Precipitation patterns and moisture fluxes in a sandy, tropical environment with a shallow water table
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Author reply to open discussion reviews.

We appreciate the comments from the reviewers and the opportunity to use this feedback to improve the clarity and quality of the paper. In this response, we address each of the reviewers' comments directly and outline how we plan to change the manuscript accordingly.

There is one major change that affects multiple reviewer concerns. Specifically, we will better leverage the numerical model as a tool to understand vertical moisture fluxes through the vadose zone. We will use it to provide insight into fluxes that lead to recharge rather than just focusing on moisture content changes. This additional piece will provide a direct tie between moisture content changes and moisture fluxes, and will strengthen the overall quality of the manuscript.

In addition, we will make changes throughout the document to help clarify the main points and to address other reviewer concerns. Please find our responses below to each specific reviewer comment.

General comments from Anonymous Reviewer #1:

1. **Reviewer's comment:** The simple data analysis revealed all the important and constructive results, while the modeling exercise is not very convincing and adds very little (reading the abstract after reading the paper, I haven't found any result or conclusion in it that was concluded from the model simulations, and haven't been clearly demonstrated before).

   Authors' response: The modeling experiments can provide a very useful supplement to the field observations. We did not, however, take full advantage of this in the initial manuscript submitted. The addition of figures and a related discussion demonstrating the links between the moisture content patterns and moisture movement through the vadose zone (as described in introductory comment above) should address the reviewer's concern. When making the revision, however, we will keep the reviewer's concern in mind, and remove modeling results that do not seem to make a new contribution that goes beyond results from the field observations.

2. **Reviewer's comment:** From the abstract it appears the study aims at the analysis of recharge, yet there are no calculations or estimations of recharge fluxes in the manuscript. I suggest being more accurate both in the abstract and title and not use " moisture fluxes" which are not calculated in this work .

$\Delta\theta$ events at 0.5 m are associated with high recharge but the two shouldn't be mixed. Recharge fluxes can be significant also in steady water contents.

Authors' response: We plan to include two classes of changes to address this comment (as well as others). First, we will re-word the abstract and other sections of the paper to clarify what the results say about moisture content changes versus what we can say about moisture fluxes and recharge. Second, as the reviewer points out, this paper focuses on changes in shallow moisture content. While that is associated with percolation of soil moisture and recharge rates, that connection is not made explicitly in the submitted manuscript. We plan to change that. As stated above (see introductory comment), we will use the model simulations to demonstrate the link between moisture content changes and percolation of soil moisture in this environment. This modification should address the reviewers' second comment.

3. **Reviewer's comment:** I assume some data on depth to water-table is available or at least can be estimated from data from nearby locations. It would have been better to introduce the reader to such data rather than only use depth to water-table in simulations to control initial (or before rain) water-content conditions.

   Authors' response: Unfortunately, data on depth to water table are not available for the time period overlapping the field observations. However, previous data collection and analysis have provided a general picture of water table behavior at the site. We plan to provide a more detailed review of what others have demonstrated about the relationship between depth to water table and recharge in this setting.

4. **Reviewer's comment:** I suggest two possible passages that can improve the manuscript significantly: 1) Invest more time in calibrating and validating the model to the temporal water-content data, and if possible to water-table level data. This will enable estimation of recharge fluxes, investigating the relationship between change in water-content at depth and recharge, and make any simulation more convincing. The homogenous domain and a rather arbitrary depth (0.05 m) of the ET sink term (root depth) is too simplistic for use in a 1D numerical model if there is no good match with observations (Figure 8). I presume that a reasonable match between model and observed water –contents can be achieved, with some calibration of hydraulic parameters, sink term depth (can vary with depth), and may be adding a layer. This calibrated model will enable to gain much more from the simulation analysis than the current model that doesn't really improves our understanding or give any estimation of quantities of interest (i.e. recharge fluxes). 2) A minimalistic approach, in which the model part is discarded and we are left with a shorter but much more solid paper, is also a possibility.

Authors' response: With the proposed additional analysis described in the introductory comments, the numerical model piece will be integral to the paper and removing it would weaken the conclusions. We did use field observations to parameterize the model, however, adequate data were not available for model calibration. Therefore, we chose to use the modeling to extend and generalize what we were able to learn from the available data. We discuss this in the manuscript, but perhaps were not clear enough. We will attempt to make the relationship between data analysis and modeling clearer in the revision. We hope the reviewers and editor agree with the approach we are proposing.

Specific comments from Anonymous Reviewer #1:

1. **Reviewer's comment:** Page 8065 line 30 – "Since it . . ." I would have been more cautious with such a statement.
   Authors' response: The caveat that we are referring to studies ***in this setting*** will be added.

2. **Reviewer's comment:** Page8066 line8–qin Eq. 1 is either flux, or flow per unit area but not flux per unit area.
   Authors' response: This will be changed to "moisture flux density" per the recommendation of the editor.

3. **Reviewer's comment:** Page 8066 line 25 – delete "to be able" and delete "to estimate water availability . . .end of sentence.
   Authors' response: We will shorten this sentence for clarity as recommended.

4. **Reviewer's comment:** Page 8067 lines 1 and 6 – avoid repletion.
   Authors' response: We will eliminate the repetitive phrase (line 6).

5. **Reviewer's comment:** Page 8072 line 15 – Reasoning for the chosen sink-term depth distribution.
   Authors' response: In this environment, the shallow soil switches rapidly between very dry and very wet at the onset of precipitation events. We chose to represent bare soil evaporation as a line sink over the top 5 cm rather than as a point sink at the ground surface because it improves model stability without significantly altering moisture patterns over the soil profile.

6. **Reviewer's comment:** Page 8072 line 25 – 8 m d^{-1} , before it was reported to be 6 m d^{-1}, explain the difference.
   Authors' response: This is a typographical error. Line 25 on p. 8072 will be changed to 6 m d^{-1}.

7. **Reviewer's comment:** Page 8081 line 25 to Page 8082 line 3, - why repeat?

Authors' response: The repetitive sentence will be removed.

8. **Reviewer's comment:** Figures 3, 9, 10 11, and 12, I believe the legend should include depths of 0.1, 0.35, and 0.5 m rather than 0.1, 0.2 and 0.3.
   Authors' response: Apologies for the errors. This will be corrected.

9. **Reviewer's comment:** Figure 5 a, b – it would be good to add the P value of the regression model's slope to assess the significance.
   Authors' response: When we update wording in this section based on other comments, we will address statistical significance.

10. **Reviewer's comment:** Figure 9 a the text on the panel "Results for field measured precipitation" is confusing.
    Authors' response: Text will be changed to "Field observations"

11. **Reviewer's comment:** Figure 11 a and c look extremely identical, check.
    Authors' response: We double-checked these figures. The plots are very similar, but there are small differences (such as the sharpness of the first peak in moisture content at 0.10 m).