Supporting Information

Article title: Sunflecks in the upper canopy: dynamics of light-use efficiency in sun and shade leaves of *Fagus sylvatica*.

Authors: Maxime Durand, Zsofia R. Stangl, Yann Salmon, Alexandra J. Burgess, Erik H. Murchie and T. Matthew Robson

The following Supporting Information is available for this article:

Table S1: Information on the four beech provenances in the trial plot.

Table S2: Dataset used for statistical analysis (see separate Excel file).

Table S3: Leaf-mass per area and chlorophyll content per leaf area with regard to canopy depth in three provenances of beech trees grown in Helsinki, Finland.

Fig. S1: Map of the provenance trial plot.

Fig. S2: Example curve fitting for photosynthesis and stomatal conductance.

Fig. S3: Photosynthetic light response curves from gas exchange on beech leaves at the top and bottom of the canopy.

Table S1: Information on the four beech provenances in the trial plot.

Provenance	Country	Elevation (m)	Coordinates	Mean annual temperature (°C)	Mean Annual Precipitation (mm)
Blaviksliarna	Sweden	75	57° 90' N, 13° 13' W	6.5	860
Eichelberg	Germany	525	48° 55' N, 11° 26' W	7.8	692
Rindelpholz	Germany	1175	47° 29' N, 10° 8' W	4.8	2535
Montejo de la Sierra	Spain	1400	41° 01' N, 3° 5' W	9.5	1100

Table S3: Leaf-mass per area and chlorophyll content per leaf area with regard to canopy depth in three provenances of beech trees grown in Helsinki, Finland. Leaves were sampled at 2, 3, and 4 m depth in the canopy, representing the top, middle and bottom layer of the canopy. Leaf area of the fresh leaves was measured using ImageJ (Schneider *et al.*, 2012), and leaf mass was recorded after drying for three days at 60°C. The leaf mass per area was calculated as leaf mass (g) divided by leaf area (cm^2). Chlorophyll content was assessed with the Dualex optical leaf clip (Force-A, Paris-Sud University, Orsay, France) by measuring the adaxial side of ten fully expanded mature leaves from five randomly selected trees per canopy layer and provenance, between the 10th and the 22nd of June 2021. Values are means $\pm$ 1 standard error. Different letters represent statistically significant differences between groups tested by *post-hoc* pairwise comparisons ($p < 0.05$).

Provenance	Canopy depth	Chlorophyll content (a.u.)			Leaf mass per area (g cm^{-2})		
Blaviksliarna, Sweden (SE)	Bottom	24.0	± 0.2	a	2.79	± 0.28	a
	Middle	28.7	± 0.4	b	4.00	± 0.19	bd
	Top	33.6	± 0.4	c	5.51	± 0.23	d
Eichelberg, Germany (DE)	Bottom	25.0	± 0.4	a	2.87	± 0.14	a
	Middle	29.7	± 0.5	b	4.30	± 0.27	bc
	Top	35.9	± 0.5	d	6.56	± 0.52	e
Montejo, Spain (ES)	Bottom	29.1	± 0.7	b	3.70	± 0.44	ab
	Middle	32.9	± 0.9	c	4.71	± 0.41	cd
	Top	39.1	± 0.7	e	6.62	± 0.31	e

