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Interactive comment on "Global root zone storage capacity from satellite-based evaporation" *by* L. Wang-Erlandsson et al.

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We are grateful for the constructive comments and shared insights, and would here like to respond to Axel Kleidon's comments. Below, Axel Kleidon's comments are in bold and our responses are in upright font. We refer to the manuscript for explanations of variable names and abbreviations.

Page 4-6: The introduction contains a nice review of the different methodologies. I think for what you describe as the "root distribution modelling approach" is more appropriately labeled an "optimization/maximization approach", as it infers rooting properties from some ecological cost function. Also, Kleidon and Heimann 1998 did not use an inverse approach, but an optimization approach, even though in a highly simplified way and without the use of an explicit root

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distribution, so it may be better to refer to such a class of "optimization" approaches.

This is a great suggestion. We will re-label the "root distribution modelling approach" as "optimisation approach". We will also move the reference Kleidon and Heimann 1998 to the "optimisation approach" category.

page 7, line 10: I think more relevant is here a link to cost-benefit type of analysis rather than evolution. It may be appropriate to refer to the classic book edited by Givnish "On the economy of plant form and functioning" by Cambridge University Press.

Gao et al., (2014) emphasised the role of co-evolution of climate, ecosystems, and hydrology. In a way, cost-benefit strategy of plants is a result of evolution. Thank you for the reference suggestion. It is a seminal book, which we will refer to here. We will replace the original statement:

"Their results suggested that ecosystems develop their root zone storage capacity to deal with droughts with specific return periods, beyond which the costs of carbon allocation to roots are too high from an evolutionary point of view."

with the following:

"Their results suggested that ecosystems develop their root zone storage capacity to deal with droughts with specific return periods, beyond which the costs of carbon allocation to roots are too high from the perspective of the plants. This resonates well with past economic analyses of plant behaviour and traits, e.g. Givnish, (1986)."

page 10, line 14: "in any measureable way" sounds rather strong. Perhaps better to say that it only affects results to a small extent?

The statement on D reset is an error that slipped through. The resetting was first introduced when we allowed accumulation to persist for two years, but we later changed this threshold to three years. In fact, we do not reset any grid cells when the threshold

of persistent D accumulation years is set to three years. We will delete the sentences "In addition, D is reset to zero by the end of a three years period in a few grid cells where D accumulation persist for three years or more. Such increases are likely the effect of lateral supply of water, or reflect erroneous combinations of P and E. The resetting of this limited number of pixels does not affect the outcome of this study in any measureable way."

page 12, line 12: It would be nice to see how well the two formulations of the stress function compare to each other. Can you show this in a figure?

we have decided to change the soil moisture stress function in STEAM in order to remove the arbitrariness of picking a parameter. Instead of the soil moisture stress function taken from (Matsumoto et al., 2008), we now use a soil moisture stress function that takes the shape of (van Genuchten, 1980)'s function for dimensionless water content:

$$f(S) = \frac{S}{S_R} \tag{1}$$

We add a comparison to the Supplement showing the differences between STEAM using the Matsumoto function and the van Genuchten function.

page 14, line 14: "electro-magnetic spectrum". do you mean different wavelengths/bands?

Electro-magnetic spectra are described by wavelength, frequency, and photon energy. In this context, both electro-magnetic spectrum and wavelength can be used. Since we in the subsequent sentences refer to regions in the electro-magnetic spectrum (i.e., visible, infrared), we considered it more appropriate to refer to the electro-magnetic spectrum.

page 16, line 14: "wind speed in two directions" really? If so, why do you use

both directions? Or do you use the two measurements to calculate wind speed?

ERA-Interim wind speed vector fields are provided in two components. We will revise this to the following for clarity: "wind speed vector fields (zonal and meridional components) at 10m height"

page 18, lines 4-11/Figure 4: the correspondence (or disagreements) between the data sets would be easier to see in a scatterplot, where the different data sets are compared at a grid-by-grid scale. How well they correspond is then reflected by the slope of the regression as well as the r2 value. It is probably not necessary to show all scatterplots (or add them as supplementary), but I think this type of analysis would really help to identify how well the different data sets compare to each other.

