Supplement

Upside-down fluxes Down Under: CO_2 net sink in winter and net source in summer in a temperate evergreen broadleaf forest

Renchon et al.

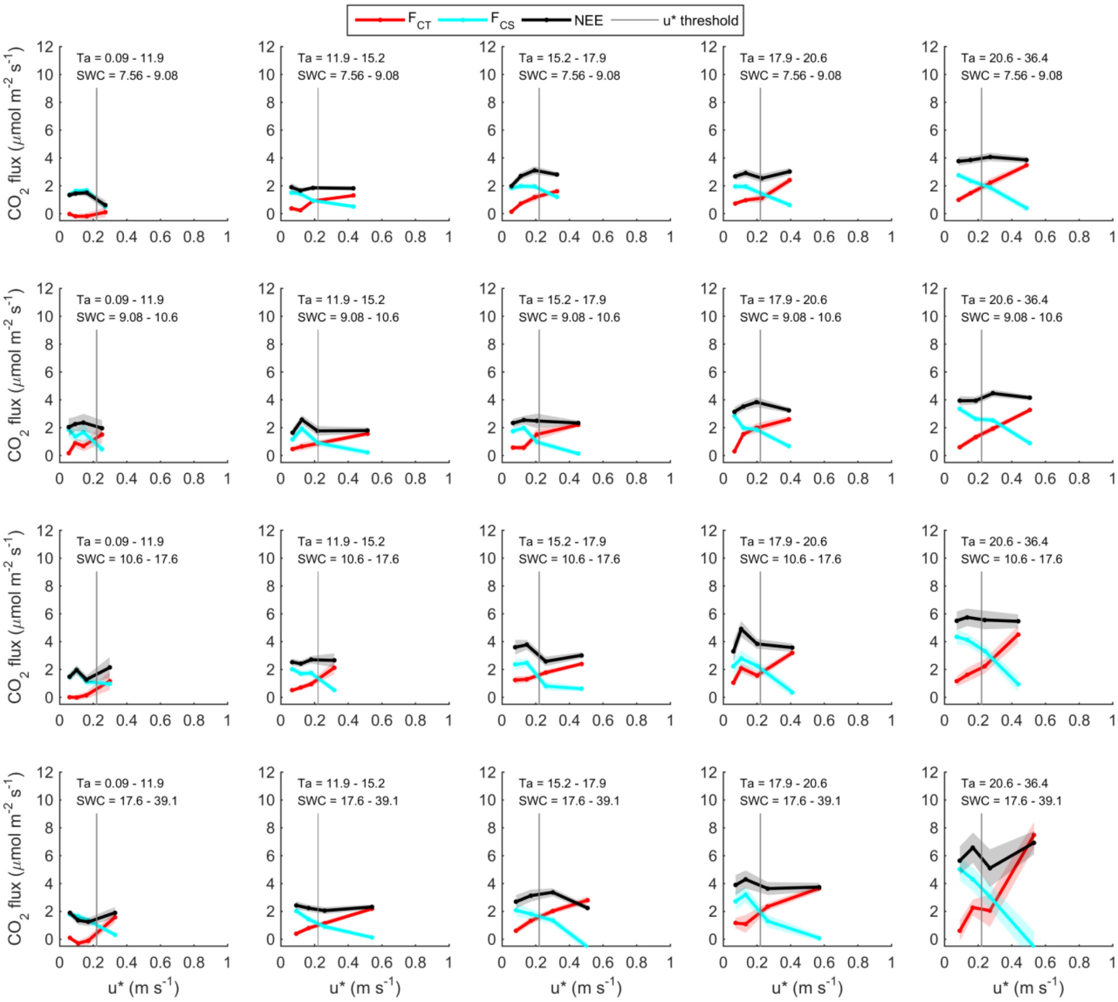

Figure S1 nighttime NEE (black), F_{CT} (red) and F_{CS} (cyan) vs. friction velocity (u*), per air temperature (T_a, left to right) and soil moisture quantiles (SWC, top to bottom). Actual value of T_a and SWC quantiles are shown in the figure. The vertical grey line show the u* threshold chosen to be conservative (no threshold detected using change point detection as NEE vs. u* was relatively flat for most T_a and SWC bins).