Schneider CA, Rasband WS, Eliceiri KW. 2012. NIH Image to ImageJ: 25 years of image analysis. *Nature Methods* **9**(7): 671-675. doi: 10.1038/nmeth.2089
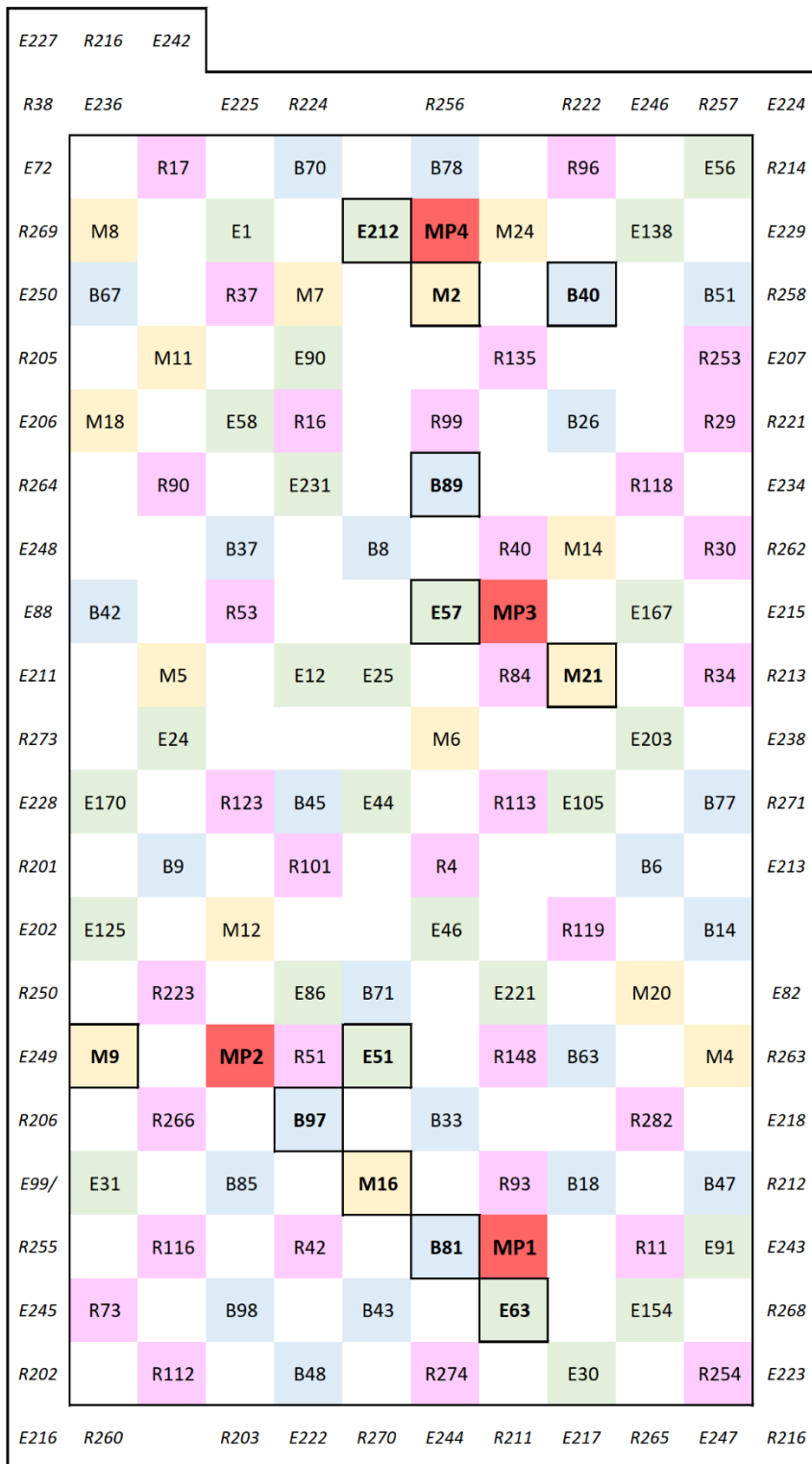
Figure S1. Map of the beech provenance trial plot. Letters B, E, R and M refer to Swedish (Blaviksliarna), central German (from Eichelberg), alpine German (from Rindelpholz), and Spanish (Montejo de la Sierra) provenance, shown as different colours (blue, green, purple and yellow, respectively). Numbers identify a unique tree. Trees marked in italics are border trees, and those marked in bold were among