

Interactive comment on “Carbon uptake and water use in woodlands and forests in southern Australia during an extreme heat wave event in the ‘Angry Summer’ of 2012/2013” by Eva van Gorsel et al.

Anonymous Referee #3

Received and published: 4 July 2016

This is a well written paper which adds to the growing body of science detailing the impacts of extreme heat events on terrestrial ecosystems. The authors introduce the story well indicating how the impacts of the extreme summer of 2013 in Australia will fit into the bigger global picture. They have then gone on to explain the finer nuances of just how the heat wave impacted on the southern Australian ecosystems during this period. In the Results and Discussion sections there is a reliance on Figure data rather than Tabular data and from this the presentation of the argument in the text is generally of a qualitative nature – this could be strengthened by putting some numbers in appropriate places. Another area where things fall a little short is in the Discussion

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section where there is little pulling together of the Australian results with related studies from Europe, North America, China to generate a more holistic view of the impacts of these extreme heat events. Comments, suggestions for changes and areas that require some clarification: 1) As a comment: the number of sites in forested systems was $n = 1$. The behavior of this system AU-Tum, was somewhat different to the rest and was also different to the behavior of the European forest systems under this sort of extreme heat event. This wet site may be buffered from the sort of behavior that is usually seen until the soil moisture reserve that the forest can tap into has been reduced. This apparently did not happen during this heat wave until right at the end. The conclusion tells the story as it was for this site but not much can be generalized from this result unless this forest type remains in a wet environment in the future climate or if other temperature forests in southern Australia also have similar soil moisture reserves. 2) For explanation: The background period of hourly measurements that was used as a baseline comparison point for the study was quite short BGH (2/1/2014 – 6/1/2014) when compared with the period of the heat wave 1/1/2013 – 18/1/2013. It was quite understandable that more data was not used from 2014 if there was another event during January but what about January 2015 as this paper was submitted 9th May 2016? The results may not be altered but it would have been much more robust if a mean over 2 years was used or a longer period in 2015 was used rather than a 5 day window that was relatively warm (some sites z-score +1) and where the soil moisture was relatively low (some sites z-score -2) in 2014. 3) Climatology is used rather loosely in the text. Generally it refers to the computed climatology from BIOS2. If we go to the CSIRO website that describes BIOS2 (<http://carbonwaterobservatory.csiro.au/bios2.html>) we get: A library of programs for the download and treatment of inputs (gridded vegetation cover, meteorological data and parameters)... A weather generator for downscaling of meteorological data from daily to hourly. The BIOS2 modelling system computes the current and historical state of the major components of the carbon and water cycles for Australia at a spatial resolution of 0.05° latitude and longitude (~ 5 km), This could have been built into the paper more explicitly so that we understand what we are

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getting – current and historical climate surfaces that are presumably calculated using Australian Bureau of Meteorology field data as primary data. In other places in the tables Climatology refers to the measured data from the flux towers. This needs to be specified more clearly. 4) Figure 2 I find confusing with the precipitation spread over the 3 panels. This would be better on its own as a 4th panel. 5) More needs to be put into the text on how close the various ecosystems were to switching from carbon sinks to sources. There were no numbers for sites to explain which sites switched to sources in Fig. 8 but what was provided indicated some MW site(s) (assuming the color code is brown) were sources in both HW1 and HW2 and some TW site(s) were sources in HW1. If this is correct then it is odd that this story was not developed as this would indicate some of these systems can be pushed over the edge by extreme heat events.

Listed details: P1/L33: BIOS2 to replace CABLE (throughout the text BIOS2 is used, CABLE is a part of this it would appear) P2/L9 : not be sustainable P3/L6: While greenhouse gas emissions generally (NOT climate change) P4/L4: Not really clear at this point how BGC and BGH differ. Spelling out that BGC is Modelled climate/fluxes and BGH are measured climate/fluxes would make it clearer. P4/L4: 2/1/2014 – 6/1/2014 Why was this reference chosen and not the mean from Jan 2014 and Jan 2015? P5/L1: the drier interior P5/L2: >30m as forests. P5/L2: Not sure what is intended here - None of this sites are montane? P5/L20: Is there a reference to ACCESS? P6/L6: Jupyter Notebooks. (otherwise it sounds like a type of hardware) P7/L28: Available energy – suggest providing a definition, this is not as well known as Bowen ratio P7/L29: at MW and TW sites during HW1 but was about the same for HW2 and the TF site. does this mean about the same for MW, TW and TF sites during HW2? P8/L16: to below background conditions in HW2 across the MW sites (?) P8/L18: For the TF site beta increased... P9/L10: pattern for associated P9/L15: heat wave in California.. P10/L4: or that there was little stomatal control of the latent heat flux at this site, This conflicts somewhat with what is written below: (L16) We observed a diurnal asymmetry in GPP at all sites and in all measurement periods. This is expected in ecosystems that exert some degree of stomatal control. (L30) With temperatures clearly above an optimum

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temperature for carbon uptake and VPD exceeding values where stomatal closure can be expected at this site P10/L9: threshold of 0.4 Where does this threshold come from for the site? P10/L31: increased incoming shortwave Suggest using the z-scores for Fsd to indicate the difference to BGH and BGC P10/L32: increased photosynthetically active leaf area likely Is there an indication from MODIS that LAI has changed? You have reported MODIS LAI in Table 1. P11/L7: Figure 8 does not do this justice – what is needed is a Table at the site level. P11/L9: remained carbon sinks during both heat waves periods. This is why a table is needed - need to see that some sites are only just carbon sinks and some are sources. P11/L21: energy balance and therefore in concert with the current environmental conditions this may either mitigate.. (is this what was intended?) P11/L22: In the 'Angry Summer' event the woodland... P11/L28-30: Which of the sites in MW or TW are more at risk? P12/L16: HW1 the latent heat flux at the MW and TW sites was reduced even further. sense here is odd. We jump from the previous paragraph on carbon to this one on LE. ie. reduced even further means ? P12/L17:observed during BGH for the woodland sites. P16/L20: CO2 P18/L30: CO2 P21: F2 Would be better with a 4 panel that shows precipitation. It is confusing seeing rainfall for a TF site on a plot of MW etc. P22:L6 F3 stars denote soil water P23:L5 F4 energy imbalance is presented here and in the table and not discussed in the text. P25:L7 F7 dark green) heat at P26: F8 What does the color coding mean here? P27: FA1 What does the color coding mean here? to the BIOS2 climatology P28: T1 oC P29: T2 N.B. Here climatology means both observed and modelled.

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-183, 2016.

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