Great suggestion, we will add comparison scatter plots to the Supplementary Information.

page 18, lines 12-28: In the discussion of the differences, it is also important to note that these datasets may use different climate data sets, particularly precipitation. Also, Kleidon (2004) calculated evaporation in a quite simple way, which also is likely to result in differences. What this means is that the differences may not simply reflect on different ways to infer rooting properties, but there is also a component related to the forcing datasets which is difficult to quantify.

Agree, we add:

"Nevertheless, different input data were also used in the different studies. Thus, it is difficult to attribute the variations in root zone storage capacity estimates to differences in methods or differences in input data."

page 25, line 2: Note that for the effect of climate change, it also depends on the ability of vegetation to adapt to altered conditions. This aspect should be mentioned.

Agree, we add: "...depending on the adaptability of vegetation to altered conditions."

page 38, Figure 1: This figure nicely illustrates the concept. I think it could be made even better if you show the integrated fluxes of Fin-Fout over time in a separate plot above the panel where you show the bins.

Good idea. We now show the integrated fluxes over time above the panel of bins in Figure 1, see below.

page 40, Figure 3: Start the caption more descriptive with something like "Estimates of root zone storage capacity of the ...". You may also want to use the same color scale in panel (c) as in Fig. 4 to facilitate comparison?

We will adopt the same color scale and revise the caption as follows: "Root zone storage capacity estimates of (a) $S_{\mathrm{R,CHIRPS\text{-}CSM}}\cdots$"

page 43, Figure 6: I find the differences difficult to see. It may be easier to attribute the differences when you use only a few discrete color values with less than 8 shadings so that one more clearly associate the differences in a region with the values. (also applies to other plots)

We will use discrete colour values in the revised manuscript.

1 References

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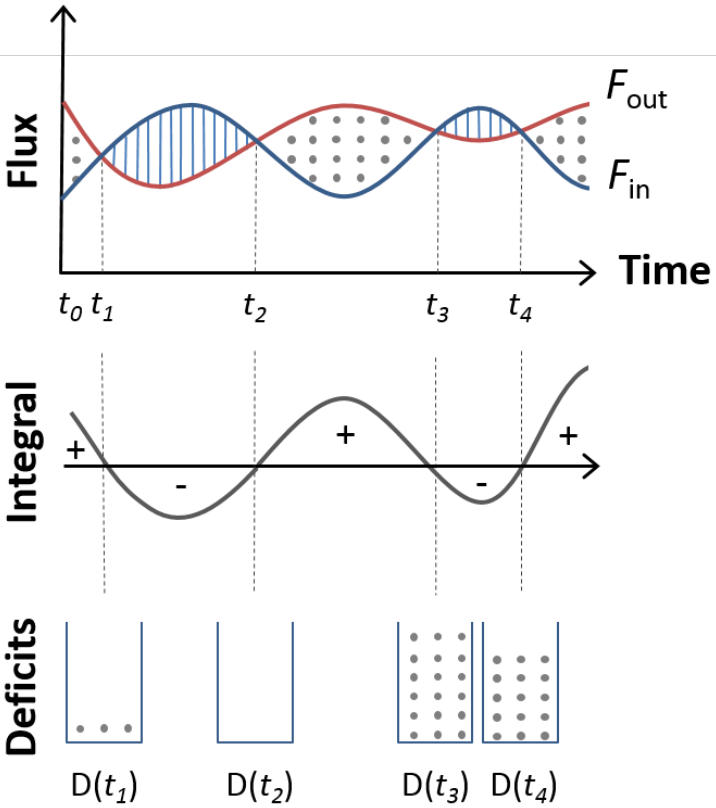

Fig. 1. Conceptual illustration of the algorithm for calculating the root zone storage capacity.

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