

The Authors thank the reviewers for these comments, which have helped to strengthen the paper. We give our latest responses in blue. Line numbers refer to the marked up version of the manuscript provided.

Response to Reviewer 1

1. Authors' response: We agree completely that accurate representation of soil physics processes in land surface models is absolutely crucial. When using a land surface model, there is inevitable uncertainty in the soil texture. Textures taken from any global dataset, as in this study, are likely inappropriately coarse. On the other hand, soil texture measurement taken at a point may also be unrepresentative of the scales on which land surface models are run.

Referee: I fully agree with you on this. Perhaps, could you help to put the above explanation also into the updated manuscript?

[Thank you for this suggestion. We have added corresponding text to the Discussion section at line 309.](#)

2. The usual approach is to use a pedotransfer function that has been optimised on very small scale measurements; here we are trialling the opposite approach and show that we can produce a consistent improvement to soil moisture outputs without generating completely unphysical soil physics parameters."

Referee: Indeed, this is the contribution of this study. Nevertheless, we should make it more specific (e.g., in the 'Conclusion') that this is realized with the Data Assimilation approach.

[We have made clearer that we have used a data assimilation approach in line 328 of the conclusion.](#)

3. We agree that using in-situ soil texture measurements would have been better. Unfortunately we do not have access to this data at the sites we used.

Referee: Could you help to make the above point clear in the updated manuscript?

[We have now made this clear on line 181.](#)

4. In addition, we wanted to investigate the possibility of using a global soil texture dataset so that our newly parameterised pedotransfer function (PTF) could then be applied anywhere.

Referee: I think this deserves further thinking. The PTF parameters calibrated over 16 UK sites to be applied at a global scale? This seems to me unrealistic Or I am happy to see I am proved wrong ...

[We agree that global application of the Cosby PTF would not be appropriate, but suggest that the newly calibrated PTF would likely be applicable in other areas of the UK. We have made it clearer that we restrict our focus to the UK at line 183.](#)

5. We agree that there is danger here of getting the right answer for the wrong reason. However, we would argue that our results are robust for the following reasons: We have optimised a pedotransfer function taking into account soil texture and COSMOS-UK measurements from 16 independent sites simultaneously. We do not optimise the PTF on a per site basis. The fact that one newly optimised PTF improves the fit to data across all 16 sites suggests that this is a systematic improvement to the PTF –i.e. to the mapping between soil texture as reported in the HWSD and the soil physics parameters. The new soil physics parameters which are obtained with the newly optimised PTF are

within the range of physically reasonable values. We did not constrain these values in any way so it would have been possible to generate physically unrealistic values; in this case we would have shared the reviewer's concern about getting a better match to soil moisture measurements for spurious reasons.

Referee: Many thanks for your further explanations. Could you help to include the above text in the update?

We have strengthened our presentation of these arguments in the Discussion section – see changes from line 297.

6. As an extra test, we re-ran our experiment using soil texture information from SoilGrids; we found that our conclusions were broadly consistent no matter which soil texture database we used.

Referee: This is good to know. Could you help to include the relevant results for SoilGrids? Or at least in the appendix (with some brief explanation). Readers (incl. this reviewer) will be more confident in the approach you proposed in this study with this result included.

We feel that including these results in the paper would require some further analysis and discussion about the similarities and differences between the two sets of results; the input soil textures are not completely equivalent as they refer to e.g. different soil depths. The authors may expand this comparison for separate publication but feel including the plots in this paper risks distracting the reader from the proposed method.

Responses to comments provided by reviewer 1 directly on the manuscript pdf:

Line 8: consider it is only calibrated with a number of UK sites, should we say the improvement of of LSM in this context is only for the regions covering UK sites? In case you meant the LSM calibrated at UK sites can be applied at global scale, then relevant results/discussions should be provided though.

Thanks for your comment. We have added clarifying text here:

'We demonstrate that calibrating a pedotransfer in this way improves the soil moisture predictions of a land surface model at 16 UK sites, leading to...'

Line 19: Could you express more explicitly on what are these requirements?

We have clarified this to read:

'... depending partly on the representation of soil physics processes in the chosen land surface model.'

Line 29: It seems this paragraph is more a fit to methodology part, since it describes technically what you are going in this study

We feel that this introduction to the methodology is useful to the reader at this point in the paper; further detail is then provided in the Method section.

