

Interactive comment on “Catchment modeling and model transferability in upper Blue Nile Basin, Lake Tana, Ethiopia” by A. S. Gragne et al.

Anonymous Referee #3

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A.) General Comments:

This paper implements the conceptual HBV model for two sub-catchments of the Gilgel Abay Catchment (a major source for the Blue Nile Basin) in Ethiopia. The objective is to investigate the required degree of model complexity to adequately represent runoff and hydrological process differences between study catchments. Further, an assessment of the model transferability between these two sub-catchments is performed at different time scales. The authors utilized an extensive data preparation and gap-filling effort due to limited data availability. They performed Monte Carlo sampling of the parameter sets to investigate the sensitivity of the simulated runoff to the model parameters. The results of the sensitivity analysis guided the manual calibration of the model parameters (at various complexities) and identification of the hydrologic process differences

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in the study catchments. I think this paper will eventually be an important contribution in the general area of predictions in poorly gauged and ungauged basins and the presented material is valuable to the HESS readership. However, it will require major revisions, specifically related to the manual calibration effort and model performance assessment. I also think that the use of English language needs to be substantially revised to improve the readability. I have listed my specific comments in Part B and the Technical Errata in Part C. The authors need to address these comments before the paper is accepted for publication.

B.) Specific Comments

1) HBV model description: Section 3.2.1 should include at least a schematic representation of the model including the parameters calibrated in this study. This is important for readers that are not familiar with the HBV model. It should also be stated that the model structure allows representation of different elevation and vegetation zones, a characteristic of the model structure that the authors utilize to represent different representations of the study catchments (CRs).

2) Section 3.2.2: The manual calibration process needs to be more clearly described so that the reader can evaluate and perhaps reproduce the steps taken by the authors. The authors state that the number of calibrated parameters varied for sub-catchments and for catchment representations (CRs) (P817,L-19), however, the reasons for the variation in number of calibrated parameters should be explained and a list of parameters for each case should be given in a table (Perhaps a reference to Table 4 needs to be provided here). If only the most sensitive parameters were calibrated, this should be explicitly stated. The time periods used for model calibration and evaluation should be explicitly stated in this section.

3) Model Efficiency: Authors evaluate the model performance using two measures, namely, Nash-Sutcliffe Efficiency (Reff) and annual flow depth. I understand that the authors use generally accepted model performance measures, however Reff should be

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used with caution when the discharge time series show strong seasonality (see Figure 2): high $Reff$ values may be obtained with models only representing broad seasonal fluctuations (for example, see Schaeffli and Gupta 2007). See also Page 824-L21-23: High $Reff$ values were obtained for 30-day model, however visual examination of the simulated hydrograph reveals inaccuracies. This limitation undermines the model performance assessment presented in this study and this needs to be discussed in the manuscript. The simulated flow depth should be reported as the % difference between simulated and observed flow depths (%Bias), so that the reader can easily assess the performance of the model in simulating the flow volume (depth).

4) Longer time-step simulations: It is not clear to the reader whether the authors re-calibrated the model for longer time-step simulations or they used the same model parameters obtained from daily model calibration and simply averaged the flow values (e.g. see Page 820, L-19).

5) Feasibility of parameter transfer at longer time-scales: Page 824-L23-27: I found these two sentences rather confusing. Please explicitly state the time steps at which transferability was feasible and at which it was infeasible. i.e. "transferability of model parameters from hydrological process point of view was not feasible both on daily and increased time steps models. However, the tests demonstrated transferability of model parameters on longer time scales...". Please clarify.

6) Section 5.2.3: Figure 2 shows that the flashy response of the catchments were not adequately captured by the calibrated models. Can we infer that the calibrated models did not adequately capture the direct runoff component in these catchments. Could this have an impact on the inferred response patterns of the two sub-catchments.

7) Sensitivity Analysis: Since the sensitivity analysis was performed before the manual calibration, I think presenting the sensitivity analysis results before the manual calibration will improve the flow of the story.

8) Overall grammar needs improvement.

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C.)Technical errata:

- 1) P813-L7: Remove duplication, i.e. "hydropower power"
- 2) P815-L6: "There are three discharge gauging stations". There are only two stations shown in Figure 1.
- 3) P816-L10: "HBV light (Siebert 2002)". I think this information is redundant. The authors state the version of the HBV model and the reference in the following sentence.
- 4) P816-L15: Match the spelling of the author name in the text and in references section.
- 5) P817-L22-26: Please correct the grammar.
- 6) P819-L3: "instationarities" should be replaced by "non-stationarities" throughout the manuscript.
- 7) P819-L25: replace "fluctuation" with "fluctuations".
- 8) Figure 1: Gauging station name "Gilgel Abay", perhaps should be replaced by "Upper Gilgel Abay".
- 9) Figure 3: Indicate the names of the catchments for the hydrographs.
- 10) Table 1: I think annual mean flow should be reported in units of depth (mm/yr), so that the reader can evaluate the simulated discharge bias reported in the manuscript.
- 11) Page 820-L22-23: The references to the catchment names should be consistent throughout the manuscript. Is this really "Gilgel Abay" catchment or the upper one, i.e. "UGASC". Similarly replace "Koga" with "KSC".
- 12) Page 821-L5: "rising and falling limbs". Perhaps the authors refer to the beginning and ending of rainy season. There are many rising and falling segments of the hydrograph during the rainy season.
- 13) Page 823-L21 & Page 824-L18: "Gilgel Abay". Is this Upper Gilgel Abay sub-

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catchment?

14) Page 823-L22-23: Baseflow values listed in Table 5 seems to be higher than the groundwater contribution reported by BCEOM. However this statement reads as the opposite. Please comment.

15) Page 825-L5: I suggest to replace "calculating" with "generating".

16) Page 825-L6: I suggest to replace "approach of" with "approach proposed by ". It seems like, by defining a threshold for selecting behavioral simulations, the authors follow the Generalized Sensitivity Analysis (GSA) approach pioneered by Hornberger and Spear. Therefore I suggest replacing the reference to Beven and Binley (1992) with Hornberger and Spear (1981). I also think that a sentence clarifying the selection of behavioral sets by using a threshold on Reff would improve the readability.

17) Page 825-L10: Before going into the results of the sensitivity analysis I think authors should define the term sensitivity as used in this study. Perhaps as defined later in L21 and with a reference to Figure 6.

18) Page 827-L7-8: Section 5.2.5 only compared base flow component of the HBV model with groundwater contribution estimated by BCEOM. Please comment.

19) Page 827-L25: Place the word "better" after the word "finally".

20) Page 812-L11: Replace "vegetations zone" with "vegetation zones".

21) Page 820-L24: "mm/yr" vs. "mm/a" Please use consistent units throughout the manuscript.

22) Page 826-L26: Explain the term "quick flow" in relation to the findings from section 5.2.3.

23) Page 827-L2: This sentence contradicts with the findings reported in the Abstract (Page 812-L11).

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24) Page 827-L5: Please give a definition of the term "satisfactory". See perhaps Page 824-L23-27.

REFERENCES:

Schaefli B. and Gupta, H.V. 2007. Do Nash values have value?, Hydrol. Process. 21, 2075-2080.

Hornberger, G.M. and R.C. Spear, 1981: An approach to the preliminary analysis of environmental systems. Journal of Environmental Management, 12: 7-18.

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