Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC1
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Reply on RC1

Robert Schweppe et al.

Author comment on "MPR 1.0: a stand-alone multiscale parameter regionalization tool for improved parameter estimation of land surface models" by Robert Schweppe et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-103-AC1, 2021

Response to Reviewer 1

We would like to thank the reviewer for her/his time and effort in revising our manuscript and the provided comments. We address her/his comments below. Reviewer comments are *italic*.

This paper describes the stand-alone version of MPR and its adaptation for two different land surface models. MPR is a well-established regionalization technique to estimate spatially explicit model parameters, and the availability of a stand-alone version could potentially contribute to significant model improvement in some land surface models and hydrological models. For modelers who already plan on incorporating MPR, this paper would provide much needed guidance. However, if the purpose of this paper is to convince other large-scale environmental modelers to adapt MPR (which would surely merit publication in GMD), significant improvement in paper organization and results presentation is needed.

Paper Organization

Some parts of the paper read more like a technical document than a scientific paper. For example, a lot of material in sections 3.1-3.3 is better suited for supplementary materials.

We understand the motivation of the referee that we want to expand our knowledge about the environment by conducting science. We share this motivation and often use numerical models as tools. We are deeply frustrated about the lack of documentations of numerical models in the past that limit the reproducibility of scientific experiments. For this reason, we decided to make the effort to document this MPR tool and make it available to interested scientists. We did submit this manuscript as manuscript type "Model description papers". We followed the instructions provided by GMD journal (https://www.geoscientific-model-development.net/about/manuscript_types.html#item1, access: Sep 22nd 2021) to create this manuscript. The purpose of the manuscript is as stated on the web page: "Model description papers are comprehensive descriptions of numerical models which fall within the scope of GMD. The papers should be detailed, complete, rigorous, and accessible to a wide community of geoscientists. In addition to complete models, this type of paper may also describe model components and modules, as well as frameworks and utility tools used to build practical modelling systems, such as coupling frameworks or other software toolboxes with a geoscientific application. The GMD definition of a numerical model is generous, including statistical models, models derived from data (whether model output or observational data), spreadsheet-based models, box models, 1-dimensional models, through to multi-dimension mechanistic models."

This is why our manuscript does not include a research question or research hypothesis which is a main requirement for a scientific paper. For this reason, we created these detailed description in Section 3 that we think is necessary to fully understand the inner workings of MPR.

Instead of these nitty gritty details, the readers may prefer to see things such as the concept of MPR explained (like how to apply TF), computing time required at a representative configuration (hardware and spatial resolution), why the experiments have to be performed online, and the pros and cons of the MPR method.

The concept of MPR is explained in the introduction (line 48ff.) and conceptual papers by Samaniego et al., 2010 and Kumar et al., 2013, that we referenced at the beginning of the paragraph. How to apply TFs is explained in detail in section 3.3.4. Following your suggestion, we will add hardware requirements, run time, and spatial resolution for the examples shown in the manuscript. We do not state that experiments need to be performed online, especially as MPR needs to be regarded as pre-processor that can run in both offline and online simulations. Following your suggestion, we will explicitly add advantages and disadvantages of the MPR concept and tool in section 2.3. These are the advantages and disadvantages that we plan to include are:

Advantages:

- use of high-resolution data sets for parameter estimation

- calculating model parameters at the highest resolution possible before aggregating to a model resolution

- flexibility to estimate parameters using arbitrary number of predictor variables, Transfer Functions and Upscaling Operators

- low run times because of Fortran implementation

- increased reproducibility of numerical work flows

Disadvantages:

- high memory requirement due to calculation at high resolution

- software dependency on Fortran compiler and netcdf library

- netcdf is the only format supported for input and output

- model coupling works only if (distributed) parameters are accepted (in netcdf format)

In Section 3.4: Please also explain the difference with old MPR release. What issues prevent the old version from being used by other models (I assume other models can also use the parameter files)? Which improvements were made to solve these issues?