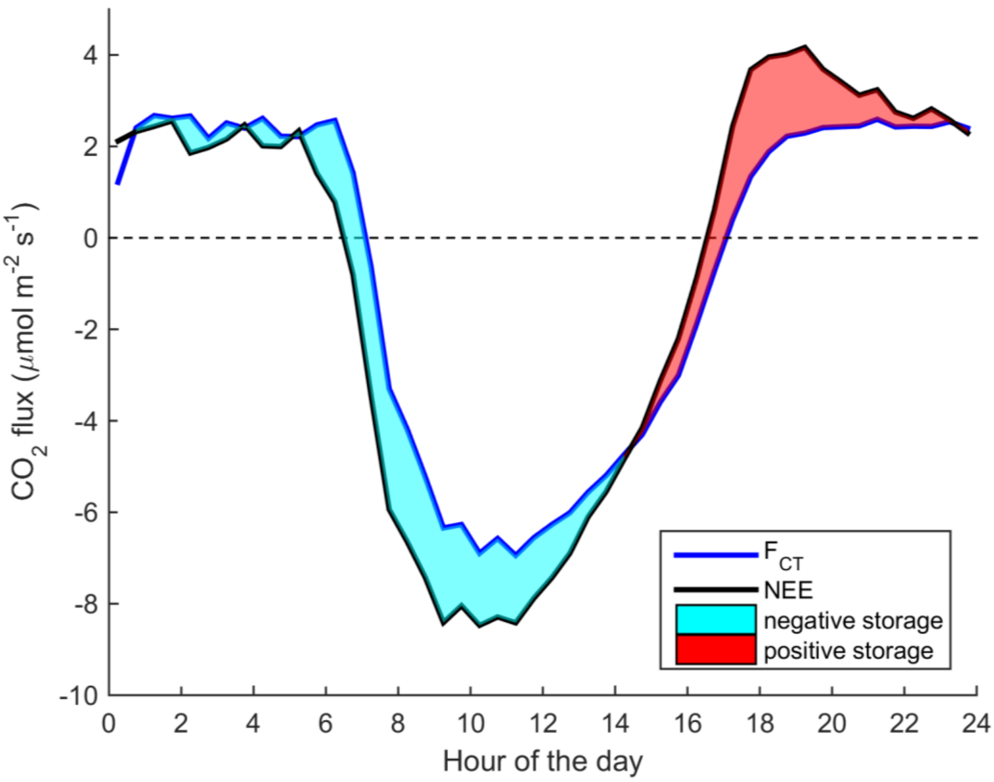

Figure S2 Diurnal course of all measured, quality checked and u* filtered net ecosystem exchange of CO_2 (NEE) and CO_2 vertical turbulent exchange (F_{CT}). The shading shows the change in storage term of the conservation of mass balance (F_{CS}, equation 1), cyan shading shows negative F_{CS} (CO_2 inside the control volume is decreasing) and red shading shows positive F_{CS} (CO_2 inside the control volume is increasing). Note that the storage flux is very impactful on flux rates during sunrise and sunset; not accounting for storage would drastically bias light response parameters.

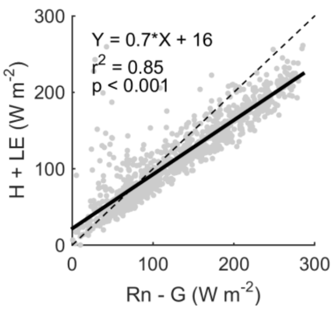

Figure S3 Energy balance closure (sensible + latent heat flux vs. net radiation - ground heat flux), daily data from 2014 through end of 2016. The black dotted line shows 1 to 1 line, the solid line shows linear regression (y = 0.7x + 16), $r^2 = 0.85$. Note that the closure deficit, about 30%, is comparable to what is obtained on most forested sites.

