Earth System Dynamics Discussions

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Comment on esd-2021-31

Anonymous Referee #2

Referee comment on "Exploring how groundwater buffers the influence of heatwaves on vegetation function during multi-year droughts" by Mengyuan Mu et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2021-31-RC2, 2021

In this study, Mu et al. evaluate the contribution of groundwater (GW) to vegetation water availability during heatwave and drought events in SE Australia. To do this, they implement a GW scheme in the CABLE land-surface model, and perform factorial simulations constrained by LAI to separate the contribution of GW to evapotranspiration and canopy temperature, which they compare with remote-sensing data.

The manuscript is concisely and clearly written, well structured and appropriately referenced and provides an important contribution to the land-surface modelling community. I find that two aspects could be improved:

(i) After reading the title one would expect a greater focus on the impacts of GW on vegetation functional aspects (assimilation, stomatal conductance, transpiration, growth…), while the manuscript focuses mostly on hydrometeorology. Transpiration differences between the two simulations are only shown in Fig. 2, for 2019, but they could have been included in Fig. 3 and S6, to complement the discussion about the functional aspects. From the model simulations, one could additionally include, assimilation rates, stomatal conductance, NPP, etc. Moreover, the DR experiment is one of the most exciting aspects of the study since it highlights the relevance of the interactions between hydrology and physiology, but it is briefly discussed and shown only in Fig. 6. I find that a deeper analysis of the DR experiment and an additional figure on the impacts of the heatwaves for GW, FD and DR would increase the relevance of the study and better support the discussion around improvements to LSMs.

(ii) one of the key conclusions mentioned in the abstract and sections 4 and 5 is that GW helps sustaining higher transpiration rates in the first 1-2 years of multi-year droughts. However, most figures of the paper, and specifically the one showing transpiration differences, refer to the 2019 event. The figures showing differences between GW and FD for the full period do not separate specifically T from ET. Moreover, even though slightly bigger differences between GW and FD are seen in 2002 (1 year following drought onset) and 2017 (drought start), strong differences are found also in non-drought years, e.g. 2013 (Fig. 3 and S6). I do not think that the results, as currently shown, can support strong conclusions about the duration of the effect of GW on HW effects.

Other comments:

L100: I think dimensional analysis gives the units of Fsoil as m3.m-3/s, or 1/s (to match the other two terms), can you confirm?

L235: "much closer": indeed, but still very far.

L250: can be complemented by a map of root length in CABLE.

L312-317: how much is this threshold dependent on model structure and parameterization? And how does it compare with the same results for the DR experiment?

L325-331: very hard to compare panels a-b with c-d. Can you use a consistent mask?

L339-341: the label of Fig. 6e,f indicates "GW-FD". Can you check? I would find it important to show DR in more figures, as discussed above.

L343: how can one compare panels a,b with g,h in Figure 6?

L375-376: can you support this by separating results per WTD bins rather than simple visual inspection?

L376-377: Where can we see the time-dependence of this response?

L408: specify what feedback is meant here

L448-449: rather than making a general statement, the authors could analyze variables related with the physiological responses (assimilation, stomatal conductance, WUE, NPP) to show that (if) GW matters.

L486: what can we see a figure supporting this conclusion?

L487: the cooling effect is shown only for 2019, correct?

L490: this is not strongly supported by results (comments above)