the trees sampled during our experiment. MP1-4 are locations at which light measurements were performed (red boxes).
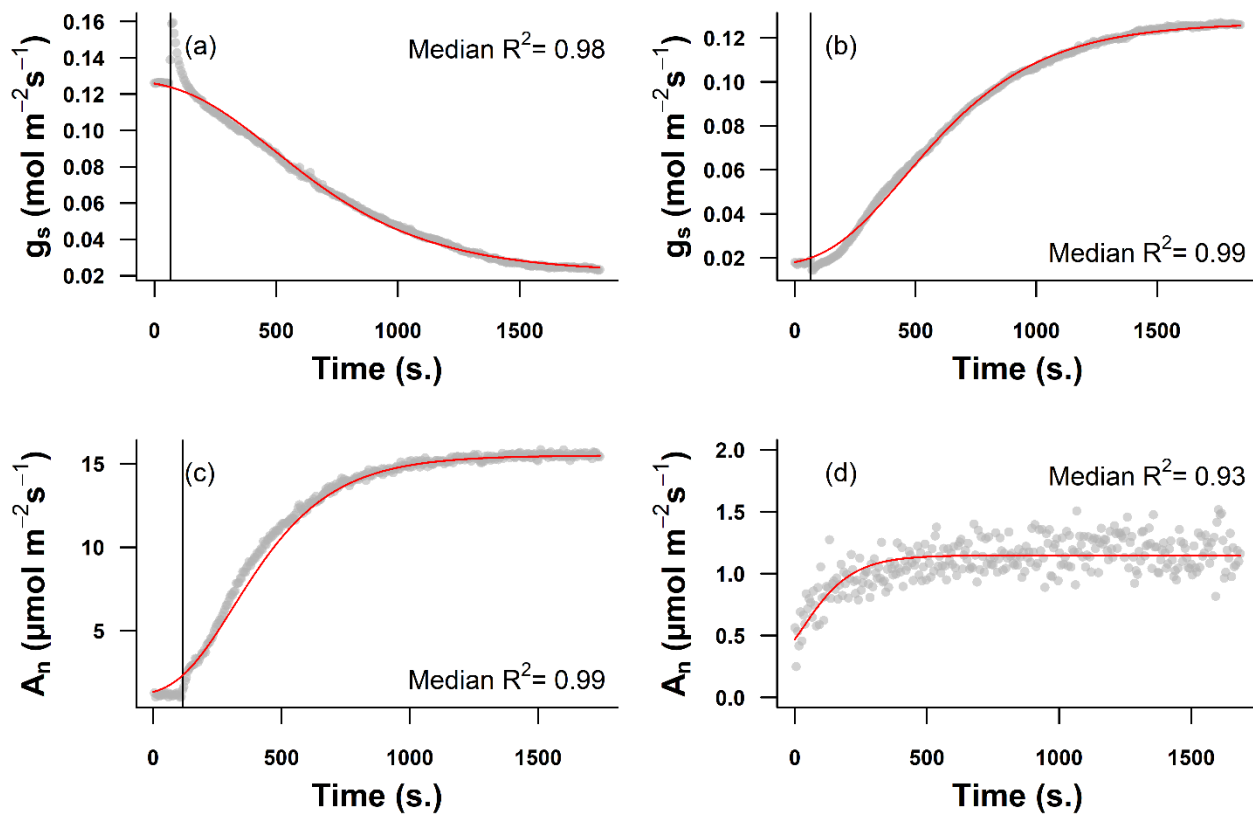
Figure S2: Example curve fitting for photosynthesis and stomatal conductance. (**a**) Stomatal closure, (**b**) stomatal opening, (**c**) photosynthesis induction, (**d**) photosynthesis recovery. Gray points show measured data and the red line show the fitted data for a leaf from the Swedish provenance at the top of the canopy. The vertical black line shows the change of irradiance from 20 μmol m^{-2} s^{-1} to 1200 μmol m^{-2} s^{-1} (or