The authors thank the reviewers for thorough reading and comments to the manuscript. Please find responses to specific comments below.

Note: The authors will add a full year (2017) to the updated manuscript.

Reviewer 2 comment:

Please eliminate the use of the diffusely defined term “atmospheric drought”. A term like “atmospheric demand” is more precise and appropriate.

Response:

Amended.

Reviewer 2 comment:

Is it really true that the canopy height is ~25 m (L105) and the top of the profile and eddy covariance system is 29 m? This is rather close to a tall canopy for an eddy covariance application for observing ecosystem fluxes. A check of the site description is needed, and if indeed these numbers correct, a clearer presentation and discussion of the implications on representativeness of reported fluxes and analyses is in order.

Response:

We agree that our initial statement was misleading, so we used airborne lidar data to inspect the structural canopy properties within the footprint of the flux tower and have done a preliminary analysis the cospectrum of the sonic sensible heat flux to assess any influence of the instrument height above the canopy on the turbulent transport characteristics. We will add a figure that summarizes the canopy structure as a height profile of the frequency of lidar returns to the supplements and amend the canopy description in section 2.1 as follows:

“The flux tower is in a mature dry sclerophyll forest, with 140 Mg C ha_{-1} aboveground biomass and stand density of ~500 trees ha^{-1}. The stand hosts a large population of mistletoe (*Amyema miquelii*), which is decreasing in abundance with increasing distance to the flux tower. The canopy structure comprises three strata, and the predominant canopy tree species are *Eucalyptus moluccana* and *E. fibrosa*. While individual trees can exceed 25 m height, an airborne lidar survey from November 2015 indicates an average canopy height of ~23 m within a 300 m radius of the flux tower (supplement figure). The mid-canopy stratum (5-12 m) is dominated by *Melaleuca decora* and the understory is dominated by *Bursaria spinosa* with various shrubs, forbs, grasses and ferns present in lower abundance.”

Furthermore, we will do an in-depth analysis of the cospectrum and add a quality figure that will meet publication standards of the cospectrum of the sensible heat flux to the supplement. The preliminary cospectrum analysis indicated that the majority of the ensemble-averaged hourly cospectra of the high frequency part (1-10Hz) followed the -4/3 slope, thus we did not find any indications of systematic high frequency dampening in the cospectras. Once the final analysis is concluded we will also update the implications on turbulence characteristics in section 2.4.

Reviewer 2 comment:

Was NDVI measured at the site or was a satellite product used? What was the rationale for using only NDVI versus EVI (or checking both)?

Response:

We used a LANDSAT satellite product. The authors will add an analysis with EVI in the supplements (or in the main document if it adds new insights).

Reviewer 2 comment:

A careful read and editing of the methods (and entire manuscript) is needed to ensure better consistency in the use of terminology and symbols be used. Furthermore, where possible, the use of more common symbols/abbreviations would be helpful. A non-exhaustive list of examples includes:

- F_{CT} and F_{CS} are used to represent the eddy flux and storage flux, respectively (Eq. 1). Then F_c and S_c are used to represent the eddy flux and storage flux, respectively (L136).
- F_N (e.g., L183-184) and R_n (L196) are used alternately to represent net radiation.
- The profile system measured CO_2 "mixing ratios" (L115), then "concentration" is used later (L160-170) with a symbol similar to the "concentrations" referred to in relation to the high frequency density measurements made by the open path IRGA.
- Use Δ or s for the slope of the saturation vapor pressure curve instead of ε
- Use LE or λE for latent heat flux

Response:

We have revised the manuscript and improved the consistency of terminology throughout.

- F_c and S_c → F_{CT} and F_{CS}
- F_n → R_n
- More precision added: CO_2 concentrations were converted to µmol m^{-3} using the ideal gas law.
- Equation (6), equation (8), $\varepsilon \rightarrow \Delta$
- Equation (6), text edits, latent heat flux L → λE
- Equation (7), U → w_s

Reviewer 2 comment:

The sign conventions regarding the directions of fluxes are mixed up in places. For example, in the abstract C sinks carry a positive sign for uptake (L18-19), but later in the text (L264-265) "C sinks" are reported with negative signs. Please carefully review the entire manuscript and ensure consistency throughout regarding sign conventions for fluxes, sinks, and sources.

