Hydrol. Earth Syst. Sci. Discuss., 10, C5614–C5621, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C5614/2013/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "From maps to movies: high resolution time-varying sensitivity analysis for spatially distributed watershed models" *by* J. D. Herman et al.

D. E. Reusser (Referee)

reusser@pik-potsdam.de

Received and published: 14 October 2013

The article investigates spatio-temporal patterns of parameter sensitivity on the example of the spatially explicit hydrological model HL-RDHM. The combined analysis of parameter sensitivity in space and time is novel to the hydrological community and an interesting extension of existing sensitivity analysis studies. The study is well designed and most of the article is clearly structured and well written.

There are a number of issues that would improve the work from a good article to an excellent article. (1) The authors present a large amount of data presenting sensitiv-

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

ities at different temporal scales in a well structured way. However, the authors could make a clearer statements about their expectations on how sensitivities should compare across the different temporal scales and for what reason. When presenting the results, they could then check if these expectations hold. At the moment, comparisons across different temporal scales are limited and some differences which were surprising to me are not mentioned and not discussed (see comments 23, 28, 29).

(2) The authors could do an even better job in connecting results from the sensitivity analysis to hydrological mechanisms (in the model). This involves (a) a more detailed explanation of the concepts and intended mechanisms behind SAC-SMA. The method section should make clear, what different mechanisms will mean in terms of (spatio-temporal) parameter sensitivities (b) Moreover, for a selected number of periods, the spatio-temporal sequence of most influential parameters could be described and compared to the intended mechanisms of the model. (See also comment 17, 24, 25)

(3) A central point of the study is "identifying key transitions between modeled hydrologic regimes". The authors should be explicit about their definition of a hydrologic regime, how a transition between hydrologic regimes are detected and how this is connected to parameter sensitivity analysis. This is currently not made sufficiently clear and somewhat disconnected. During the presentation and discussion of results, the authors could make clearer when we observe such a transition between hydrologic regimes.

1 Detailed comments

- Comment 1, P10776 L15 I would suggest to drop the word "surprisingly". Otherwise, the authors should make clear throughout the manuscript, why they expect different performance controls for events with different forcing and initial states.
- Comment 2, P10777 L8-9: add Reusser et al. (2009) as a study on "tracing the

HESSD

10, C5614–C5621, 2013

causes of desirable or undesirable model performance"

- Comment 3, P10777 L18-25: Another example of global sensitivity analysis for a spatially distributed watershed model is Guse et al. 2013
- Comment 4, Section 2.1: A description of the concepts of HL-RDHM is lacking, except for a reference to Figure 1c. However a detailed description of concepts and mechanisms is necessary to understand detailed results about the timing of different parameters.
- Comment 5, Fig. 2: The figure is quite confusing at a first glance. The y-axis represents on the one hand different grid cells (abstracted spatial information) and on the other hand the level of streamflow (information about magnitude of certain quantities). This needs careful introduction. The figure caption is completely silent about this double meaning of the y axis and is misleading.
- Comment 6, Fig. 2: A short comment on the different visual impression related to rainfall intensity from the top panel compared to the lower three panel would be helpful (The top panel appears to represent much lower rainfall intensities due to the thinner line). The same issue is also somewhat relevant for Figures 6 - 8, because some details may get lost due to the thin lines and should be mentioned.
- Comment 7, P10780, L16-20: At this point, it is unclear to the reader that this describes only a part of the experimental setup and will provide the basis to compare high-resolution results to event-scale results. The experimental setup related to different time scales should be clarified at this point.
- Comment 8, P10781, L7: Suggestion to rephrase: Each of N trajectories yields one estimate...
- Comment 9, P10781, L10-11: It is not sufficiently clear what f(x1,...,xi+di,...,xp) is. Appears to have multiple function arguments, but f(x) is only defined for one

HESSD
10, C5614–C5621, 2013

argument.

- Comment 10, P10781, L24: Be more specific about whether Herrman et al. 2013a benchmarked Morris method against first order or total order variance.
- Comment 11, P10782, L1-3: Suggestion to drop the introduction of the standard deviation, because it interrupts presentation of the averaging procedure. It is confusing to the reader that the averaging is discussed on P101781, L25-26 and also P10782, L3-5
- Comment 12, Section 3: Did you take care to avoid conceptual inconsistencies? For example, we would expect the withdrawal from the upper zone to be quicker compared to the lower zone. However, parameter ranges are overlapping, such that withdrawal from the lower zone could actually be higher then withdrawal from the upper zone for some runs. How does the model deal with such conceptual inconsistencies? This needs to be briefly touched and discussed if this could affect results in a critical way.
- Comment 13, P10784, L5: Does this implementation include the improvement of Campolongo 2007?
- Comment 14, P10784, L17-18: Please provide a table where you report the original range sensitivities for each experiment.
- Comment 15, Section 4: Be explicit about when you consider a parameter to be sensitive. Is it a value of 0.5 throughout the entire manuscript?
- Comment 16, Figure 3-5: For each panel, please also provide an alternative representation using the approach arranging the cells along the y-axis. This will allow better comparison between results from the various figures (e.g. precipitation patterns show in Fig. 2 and 4)

HESSD

10, C5614–C5621, 2013

- Comment 17, P10785 L21-25: This is one possible explanation. An alternative explanation would be the following: Figure 2 shows multiple short rainfall events for Period2. River discharge reacts only after the last rainfall event which is concentrated in the lower catchment. We may hypothesise that only this last rainfall event was actually causing the discharge reaction and that earlier rainfall is insignificant. This would be an alternative explanation for the observed concentration of parameter sensitivity in the lower catchment

  The way results are currently presented does not allow to make a clear judgment about which explanation is more consistent with the processes in the model. This is one possibility how authors may better link parameter sensitivity patterns to hydrological processes (see my general comment (2)). Presenting the results in a way that would clearly indicate the ongoing processes (in the model) and would allow to discriminate the two potential explanation could improve the benefit from this study.

