Supporting information for "The stomatal response to rising $CO_2$ concentration and drought is predicted by a hydraulic trait-based optimization model"

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**1** Table of experiment design.

**Table S1** Default setting of the growth chamber and the settings for the treatments. Row [$CO_2$] was the chamber $CO_2$ concentration; row RH was the relative humidity; row Soil indicated whether the trees were watered (W for watered, NW for not watered); row PAR was the light intensity; row $T_{air}$ was the chamber air temperature; row Day time was the time frame for light in the chamber. Column Default and Treatment stages showed the default settings of the chamber. The $P_{pd}$ and $P_{leaf}$ indicated that predawn water potential and leaf xylem pressure were measured for that treatment. $P_{pd}$ was measured once for the [$CO_2$] and RH treatment. $P_{pd}$ was measured after each stage in the drought treatment. PAR was set at a constant 1000 μmol $m^{-2}$ $s^{-1}$ during the day and air temperature was set at 25 °C throughout the experiment.

| Treatment | Default | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Note |
|---|---|---|---|---|---|---|---|
| $[CO_2]$ (ppm) | 400 | 800 $P_{leaf}$ | 600 | 400 $P_{leaf}$ | 300 | 200 $P_{leaf}$ | Same day $P_{pd}$ for all stages |
| RH (%) | 55 | 75 $P_{leaf}$ | 65 | 55 $P_{leaf}$ | 45 | 35 $P_{leaf}$ | Same day $P_{pd}$ for all stages |
| Soil | W | W $P_{pd}$, $P_{leaf}$ | NW $P_{pd}$ | NW $P_{pd}$, $P_{leaf}$ | NW $P_{pd}$ | NW $P_{pd}$, $P_{leaf}$ | Different $P_{pd}$ for all stages |
| PAR (μmol $m^{-2}$ $s^{-1}$) | 1000 | | | | | | Constant throughout the experiment |
| $T_{air}$ (°C) | 25 | | | | | | |
| Day time | 8 am to 6 pm | | | | | | |

**2** Table of traits for each tree.

**Table S2** Top: vulnerability curves for root, stem, and leaf elements. The "B" and "C" are parameters of the Weibull function used to fit vulnerability curve data. Resistance partition is the resistance of each segment as a percentage of the whole plant resistance. The VCs were same for each tree. Below: tree-specific traits. In the column “Note”, C, D, and P denoted if the tree was

used in the $CO_2$, RH, and drought treatment, respectively.

Vulnerability curves:

