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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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This paper describes a hydrological modelling GUI which has been designed as a teaching tool. The GUI is built in Matlab and runs a version of HBV as the hydrological model. The main differentiating point between this and previous teaching software is the ability to create and run an ensemble of models. The ensemble is created by random sampling of parameter sets, with parameter values between lower and upper bounds selected by the user. The software then uses the model ensemble to create confidence bounds around the simulated streamflow.

The paper is clearly written and addresses an important question; namely how to introduce students to the uncertainty inherent in parameter choice for hydrological models,

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and the effects of this uncertainty on the modelled flow. However there are several points where I feel the paper and modelling tool could be improved.

1. The modelling concept is very similar to the GLUE procedure as introduced by Keith Beven. The authors should make this clear, and perhaps comment on the GLUE demonstration software already made available by Keith through the Lancaster University web site. One difference is that HBV-Ensemble does not weight the ensemble members by their NS score: the authors could comment on why they chose not to do this.

2. In Section 2.1, the list describing the procedure has bullet 4 repeated and seems to miss a description of how all ensemble members are run and the confidence bounds are created. It also states that the 'model gives the best set of parameters using GLUE' – but GLUE does not give a best set of parameters.

3. A helpful addition to the software would be an ability to view the 'dotty plots' which are commonly associated with this type of analysis, i.e. scatter plots of each parameter value against the performance measure. This would be a good way to introduce the students to sensitivity analysis and see whether the parameter bounds chosen were reasonable.

4. The software is said to produce the 'Simulated Runoff'. Is this the ensemble median? Or a deterministic run. It is not clear.

5. There is some confusion in the paper about applications of the software which do or don't use the ensemble feature. In the Section 3. Application, there are several comments which suggest that a deterministic model is being used, e.g. students 'changing the parameters' and 'comparing output hydrographs'. The authors should make clear whether their software also provides for deterministic simulations, and which applications relate to the deterministic vs ensemble version.

6. It would be nice to see some applications which specifically use the ensemble

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feature of the model, since that is the focus of the paper. For example, how does changing the performance measure used and the behavioural threshold change the spread of the ensemble? Is the spread different in different parts of the hydrograph (rise, peak, falling limb, recession period)? Which parameter bounds have most effect on the ensemble spread? The last question would become much clearer if the dotty plots suggested above were presented.

7. A further useful extension would be to provide some performance measures for the simulation ensemble. These could be simple (e.g. % of time the measured flow is within the ensemble bounds) or more complex such as skill score or rank histogram.

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