

Biogeosciences Discuss., referee comment RC2
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Comment on bg-2021-254

Anonymous Referee #2

Referee comment on "Examining the role of environmental memory in the predictability of carbon and water fluxes across Australian ecosystems" by Jon Crancko Page et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-254-RC2>, 2021

The manuscript "Examining the Role of Environmental Memory in the Predictability

of Carbon and Water Fluxes Across Australian Ecosystems" by Crancko Page and coauthors deals with the crucial topic of ecological memory and how this affects biosphere-atmosphere net CO₂ fluxes and latent heat.

The manuscript builds on Liu et al., 2018, but it's incremental because of the use of different models (i.e., k-mean clustering) and the use of terrestrial biosphere models.

The manuscript is well written. The analysis is well done and robust. The results are fascinating and well discussed. I think this will article provide an exciting contribution, and it will be of great interest for the Biogeoscience journal readership. It's an excellent manuscript.

I found that only one aspect should be improved: a deeper discussion on how the community can modify models to describe the ecological memory better. I found this aspect a bit weak and can be improved.

For the rest, I believe that the manuscript is well done, enjoyable, and scientifically very robust.

I have a few comments I suggest the authors should address:

Line 4: I suggest including what is meant for structural lags: "...structural lags (i.e., ...)"

Line 5: I suggest substituting models with "terrestrial biosphere models" to be specific

Line 10: substitute latent heat with λ

Line 45: In my opinion, this statement critically depends on the timing of the precipitation with respect to the phenological stage. Please consider rephrasing to account for this comment

Line 51: I agree on the vegetation type, but it would be better to be more specific on which aspects and differences between vegetation types can be critical confounding factors (different allocation strategies, height, etc). This would set the ground for the discussion.

Lines 63: "models fail to capture the impact of water stored in reservoirs with longer response times to climate". I think the authors should clarify why models do not describe well the climate impact: missing water table depth, poor description of soil layers and the root profile, etc.

Table 1: I suggest adding the vegetation type

Line 103: If I am not wrong latent heat and net ecosystem exchange are already defined

Line 105: Specify already here the time scale used (i.e., daily data). This information is reported a few paragraphs later. I think it will help the clarity. Also, the assumption of a certain degree of independence between NEE and latent heat would not be valid at hourly data during the daytime, when photosynthesis dominates the signal of NEE, so better to clarify that you are talking about daily data.

Line 115: I see the importance of using the long-term and consistent NDVI data. The authors use NDVI as a phenological and structural proxy. I suggest at least discussing the use of radar data rather than only optical data. For instance, I invite the authors to test Sentinel-1 data rather than MODIS NDVI for a few selected sites or give a perspective beyond the NDVI. Would you please specify which temporal resolution (8-day composite?)? I think it might be a piece of important information for the study of lag effects.

The methodology is sounding. I suggest calculating linear relaxed precipitation instead of using the 15-days rainfall average. Linear relaxed precipitation can be calculated with a backward moving weighted average with 15 days width and weights that linearly decrease along with the window. The result is a pseudo soil moisture time series that might serve the purpose of the analysis better than the 15-days rainfall average.

Finally, the authors assume a Laplace distribution of the error at the daily time scale. There are contrasting reports in the literature, and some suggest that even at half-hourly time-scale, the Laplace distribution is the result of the the superimposition of two gaussian distributions of daytime and nighttime error (e.g. Lasslop et al., 2008), and at daily time scale the error is likely to be gaussian. I don't think this would impact the results, but I think it should be clarified to report all the positions in the literature.

Figure 2 and results section on the sensitivity: The sensitivities should have units if I understood the method. Would you please add them everywhere?

Line 195: Something missing at the end of the sentence?

Line 303: "No clear relationship between lagged responses and the prevailing vegetation at the sites.."

It would be interesting to check that relationship with quantitative vegetation characteristics reported for many OzFlux sites rather than a general statement on the prevailing vegetation. Did the author verify if the average canopy height, C4 fraction, fractional tree cover, rooting depth if known, etc., are possible controlling factors of the lagged response?

Line 350-351: I agree, but I think other potential causes are: 1) lags between respiration and photosynthesis due to transport or relocation of CO₂ and assimilated (Mencuccini, M. and Hölttä 2010), as well as 2) potential rapid dynamic modulation of allocation due to phenology or response to stress.

Line 360: please check the reference

Line 416: typo in 1:94 kPa

Figure 3) and 4). There are double labels for some panels. I find it confusing. I suggest to change it.

Discussion on the terrestrial biosphere models: as mentioned above, I think there is a need to describe better processes that can be improved in models to improve the predictability of the fluxes

References:

Lasslop, G., Reichstein, M., Kattge, J., and Papale D. (2008) Influences of observation errors in eddy flux data on inverse model parameter estimation. *Biogeosciences*, 5, 1311–1324, 2008 www.biogeosciences.net/5/1311/2008/

Liu, Y., Schwalm, C. R., Samuels-Crow, K. E., and Ogle, K.: Ecological Memory of Daily Carbon Exchange across the Globe and Its Importance in Drylands, *Ecology Letters*, 22, 1806–1816, <https://doi.org/10.1111/ele.13363>, 2019.

Mencuccini, M. and Hölttä, T. (2010), The significance of phloem transport for the speed with which canopy photosynthesis and belowground respiration are linked. *New Phytologist*, 185: 189-203. <https://doi.org/10.1111/j.1469-8137.2009.03050.x>