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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Spatially distributed sensitivity of simulated global groundwater heads and flows to hydraulic conductivity, groundwater recharge and surface water body parameterization" *by* Robert Reinecke et al.

Anonymous Referee #2

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Major comments

First of all, I apologize the significant delay in reviewing this article. I did all my best, but I was not able to complete this sooner.

The authors conducted a series of sensitivity tests of the G3M global groundwater model by using two versions of geographical dataset and 2000 parameter sets. Because of the limitation in available observation and its heterogeneity, validation of groundwater simulation is highly challenging. Although sensitivity test does not vali-

date model's performance, it provides some clues to understand the behavior of the model and to interpret the results. I found overall this study presents interesting results and well-considered discussion but some parts need further explanations and clarifications.

Specific comments

Page 2 Line 22 "To the knowledge of the authors": What about Widen-Nilsson et al. (2007)?

Page 3 Line 8 "Elementary Effects (EE)": To improve readability, this term needs a brief explanation.

Page 3 Line 18 "two vertical layers with a thickness of 100m": Do you mean totally 200m? What does each layer represent?

Page 4 Line 2 "exp(-50mf-1)-1": What is m?

Page 4 Line 16 "G3M is a conceptual model with one river in every 5' grid cell": What is a "river" in a groundwater model? Perhaps this sentence would be better read 'The interaction of groundwater and surface water bodies (lakes, wetlands, and rivers) is conceptualized in G3M as follows.'

Page 4 Equation 1: h must be defined. A simple schematic diagram is needed to explain h, Bswb, hswb, L, and W. Actually I still cannot clearly figure out the relationship of these terms.

Page 4 Line 24 "a static thickness of 5m": Do you mean the difference between hswb and Bswb in Equation 1 is always 5m?

Page 5 Line 1 "Eswb and hswb,riv": Define these terms.

Page 5 Line 2 "These conductance equations are inherently empirical": Unclear. Equations 1-3 show physical relationships (although quite simplified). What are the "empirical" aspects?

Page 5 Equation 4 “haq”: Define this term.

Page 6 Line 10 “Elementary Effect (EE) for a given value of X for the ith model input”: What are the value and the input? Because this is a parameter sensitivity test, I thought X was parameter, but it didn’t work. Anyway, the terms ‘value’ and ‘input’ are highly confusing to me.

Page 6 Line 14 “y(X) the model output.”: What are outputs? For example, the groundwater level (h) is an output?

Page 6 Line 14 “The total effect of ith parameters”: What does “total” mean here? Here the term “parameters” appears in addition to “values” and “inputs”.

Page 6 Line 24 “Eswb in the model is higher than the range used in this study”: Indeed it looks extremely small in Table 1.

Page 8 Line 3 “optimized using Ruano et al. (2012)”: Optimized to what? What was the objective function?

Page 9 Line 30 “at boundaries of large areas where K changed”: What are “large areas”? Are there any “small areas”?

Page 10 Line 12 “latter error”: Do you mean the last error (4) or the latter two errors (3-4)?

Page 11 Line 4“the multiplier of Eswb produces the highest shifts in regions with high elevation that might cause a switch from gaining to losing conditions and vice versa”: Hard to read

Page 11 Line 7 “these combinations may yield conditions that are exceptionally challenging for the numerical solver.”: Hard to understand what the authors meant here. Clarify the logic.

Page 11Line 22 “independent of the applied parameter changes”: Why is this independent? I am confused because the change in parameters should be the only source of

difference in sensitivity simulations. . .

Page 12 Line 1 “lowest agreement”: Do you mean the lowest percentage (0-1%) or the lowest agreement (50%)?

Page 15 Figure 6 “Parameters are ranked from top to bottom”: Only three panels for eight parameters. What does “bottom” mean? The third or the eighth?

Page 18 Line 24 “a vector norm of residuals”: Explain what it means.

Page 19 Figure 9 “If a parameter is not present the mean sensitivity for that GHRU was close to zero”: Because the axes are logarithmic, “close to zero” sounds a bit odd. Consider rephrasing the overall caption because this figure is particularly hard to understand.

References

Widén-Nilsson, E., Halldin, S., and Xu, C.-y.: Global water-balance modelling with WASMOD-M: Parameter estimation and regionalisation, J. Hydrol., 340, 105-118, https://doi.org/10.1016/j.jhydrol.2007.04.002, 2007.

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