The authors highlight the importance of the root zone in different disciplines, reviewing the concepts that can be easily confused with it and the methods used to estimate it. Although I am convinced of the importance of understanding the processes occurring in the root zone to advance in the solution of a wide variety of problems of high research interest, I do not see a clear objective in this manuscript. The authors mentioned a possible confusion in defining the root zone but did not contrast them or show examples. Most importantly, they did not define the root zone clearly but posed many "root zone is not". Besides, I did not find clearly which type of article this manuscript pretends to be since it is not detailed enough to be a review and is too general to be a perspective or opinion paper. In my opinion, the manuscript will be highly improved if the authors delineate the intention of the paper and focus on describing and discussing it. If the objective is to provide a unique and clear definition of the root zone, the structure and much of the information written in the manuscript could be inadequate. If the objective is to claim a holistic perspective for calculating the root zone, it should be better described this perspective and compared with the reductionist one. Moreover, I found several affirmations confusing, repetitive and not adequately referenced, and most of the figures were not well connected to the text. Please see the attached pdf for more details.
Reply: We thank Anonymous Referee #2's endorsement for the "importance" and "high research interest" of this paper. There are three objectives of this manuscript: 1) provide a holistic definition of the root zone; 2) define the root zone as a living, evolving, adapting and most essential part of the Earth system; 3) advocate for a shift from the traditional reductionist approach towards a holistic ecosystem-centered perspective that offers a more realistic, simplified, and dynamic representation of the root zone in Earth system science.
In the revision, we will give a clear definition of the root zone, and meanwhile further sharpen our argument on our proposed holistic method to estimate root zone spatial and temporal variations.

Major comments:
- The abstract does not include the results or conclusions of the manuscript. Having the "correct" definition of the root zone would be helpful.
We shall give a clear definition of the root zone.

- In the introduction, I expect more development of the need to clarify the definition of the root zone and the problems resulting from using different definitions.
We shall clarify the problems of using erroneous root zone definitions and provide a clear definition of the root zone.

- L116. Please explain Sumax better. What do the authors mean by "maximum water deficit in the root zone"? What is a maximum water deficit? Furthermore, it is not clear to me how this can happen when all the available water has been consumed after a critical period of drought. What is a critical drought period? I understand the water storage capacity as the volume of water that the root zone can contain (Rodríguez-Iturbe & Porporato 2004).
Indeed, the root zone storage capacity is the accessible volume of water that the root zone can contain. We shall cite the paper by R-I and P.

- L245-L247. It is not clear how the figure shows that. Consider numbering the different panels in the figure and associating them with what they are intended to indicate.

We will add more description about Figure 5 in its caption.

- L356. Is De Roo et al. The last quantification? It was made 30 years ago.
We will use more recent references, e.g. Zhong et al. (2022).
Zhong, F., Jiang, S., van Dijk, A. I. J. M., Ren, L., Schellekens, J., and Miralles, D. G.: Revisiting large-scale interception patterns constrained by a synthesis of global experimental data, Hydrol. Earth Syst. Sci., 26, 5647–5667, https://doi.org/10.5194/hess-26-5647-2022, 2022.

- L369. Is it possible to make this very general statement? Wouldn't the importance of the site and its conditions depend?
Before this sentence, we discussed the results of global calculation, which is a quite general statement. But as Anonymous Referee #2 said, this could be site- and condition-specific. Generally, soil evaporation plays a more important role in arid rather than in humid regions. We shall clarify that and improve the narrative here.

- L428-L429. What do the authors mean by "Changes in the root zone are generally cumulative, which may be introduced by slow, gradual or abrupt changes." Please be more specific.
What we meant to express here is that the root zone has a memory (cf. van Oorschot et al. 2021,2024), and the water deficit is cumulative. All changes, irrespective of their time scale and thus including slow, gradual or abrupt changes, will eventually be accumulated in the root zone storage. We will improve this sentence, and make it more specific.

