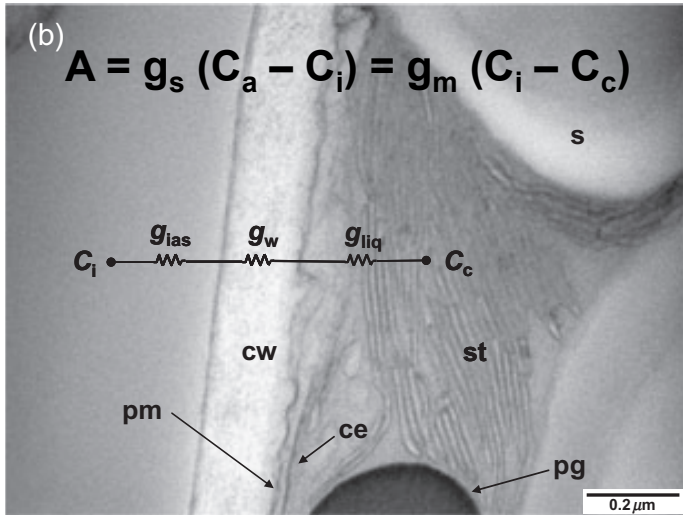
FURTHER ANALYSES

Leaf level – mechanistic

- Light response curve (A_{light})
- ***Rubisco-mediated*** carboxylation (V_{cmax})
- ***Electron transport-mediated*** maximum rate of carboxylation (J_{max})
- ***Mesophyll-mediated*** conductance (g_m)
- Specific leaf area (SLA)

Canopy level – integrative & system-relevant

- Correlation with soil water availability *vs*. VPD
- Whole-tree CO_2 assimilation rate (A_{tree}= f(sap flow))
- Disentangling carbon starvation from hydraulic failure



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