# Wood microclimate as a predictor of carbon dioxide fluxes from deadwood in tropical Australia

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## Supporting Figures and Tables

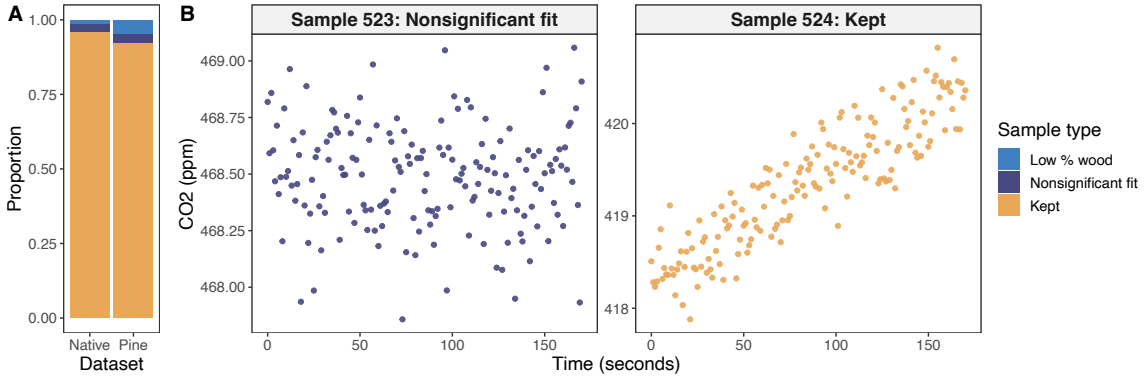


**Figure S1.** Flux measurement cleaning. Panel A shows the proportions of samples designated as less than 50% wood and nonsignificant linear fits from gas analyzer measurements, which were removed from analysis. 18/366 pine blocks and 8/617 native stems (5%, 1%) were removed for low wood percentage and 11/366 pine blocks and 16/617 native stems (3%) were removed for nonsignificant fits (p>0.05). Panel B shows example gas analyzer measurements that were removed (523) and kept (524). Both samples were from the species *Cardwelia sublimis*.

**Table S1.** Summary of the model fit results

model = brm($CO_2$_resp_rate FMC_nor * T_nor + (1|site),data = pine_flux,iter = 3500,family ="beta", control = list(adapt_delta = 0.96),seed=123)

| | mean | se_mean | sd | 2.5% | 25% | 50% | 75% | 97.5% | n_eff | Rhat | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| b_Intercept | 2.2 | 0.1 | 4.99 | -7.5 | -1.2 | 2.2 | 5.5 | 12.1 | 4247 | 1 | 0.9 |
| b_FMC_nor | -56.0 | 0.2 | 14.4 | -84.7 | -65.9 | -55.9 | -46.3 | -27.9 | 3718 | 1 | <0.001 |
| b_T_nor | -8.3 | 0.1 | 5.7 | -19.6 | -12.0 | -8.3 | -4.4 | 2.8 | 4206 | 1 | 0.348 |
| b_FMC_nor:T_nor | 66.9 | 0.3 | 16.7 | 34.4 | 55.6 | 66.8 | 78.4 | 100.0 | 3717 | 1 | 0.001 |
| sd_site__Intercept | 0.79 | 0.01 | 0.5 | 0.3 | 0.5 | 0.7 | 0.9 | 2.1 | 1722 | 1 | |
| phi | 108.5 | 0.1 | 11.1 | 87.9 | 100.6 | 107.97 | 115.8 | 131.4 | 6663 | 1 | |
| r_site[wet rainforest,Intercept] | 0.4 | 0.01 | 0.4 | -0.5 | 0.2 | 0.4 | 0.6 | 1.2 | 2082 | 1 | |
| r_site[sclerophyll,Intercept] | 0.3 | 0.01 | 0.4 | -0.6 | 0.1 | 0.3 | 0.5 | 1.1 | 1998 | 1 | |
| r_site[dry rainforest,Intercept] | 0.2 | 0.01 | 0.4 | -0.7 | -0.03 | 0.2 | 0.4 | 0.95 | 2014 | 1 | |
| r_site[dry savanna,Intercept] | -0.8 | 0.01 | 0.5 | -1.75 | -0.98 | -0.7 | -0.5 | 0.01 | 2016 | 1 | |
| r_site[wet savanna,Intercept] | -0.5 | 0.01 | 0.5 | -1.4 | -0.7 | -0.5 | -0.2 | 0.3 | 2022 | 1 | |
| lprior | -15.1 | 0.01 | 0.31 | -15.7 | -15.3 | -15.1 | -14.9 | -14.5 | 4472 | 1 | |
| lp__ | 1029.3 | 0.06 | 2.8 | 1022.9 | 1027.6 | 1029.6 | 1031.3 | 1033.9 | 2263 | 1 | |

