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Hydrology and Earth System Sciences Discussions



# *Interactive comment on* "Evaluating uncertainty estimates in hydrologic models: borrowing measures from the forecast verification community" *by* K. J. Franz and T. S. Hogue

**Anonymous Referee #1**

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In this paper, a review and demonstration of methods to evaluate probabilistic streamflow forecasts is given. The results are useful to the reader as they:

- summarize a number of methods to evaluate probabilistic forecasts
- show how these can be applied to hydrologic forecasts

I do have a number of points to bring forward, which results in a major revision:

1. First of all, while reading the introduction, the aim of the paper seems clear:

review and demonstrate methods to evaluate probabilistic forecasts. From the results in section 3 it seems that you want to compare and evaluate GLUE, modified GLUE (essentially the same as GLUE) and SCEM, which means comparing uncertainty estimation methods. This doesn't get across at all in the introduction.

2. In the introduction, a number of methods to probabilistic stream flow prediction are mentioned (ESP, ensemble DA, multi-models), however, one important type of methods is missing, which is particularly useful for practical applications because it is often computationally very efficient: stochastic post-processing methods, such as the Hydrological Uncertainty Processor (Krzysztofowicz and Kelly, 2000), the meta-gaussian approach (Montanari and Brath, 2004), Quantile Regression (Weerts et al., 2011) and the Model Conditional Processor (Coccia and Todini, 2010). These methods should be added to the introduction.

3. The paper claims to demonstrate probabilistic forecast evaluation methods, yet no hindcasts (with e.g. increasing lead times and uncertainties due to state uncertainties, NWP uncertainties etcetera) are used. This makes this claim weak. I suggest to alter this to demonstration of evaluation methods for stochastic simulations.

4. the discussion merely summarizes results again (in a lengthy manner). There are considerable differences found between results using GLUE or SCEM and I would like to see a discussion of these differences and the reasons for these differences rather than the summary of results here.

5. The equations throughout the paper are in one word sloppy. They are often incorrect and abbreviations are used within the equations rather than proper symbols. Symbols are also inconsistently used throughout the text. Some suggestions are mentioned in the remainder of this review.

6. The paper seems lengthy to me. Section 2 can be shortened and description of



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results more tailored to the aim of the paper.

p. 3089, l. 3, GLUE is the Generalised Likelihood Uncertainty Estimation. l.5, "...over a selected set of basins..."

p. 3089, it would help the reader to have a brief overview of the structure of the paper here.

The 'symbols' in the equations are more like abbreviations. Please select proper symbols e.g. $L_{NSE}$ (likelihood NSE), $L_{RMSE}$ etc. p. 3091. Equation (1) is wrong and should be:

$$L_{NSE} = 1 - \frac{\sum_{t=1}^{n} (x_t - o_t)}{\sum_{t=1}^{n} (o_t - \bar{o}_t)} \quad (1)$$

'$t$' should be formatted as subscripts in all equations. Equation (3) is also incorrect and should be

$$L_{bias} = \frac{\sum_{i=1}^{n} (x_t - o_t)}{\sum_{i=1}^{n} o_t} (2)$$

p. 3092. l. 4-6. It seems to me that 2 thresholds are being used ($L_{NSE} > 0.30$ and the 90% behavioural interval, which is not required for GLUE. Why has this been done?

W-GLUE is to my mind just GLUE. A different criterium has been applied but the method is still exactly GLUE. I disagree with the use of a new term for this method.

p. 3095, the equations: IQR, MAD and Range are abbreviations and words and should not be used as such in equations (mathematicians would read IQR as $I \times Q \times R$). Please use proper symbols. Eq. 7: $\sum_{i=1}^{n} x_i(t) - q_{0.50}(t)$ should be $\sum_{i=1}^{n} |x_i(t) - q_{0.50}(t)|$

p. 3095, l. 11, The symbol $N$ should be $n$. The confusion is because it is not consistent with the annotation in eqs. (1)-(3).

p. 3096, l. 20. are used to assess the accuracy of the ensemble mean, if I'm not mistaken.



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p. 3111, l. 17-25. Nothing is demonstrated here so either move this statement to section 2 or do not mention it at all.

Fig. 2. Please discuss the consierable differences in the discussion section

Fig 5. Why are these CDF's on a double-log scale? This distorts the results very much in disfavour of the low flows.

References:

Coccia, G. and Todini, E.: Recent developments in predictive uncertainty assessment based on the model conditional processor approach, Hydrol. Earth Syst. Sci. Discuss., 7(6), 9219-9270, doi:10.5194/hessd-7-9219-2010, 2010.

Krzysztofowicz, R. and Kelly, K. S.: Hydrologic Uncertainty Processor For Probabilistic River Stage Forecasting, Water Resour. Res., 36(11), 3265-3277, 2000.

Montanari, A. and Brath, A.: A stochastic approach for assessing the uncertainty of rainfall-runoff simulations, Water Resour. Res., 40, W01106, doi:10.1029/2003WR002540, 2004.

Weerts, A. H., Winsemius, H. C. and Verkade, J. S.: Estimation of predictive hydrological uncertainty using quantile regression: examples from the National Flood Forecasting System (England and Wales), Hydrol. Earth Syst. Sci., 15(1), 255-265, 2011.

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