Response:

We have consistently adopted the usual convention from micro-meteorology, that is C going out of the atmosphere is negative (uptake), and C going into the atmosphere is positive (source).

Reviewer 2 comment:

L111…The LI190SB quantum sensor is calibrated to report PPFD as µmol/m^2/s. Was this then converted to W/m^2? Check the units throughout the manuscript because the reported values for incident PAR in W/m^2 (e.g., L230-231 and 242, Figs. 1 and 3) are not physically possible. Also check to ensure that there was no effect on analyses and it is only an error in the manuscript text.

Response:

There was an error in the manuscript text; PPFD is measured in µmol m^{-2} s^{-1}. This has been corrected throughout the text, equations and figures.

Reviewer 2 comment:

L129-137: If the net ecosystem exchange reduces to the sum of the eddy flux and the storage flux, then don't worry about including advection in the equation. Just state the simplifying assumptions clearly in full in the text. Note that more than just well-developed turbulence (L133-134) is needed to simplify the mass balance on the control volume (e.g., horizontal homogeneity). Please be more complete in this description in the text. Were there any concerns regarding the validity of the simplifying assumptions because of proximity of the EC system to the canopy (as mentioned previously)?

Response:

We deleted the advection terms in equation (1), and added more precision regarding the assumption of negligible advection (quality flag of stationarity and turbulence development test, (Foken et al. 2004)). Relating to a comment above we also added a preliminary analysis of the turbulence characteristics to section 2.4, which will be finalized before submitting the revised manuscript (see response to second comment)

Reviewer 2 comment:

On the calculation of the eddy flux:

- It is more accurate to state that the IRGA measures the (number) densities of CO_2 and water vapor (L142).
- Eq. 2 is not necessary with an adequate description in the text (but if you keep it define primes and the overbar). It's not the most elegant presentation in the current Eq 2…especially since the equation doesn't include the WPL terms, which are needed. Given the maturity of the EC method a text description is fine.
- L148-149. Rephrase: "Fluxes were rotated into the natural wind coordinate system using the double rotation method". Wilczak et al. isn't the best reference for the double rotation. The original is Tanner, C. B. and Thurtell, G. W.: 1969, Anemoclinometer Measurements of Reynolds Stress and Heat Transport in the Atmospheric Surface Layer, University of Wisconsin Tech. Rep., ECOM-66-G22-F, 82 pp. [Available from US Army Electronic Command, Atmospheric Sciences Laboratory, Ft. Huachuca, AZ 85613.] or referencing the chapter in the Handbook of Micrometeorology.
- L149…what time lags? Between the sonic and IRGA?
- L150-151. Block averaging is not a detrending operation.
- Check to make sure that the order of the steps in the description of the flux calculation matches what was actually done (e.g., one of the last items in the description concerns the removal of spikes in raw data, L153).

Response:

- Concentration replaced with number density
- Equation (2) deleted, the text describes the calculation details.
- Amended.
- Amended (yes, time lags between the sonic and IRGA, which are of course much smaller in open-path yet still recommended, due to the physical distance between the two instruments).
- Amended "We applied the block averaging method to calculate each half-hour average and fluctuation relative to the average, to calculate the covariance"
- Amended, 1. Raw data screening (spikes removal …), 2. If 10% data is missing, flux will be flagged NA 3. Rotation 4. Time lags 5. Block average 6. WPL, flux calculation 7. Flags applied

Reviewer 2 comment:

On the calculation of the storage flux:

- A complete description of Eq (4) is lacking (definition of all symbols etc.)

- Why were storage fluxes of water vapor not estimated? Is this a significant source of bias in LE measurements?

