## Supplementary Information

In order to determine if there is a general relationship between overall photosynthetic capacity and the magnitude of within-canopy gradients we surveyed the literature to determine values of the capacity of ribulose-1,5-bisphopshate-carloxylase/oxygenase (Rubisco) for upper canopy leaves, $V_{\max (0) \text {, and an extinction }}$ coefficient describing the exponential decline with depth in the canopy (expressed as the cumulative leaf area index, $L$, from the top down) with the Rubisco extinction coefficient being denoted $k_{\mathrm{v}}$. For some studies, e.g. Carswell et al. (2000), these parameters were directly estimable, but in many cases some assumptions had to be made; for example to deduce either the Rubisco activity from measurement of the light saturated photosynthetic rate - this requiring an estimate of the intercellular partial pressure of $\mathrm{CO}_{2}\left(c_{1}\right)$ or to estimate $L$ from the given light profile. For the former case, we also used the standard equations of Rubisco limited photosynthesis (Farquhar et al. 1980) with Rubisco kinetic constants as given by Bernacchi et al. (2001). For converting radiation interception values to $L$, we took where $I / I_{0}$ represents the incident flux density, $I$, relative to that at the top of the canopy, $I_{0}$, as given in several of the studies (eg. Hollinger, 1996; Kull and Niinemets, 1998; Meir et al., 2002) taking a general value for the light extinction coefficient, $k_{\mathrm{I}}$, of 0.6 except where as noted in Table S 1 .

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| Species | Reference | $\begin{gathered} V_{\max (0)} \\ \left(\mu \mathrm{mol} \mathrm{~m}^{-2} \mathrm{~s}^{-1}\right) \end{gathered}$ | $\boldsymbol{k}_{\mathrm{v}}$ | Notes |
| :---: | :---: | :---: | :---: | :---: |
| Acer saccharum | Ellsworth and Reich (1993) | 32 | 0.11 | $V_{\max (0)}$ and $k_{\mathrm{v}}$ estimated directly from Fig. 4 b and Fig. 5a assuming $a_{1}=22 \mathrm{~Pa}$. |
| Acer saccharum | Raulier et al. (1999) | 63 | 0.18 | $V_{\max (0)}$ and $k_{\mathrm{v}}$ estimated from Fig. 6 with $k_{\mathrm{I}}=0.5$ (as stated in the text) with $c_{1}=22 \mathrm{~Pa}$ (Fig 2) |
| Betula grossa | Uemura et al. (2006) | 39 | 0.13 | By matching profiles of $A_{\max }$ at high $\left[\mathrm{CO}_{2}\right]$ (their $A_{\text {sat }}$ ) and $L$ with height with $V_{\max (0)}$ estimated from $A_{\text {maa }(0)}$ at high $\left[\mathrm{CO}_{2}\right]$ assuming $a_{1}=100 \mathrm{~Pa}$. |
| Betula pendula | Meir et al. (2002) | 114 | 0.25 | $V_{\max (0)}$ directly from the authors, $k_{\mathrm{v}}$ estimated from Fig. 5 assuming $k_{\mathrm{I}}=0.6$ |
| Castilla elastica | Poseda et al. (2009) | 84 | 0.36 | $V_{\max (0)}$ estimated from profiles of $A_{\max }$ in Fig. 1 assuming $c_{1}=22 \mathrm{~Pa}$ and with $k_{\mathrm{I}}=0.7$ (Wirth et al., 2001). |
| Eucalyptus globules | Turnbull et al. (2007) | 50 | 0.17 | $V_{\max (0)}$ and $k_{\nu}$ estimated from Fig. 6 using a low $k_{\mathrm{II}}$ of 0.3 due to near vertical leaf orientation (Goudriann, 1977). |
| Fagus crentana* | Uemura et al. (2006) | 54 | 0.14 | By matching profiles of $A_{\max }\left(\right.$ high $\left.\left[\mathrm{CO}_{2}\right]\right)$ and $L$ with height with $V_{\max (0)}$ estimated from $A_{\operatorname{maa}(0)}$ (high $\left[\mathrm{CO}_{2}\right]$ ) assuming $\mathfrak{c}_{1}=100 \mathrm{~Pa}$. |
| Fagus sylvatica | Meir et al. (2002) | 64 | 0.19 | $V_{\max (0)}$ directly from the authors, $k_{\mathrm{v}}$ estimated from Fig. 5 assuming $k_{\mathrm{I}}=0.6$ |
| Ficus insipid | Poseda et al. (2009) | 111 | 0.43 | $V_{\max (0)}$ estimated from profile of $A_{\max }$ in Fig. 1 (upper curve) assuming $c_{1}=22 \mathrm{~Pa}$ and with $k_{\mathrm{I}}=0.7$ (Wirth et al., 2001). |
| Lubea seemannii | Poseda et al. (2009) | 95 | 0.22 | $V_{\max (0)}$ estimated from profile of $A_{\max }$ in Fig. 1 (upper curve) assuming $c_{1}=22 \mathrm{~Pa}$ and with $k_{\mathrm{I}}=0.7$ (Wirth et al., 2001). |
| Nothofagus fusca | Hollinger (1996) | 40 | 0.11 | $V_{\max (0)}$ from Table 1, $k_{v}$ estimated from Fig. 4 assuming $k_{\mathrm{I}}=0.6$ with two outliers omitted from the analysis. |
| Populus tremula | Kull and Niinemets (1998) | 113 | 0.24 | $V_{\max (0)}$ from initial slope of $A ; c_{1}$ curve, with $k_{\mathrm{v}}$ also estimated from Fig. 2 a assuming $k_{\mathrm{I}}=0.7$ (Green et al. 2001) |
| Prunus persica | Walcroft et al.(2002) | 80 | 0.16 | $V_{\max (0)}$ and $k_{\mathrm{v}}$ from Fig 3c (May 1999) using relationship of Fig. 6 and assuming $k_{\mathrm{I}}=0.6$ |
| Quercus glauca | Miyazawa et al. (2004) | 98 | 0.10 | Gradient in $V_{\max }$ estimated from gradient in $[\mathrm{N}]_{\mathrm{A}}$ (Fig. 2) and relationships between $[\mathrm{N}]_{\mathrm{A}}$ and both $A_{\text {max }}$ and $c_{1}$ (Fig. 3) assuming $k_{\mathrm{I}}=0.6$. |
| Quercus petraea | Meir et al. (2002) | 104 | 0.20 | $V_{\max (0)}$ directly from the authors, $k_{\mathrm{v}}$ estimated from Fig. 5 assuming $k_{\mathrm{I}}=0.6$ |
| Tilia cordata | Kull and Niinemets (1998) | 78 | 0.17 | $V_{\max (0)}$ from initial slope of $A ; c c$ curve, with $k_{\mathrm{v}}$ also estimated from Fig. 2 a assuming $k_{\mathrm{I}}=0.7$ (Green et al. 2001) |
| Miscellaneous tropical forest species (Manaus) | Carswell et al. (2000) | 58 | 0.18 | As independently estimated by Mercado et al. (2006). |
| Miscellaneous tropical forest species (Tapajos) | Domingues et al. (2005) | 64 | 0.15 | With $k_{\mathrm{v}}$ as estimated in the main text, with $V_{\max (0)}$ directly from equations in Tables 3 and 4. |

Table S1. Values for Rubisco activity of uppermost canopy leaves, $V_{\max (0)}$, and the Rubisco extinction coefficient $k_{v}$ used for Figure 10 in the main text.
*Fagus japonioca was not analysed as its profiles appear very similar to F. crenata.

