

## Revised manuscript and author's replies to reviewers

We thank the anonymous referee #2 ("AR2") for his/her review, the intensive examination of our manuscript and the interactive discussion. As proposed earlier, we will give a point by point response to AR2s referee comments in the following.

### Anonymous Referee #2, Interactive Comment 1, General Comments

*" Over all, this article shows certain progress of root water uptake models. During discussions, author correspond various comments in consciously."*

The main purpose of our study was to investigate, to what extent different parameterizations of root hydraulic properties in entire root systems influence basic efficiency criteria in terms of "benefits" and "costs" as well as spatiotemporal root water uptake dynamics. Although we believe our results may be useful identifying likely parameterizations, it was not our primary goal to model "real" root water uptake of a specific plant.

### Anonymous Referee #2, Comment 1, Specific Comments

#### **RC1**

*"How to evaluate the accuracy of this model? Author introduced "water yield" and "effort". Reader would confuse of reproducibility of water yield and effort. Author did not show enough information on the observation of those functions. If author did not show them, this model would be just a model."*

Our model, similarly as other three-dimensional models, is to conceptualize the complex processes of root water uptake, which are difficult to measure (Dunbabin et al., 2013). One important but largely unknown set of input parameters to root water uptake models are the local root hydraulic properties, which alter depending on plant age and maturation. Our study aims at distinguishing likely root hydraulic parameterizations from unlikely ones (including homogeneous parameterizations) with the help of two efficiency criteria. As such, the scope of our model is in exploring complex interaction of the soil-root system, not in reproducing actual root water uptake patterns, e.g. of a controlled experiment. This is similar to other applications of complex three-dimensional models (i.e. Couvreur et al. 2014). We understand that it is important to point this out clearly in the manuscript and we emphasized in the revised manuscript that our study is more an exploratory approach, which serves to evaluate the principal influence of heterogeneity on root water uptake dynamics and its efficiency in a systematic manner.

**New:** This modelling study aims at describing and assessing the combined role of heterogeneity of root hydraulic properties and branching topology on root water uptake

1 dynamics. We also investigate their relation to the spatiotemporal evolution of xylem  
2 water potential, the overall efficiency of root water uptake and microscopic and  
3 macroscopic water relations including hydraulic lift.  
4

5  
6 **RC2**

7  
8 *"Root geometry: Is this model able to apply to represent water uptake of*  
9 *actual plant? For instance, in Figure 7, author sowed the root water*  
10 *uptake dynamics in fixed root geometry. What kind of plant did you*  
11 *imagine? Some plants have young roots mainly in upper region, where*  
12 *near ground surface"*  
13

14 As mentioned above, we did not aim to predict actual root water uptake of a specific  
15 plant. Instead, we wanted to elucidate one major problem that prevents researchers from  
16 applying three dimensional root water uptake models on such purposes: The actual  
17 distribution of root hydraulic properties in root systems is still largely unknown. For what  
18 is more, to our knowledge no systematic studies on the influence of varying  
19 heterogeneous root hydraulic properties on root water uptake dynamics have been  
20 conducted before.  
21

22 Within our simulations we varied the hydraulic properties within one fixed root  
23 geometry, corresponding to a 28 d old sorghum plant (see also Sect. 2.3 of our  
24 manuscript). Some of our parameterizations are likely to be unrealistic, because we  
25 varied the fraction of young roots between 0 and 100 %. Furthermore we do not consider  
26 any other information about root age, branching order or the distances from the collar or  
27 branching points. We only ensure that root tips always correspond to the youngest part of  
28 the root system. We make these partly unrealistic assumptions as we are only interested  
29 in the effects caused by varying root hydraulic properties (see Sect. 2.3 of our  
30 manuscript).  
31

32  
33 **RC3**

34  
35 *"Unit In Table 2, "saturated soil water conductivity" should be*  
36 *"saturated hydraulic conductivity". And author should not use micro but*  
37 *10<sup>-6</sup> (ten powered by minus one)"*  
38

39 We changed this accordingly.