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Hydrology and Earth System Sciences Discussions
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Interactive comment on "Root growth, water uptake, and sap flow of winter wheat in response to different soil water availability" *by* Gaochao Cai et al.

Anonymous Referee #2

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This paper compares the performance of two root water uptake models against a field dataset of soil water contents/potentials and sap flow measured in two contrasting soil types for three different watering regimes. The dataset is comprehensive, the model application has been performed carefully, and the results are also very interesting. The paper should make a valuable contribution to the literature on this important topic.

One concern I have is that the methods are not fully described. Firstly, the water uptake models themselves are not well explained. The equations are given, but the readers are given no indication of how they have been derived. The authors should explain that although it is physics-based, the C model is an approximate solution to

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Discussion paper

a 3D root architecture model that does involve some assumptions and simplifications. For completeness, these should be stated. For the empirical FJ model, the authors should give some background information on what the main functions and parameters in the models are supposed to reflect (there is actually some physical basis to the model). Similarly, although a detailed description is not necessary, the authors should at least mention the basic principles of the method they used to calibrate the model parameters.

The authors emphasize that one important advantage of the physics-based C model is that it accounts for the effects of total root conductance (or root length) on uptake, whereas the empirical (phenomenological) FJ model only considers a relative root distribution. This is certainly true of the way the FJ model was originally formulated and is still mostly used. However, I think the authors should mention in the paper that the analysis in Jarvis (2011) shows that the compensation parameter omega_c in the FJ model should be dependent on the ratio of the potential transpiration rate to the total root length/conductance. From this point of view, it would have been better to calibrate omega_c separately for each combination of soil type and watering treatment. The derived values could then have been compared with the measured LAI/root length ratios. With a smaller LAI/root length ratio, the covered treatment (especially in the stony soil) should have smaller omega_c values. This could also have given better simulations of the sap flow data. This lumping of the treatments might also explain why the calibration of the FJ model seemed to suffer from poorly defined parameters (equifinality) and also why the overall calibrated omega_c values were 0.95 at both sites, which implies that virtually no compensation occurred. This result should also be discussed in the paper in light of the above points, because otherwise it might seem very surprising to the reader given the drought conditions that were induced in the covered treatment. Of course, ideally, model parameters should be constant! But in this case, I think it could help understanding to explore and discuss why omega_c might not be constant.

Specific (minor) comments

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Abstract, Line 15 (and Page 10, lines 4-14): this result is only shown in the supplementary. If it is important enough to mention in the abstract, then it should be shown in the paper itself.

Page 4, line 10: how close? Please give the exact distance.

Page 4, line 18: Are these rainfall totals, not precipitation? You need to be careful about the choice of words here, because of the irrigation supplied to some plots.

Page 6, line 28: some brief details of the method are needed here.

Page 7, lines 25-32: you could also discuss the effects of water treatment on LAI here. LAI may be more directly related to potential transpiration than above-ground biomass?

Page 8, line 22: “above-ground”

Page 8, lines 30-31: better to replace “stimulated” by “restricted” and swop “silty” and “stony”

Figure 10: perhaps this should be split into two figures?

Reference

Jarvis, N.J. 2011. Simple physics-based models of compensatory plant water uptake: concepts and eco-hydrological consequences. Hydrology and Earth System Sciences, 15, 3431-3446.

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