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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Impact of capillary rise and recirculation on crop yields" *by* Joop Kroes et al.

Anonymous Referee #2

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In this manuscript, the authors quantify the impact of capillary rise and water vertical recirculation on yield through simulations with the software SWAP. The model is calibrated for maize, grassland and potato over several years and places throughout the Netherlands. In order to isolate the respective impact of capillary rise from the groundwater, and water recirculation, the simulation boundary condition is modified from average fluctuating groundwater ("Ave") to free drainage ("FDrc") to free drainage with no upward water recirculation at the lower limit of the root zone ("FDnc").

General comments:

The paper is well written and the tables and figures are clear. However, substantial effort would be necessary improve the methods and properly discuss the results in light of the existing literature.

Throughout the introduction, the authors make the points (i) that capillary rise and recirculation are different things, (ii) that they both contribute to crop yield, (iii) that a significant part of crop models use a "bucket approach" to soil water storage (with no capillary rise/recirculation), and (iv) that capillary rise and recirculation should be included in crop models as they significantly contribute to yield. I think that the latter point is of great interest (does this extra process significantly improve the predictive power of the crop model?), and demonstrating it for several crops and soils seems to be the core idea of the paper. Here I have a first major concern because such a demonstration would necessitate comparing the accuracy of yields predicted with the bucket approach versus the proposed approach, which was not properly done in this study and would imply quite substantial additions to the manuscript. Among other additions: both approaches would need independent calibrations; the validation stage should involve an independent partition of the observed data (not already used in the calibration stage); proper statistical analyses should be used to determine if the added process and parameters significantly improve the predicted yield.

My second major concern is that the description of the methods is rather incomplete, as central elements of the study are not presented. How is the numerical method blocking recirculation implemented? What is the domain vertical discretization? How is yield affected by water limitation in SWAP (provide at least a couple of sentences)? How were the 72 sets of Mualem – van Genuchten parameters obtained (e.g. artificial neural network, pedotransfer function, etc.)?

In the results, the authors (i) claim that the differences between simulated and observed yields are within acceptable range, and then (ii) use simulated yields to draw more general conclusions on the relative contribution of upward water flow to yield. My third major concern is that the quality of the yield model is not as good as suggested by the mean error indicator, which is the indicator mostly referred to throughout the results and discussion. In the mean error indicator, positive and negative errors cancel each other, so that a model with random predictions but the same average value as the

average observation would have a null mean error. Hence, the mean error is not such a good model quality indicator. In Table 2, 4 out of 5 Nash-Sutcliffe indices for yield are below zero, which suggests that the yield model is not accurate. Furthermore, the yield model root mean square errors (10% to 25%) exceed the yield model sensitivity to upward flow (2% to 22% in Table 3). Given the low certainty on yield predictions, I do not think that the impact of upward flow on yield can be discussed with confidence.

Specific comments:

Title: The title should mention that the paper presents simulated results. I think that "Impact of capillary rise and recirculation on simulated crop yields in SWAP" would be more representative of the current content of the manuscript.

Line 31 (L31): It is unclear what the unit "a" represents. Time units are year and season throughout the paper, but it does not seem to correspond to any of them.

L137: The chosen time step is one day, which seems inappropriate considering that recirculation reportedly varies largely within a day-night cycle [Li et al., 2002; Guderle and Hildebrandt, 2015]. How does the chosen time step affect the quantified recirculation? It should be discussed, and could easily be tested in the model I guess. Yet, at line 269 the authors mention variable time steps lower than a day. Please clarify from the beginning.

L183: Feddes et al. [1978] stress function and Jarvis [1989] compensation function are known to be entangled in such a way that they simultaneously affect plant water stress [Javaux et al., 2013], and thus (I guess) yield in SWAP. However, only Feddes et al. [1978] stress function parameters are presented in Table 1. Please provide compensation parameters too.

L252 and many other places: The term "upward flow" is ambiguous as capillary rise and upward recirculation are both upward flow. Please clarify if one of them, or both, is/are concerned.

L409-L434: Please use references to support your claims.

Typos:

L96: "ss"?

References:

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