Samples were drawn using NUTS(diag_e) at Mon Aug 21 22:22:12 2023. For each parameter, n_eff is a crude measure of effective sample size, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat=1).

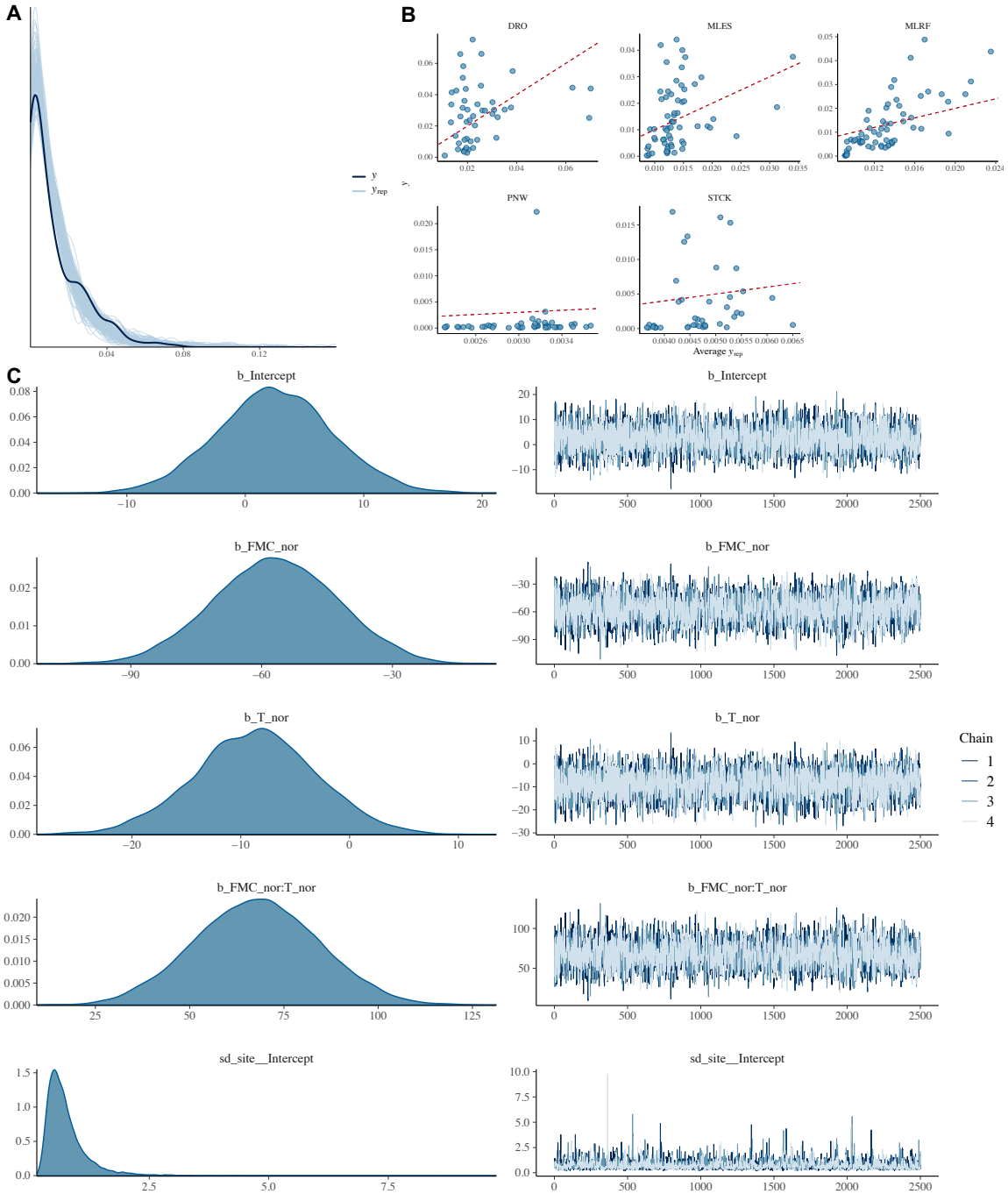


**Figure S2.** Posterior predictive check of the total data (A) data in each site (B), as well as tracer plots and posterior distribution of the model parameters (C).

**Table S2.** Fitted model parameters for FMC sticks and pine blocks across the precipitation gradient (wettest to driest: wet rainforest, dry rainforest, sclerophyll, wet savanna, dry savanna).

| Parameters best fit | Wet rainforest | | Dry rainforest | | Sclerophyll | | Wet savanna | | Dry savanna | |
|---|---|---|---|---|---|---|---|---|---|---|
| | stick | block | stick | block | stick | block | stick | block | stick | block |
| $f$ | 0.4 | 0.1 | 0.4 | 0.1 | 0.5 | 0.1 | 0.8 | 0.2 | 0.4 | 0.2 |
| $A$ | 4.0 | | 4.0 | | 4.3 | | 3.8 | | 4.2 | |
| $B$ | -12.6 | | -12.6 | | -15.3 | | -16.6 | | -14.1 | |
| $d_s$ | $1.1 \cdot 10^{-6}$ | | $1.1 \cdot 10^{-6}$ | | $1.1 \cdot 10^{-6}$ | | $1.1 \cdot 10^{-6}$ | | $1.1 \cdot 10^{-6}$ | |
| $m_{max}$ | 1.2 | 4.0 | 1.2 | 4.0 | 0.8 | 4.0 | 0.8 | 2.0 | 1.0 | 1.0 |
| $svf$ | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.2 | 0.9 | 0.7 | 1.0 | 0.9 |
| $SSE$ | - | - | 384.3 | - | 372.8 | - | 252.4 | - | 360 | - |

