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Hydrology and Earth System Sciences Discussions

Interactive comment on "An educational model for ensemble streamflow simulation and uncertainty analysis" *by* A. AghaKouchak et al.

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The authors thank Prof. Helge Bormann for his thoughtful comments and critics on our manuscript which led to substantial improvements in the revised version. In the following, the issues raised by the reviewer are addressed point-by-point in the order they are asked. Reviewer comments are shown in italic; authors' reply is shown in regular text. For convenience and better tracking of changes, a copy of the manuscript with the changes highlighted is included.

RC: H. Bormann (Referee)

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RC: Received and published: 23 August 2012

RC: The authors present a well written paper introducing the hydrological modelling software HBV-Ensembles and possible application for teaching hydrological modelling. The paper consists of a general introduction of the model, a description of exemplary model application and students feedback. The authors shortly explain the technical details of the model (referring to earlier papers), highlighting the possibilities of HBVEnsembles compared to the classical HBV approach.

The reason behind a very "brief explanation" of the HBV model is that another paper in the same special issue by Seibert and Vis, 2012 ([1]) provides a detailed description of HBV and its processes.

RC: There are already two reviews available for this manuscript (HESS-D interactive discussion) commenting various aspects with respect to content and technical aspects. I agree with almost all of them and will not repeat them in this review. But there are a few further aspects which I rate to be important for such a manuscript. They will be explained in the following.

RC: 1. This manuscript is intended to be part of an educational special issue. Therefore I expect the authors not only to present a model which may be used for educational purposes, but also at least to shortly describe their teaching strategy (or the related curriculum) and to explain how the authors think such a model could contribute to the strategy / curriculum, and how to improve the expected learning outcome. This seems to be important to me since the authors argue in one the authors comments that this model could be even used for undergraduate courses. My experience is that even conceptual and deterministic models should be used carefully in that phase of the studies.

We agree with the reviewer that care should be taken when introducing advanced topics to undergraduate students. It should be noted that for undergraduate students, Watershed Modeling class (from which data is provided in this paper) is an upper divi-

sion course, and participants are required to have passed Hydrology. This means that undergraduate students who were exposed to this educational toolbox had already some background in hydrology. We have made this clear in the manuscript.

Regarding the purposes, curriculum and teaching strategy: the objective of the course (from which student feedback is reported) is to introduce hydrologic modeling tools and techniques to students (added to text in Section 4). The course starts with some theoretical background, during theoretical presentations of the course, with the help of the instructor, students perform all the calculations for a hydrologic modeling exercise in the class using an Excel Spreadsheet. The reason for using a spreadsheet was to ensure students learn the calculations and how modeling works in general. Then, the educational tool is used for more detailed discussions and practice on topics such as parameter sampling, model calibration, etc.

On how the model contributes to the curriculum, and expected learning outcomes: As mentioned in Section 4, while the student feedback show positive responses to the questions asked, we cannot claim that the positive feedback are solely because of using this particular educational toolbox. The authors acknowledge that evaluating students' responses and associating them to only the model and not to the combination of instruction and model use are not possible in the current study.

RC: 2. The authors explain in detail the possibilities and advantages of the presented model in terms of uncertainty and sensitivity analysis. Unfortunately they do not comment possible drawbacks, in particular related to the comment made before related to the teaching concept. Are undergraduate students already able to profit from such tools? If yes, up to which extent? Which additional features can additionally be used for graduate student courses or even for phd students? I would like the authors to comment on such limitations.

The following is added to Section 4 to highlight requirements, and limitations of HBV-Ensemble: We need to emphasize that the students exposed to this model had a

background in hydrology. In addition, theoretical aspects of hydrologic modeling were introduced prior to using HBV-Ensemble. The authors recommend using this educational toolbox after students are introduced to theoretical hydrology. Students, especially undergraduate students, without basic knowledge of hydrology may not be able to benefit from this educational toolbox.

We believe all features of the model can be used by interested PhD students. However, this educational toolbox is not designed specifically for PhD students. Efforts are under way to include more advanced topics for graduate students (not completed, and hence not included in this manuscript).

RC: 3. The authors present the feedback of students to a course in which the model has been applied without commenting the presented results. What can the reader learn from such feedback and its statistical presentation? Many teachers argue that such feedback rather describes a "feel good factor" than an objective representation of the teaching/learning successes. Thus, please comment how you rate the presented results in this context. In addition, I assume that the feedback will strongly depend on how the course (model application) is integrated in the teaching concept / curriculum which is not yet described in this manuscript (see above comment).

We absolutely agree with the reviewer. We have tried not to oversell the reported student feedback and not to link the student feedback solely to the educational tool introduced in [2]. As mentioned in the manuscript, we cannot claim that the student responses are solely because of using this particular educational toolbox. We acknowledge that students' feedback represent not only tools and techniques, but also the instructor and instruction approach.

RC: 4. The authors conclude that the use of the presented model gains insight into the interconnection of hydrological processes. Please explain how this can be achieved.

In basic hydrology, students learn about individual components of the hydrological cycle. Through modeling experience students learn how individual components of the

hydrological cycle are interconnected. More detail is available in [3].

RC P7315, Figure 5: Please explain the learning gains as part of the figure caption.

Learning gains were added to the figure caption.

References

[1] Seibert, J. and Vis, M. J. P.: Teaching hydrological modeling with a user-friendly catchment-runoffmodel software package, Hydrology and Earth System Sciences Discussions, 9, 5905–5930, doi:10.5194/hessd-9-5905-2012, 2012.

[2] AghaKouchak A., Nakhjiri N., Habib E., 2012, An Educational Model for Ensemble Streamflow Simulation and Uncertainty Analysis, Hydrology and Earth System Sciences Discussions, 9, 7297-7315, doi:10.5194/hessd-9-7297-2012, 2012.

[3] AghaKouchak A., Habib E., 2010, Application of a Conceptual Hydrologic Model in Teaching Hydrologic Processes, International Journal of Engineering Education, 26(4), 963-973..

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 7297, 2012.