**Supplementary information I (FOR ONLINE PUBLICATION ONLY)**

*Collecting leaves and measuring photosynthesis*

For the gas exchange measurements, five species that together represent less than 50% of the basal area in the research plot were selected. The measured species were *Weinnmania crassifolia*, *Clethra cuneata*, *Schefflera allocotantha*, *Clusia cretosa* and *Prunus* *integrifolia*. From these species, 5-6 individual trees were selected. For each tree we carried out CO2 response curves (*A*-*C*i curves) on leaves from the top (fully sunlit), middle and bottom part of the canopy, leading to a total of 82 *A*-*C*i curves. To get access to the canopy, branches were detached and immediately re-cut under water to reconstitute the water column (Domingues and others 2010). After detachment, *A*-*C*i curves were completed within 30-60 minutes. According to Santiago and Mulkey (2003), alterations in stomatal conductance during this process do not affect the calculation of *V*cmax, unless stomatal conductance (*g*s) declines to very low levels. In cases of very low *g*s, measurements were excluded from the dataset, leading to an ultimate dataset of 78 *A*-*C*i curves.

*A-Ci curves*

Portable photosynthesis equipment (Li-Cor 6400, Li-Cor Inc, Lincoln, USA), fitted with an LED light source (6400-02B Red/Blue Light Source, Li-Cor, Inc, Lincoln, USA), was used to carry out the *A*-*C*i curves, following the procedural guidelines in Long and Bernaccchi (2003) with CO2 concentrations inside the chamber ranging from 50 to 2000 ppm (in the order of 400,300, 200,100, 50, 400, 700, 900, 1200,1600, 2000 ppm CO2). Prior to conducting *A*-*C*i curves, we tested what the light-saturated levels of photosynthetic active radiation (PAR) were per canopy layer. Values higher than these photon flux densities lead to decreases in photosynthesis, probably caused by photo damage. We used PAR values of 1200 μmol m-2 s-1 for top canopy leaves, 700 μmol m-2 s-1 for middle canopy leaves and 500 μmol m-2 s-1 for lower canopy leaves for the *A-C*i curves. Relative humidity was maintained at ambient levels, but never over 80 %.

A curve fitting routine similar to Domingues and others (2010) was used to analyze the *A*-*C*i curves to calculate *V*cmax and *J*max. The curve fitting is based on minimum least-squares and was developed for use in an “R” environment (R Development Core Team 2008). The fits were obtained using the Farquhar biochemical model of leaf photosynthesis (Farquhar and others 1980; von Caemmerer and Quick 2000), with a modification for triose phosphate *utilization* (TPU) by Harley and others (1992). The enzymatic kinetic constants were taken from von Caemmerer and Quick (2000), assuming an infinite internal conductance term.

Table A. Relative Values of the Basal Area per Species (*bottom*) and the Relative LAI per Canopy Layer as Used for Calculating the Average *V*cmax and *J*max per Canopy Layer the SPA Model

|  |
| --- |
| **Relative LAI per species (sum per species =1)** |
| **Canopy Layer in SPA Model** | *Schefflera alloconthanta* | *Prunus integrifolia* | *Weinmannia Crassifolia* | *Clethra cuneata* | *Clusia cretosa* |
| 1 | 0.341 | 0.324 | 0.197 | 0.218 | 0.152 |
| 2 | 0.214 | 0.428 | 0.307 | 0.420 | 0.474 |
| 3 | 0.175 | 0.231 | 0.192 | 0.209 | 0.276 |
| 4 | 0.200 | 0.017 | 0.172 | 0.153 | 0.099 |
| 5 | 0.061 | - | 0.075 | - | - |
| 6 | 0.009 | - | 0.020 | - | - |
| 7 | - | - | 0.019 | - | - |
| 8 | - | - | 0.018 | - | - |
| 9 | - | - | - | - | - |
| 10 | - | - | - | - | - |
| **Relative basal area (sum species =1 )** | 0.030 | 0.071 | 0.611 | 0.062 | 0.226 |

Layer 1 represents the top of the modelled canopy.

*Scaling* V*cmax and* J*max*

The SPA model has 10 layers of canopy of which 8 of the 10 layers were assigned foliage in order to represent the vertical distribution as observed in the field. Per species the top and bottom layer were assigned the average *V*cmax and *J*max values that had been measured in the top and bottom canopy, respectively. Depending on the amount of layers in the model that corresponded to the observations per species, the *V*cmax and *J*max values of the other layers were then linearly interpolated, using the measured mid-canopy values as well. In this way, we avoided for example that the bottom leaves of *Clethra cuneata*, which are relatively high in the canopy, were assumed to contribute to the same bottom layer as those from *Weinmannia crassifolia*. Average *V*cmax and *J*max per layer were consequently calculated by weighing the values per species according to the proportional basal area per species and their LAI distribution. Likewise, the estimated amount of total LAI per canopy layer was calculated using the relative LAI per species per layer and the species’ basal area as can be found in Table 1 of the manuscript.

**References**

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**Supplementary information II**

Table B. Structural Parameters and Starting Values of State Parameters Used in the Standard SPA Model Simulations, Together with Their Units and Their Source

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Units** | **Value** | **Source** | **Comments** |
| Canopy height | m | 12.8 | Field observations |  |
| Aboveground conductance | m2 MPa mmol-1 | 3.5 | Parameterised according to leaf specific conductivity (*LSC*) | Aboveground and belowground resistances were supposed to both represent 50% of the total resistivity. |
| Root resistivity | MPa s g mmol-1 | 140 | Parameterised according to leaf specific conductivity (*LSC*) | Aboveground and belowground resistances were supposed to both represent 50% of the total resistivity. |
| Rooting depth | m | 0.3 | Measurements from field samples (Girardin and others 2013) |  |
| Root biomass | g m-3 | 7240 | Measurements from field samples (Girardin and others 2013) |  |
| Total root biomass | g m-2 | 1448 | Measurements from field samples (Girardin and others 2013) |  |
| Organic Fraction |  | 0.154 | Field measurements (Zimmermann and others 2009) |  |
| Sand Fraction |  | 0.096 | Field measurements (Zimmermann and others 2009) |  |
| Clay fraction |  | 0.149 | Field measurements (Zimmermann and others 2009) |  |
| Initial water fraction |  | 0.22 | Observations local weather station |  |
| Initial soil temperature | °K | 275 | Observations local weather station |  |
| Root density | g biomass m-3 root | 0.51 | Calculated from root biomass and root length measurements (Girardin and others 2013) |  |

**References**

**Girardin, CAJ,** Aragão, LEOC, Huaraca Huasco, W, Malhi, Y, Metcalfe, DB, Durand, L, Mamani, M, Silva-Espejo, JE, Whittaker, RJ, Fine Root dynamics along an elevation gradient in tropical Andean forests, Global Biogeochemical Cycles 27: 252–264.

Zimmermann M, Meir P, Bird MI, Malhi Y, Ccahuana AJQ. 2009. Climate dependence of heterotrophic soil respiration from a soil-translocation experiment along a 3000 m tropical forest altitudinal gradient. European Journal of Soil Science 60:895-906.

**Supplementary information III**



The relative temperature sensitivity of *V*cmax and *J*max from the SPA model (closed symbols) and as found in Table 1 of Sharkey and others (2007) (open symbols), given the premise that both curves give the same value at 20 °C.

Sharkey, TD, Bernacchi, CJ, Farquhar, GD, Singsaas, EL, 2007. Fitting photosynthetic carbon dioxide response curves for C-3 leaves. Plant Cell and Environment 30, 1035-1040.