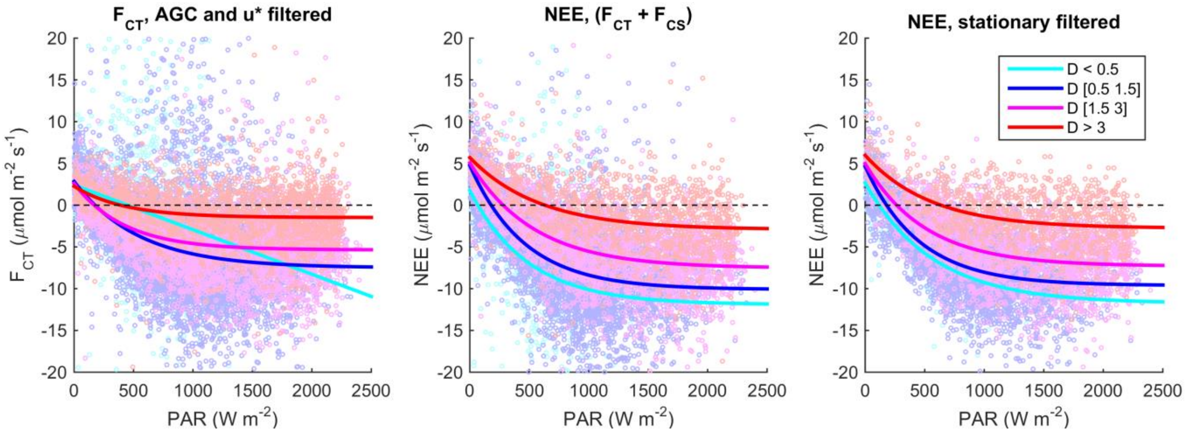

Figure S4 Light response of F_{CT}, NEE, and NEE after stationarity filter, colored by D. Line shows light response curves fit (Mitscherlich (1909); Eq. 5). Note that accounting for the change in storage flux (F_{CS}) is necessary for constraining light response parameters correctly; light response parameters using F_{CT} can lead to negative R_d or low D limiting photosynthesis, both are incoherent. Stationarity filter allow to further enhance quality check of NEE data. These two steps are particularly important under low D condition (which happen at sunrise, when PAR ~ 0, where data constrain both R_d and α).

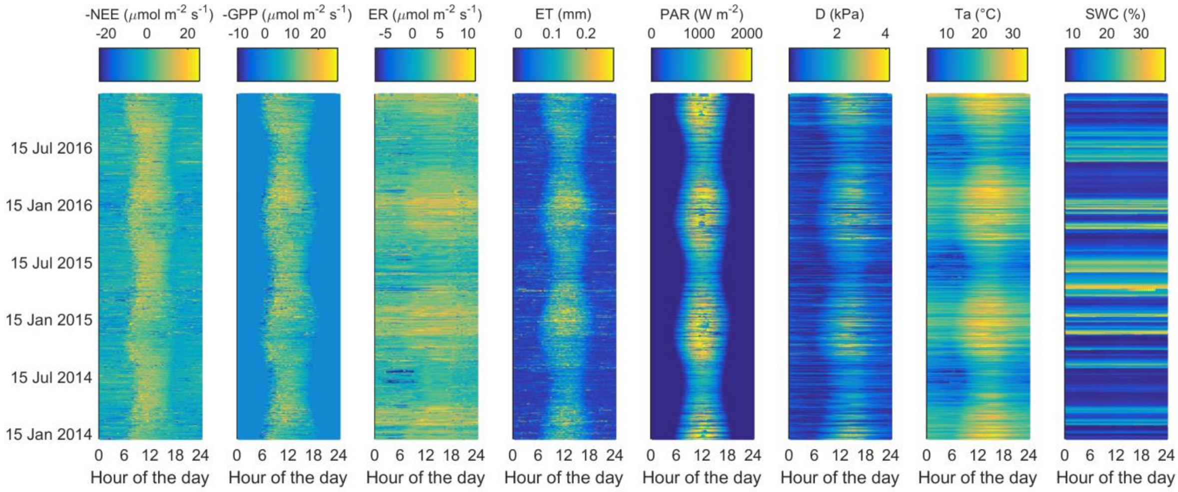

Figure S5 Time series (bottom: January 2014, top: January 2017) and diurnal course of fluxes and environmental drivers over the three years of the study. Note the reduced NEE and GPP in the afternoon during summer, despite estimated ER being higher (which would increase estimated GPP). Note the shorter day length and light intensity in winter. 98% of the data (> 0.01 quantile and < 0.99 quantile) is shown, in order to filter extreme value impacts on color-axis range.