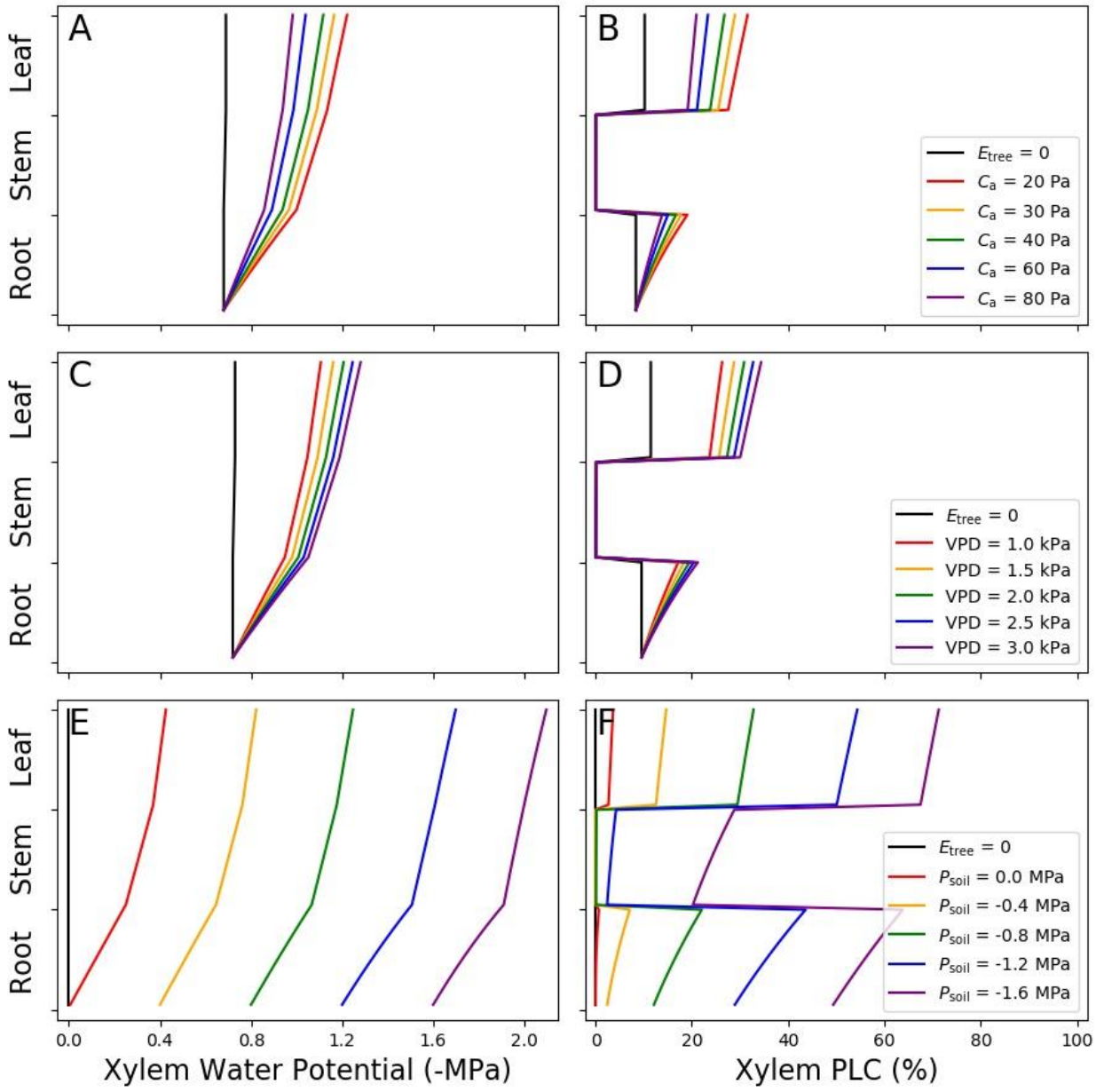
| | B | C | Resistance partition |
|---|---|---|---|
| Root | 1.879 | 2.396 | 53.7% |
| Stem | 2.238 | 9.380 | 24.3% |
| Leaf | 1.897 | 2.203 | 22.0% |

Traits for each individual:

| Tree | Note | Root $K_{max}$ | Stem $K_{max}$ | Leaf $K_{max}$ | $K_{max}$ | $V_{cmax}$ | $J_{max}$ | LaBa |
|---|---|---|---|---|---|---|---|---|
| | | kg $h^{-1}$ $MPa^{-1}$ $m^{-2}$ | | | | μmol $CO_2$ $m^{-2}$ $s^{-1}$ | | $m^2$ $m^{-2}$ |
| 1 | CD | 2589.516 | 5725.834 | 6304.174 | 1389.961 | 54.947 | 107.505 | 5663 |
| 2 | CDP | 3478.758 | 7692.092 | 8469.033 | 1867.275 | 69.840 | 128.280 | 5663 |
| 3 | C | 1043.779 | 2307.963 | 2541.080 | 560.264 | 59.719 | 104.973 | 2648 |
| 4 | CP | 2893.333 | 6397.621 | 7043.815 | 1553.039 | 64.618 | 118.730 | 5663 |
| 5 | C | 1451.979 | 3210.557 | 3534.840 | 779.371 | 50.968 | 68.376 | 2648 |
| 6 | CP | 2241.282 | 4955.832 | 5456.397 | 1203.041 | 96.578 | 202.987 | 5663 |
| 7 | D | 2161.774 | 4780.028 | 5262.836 | 1160.364 | 12.794 | 24.004 | 2648 |
| 8 | DP | 2494.907 | 5516.638 | 6073.847 | 1339.178 | 67.316 | 126.116 | 5663 |
| 9 | DP | 2055.616 | 4545.295 | 5004.394 | 1103.382 | 65.145 | 122.198 | 5663 |
| 10 | DP | 1869.949 | 4134.758 | 4552.390 | 1003.723 | 75.456 | 141.540 | 5663 |