- Comment 18, P10787, L9-12: The previous comment needs to be reflected here as well.

- Comment 19, P10788, L4-6: How critical is the choice of the size of the moving window for the results presented? How was the choice made? How do the 24 hours compare to a typical event? How does potential noisiness in rainfall and discharge data affect the results for such a short time window?

- Comment 20, P10788, L13-14: Please also provide movies for single parameters and combinations of parameter groups if there are no size limits on the multimedia supplements.

- Comment 21, P10788, L15-21: This is a repetition and can be replaced by a simple reference to Figure 2

HESSD

10, C5614–C5621, 2013

- Comment 22, Figures 6-8: Also provide Fig 6-8 for selected events as supplementary material (issue with the visual impression apparent in figure 2).
- Comment 23, P10789 L2-4: Comparing fig 4 and fig 6 we find important differences: In Fig 6 Parameter LZSK shows high sensitivities (brown) in the lower part of the catchment. In Figure 4 however, sensitivities are high in the middle of the catchment (brown) but low in the lower catchment (yellow) - see also my general comment (1). The authors need to analyse, present and discuss such differences. The statement on p10789, L 3 (insighs largely align with those found ... in Figs 4) is not sufficient.

  Also, This is another reason to provide the representation with spatial information on the y axis in Figure 4
- Comment 24, P10789 L16-18: Is this expectation due to the water routing only or are there other mechanisms leading to this expectation. Be explicit. This might already be presented in section 2.1.
- Comment 25, P10790 L1-6: I like this part already a lot. It could be further improved if you provide more explanation about the conceptual bases of the two parameters UZTWM and PCTIM in Section 2.1. Moreover, can we go a step further in understanding the mechanisms? Are impervious areas and tension storage capacity more likely to refer to independent processes or are they interconnected?
- Comment 26, P10790 L6: This phenomenon is not visible at event scale because you did not analyse such periods. I'm quite confident that if you define an additional event (for example just before Period1) you would be able to see this. I suggest that you add this to the discussion about the impossibility to find representative events.

HESSD

10, C5614–C5621, 2013

- Comment 27, There is a second exception to the statement from P10789L27-29: UZK shows high sensitivity quite a long time after an event during low flow periods. This should also be briefly presented.
- Comment 28, P10790 L8: Please present and discuss other inconsistencies between Figure 4 and Figure 7. For example: Event1, UZK Figure 4 shows high sensitivity in the middle of the catchment, while Figure 7 shows sensitivity only in the lower part of the catchment.
- Comment 29, P10790 L19: Please present and discuss inconsistencies between Figure 4 and Figure 8. For example REXP, Event 1: Figure 4 high sensitivity in the middle of the catchment while absent in Figure 8
- Comment 30, Figure 9: Such a graphical summary is very nice. However, the distinction between events/periods appears somewhat arbitrary. For the event time scale, I would avoid combining events 1 and 2. There are important differences in parameter sensitivity. For the high-resolution case, the authors need to provide reason, why the four cases presented are sufficient to represent all periods. For example, by relating each point in time to one of the four cases.
- Comment 31, P10791 L20: How much is this determined by your selection of performance metric? RMSE is known to focus on large events.
- Comment 32, Section 4.3: A critical reflection and discussion of the limitations of your approach is lacking.
- Comment 33, P10793 L19: This opportunity to identify location and timing for data collection is very interesting. Could you elaborate a little more and explain how you would extract this information from the large amount of data presented?
- Comment 34, P10793 L21-22 How far is your visualization approach limited to this special case of a long and narrow catchment? I could imagine that results

HESSD
10, C5614–C5621, 2013

are more confusing for other catchment shapes if arranged according to distance from the catchment outlet. Imagine a catchment with bare bedrock on the one side of the river, while the other side has soils with large storage capacity. How could your visualization approach be extended to cover such a case?

2 Technical issue

P10778 L7-8 The statement "This approach has been limited to lumped models" needs reformulation since WaSiM-ETH used in Reusser et al. (2011) is spatially explicit.

3 References

Reusser, Dominik E., Theresa Blume, Bettina Schaefli, and Erwin Zehe. 2009. "Analysing the Temporal Dynamics of Model Performance for Hydrological Models." Hydrology and Earth System Sciences 13 (7) (July 7): 999–1018. doi:10.5194/hess-13-999-2009

Guse, Björn, Dominik E. Reusser, and Nicola Fohrer. 2013. "How to Improve the Representation of Hydrological Processes in SWAT for a Lowland Catchment - Temporal Analysis of Parameter Sensitivity and Model Performance." Hydrological Processes (April 24): n/a–n/a. doi:10.1002/hyp.9777

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 10775, 2013.