

## Response to reviewers comments on “An introduction to the Australian and New Zealand flux tower network – OzFlux” by Jason Beringer et al.

Comment by D. Papale (Referee) [darpap@unitus.it](mailto:darpap@unitus.it)

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Beringer and co-authors submitted a nice overview and synthesis of the OzFlux network where its importance is well documented and explained. For the nature and content of the paper however I think that it should be submitted as “Review and synthesis” and not “Research article”. The main limitation in the paper that I think must be addressed is that OzFlux includes both Australia and New Zealand (as also cited by the authors) but the paper is only on Australian sites. This is an important limitation. I can understand that there could be data policy limitations and issues however at least in the general part of the description the New Zealand sites could be added and described. Clearly it would be better if the sites can be added also to the analysis.

- We will work with our colleagues to include all available long term sites in NZ to the data tables and analysis. We will include additional information on the history of the NZ science as well as differences between the two countries within the OzFlux network in terms of climate, instrumentation, etc.. We anticipate to redraw figures as necessary.

Other comments:

- Affiliation 23, the word “Australia” is missing
  - Will correct
- Affiliation 25 is not an affiliation
  - Will remove
- It would be important to stress the unique characteristics (in general) of the Australian sites respect to the rest of FLUXNET and why their contribution is crucial globally.
  - The reviewer raises a good point here so we will take the opportunity to add the following text, “Australian vegetation is quite dissimilar to the northern Hemisphere as a result of continental isolation, tectonic-geological history and climate that results in the dominance of sclerophyllous, evergreen, woody species that do not fit in well with the common global plant functional types as discussed in Peel et al. (2005). The ancient nutrient poor soils of Australia have driven the evolution of woody and sclerophyllous vegetation such as eucalyptus and acacias which are characterized by the presence of small, rigid, long-lived leaves (Peel et al., 2005). The eucalypts and acacias are predominately evergreen broadleaf plant functional types and represent a large fraction of this type globally as represented in global climate models. The OzFlux network is the only source of flux information for the eucalypts and acacias that dominate the continent and, as these life forms are not significantly represented in natural biomes outside Australia, OzFlux is of considerable importance to FluxNet in completely the global picture. These vegetation groups occur primarily in arid and semiarid climates that dominate the Australian landscape (this paper) and provide a crucial source of information in understanding the role of semiarid vegetation in the global carbon cycle (Ahlström et al., 2015; Poulter et al., 2014).
- Line 100: other more recent examples exist respect to Running 1999, I suggest to add them also to better highlight the role of eddy covariance measurements in recent activities.
  - A good suggestion. We will add a number of references covering the breadth of the role of EC in remote sensing better. i.e. (Anav et al., 2015; Moore et al., 2016; Running et al., 1999; Schimel et al., 2015).

- Line 110: you forgot Europe, that is an historical network that together with AmeriFlux were the start of the FLUXNET. . .
  - We didn't intend to make an exhaustive list here but will add one of the most important ones, the European flux network.
- Lines 167-168: it refers to standard protocols that however should be better explained at least with references. The same is valid for the list of common measurements present at all the sites: it would be an important info to add.
  - We refer the reader at this point in the text to the section describing this in the paper documenting the network setup and modify the text as “OzFlux established an agreed set of core measurements and common protocols for measurements of carbon, water and energy fluxes across the national network (see section 3) to provide consistent observations to serve the land surface and ecosystem modelling communities.”
- Lines 174-178: it is not clear which are the tasks specific of the central hub respect to the site managers. Who is doing the quality control and processing – postprocessing?
  - We suggest modifying the text to “The central node implements a centralised database and provides feedback on live data feeds (equipment failure) and measurement quality to site operators. Individual site operators have responsibility for tower operation, data processing and quality control using OzFluxQC, gap filling, post-processing and are then required to deliver data streams to the central database.”
- In the Section 5.2 it could be added the importance of the OzFlux sites also in the empirical upscaling models since they are covering unique climate and vegetation.
  - This is another good point and we will add the following “Finally, flux tower information for Australia has been used in empirical upscaling methods (such as machine learning) that uses gridded satellite information and meteorology to produce global estimates of carbon and water budgets (Jung et al., 2009, 2011). These utilised some of the earlier data from Howard Springs, Tumbarumba and Wallaby Creek in the la Thuile fluxnet database that helped constrain the global uncertainties.”
- I suggest to add the significance of the correlation in figure 5. In addition the use of MODIS LAI should be better evaluated. It is not a measurement and has uncertainty: why not using measured LAI? Or if satellite data are needed why not Vegetation Indexes (direct measurements)?
  - It is not currently straight forward to add the significance to the plot. If this is important then it can be done and we leave this to the editors discretion. Yes we point this out in the paper “Note that the magnitude of LAI from the MODIS LAI product utilised in this paper varies from site based estimates but has been used for consistency.” We make a stronger case for its use in the text as below “Here we use MODIS LAI purely in a relative sense to assess the relative differences in cover and how they may influence the observed fluxes. Many sites have no LAI measurements and some others have ad-hoc measurements over time. In addition, we know that the magnitude of LAI from the MODIS LAI product utilised in this paper varies from site based estimates but has been used for consistency. ”.
- Still on Figure 5, there are mixed the interannual variability and spatial variability. This makes the analysis difficult to interpret because in the network there are sites with long time series and sites with only few years of data. A possible solution could be to redo (or add) the figure using only average multi-year data (analyzing only spatial variability).
  - The review makes a good point about mixing spatial and temporal variability and we were concerned about this. We checked the data used it is was in fact site averaged data so the figure just includes spatial variability. We will keep the figure as is but amend the caption to read ” Simple heat map of Australian OzFlux tower measurements to identify the correlations between fluxes, driving variables and ecosystem indices using all site averaged data for available site years to represent spatial variability.”