Response:

- Amended: added: "Where C is CO_2 (µmol m^{-3}) and t is time (s) ($\Delta C/\Delta t$ is the variation of C over 30 minutes), z is the height (m), k [1 to n = 8] represents each inlet.
- The IRGA used for canopy storage was calibrated for water vapor only starting in 2016. We calculated storage flux of water for 2016, and the contribution of the storage to the total flux of water (turbulent exchange + change in storage) was very low. Therefore we neglected water vapor storage in the current manuscript.

Reviewer 2 comment:

L183. What exactly is specific heat density (SHD)?

Response:

This was a typo, SHD stands for specific humidity deficit.

Reviewer 2 comment:

L188-194. It would be worth presenting a footprint climatology in the supplementary information.

Response:

We will add a footprint climatology to the supplementary information as suggested.

Reviewer 2 comment:

L195-199. Clarify whether closure was forced on the fluxes reported in the results.

Response:

We did not force closure on the fluxes reported, this will be clarified in the text.

Reviewer 2 comment:

L200-210. Why were the turbulent fluxes not substituted for available energy when calculating surface conductance? The spatial representativeness would be better.

Response:

Surface conductance was calculated using the turbulent flux of water vapor coming from transpiration and the net radiation (Eq. 6). We apologise that the notation was not clear in the previous version; this has been corrected.

Reviewer 2 comment:

Eq 7. Check the 2nd term in the denominator on the RHS…the exponent should be -0.67. Add a citation and be sure all terms are defined.

Response:

Amended.

Reviewer 2 comment:

L241-244. The description of leaf-level sampling needs more detail. Since there is a reference that describes these measurements in more detail, the description in this manuscript can be abbreviated, however, a more thorough description of the basics.

- The instrument used
- More details on leaf chamber conditions…were the temps, humidity etc matched to ambient?
- Were sunlit or shaded leaves (or both) measured?
- What species were targeted?

Response:

We removed this section from the methods because we used previously published data; in the results, we provide the citation to the paper as well as the doi for the data (http://dx.doi.org/10.4225/35/55b6e313444ff).

Reviewer 2 comment:

L266-267. "Summer GPP was higher (-460 ± 112 g C m-2) compared to winter GPP (-291 ± 28 g C m-2)": -291 is higher (>) than -460. Check the manuscript for any other discrepancies when comparing magnitude and direction and ensure that the wording is correct.

Response:

Amended: Summer GPP indicated greater uptake (-460 ± 112 g C m^{-2}) compared to winter GPP (-291 ± 28 g C m^{-2}) (Table 1), that is a difference of ~ 169 g C m^{-2}.

Reviewer 2 comment:

L272-278. It looks like there is still hysteresis during winter (albeit less severe than in summer, Figs. 2 and 3). It might be useful to add 2 panels to Fig. 3 and show surface conductance light responses to help with underscoring the importance of stomatal regulation of C fluxes.

Response:

We agree that there is still hysteresis during winter, and will add the panels to Fig. 3 indicating light response of surface conductance as suggested by the reviewer.

Reviewer 2 comment:

L336-337. Is soil respiration in the subsoil really that important to the integral over the whole profile?

Response:

This is a good point. We have measured soil respiration in a nearby site (1.5 km away), showing that soil respiration can be limited in summer when surface soil is dry. This is also seen in the flux data, as shown in figure 1.

Text edit: low soil moisture in the shallow layers sometimes limited decomposition (January and February 2014, January 2015, see Figure 1), but more often shallow soil moisture was not limiting.

Reviewer 2 comment:

L345-356. The paragraph starts out by rather definitively stating that "strong stomatal regulation" was the driver of diurnal hysteresis in NEE during summer and then becomes less clear and murkier. Seems odd to take this approach if it is was found that there was strong stomatal regulation of GPP and NEE. Revise.

Response:

Agreed.