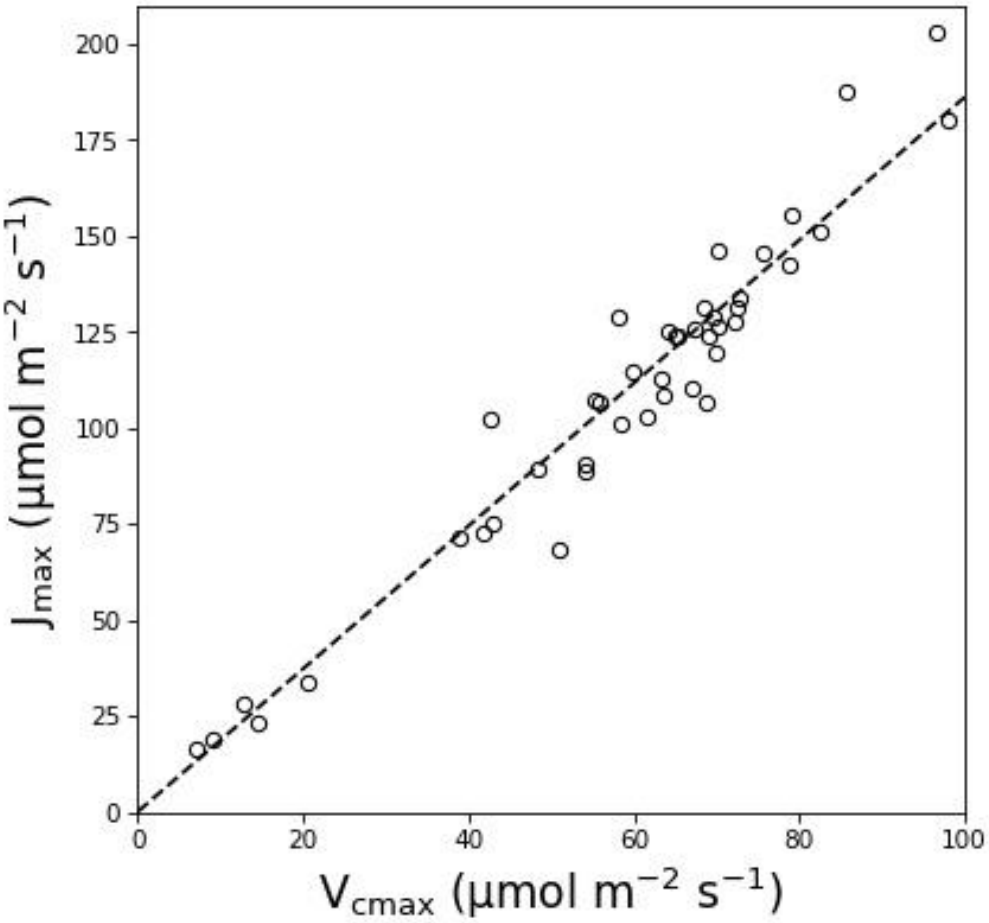
**3.** Example of tree response to the environment

**Fig. S1** Xylem water potential ($P_x$) and percentage loss of conductance (PLC) in root, stem, and leaf at different environmental conditions. Panel A and B: responses of $P_x$ and PLC to atmospheric [$CO_2$] at a soil water potential of -0.68 MPa (mean value for six trees). Panel C and D: responses to atmosphere vapor pressure deficit (VPD) for a soil water potential of -0.72 MPa (mean value for six trees). Panel E and F: responses to soil water potential. The black line in each panel represents when whole tree transpiration is 0 meaning only gravity governs the xylem water potential drop. Vulnerability curve parameters of root, stem, and leaf are from Table S1. The $K_{max}$, $V_{cmax}$, $J_{max}$, and LaBa are the average values of the ten trees from Table S1. Stem height is set to 1 m.




**4** Correlation of $V_{cmax}$ and $J_{max}$

**Fig. S2** Correlation between maximal carboxylation rate at 25 °C ($V_{cmax}$) and maximal electron transport at 25 °C ($J_{max}$). The dashed line plots the linear regression (y = 1.86x, $R^2$ = 0.992).


200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
$J_{max}$ (µmol $m^{-2}$ $s^{-1}$)
$V_{cmax}$ (µmol $m^{-2}$ $s^{-1}$)