- L437. Please elaborate in more detail why ecosystems can increase their Sumax while reducing tree cover.
This is a trade-off between above ground and belowground biomass in a water-stressed ecosystem. With limited rainfall and increasing water-stress, vegetation may allocate more biomass to the root zone, and simultaneously shed leaves in order to avoid water loss through transpiration. More details can be found in Singh et al. (2020).
Singh, C., Wang-Erlandsson, L., Fetzer, I., Rockstroem, J., and van der Ent, R.: Rootzone storage capacity reveals drought coping strategies along rainforest-savanna transitions, Environ. Res. Lett., 15, https://doi.org/10.1088/1748-9326/abc377, 2020.

- L455. Not in all cases, some ecosystems are currently emitting more CO2 than they assimilate. Please provide references.
We shall modify and add references.

- L458. Please elaborate if carbon in the root zone has the greatest uncertainty, how is it possible to claim that it has a large influence on carbon neutrality and sequestration?
There is consensus that the root zone has a large carbon stock, but its specific amount is highly uncertain. Due to its large stock, a relatively small variation may have an important influence on the absolute value, the carbon neutrality and sequestration, even allowing for uncertainty.

- L603. How large is the difference?
We shall add more specific numbers here.

- Figures. In general, the figures show much more information than what is considered and described in the text. Their link and appearance in the manuscript do not seem clear to me.
We shall present more information about the figures in the captions and in the main text.

Minor comments:
Abstract
- Since this is a specialised magazine, I suggest eliminating the words in parentheses (water, soil, etc.). The same goes for the expression "water-centered perspective."
Will modify.

Introduction
- L72. Homogenize micro-biotic (microbiotic) and macro-biotic (macrobiotic).
Will modify.

- L87. What do the authors mean by "different reasons"? Please be more specific.
We meant "for different research and application purposes". Will modify.

Section 2
- L98. Storage of water. Moisture is a relationship or ratio.
Both the absolute value and ratio are difficult to determine. Will make changes.

- L115. Why "reversely"?
Will change to "similarly".

- L120. Sumax is a variable, not a parameter.
This is an interesting point. In hydrology and land surface models, Sumax describes a vegetation controlled property of the subsurface in terrestrial systems and defines the *maximum* subsurface water volume accessible to roots of vegetation and is at the time scales of typical water management problems typically treated as a parameter in these models (fixed in time). But in an "alive model" with long term evolution, it is changing in response to climate variability and human intervention, and therefore becomes a variable.

Section 3
- L147. Is the root zone the only one that determines the ecosystem's resilience to droughts and climate change?
Except for the root zone storage capacity, there are other properties that affect the resilience of an ecosystem, such as changing the composition of species in the ecosystem, but also adjustment of species themselves, such as by the shape of the leaves and stomata distribution and regulation. There is ample indication that the root zone of ecosystems can react relatively fast to climate change, and determines the roots water uptake to overcome droughts, thus we believe "determines" is a proper word. But we shall expand on this issue in the revised version.

- L148. What about nutrient availability?

Under natural condition, nutrient availability itself is also a result of long-time coevolution between ecosystem and climate, geology and topography.

- L149. As it is a specialized journal, I do not think it is necessary to define “vegetation”.
This is not a definition of “vegetation”, but we emphasize: 1) that it does not refer to an individual plant; 2) that “present at any moment” indicates that it is the result of adaptation.

- L151-L156. Please provide appropriate references.
Will add references.

- L168. It is not necessary/possible to sample all trees. Isn't it better to compare in terms of species?
This sentence intends to demonstrate that “we have very limited knowledge of the root system”.

- L181. Please provide appropriate references.
Will add references.

- L185. What do the authors mean by “accidental discoveries”?
It firstly means “>70-m-deep roots in wells and >20-m-deep roots in caves” rarely occurred in observation. Secondly, it means these discoveries are revealed not by rigorous scientific studies , but by casual observations

- L186. Please specify which type of flexibility the authors refer to.
The flexibility of rooting depth to its environment.

- L184-L186. Please provide appropriate references.
Will add references.

- L195-L205. I found this paragraph repetitive.
Agreed, we will make a clearer structure.

- L215-L216. Please provide appropriate references.
Will add references.

- L232-L236. Consider to rewrite this paragraph.
Will modify.