**Table S3.** Fixed parameters for FMC sticks and pine blocks.

| Parameters | Description | Unit | Stick | Wood |
|---|---|---|---|---|
| $\rho_s$ | Stick density | $\mathrm{kg\,m^{-3}}$ | 400 | 480 |
| $L$ | Length | $\mathrm{m}$ | 0.41 | 0.1 |
| $r$ | Radius | $\mathrm{m}$ | 0.0065 | 0.035 |
| $\epsilon_s$ | Stick emissivity | - | 0.85 | |
| $\sigma$ | Stephan-Boltzmann constant | $\mathrm{J\,h^{-1}\,m^{-2}\,K^{-4}}$ | 0.00020412 | |
| $\epsilon_g$ | Emissivity of the ground | - | 0.95 | |
| $\epsilon_v$ | Emissivity of the vegetation | - | 0.965 | |
| $a_1$ | Fit parameter 1 | - | 1.2 | |
| $a_2$ | Fit parameter 2 | - | 3 | |
| $a_3$ | Fit parameter 3 | - | 0.5 | |
| $Ce$ | Climatological value | $\mathrm{cm\,K\,hPa^{-1}}$ | 46.5 | |
| $\beta$ | Constant based on cloud type | - | 0.26 | |
| $\alpha_s$ | Stick Albedo | - | 0.65 | |
| $\alpha_g$ | Ground albedo | - | 0.185 | |
| $\rho_A$ | Density of air | $\mathrm{kg\,m^{-3}}$ | 1.093 | |
| $c_a$ | Specific heat of air | $\mathrm{J\,kg^{-1}\,K^{-1}}$ | 1005 | |
| $k$ | Thermal diffusivity of the air | $\mathrm{m^2\,h^{-1}}$ | 0.0684 | |
| $v$ | Kinematic viscosity of air | $\mathrm{m^2\,h^{-1}}$ | 0.0000151 | |
| $M$ | Molecular mass of water | $\mathrm{kg\,mol^{-1}}$ | 0.018 | |
| $R$ | Gas constant | $\mathrm{m^3\,kPa^{-1}\,mol^{-1}}$ | 0.008314 | |
| $g$ | Specific gravity of the stick | - | 0.42 | 0.41 |
| $c_{water}$ | Specific heat of water | $\mathrm{J\,K^{-1}\,kg^{-1}}$ | 4200 | |
| $cv$ | Vegetation contribution coefficient | - | 0.5 | |
| $dv$ | Density of water | $\mathrm{kg\,m^{-3}}$ | 1000 | |

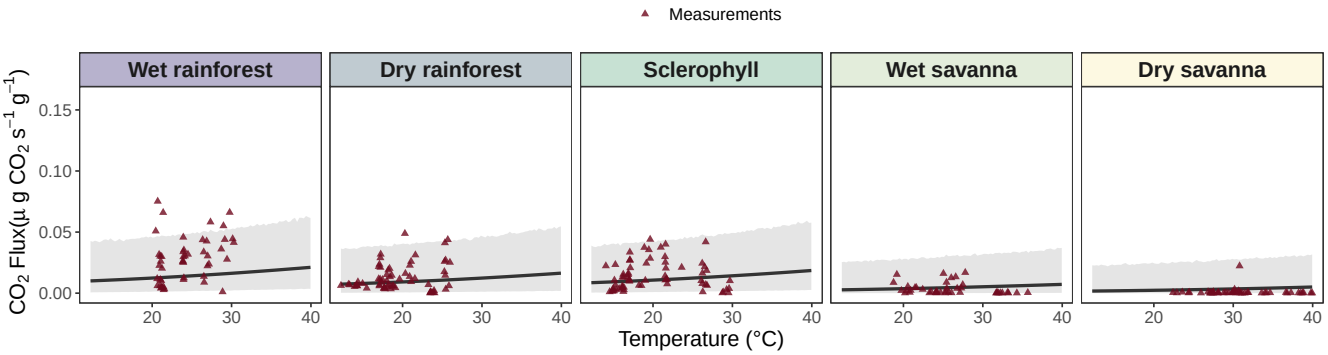


**Figure S3.** Mixed model of $CO_2$ fluxes ($\mu g\, CO_2\, s^{-1}\, g^{-1}$) from decaying wood, with wood moisture content and temperature as fixed effects and site as a random effect. The figure shows flux predictions against ambient temperature. Different colors represent different sites and the red triangles represent pine block measurements used to construct the models. An outlier in the dry savanna was kept, as there was no indication that there was an error in measurement.