the reverse). No black line is shown in (**d**) because the increase in A_n occurs after a larger and sudden decrease in A_n following the decrease in irradiance. The median R^2 of the curve fitting over the whole data set is shown.
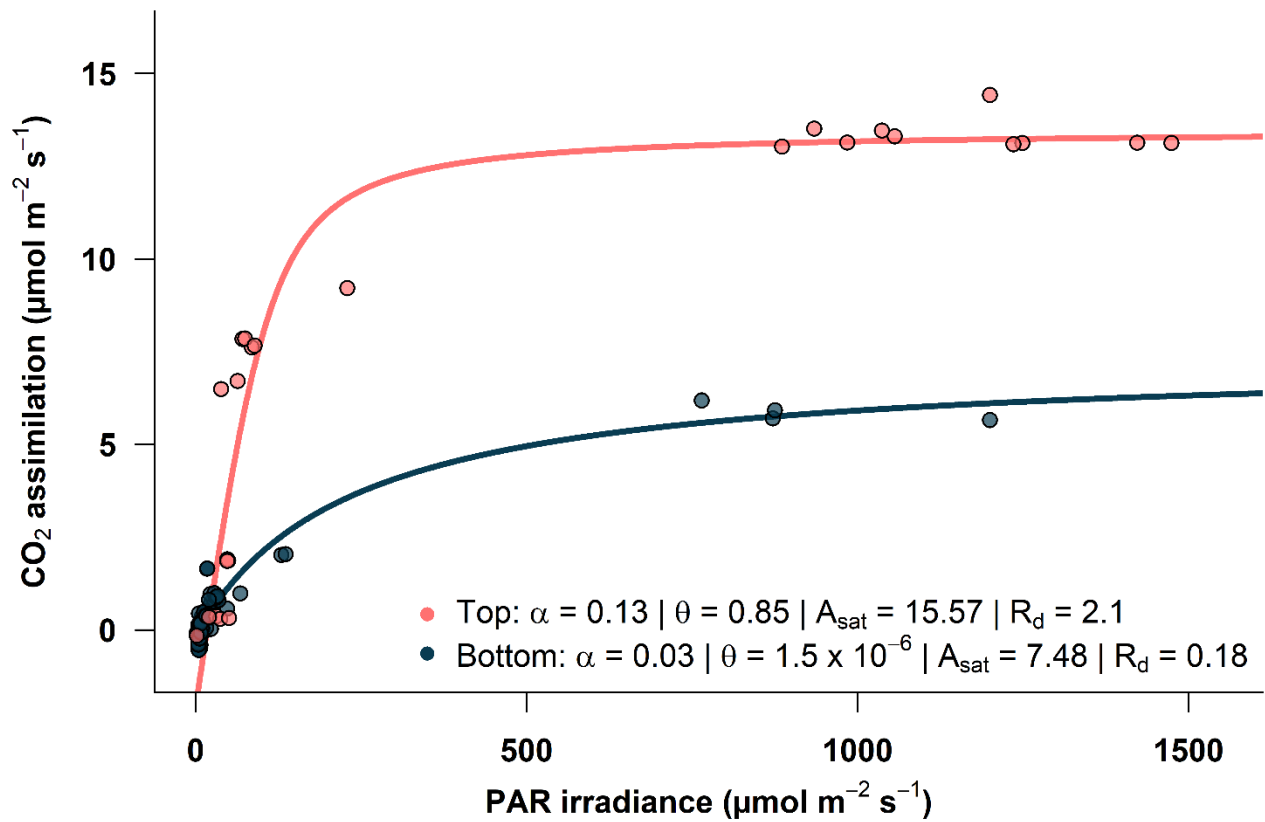
Figure S3: Photosynthetic light response curves from gas exchange on beech leaves at the top (2 m depth, in red) and bottom (4 m depth, in blue) of the canopy. The lines show the fitted curves, with the parameters of the non-rectangular hyperbola (α, θ, A_{sat} and R_d) given. Beech trees were 12 years-old and grown in Helsinki.