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Hydrology and Earth System Sciences Discussions

Interactive comment on "Gauging the ungauged basin: how many discharge measurements are needed?" *by* J. Seibert and K. Beven

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We thank the reviewer for his/her valuable comments which will help to clarify our manuscript. The reviewer points out a number of previous studies. The commentary by Moss (1979) demonstrates that the question of what to measure where and when is a long-standing question in hydrology (even if Moss talks rather about data networks than the value of a limited number of observations). We are aware that we missed including and discussing the similar studies by the Cemagref group (Perrin et al, 2007; Rojas-Serna et al, 2006) (see also our reponse to the comment by Andréassian et al.). Three of the papers mentioned (Sorooshian et al.,1983; Gupta and Sorooshian, 1985; Yapo et al., 1996) deal rather with the length of runoff series needed for a 'full' calibration than with the value of a few gaugings in constraining prediction uncertainties. This is

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a somewhat different question, nevertheless we will discuss these previous studies in the revised version. It is also important to point out that all of these previous studies relied on calibration of a single parameter set. Based on our previous work we would argue that there usually is no single best parameter set but that there will generally be equally acceptable parameter sets in different regions of the parameter space. Our approach of allowing for several behavioral parameter sets combined into a weighted ensemble mean, is a way to tackle this issue and to ensure robust results.

The paper by Fenicia et al. (2008) deals with the value of different types of measurements. As such their approach is different from the one we took. However, combining the approaches generates interesting questions such as what is the value of a groundwater level observation compared to a streamflow gauging?

The reviewer also raises the question whether this study really should be considered as a contribution to PUB. Reading the PUB science plan (Sivapalan and Schaake, 2003) one can recognize that constraint of uncertainty is an important part of PUB. The plan does not say that we have to do this in process terms only (although clearly this is one strategy). We argue that taking some measurements should be informative about the processes and help decide whether a particular model structure or parameterization (as hypothesis about system function) is viable or not. In this application our experience suggested that the model used should be an adequate predictor for this limited range of catchments. We claim that our study very much follows the objective stated as PUB community objective 3: "Increase the awareness of the value of data, especially the gauging of hydrologic variables, for the management of water resources and water quality around the world, and demonstrate the need for targeted gauging of currently inadequate or nonexistent data sources by quantifying the links between data and predictive uncertainty;" (Sivapalan and Schaake, 2003, p.9).

Specific comments: >p. 2281 l.27: why did you not weight the parameter sets based on the Reff?

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Since we used the SSE for ranking, results would have been exactly the same as for using Reff with the only difference that Reff cannot be computed if the variance in the observed runoff is zero (which would have been the case when using one observation day)

>p. 2283 l. 23: why this was clear?

Our formulation was awkward, what we meant is that results clearly showed that the ensemble mean outperformed the individual simulations.

>p. 2285 l. 13. might be due to the fact that you chose the Nash criterion as the objective function.

We agree, results would be different for another objective function.

>Fig. 1 The efficiencies of the tested models are rather bad. Why is that? Fig. 4 seems to indicate much better efficiencies for the individual ctachments.

Figure 1 shows the median of the performances using individual parameter sets. The values for the individual catchments in Figure 4, where ensemble means were used, should rather be compared with Figure 3.

>Fig. 1 How did you compute the 100 best para sets if there are no measurements available. I suppose that you took all model runs but then the legend is misleading

For the no-observations-at-all case the 100 'best' parameter sets were a random selection from the 10000 parameter sets.

Sivapalan, M. and Schaake, J. 2003. PUB Science and Implementation Plan, V5., available on http://pub.iwmi.org/UI/Images/PUB_Science_Plan_V_5.pdf.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 2275, 2009.