Geoscientific
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Interactive comment on "DECIPHeR v1: Dynamic fluxEs and ConnectIvity for Predictions of HydRology" *by* Gemma Coxon et al.

Anonymous Referee #2

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General comments

The authors extended the concept and code of Dynamic TOPMODEL and developed an improved model termed DECIPHeR v1. They applied it to the entire Great Britain by calibrating and validating at 1366 gauges, and claimed that the performance was satisfactory. As a hydrological modeler who has developed open source code and applied it to an extensive study domain, I fully acknowledge the considerable efforts the authors made. The paper is overall readable for most parts but seems lacking some important statements particularly on the novelty and originality. The key characteristics and strengths of DECIPHeR should be clearly stated in comparison with existing catchment and global hydrological models (the current form of paper only compares DECIPHeR with the original Dynamic TOPMODEL). Also the value and significance

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of the model application to the entire Great Britain should be further discussed (the current form displays the performance scores without referring any earlier efforts).

Specific comments

Page 1 Line 15: "a new flexible model framework": Make this part more specific. What is a flexible model framework (or what is an inflexible model)? Also, add the key strengths and characteristics of DECIPHeR compared to existing hydrological models.

Page 1 Line 18: "modified to represent different levels of heterogeneity, connectivity and hydrological processes as needed": Make this part more specific. All models can be "modified to represent" these in some extent. Add more concrete words in what sense DECIPHer is more adaptable compared with other models.

Page 2 Line 30 "the underlying model structures do not have the flexibility to represent different levels of complexity in different landscapes": Quite unclear. Since this part is crucially important to identify the research needs/questions, discuss concretely what have been already achieved and what are still lacking by earlier models.

Page 2 Line 42: "This is despite significant development of various modeling tools . . .": Again quite unclear. What have been already achieved and what are still lacking by earlier models?

Page 3 Line 36 "builds on the code and key concepts of Dynamic TOPMODEL.": This sounds that DECIPHeR is an upgrade of Dynamic TOPMODEL. If this is the case, it is more readable to introduce the concept and formulations of Dynamic TOPMODEL first, then show the new functions and characteristics of DECIPHeR. Actually, the present form is hard to know what are same or different between two models.

Page 4 Line 18 "To realise this, DECIPHeR uses hydrological response units (HRUs)": It is hard to know whether the HRV concept has been already included in Dynamic TOPMODEL or not. I was confused similarly by many parts in this section. As mentioned earlier, please make it clear what are same or different between two models

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more clearly.

Page 6 Line 9 "In DECIPHeR, they provide the basis for river routing . . .". Ibid.

Page 8 Line 12 "2.3.5 Model Structure": Unfortunately, I could hardly understand the model structure. Please describe all the equations for the terms in Figure 3 and the parameters in Table 1. At least describe where such full description of equations is available.

Page 9 Line 9 "The parameter, SZM, sets..": This paragraph is particularly hard to follow. Please show the key equations how these parameters work.

Page 12 Line 44 "3.4.2 Overall model performance" and Figure 6: I am wondering why the parameters are so insensitive to the results (i.e. it is surprising that 90% of parameter sets yield NSE >0). I am also puzzled why the entire ensemble outperforms the behavioral ensemble (top 1% performance, if I understood correctly). Please elaborate these points.

Page 14 Line 21 "We calculated four evaluation metrics for 10,000 model simulations for 1366 GB gauges. . .": Is this the first study to apply a hydrological to the entire Great Britain? If it is the case, clearly state so. If it is not, clearly refer the earlier efforts and compare the performance of them with this study.

Technical comments

Page 7 Line 27 "a parameter file specifying set parameter bounds for Monte-Carlo-sampling": Is "set" needed?

Page 7 Line 42 Q_SAT: I guess this term first appears. Define what this term is.

Page 12 Line 37: "13,600,600" reads 13,660,000.

Page 13 Line 4"The vast majority of gauges (90% of the whole ensemble)": 90% of the gauges or 90% of the ensemble (i.e. 9000 simulations)?

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Page 14 Line 27: "is" reads in.

Page 34 figure 6: The caption says "weaker and stricter" while the figure says "upper and lower".