RC1

Dear editor, dear authors,

I reviewed the paper in detail, and the tutorial cursorily. The case for the model introduced by the authors is made convincingly, and the model clearly falls within the scope of GMD. Although the model consists of existing components that have been augmented and linked, there is enough new material in the paper to justify publication in GMD. The relevance for practical applications is explained well by the authors.
Response: Thank you for providing a review of this manuscript, and for your comments.

The tutorial could use a few more references (including links) to established methods/techniques/software that the authors used. Examples of established software used are Notepad++ and QGIS, which are given without link or reference. Several links to other useful resources are given in the text of the tutorial, but not included in the reference list, which is a bit inconvenient.
Response: Thank you for pointing this out. We have included the following note on **Page 2** of the tutorial: "Note: This tutorial references QGIS, a geographic information system software that is free and open-source, version 3.42.1-Münster." We have edited the text on **Page 30**, in reference to text editors: "You can open up each file inside a text editor (e.g., Notepad++, a free source code editor for use with Microsoft Windows; EditPlus, a text editor for Windows) to view the contents."

The tutorial explains the working principle of PEST very well, which was quite helpful. But the Morris method used for the global sensitivity analysis used by PEST++ appears without explanation or reference.
Response: Thank you. We have now included the following explanation of the Morris method, with accompanying reference:
Lines 414-418:
"In the Morris Method (Morris, 1991), the influence of a selected model parameter is assessed by quantifying the ratio of the change in the simulated response (e.g., streamflow, groundwater head) to the change in parameter value. This ratio is calculated for multiple base values of the parameter, with the collection of ratios then averaged to provide an overall sensitivity index for the parameter. This process is repeated for all selected model parameters, with the parameters then ranked according to their sensitivity index. Parameters with the highest index have the highest control on model output."

All in all, I have no major comments. A few unclarities and inconsistencies appear in the text, highlighted in the minor comments directly inserted into the text. I suspect the inconsistencies are textual, rather than substantial, and can therefore be removed by a suitable rewriting of the text. I do not think the model code itself needs corrections. If this assessment proves to be correct, minor revisions should be sufficient.
Response: Thank you for these comments. We have addressed them as follows:

- QGIS reference: this is now included.
- Comma delimiter for thousands separator: I did not find this in the submission guidelines, so at this point we will leave the commas in the manuscript text and the tutorial. We can change at the technical editing stage, if requested.

- Line 100, handling salts: Yes, we have developed a salt module for SWAT+. However, it has not yet been published, so there is no reference for this.
- Lines 104-105 (network of channels): the network can be identified in either manner: the channel network can be "burned in" to the digital elevation model; or conversely, the channel network is identified using solely the topography from the digital elevation model.
- HRU: HRUs are defined in the preceding paragraph, as computational units with distinct land use, soil, and slope composition. For these two study regions, a portion of these are cultivated fields. To clarify this delineation, we have included the following text:
  Lines 103-104: *"JMR has 101 subbasins, 1,324 channels, and 10,611 HRUs, of which 5,101 are assigned to boundaries of individual, cultivated fields."*
- Line 112: the original SWAT+ model is not capable of handling this process (channel seepage to aquifer, if the water table is lower than channel stage). However, with the coupling of MODFLOW, this process can now be handled.
- Figure 1 caption (NHD+ channels): this is now defined in the Figure 1 caption (*"NHD+ channels = stream segments from the digital stream network of the United States (Moore and Dewald, 2016)."*)
- HUC8: we apologize for not defining this. We have now defined it in the Table 1 caption.
- Line 144: the unconfined aquifer is divided into a set of small sections (grid cells), which are connected via groundwater lateral flow.
- Paragraph 170: correct, the MODFLOW model only included the unconfined (phreatic) aquifer. Based on previous studies in these two basins, there is no significant exchange with deeper, confined aquifers.
- Line 178: this refers to the vertical discretization (13 layers), whereas the discretization on line 144 refers to the horizontal discretization, using 500 m grid cells.
- Line 182: yes; we have now clarified this in the text.
- Line 182: yes, they are both MODFLOW models. We have now clarified this in the text.
- Line 206: thank you; we have corrected this.
- Line 221 (Figure 3): yes, we understand that this might be confusing. We have now changed the figure, so that the crops and tree (on the right) are positioned in the "birds-eye" view.
- Line 232: yes, this is a good point. We have changed this to "to".
- Figure 4: thank you; we have included a "volume transfer" designation in Figure 4B, to show the volume of groundwater that is transferred to the soil profile.
- Line 248: thank you for pointing this out; according to the submission guidelines, the correct style is to use only numbers: (1), (2), etc. We have corrected this for each of the 5 equations.
- Figure 5: thank you; we have now outlined the cell and labeled it clearly in Figure 5.
- Line 275: correct, that capillary fringe is not included in the simulation; therefore, the volume of groundwater transferred to the soil profile is only the depth of groundwater above the base of the soil profile.
- Lines 303-304: thank you for noticing this duplicate sentence. We have deleted it.
- Line 323: thank you. We have now defined soil water stress in the text: *"defined as the fraction of potential plant growth achieved due to soil water deficit"*
- Lines 324-325: we have clarified this in the text: *"Multiple irrigation sources can be specified for each demand object, with the order and demand fraction specified for each source."*

- Lines 326-327: these are arbitrary values, based on what is expected in these two regions. Typically, 1 inch (25.4 mm) or water is applied per irrigation event, and irrigation is applied when soil water stress occurs.
- Line 331: depth of water is specified by the user, and in our models we have set it to 25.4 mm (1 inch), as indicated on line 327.
- Line 339: yes, evaporation can happen. We do not account for this flux in the model, as seepage is often much higher in magnitude than evaporation.
- Line 360: thank you. We have indicated in the figure caption that these are cultivated fields.
- Line 365: SWAT+ has a routine that uses DRAINMOD, calculating a shallow water table and determining if it is above the elevation of the drain.
- Lines 367-368: correct.
- Line 399: The "command" subroutine calls the subroutines for HRU, routing unit, reservoir, point sources, and channel routing. These routes are then followed by a set of subroutines that write out results for each object type. This has now been added (with an arrow) in Figure 8.
- Line 403: we apologize for neglecting this reference. We have now included the White et al. (2020) reference.
- Lines 415-417: thank you; we agree that this sentence is long and confusing. We have now divided it into two sentences: *"Therefore, including MODFLOW for these two regions increases model run-time by 250% and 100%, respectively. These increases seem to be acceptable for model applications such as calibration, sensitivity analysis, and uncertainty analysis which often require hundreds or thousands of model runs."*
- Line 422: Line 416 indicates that run-times for calibration would be acceptable. We did not actually perform a calibration with PEST++.
- Line 424: we have not investigated the effect of including/neglecting evaporation from open ditches. This is a great point, and we will assess in future studies.
- Line 438: we agree that including north arrows and scale bars is helpful; we have included this in Figures 10 and 11.
- Line 470: D indicates seepage from canals, which are shown in Figure 1B as red lines; seepage occurs for cells that intersect these canal lines.
- Line 480: positive values indicate a decrease in head, which is a result of groundwater pumping. We have now clarified this in the figure caption.
- Line 485: we have now indicated this in the figure caption. Positive values indicate a decline in head, negative values indicate an increase in head.
- Line 510: thank you; we have changed this to "unsaturated flow".

Sincerely,
Gerrit de Rooij

We thank Reviewer #1 for the helpful comments and suggestions.