We will expand Section 3.4 on differences between the new and old version repeating some of the statements made in the introduction (l. 57ff). The old version is hard-coded in the source code of the mesoscale Hydrologic Model (mHM). The user cannot change the TFs and upscaling operators for another purpose. Additionally, the obtained parameter fields are stored in a format internal to mHM that cannot be used for other models easily.

Results Presentation

For other LSM modelers, Figure 5 would be most interesting. One would naturally ask whether the use of MPR result in better ET, which transfer function (TF) was used (and how to choose appropriate TF), and whether the authors have noticed some similarities (i.e., if improved results are shown in both cases) in these two LSMs. These issues are important for new users to judge the applicability of MPR. I would recommend the authors to consider using some open-source benchmarking tools such as ILAMB to comprehensively assess whether the simulation results of the two LSMs have improved in various key variables.

We would like to thank you for this comment. The purpose of this Figure is to demonstrate that using different TFs has an impact on simulated fluxes. This shows that the MPR method is relevant. The question which TFs to choose to minimize a given objective function is out of the scope of this paper. However, we are working in this direction and did find large improvements in streamflow simulations when optimizing soil parameters of Noah-MP and HTessel, but cannot show results here.

Figure 3: The examples presented in this paper discussed theta_s and K_s, while LAI was not discussed. So why not show dependency graphs for these two parameters instead?

In Figure 3, LAI was chosen as it nicely highlights the use of multiple dimensions and uses simplistic TFs. The derivation of the K_s and theta_s parameters in mHM is rather complex as a correction for organic matter in tillage layers is applied. Thus, we refrained from using this as an example in the manuscript. Please see the dependency graph for these two soil parameters attached.

Some Minor Points

L372-376: Have you contacted that paper’s authors for this issue?

L372-376 No, we have not contacted the authors.

L429-L430: How?

L429-430 The example refers to Noah-MP. The model comes with a default parameter table. Likely, this is derived from literature or previous versions and is assumed to work for a given set of input data (soil, landuse, etc.). We assume, that the model bias in key variables observed by Ma et al. (2017) stems in part from the parameters used. Applying MPR will alter the parameter distributions so that bias might be minimized by model parameter calibration. We will add the following sentence at the end of the paragraph: "For example, MPR and Noah-MP can be executed subsequently by an optimization algorithm. The optimizers draws new parameter sets for MPR that result in updated soil parameter maps for Noah-MP. In turn, updated ET fields are calculated by Noah-MP."

L514: “optimization applications is low” do you mean “optimization applications is high”?

L514 We will change as indicated by you.

Code availability: please provide sample data and installation guild if possible. Data to reproduce the figures cannot be downloaded without contacting UFZ.

Sample data are already part of the code base (in tests section). Download instructions will be provided. We removed the barrier for the access to the manuscript's meta information so the reviewer does not need to reveal her/his identity while downloading.

References

Ma, N., Niu, G.-Y., Xia, Y., Cai, X., Zhang, Y., Ma, Y., and Fang, Y.: "A Systematic Evaluation of Noah-MP in Simulating Land-Atmosphere Energy, Water, and Carbon Exchanges Over the Continental United States", Journal of Geophysical Research: Atmospheres, 122, 12,245–12,268, https://doi.org/10.1002/2017JD027597, https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2017JD027597, 2017.

Samaniego, L., Kumar, R., and Attinger, S.: Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale, Water Resources Research, 46, https://doi.org/10.1029/2008WR007327, https://agupubs.onlinelibrary.wiley.com/doi/abs/10. 1029/2008WR007327, 2010

Kumar, R., Samaniego, L., and Attinger, S.: Implications of distributed hydrologic model parameterization on water fluxes at multiple scales and locations, Water Resources Research, 49, 360–379, https://doi.org/10.1029/2012WR012195, https://agupubs.onlinelibrary.wiley.com/ doi/abs/10.1029/2012WR012195, 2013b

Please also note the supplement to this comment:
https://gmd.copernicus.org/preprints/gmd-2021-103/gmd-2021-103-AC1-supplement.pdf