- The table 1 is quite large and difficult to read and use. I suggest a more condensed version and the rest probably as supplementary data, better if directly as csv file. I suggest also to report the coordinates of the sites with at least 4 decimal digits: these data will be used by people working in remote sensing and it is important to give the best information available.
  - Will submit the site history information as a supplement.
  - Good idea. We will add further decimal places to the coordinates

## Anonymous Referee #2

The manuscript provides detailed introduction of the background of OzFlux network and its evolution. Synthetic description for various Australian sites is also informative. However, first of all, there is a discrepancy between the title (Australian and New Zealand flux tower network) and the contents (data only from Australian network). I would recommend changing the title to fit the contents such as "the Australian flux tower network". More desirably, the authors could modify discussions significantly including the data from sites located in New Zealand. Otherwise the main discussion would not match the title emphasizing "Australian and New Zealand flux tower network".

- This comment is similar to reviewer 1 and we address that above

Secondly, I would like to encourage the authors to include more target-oriented data analyses. Figures 4-6 express static relationships between meteorological elements and carbon- and water-cycle components, and that would be important basic information. However, the authors could expand their analyses based on their matter of interest expressed in the introduction, for example, risks of fire, disease, management practices and land-use changes under future climate change. Technological advances have also accelerated during the past several years for better regional estimates based on both up-scaled flux-tower data-sets and inversion analyses (I suppose that CSIRO is one of the leading institutes on the topic). How well the Australian tower flux data would contribute to solve some of such issues or improve estimates of regional and global carbon- and water-cycles? I suggest that the authors would show some more new hypothesis or attempts in the manuscript in order to answer such questions using the Australian data-sets. At present, the manuscript includes sufficient information of introduction of Australian flux sites and reviews of their studies, however, original scientific findings are relatively limited.

- Clearly thematic and systematic issues based analyses are crucial in advancing the science and our understanding of Australian ecosystems. However, this is an overview of the network and specific analyses are beyond the scope of this paper. However, these are outlined as future directions and opportunities for the network and will be the focus of OzFlux science in the coming decade. We also already discuss the utility of the flux information for regional modelling and remote-sensing. Moreover, there are a number of papers in the special issue that address these explicitly. We will make better connections to these in the paper.

Specific comments: Pages 4-5 "The role of flux research in Australia": I would recommend referring more papers from Oceania and stating more region-specific issues. In particular, more recent papers would have been published for topics listed in Page 5, lines 93-100.

- More recent references will be given as below. This section is however addressing how EC as a method can address, however, we will rewrite this list as follows:
  - 1) providing accurate, continuous half-hourly to annual estimates of sinks and sources of greenhouse gases and water from ecosystems for carbon accounting and water management that is particularly important in such an arid country as Australia (Hutley et al., 2005; Raupach et al., 2013);

2) evaluating the effects of disturbance, topography, biodiversity, stand age, insect/pathogen infestation and extreme weather on carbon and water fluxes particularly cyclone, fire and heat waves in the Australian environment (Beringer et al., 2014; Bowman et al., 2009; van Gorsel et al., 2016; Hutley et al., 2013);

3) examining the effects of land management practices, such as harvest, fertilisation, irrigation, tillage, thinning, cultivation and clearing, especially agriculture in the region (Bristow et al., 2016; Campbell et al., 2015; Rutledge et al., 2015); and

4) producing important ground-truth data for parameterising, validating, and improving satellite remote sensing and global inversion products (Anav et al., 2015; Moore et al., 2016; Running et al., 1999; Schimel et al., 2015), particularly phenology (Ma et al., 2013; Moore et al., 2016) and water balance.

Pages 12-15 “Biotic and abiotic controls on land-surface exchanges”: This part well describes specific characteristics of Australian surface processes. However, the contents was relatively limited in the past studies and showing only Fig.5. More original and new scientific questions would be desirable to be discussed. For example; were there any long-term trends detected in spatial distribution of each flux, biomass, LAI, species composition, etc.? Since the OzFlux seemed to have a good collaboration with TERN as described in “Introduction”, I would expect that the data and understandings obtained by TERN could be used for interpretation of long-term trends in biotic and abiotic controls on land-surface exchanges.

- We feel that these are best discussed in the section on “Future outlook” and we already have questions posed on drought response and disturbance. The reviewer highlights an important point about long term trends and currently the network is limited in long term sites that have enough years to attribute temporal changes. This is a good suggestion from the reviewer so we will add the following paragraph to the Future outlook section.
  - “While there is no significant influence of temperature on NEP or GPP across Australian biomes the strong dependence of these variables on MAP indicates that even in currently well-watered areas the combined effect of increased temperature and VPD, similar or reduced water availability will potentially place these systems under stress. OzFlux then is well positioned to provide continuous assessment of the long-term condition of these ecosystems and provide early warning across multiple ecosystems of changes in plant performance as the planet moves into the more forceful climate of the Anthropocene. It should be noted that the network is relatively young with only 3 sites with data over 10 years. As such the ability for OzFlux in conjunction with other TERN Facilities to decipher long term trends is currently a limitation that can be improved only with time.”

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