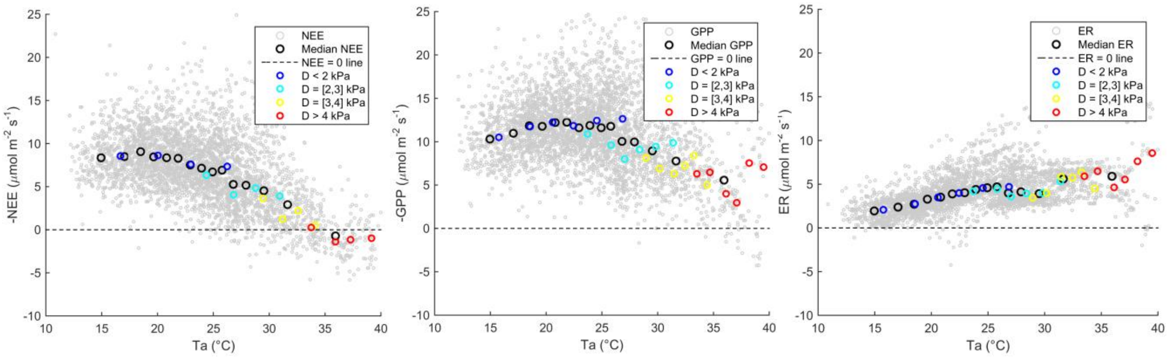

Figure S6 Light-saturated (photosynthetically active radiation (PAR) > 1000 µmol m^{-2} s^{-1}) C-fluxes: net ecosystem exchange (NEE), gross primary productivity (GPP) and ecosystem respiration (ER, from SOLO) versus air temperature. Grey dots are half-hourly measurements; black dots are C-flux for 15 T_a bins of equal sized n; colored dots are C-fluxes for 4 T_a bins within a D bin. Maximum light-saturated GPP rates occur around 22 °C, NEE becomes negative (net C source) at light saturation above 35 °C.

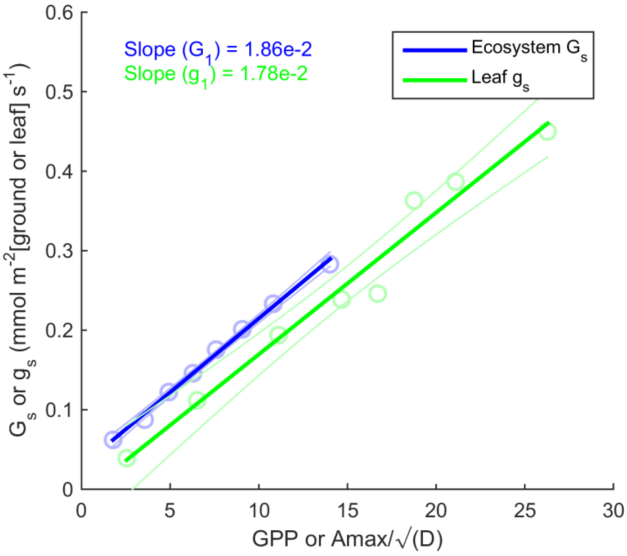

Figure S7 G_s or g_s vs. GPP or Amax/√D (g_1 or G_1 is the slope). Eddy-covariance data filtered out periods after rain events (see surface conductance methods) in order to minimise contribution of soil evaporation to ET. G_s and g_s datasets are binned into 8 bins of equal size. G_s is estimated as ET*P/D. Leaf-level data were measured at a site within 1.5km of the flux tower (Gimeno et al. 2016). Note that leaf level and ecosystem level g_1/G_1 compare well, which is encouraging considering this parameter does not always compare between leaf and ecosystem level (Medlyn et al. 2017).

Gimeno, T. E., K. Y. Crous, J. Cooke, A. P. O'Grady, A. Ósvaldsson, B. E. Medlyn, and D. S. Ellsworth. 2016. Conserved stomatal behaviour under elevated CO2 and varying water availability in a mature woodland. Functional Ecology **30**:700-709.

Medlyn, B. E., M. G. De Kauwe, Y. S. Lin, J. Knauer, R. A. Duursma, C. A. Williams, A. Arneth, R. Clement, P. Isaac, and J. M. Limousin. 2017. How do leaf and ecosystem measures of water-use efficiency compare? New Phytologist.