- L238-L239. Please provide appropriate references.
Will add references.

- L259-L260. Why is this sentence quoted?
This quoted sentence is from the literature of National Research Council in the US.

- L270-L271. What do the authors mean by “precipitation of moisture”? Do they mean rainfall? Moisture cannot precipitate.

Will change to “precipitation”.

- L275. What do the authors mean by “are to a larger or lesser extent”? Please be specific.
The amount of water in the root zone, to a larger extent, dominates vegetation transpiration rainfall infiltration into soil, and percolation into deeper groundwater. To a lesser extent, root zone moisture influences infiltration excess overland flow to the drain.

- L276. Yes, it has been widely studied. Consider to review the work by I. Rodríguez-Iturbe.
Will do that.

- L280. Figure 6 does not indicate that.
We will add more description about Figure 6 in the main text and its caption.

- L297. I don't agree that it's always mainly driven by topography. Please provide references.
Agreed. We will tone this down and we will also add some references on the variable contributing area theory and observations.

- L297. What do the authors mean by “runoff threshold has a spatial distribution function”? That is confusing. Runoff can vary in space and that variation can be represented by a function.
We mean that to generate runoff water storage thresholds need to be overcome. These storage thresholds can and do vary in space. We will rephrase that statement.

- L298-L299. This sentence is not clear. Please indicate first what.
Will rephrase this sentence.

- L301-L302. Is called by who? Please provide the references.
This is a classic runoff generation theory, and widely used in hydrological modeling studies. Will add this reference.
Ambroise, B. Variable ‘active’ versus ‘contributing’ areas or periods: a necessary distinction. Hydrol. Process. 18, 1149–1155 (2004)

- L304. Is P intensity, depth, frequency? Precipitation can be quantified with different variables.
P represents the amount of precipitation in a given time t.

- L305-L306. In Gao et al, 2017 beta is defined as a parameter of the storage capacity curve function. It determines the shape of this curve.
Will add more references from HBV, Xinanjiang, and FLEX model etc.

- L313-L314. Please define “matrix infiltration capacity” and “preferential infiltration capacity”.
There are two types of land surface infiltration processes, i.e. matrix flow and preferential flow. Infiltration capacity is the root zone’s property determining the infiltration rate of rain water, controlled by matrix infiltration capacity in homogenous soil materials, and preferential infiltration capacity in heterogenous conditions characteristic of soils with roots and rocks.

- L335. Please differentiate between superficial and depth runoff..
I cannot understand this question. If I take it right, the Reviewer wants us to differentiate between surface runoff and subsurface runoff. We will do that in revision.

- L344. Are the authors referring to flow in streams?
Yes, runoff is the flow in streams.

- L351-L355. Please provide appropriate references.
Will add references.

- L376-L377. Please provide appropriate references.
Will add references.

- L387. Why “inversely”?
We will rephrase this sentence and its previous one.

- L400-L402. Please clarify this sentence.
Will clarity it.

- L407. What do the authors mean by “climate change”? That is very general.
We believe the reviewer meant L417. Climate change mostly means global warming, but also includes other changes, such as precipitation, snow cover, radiation, albedo etc. All these changes in climatic variables will impact active layer thaws in permafrost region.

Section 4
- L425. The upper boundary is the atmosphere not climate.
Climate refers to atmospheric changes, and “has the dominant impact on root zone dynamics”. Thus, we prefer to use “climate”.

- L427-L428. That is not such general. Please provide the references.
Will clarify it, and provide references.

- L433-L435. Please provide the link between this statement and the manuscript.
This statement is very relevant to the manuscript. The transition patterns across tropics and subtropics found by Singh et al. (2020) provide a potential option to infer temporal root zone trajectories in future climate change, with the “space-for-time” assumption.

- L435. What do the authors mean by “By comparing Sumax with aboveground tree cover”? This sentence is not clear.
We will rephrase this sentence as “By comparing belowground Sumax with aboveground leaf area index (LAI)”.

- L436. Please specify which type of transitions the authors are referring to.
We referred to “rainforest-savanna transitions”.