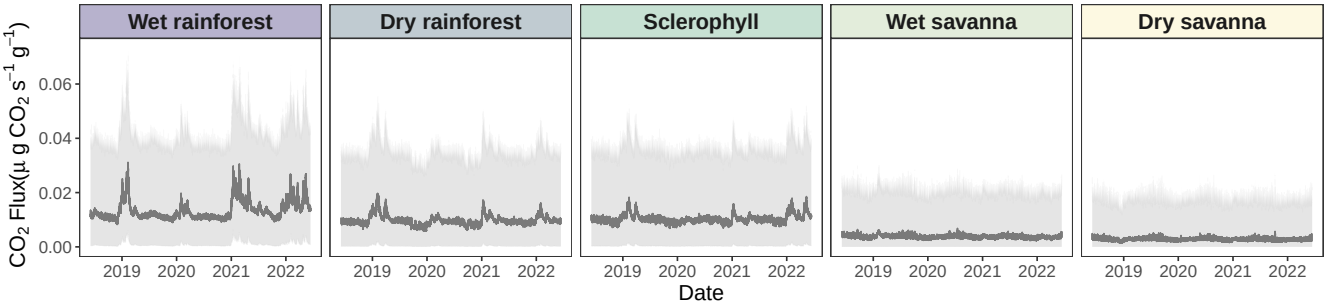


**Figure S4.** Time-resolved flux predictions with uncertainty.

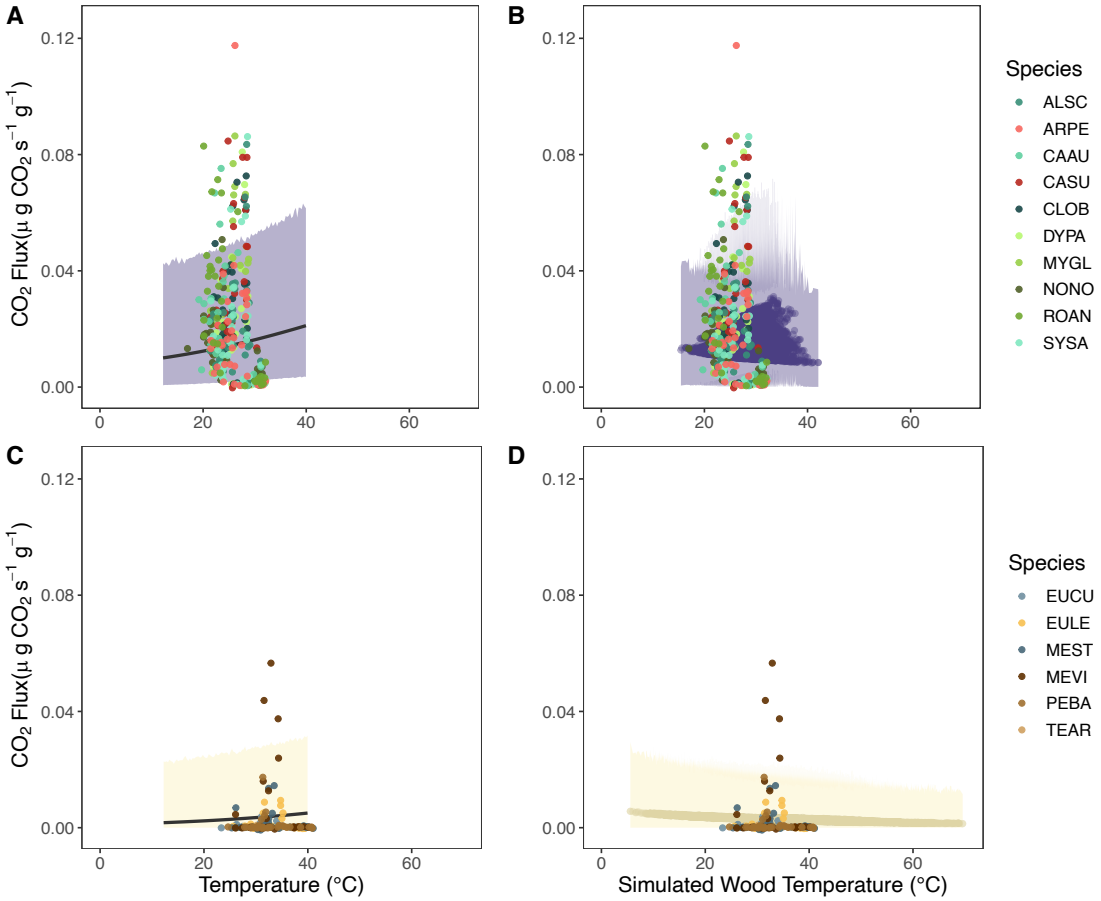


**Figure S5.** Measured native stem ambient temperature and $CO_2$ fluxes plotted with estimates from the statistical model (A, C) and time-resolved simulations (B, D) Panels A and B show native species found at the wet rainforest panels C and D from the dry savanna. The species name for each code given in Figure 6 is described in Table S3.