Paragraph entirely revised,

A morning-afternoon hysteresis of NEE response to PPFD occurred in summer, but not in winter (Figure 3). In winter, low D and moderately warm daytime air temperatures and high PPFD were sufficient to maintain high photosynthesis rates throughout most of the day (see Figure 1 for monthly average of daily maximum PPFD, D and T_a). In summer, two possible explanations of the diurnal hysteresis of NEE are (1) ER is greater in the afternoon compared to morning or (2) GPP is lower in the afternoon compared to morning. Explanation (1) is plausible, as temperature drives autotrophic and heterotrophic respiration; however, it is unlikely to explain the hysteresis magnitude which is much higher in summer compared to winter. Explanation (2) could arise from lower afternoon stomatal conductance or lower photosynthetic capacity (e.g. Vcmax decrease above at high T_a), or a combination of both or even circadian regulation (de Dios et al. 2015; Jones et al. 1998). An analysis of surface conductance showed strong stomatal regulation (Figure 2, Figure 5), induced by high atmospheric demand and high air temperature (Duursma et al. 2014), limiting photosynthesis during the afternoon of warm months (see Figure S6). These diurnal patterns of NEE, GPP and ER play a strong role in regulating the seasonal carbon cycling dynamics in this ecosystem.

Reviewer 2 comment:

L357-366. Hard to follow…especially the first sentence. Revise and clarify.

Response:

Agreed.

We revised the first sentence:

We analysed leaf-level and ecosystem level gas exchange response to D and SWC (leaf A_{max} and ecosystem GPP, leaf T and ecosystem ET –filtered for rain events to minimise E, leaf WUE (A_{max}/T) and ecosystem WUE (GPP/ET), leaf g_s and ecosystem G_s). We observed comparable responses (Figure 5).

Reviewer 2 comment:

L367. "Canopy dynamics"…be more specific about what you are referring to.

Response:
Right. We refer to leaf area index. Text amended.

Canopy dynamics → canopy dynamics (specifically, LAI in our analysis)

Reviewer 2 comment:

L390-393. Is the temperature/moisture regime at Cumberland Plain the only difference versus the other sites in eucalyptus forests? Are all the sites at similar ages and stages of succession?

Response:

The authors will gather more information about ages and stages of succession from other sites and add the information in the discussion.

Reviewer 2 comment:

Figs. 2 &. It still looks like there is hysteresis in winter…is it that it is not statistically significant?

Response:

There is a hysteresis in winter, but of lower magnitude. The text has been corrected accordingly.

Reviewer 2 comment:

Fig. 4. Check units for apparent quantum yields (α). These values seem high.

Response:

The units states that the y-axis is multiplied by 10^{-2}, i.e. quantum yields value are around 0.02 (μmol CO_2 μmol $photon^{-1}$), values comparable to (Aubinet et al. 2001, fig. 10). Note that Mitscherlich equation (7) fits the slope to NEE, not to GPP (as in Michaelis-Menten), so the slope account for ER and are bigger.

References:

de Dios, V. R., A. W. Fellows, R. H. Nolan, M. M. Boer, R. A. Bradstock, F. Domingo, and M. L. Goulden, 2015: A semi-mechanistic model for predicting the moisture content of fine litter. *Agricultural and Forest Meteorology*, **203,** 64-73.

Duursma, R. A., and Coauthors, 2014: The peaked response of transpiration rate to vapour pressure deficit in field conditions can be explained by the temperature optimum of photosynthesis. *Agricultural and Forest Meteorology*, **189,** 2-10.

Foken, T., M. Gockede, M. Mauder, L. Mahrt, B. Amiro, and W. Munger, 2004: Post-field data quality control. *Handbook of Micrometeorology: A Guide for Surface Flux Measurement and Analysis*, **29,** 181-208.

Jones, T. L., D. E. Tucker, and D. R. Ort, 1998: Chilling delays circadian pattern of sucrose phosphate synthase and nitrate reductase activity in tomato. *Plant Physiology*, **118,** 149-158.