Line 30: perhaps the information of 16 sites should be explicitly mentioned here?

We mention that there are 16 sites in this study in the next sentence.

Line 39: Could you illustrate more on this statement? It is not clear on why, how and what?

We have changed this text to clarify that we wish to preserve the physical relationships between soil physics parameters:

‘We chose to optimize the pedotransfer functions rather than directly optimizing soil physics parameters since this preserves the physical relationships between soil physics parameters that the pedotransfer functions describe. This approach also has the advantage that...’

Line 42: How can the calibrated PTF parameters, using 16 UK sites, be applied beyond the calibrated region? Is this what you refer to here with 'beyond'?

We suggest that the updated PTF could be used UK-wide, since the only input required is soil texture. We have clarified this:

‘This approach also has the advantage that we can assimilate observations from all sites simultaneously to produce one set of pedotransfer functions applicable at all 16 study sites. The same pedotransfer function could then potentially be applied anywhere in the UK that soil texture is available.’

Line 44: ?

We have clarified this sentence:

‘We use CRNS soil moisture measurements in this study. Larger scale soil moisture measurements are also increasingly available from satellite products...’

Line 52: COSMIC model

We have replaced 'method' with 'COSMIC model'

Line 58: Is this conflicting to the sentence on line 37-38?

We don't believe there is a conflict here. We have updated the PTF we use to generate soil physics parameters; it makes sense to look at the changes to the PTF along with the resulting changes in soil physics parameters.

Line 59: with?

We have replaced 'for' with 'with'

Line 135: any citation?

The citation for the dataset is given in line 110, but we have provided it again here.

Line 156 and 157: 75cm?

The 75m here refers to the horizontal distance from the CRNS probe position. We have clarified this:

... at 75m from the CRNS (in the horizontal direction).

Line 158: This is less than 75cm? D86 is from the top to certain depth? It seems the description here is not clear.

In equation (12) the D86 refers to depth from the top of the soil; the 75m previously mentioned has now been clarified.

Line 220: This reviewer suggest to merge Figure 3-6 into one figure.

We feel that this would make the resulting captions unnecessarily complicated.

Figure 8: it is suggest to put the unit of each parameter, for those parameter without unit you can just use (-)

The units for each parameter are already provided in Table 1.

Line 307: but you assumed soil texture information from HWSD is corrected?

We make this assumption for the experiment - i.e. we make no attempt to update the soil texture information in the data assimilation algorithm. However, we know that the soil textures will really have uncertainties associated with it (as for any dataset), and these uncertainties will cascade through to the soil moisture estimates. We have made changes to the discussion section to make this clearer.

Line 328: Calibrating PTFs with Data Assimilation Approach

We have now specified that we use a data assimilation approach here.

Response to Reviewer 2

The proposed method in this study is quite attractive to help obtain the spatial soil hydraulic properties and improve soil moisture estimates. Although a fact is that there are uncertainties in laboratory measurements and in the representative of those measurements for spatial scales, in situ measurements are still the basis to help seek solutions for tackling scale issues. I also think that the paper shall provide comparisons between the estimated soil hydraulic properties to in situ measurements (e.g., soil water retention curve, hydraulic conductivity curve) for convincing the audience that the optimized results align with the truth, and therefore the optimization method does make senses from the soil physical perspective. On the other hand, once the soil texture is available, the paper may check the results of optimizing soil texture, and compare to those by optimizing the constants of underlying PTFs. This will prove if this is a systematic improvement to the PTF. I am sorry. I finally decide to suggest authors complementing in situ measurements and resubmit for a best presentation.

The authors agree that it would have been extremely useful to be able to compare our results to those from in situ measurements. Unfortunately such measurements were not available for use in the study. Further, the focus of the paper is to compare how soil physics parameters generated via use of a traditional PTF (calibrated on small-scale measurements) compare to those generated when the PTF is calibrated with field scale measurements. This is of particular interest since land surface models are generally used at larger than point scale. We chose to take this approach, rather than optimizing soil texture, since we do not have access to soil texture measurements at the sites we used; we also wished to have a method which was applicable at other UK sites without soil texture measurements. We have made our choice of approach clearer at line 39 and line 181.