**Table S4.** Code and species description of native tree species deployed at the wet rainforest and dry savanna.

| Code | Wood species | Location |
|---|---|---|
| *Alstonia scholaris* | ALSC | Rainforest |
| *Argyrodendron peralatum* | ARPE | Rainforest |
| *Castanospermum australe* | CAAU | Rainforest |
| *Cardwelia sublimis* | CASU | Rainforest |
| *Cleistanthus oblongifoloius* | CLOB | Rainforest |
| *Dysoxylum papuanum* | DYPA | Rainforest |
| *Myristica globosa* | MYGL | Rainforest |
| *Normanbya normanbyi* | NONO | Rainforest |
| *Rockinghamia angustifolia* | ROAN | Rainforest |
| *Syzygium sayeri* | SYSA | Rainforest |
| *Eucalyptus cullenii* | EUCU | Savanna |
| *Eucalyptus chlorophylla* | EULE | Savanna |
| *Melaleuca stenostachya* | MEST | Savanna |
| *Melaleuca viridiflora* | MEVI | Savanna |
| *Petalostigma banksii* | PEBA | Savanna |
| *Terminalia aridicola* | TEAR | Savanna |

**Table S5.** C loss model

model = Carbon Flux ∼ Carbon Loss * Site * Termite Discovery

| Characteristic | Beta | 95% CI | p-value |
|---|---|---|---|
| Carbon Loss | 0.94 | 0.67, 1.2 | **0.001** |
| Site | | | |
| Dry rainforest | — | — | |
| Dry savanna | -0.13 | -0.24, -0.01 | **0.029** |
| Sclerophyll | -0.06 | -0.19, 0.07 | 0.3 |
| Wet rainforest | 0.01 | -0.11, 0.13 | 0.8 |
| Wet savanna | -0.06 | -0.17, 0.05 | 0.3 |
| Termite Discovery | | | |
| No | — | — | |
| Yes | 0.06 | -0.09, 0.20 | 0.4 |
| Carbon Loss * Site | | | |
| Carbon Loss * Dry savanna | -0.16 | -1.1, 0.77 | 0.7 |
| Carbon Loss * Sclerophyll | -0.04 | -0.41, 0.33 | 0.8 |
| Carbon Loss * Wet rainforest | 0.00 | -0.33, 0.34 | >0.9 |
| Carbon Loss * Wet savanna | -0.60 | -1.0, -0.18 | **0.007** |
| Carbon Loss * Termite Discovery | | | |
| Carbon Loss * Yes | -0.37 | -0.74, -0.01 | **0.047** |
| Site * Termite Discovery | | | |
| Dry savanna * Yes | -0.07 | -0.27, 0.14 | 0.5 |
| Sclerophyll * Yes | 0.11 | -0.13, 0.35 | 0.4 |
| Wet rainforest * Yes | 2.8 | 1.5, 4.0 | **0.001** |
| Wet savanna * Yes | -0.06 | -0.27, 0.15 | 0.5 |
| Carbon Loss * Site * Termite Discovery | | | |
| Carbon Loss * Dry savanna * Yes | -0.07 | -1.1, 0.99 | 0.9 |
| Carbon Loss * Sclerophyll * Yes | -0.18 | -0.69, 0.33 | 0.5 |
| Carbon Loss * Wet rainforest * Yes | -3.8 | -5.5, -2.1 | **0.001** |
| Carbon Loss * Wet savanna * Yes | 0.25 | -0.35, 0.86 | 0.4 |

[1] CI = Confidence Interval