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Geoscientific Model Development Discussions

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

Anonymous Referee #1

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This paper describes the development of the Dynamic fluxEs and Connectivity for Prediictiosn of HydRology (DECIPHeR) framework for simulation of hydrology (especially river flow) at catchment to continental scales. The model is tested across the Great Britain at 1,366 gauges in the current study but the authors intend to expand the model domain and suggest that it can be applied at the continental scales. The framework appears to be efficient computationally but there are a number of issues that authors need to address before the manuscript can be considered for publication. I provide my specific comments below.

(1) The authors should revise the introduction to clearly highlight the motivation behind and the need for such a framework in relation to numerous other ongoing model development efforts. For example, how does the proposed study advance hydrolog-

ical modeling compared to the model presented by Chaney et al. (2016)? Further, there are a number of large-scale models that have the capability to simulate far more number of processes (e.g., groundwater dynamics, pumping, flood dynamics, human impacts) than those presented in the current framework (for example: Hanasaki et al. 2008; Ozdogan et al. 2010; Pokhrel et al. 2015; Wada et al. 2014). Certainly these models are intended for global/regional applications but there have been ongoing efforts to increase the spatial resolution (i.e., hyper-resolution models) for application of these models at smaller scales. Extensive review of these models is available in recent literature (Nazemi and Wheater 2015; Pokhrel et al. 2016; Wada et al. 2017). I suggest that the authors thoroughly revise the introduction including a discussion on these past/ongoing efforts. Note that most of these models use TOPMODEL to simulate some of the surface/sub-surface hydrologic processes.

(2) Since the framework is currently designed to primarily simulate river flow, it is also important to note studies on streamflow/flood simulations at local to continental scales (Bates et al. 2010; Miguez-Macho and Fan 2012; Yamazaki et al. 2011; Zhao et al. 2017). What is the rationale for having the new framework?

(3) The above two issues are important because the authors' intent is to provide a framework for large-scale application.

(4) P4, L16-40: Why did the authors use HRUs instead of doing a fully-distributed model? Is it just the run time minimization? Is there a compromise in terms of adding new features such as groundwater flows and human water use? Again, I suggest adding a note on how this framework advances our capability to simulate the hydrology in comparison to numerous existing framework (see comments above)?

(5) P5, L15: "must contain no sinks": What if there are real inland sinks? There are too many across continents.

(6) Section 2.2.3: What is the routing scheme used? I find some description later in another section. Please consolidate the text and provide more details.

(7) P7, L24: "potential evapotranspiration": first, this term is used here and then abbreviated several times later. Second, why is PET required for rainfall-runoff modeling? Is it to calculate the actual ET? If yes, where is such description provided?

(8) P7, L40: why and how was the 1mm/day set?

(9) P7, L43: what are the "internal states"? Some examples should be provided.

(10) P7, L45: How are runoff generation, infiltration, and soil moisture movement modeled? Are they done in the same manner as in the original TOPMODEL?

(11) P8, L15: What does the "multiple different" refer to?

(12) P8, L24: How is SRmax determined?

(13) P9, L6: "kinematic wave" formulation: is this sufficient when applying the model over large continents where backwater flow and other river-flood dynamics are important (see: Bates et al. 2010; Miguez-Macho and Fan 2012; Yamazaki et al. 2011; Zhao et al. 2017).

(14) P9, L42: "evapotranspiration losses are highest . . ..": The figure shows PET, not the actual ET, and I believe high PET doesn't necessarily mean high ET (in water limited regimes). I think this argument is not supported unless the actual ET is shown. Could the authors clarify this?

(15) P10, L32-L42: Is the river network map described consistent with the topography data described in the previous paragraph? Isn't it necessary to generate a river network map from the DEM used in the model?

(16) Section 3.3.1: Are the precip data used here same as those shown in Fig. 3.1?

(17) Section 3.3.2: What are the calibration and validation periods?

(18) P11, L14-25: what is the use of PET here? In fact, it was not clear to me on what the forcing variables are. Typical hydrological models use Precip, Temp, Radiation,

Humidity, Wind etc. If such variables are used, is the PET consistent with those forcing variables?

(19) Section 3.4.3 (P13, L33): The authors should present the actual time streamflow time series. Since this is the only the variable simulated/discussed, I was surprised that authors are not showing the time series plots. I suggest selecting certain representative gauging stations with varying catchment area and those located in different climatic regions for such analysis (it could be a 20 stations for example).

(20) Then, I also suggest showing the annual mean flow (rate or volume) as a scatter diagram for all gauging stations. Evaluation of high (Q5) and low (e.g., Q95) can also be presented similarly. Overall, the validation provided in the current version is not satisfactory/sufficient.

(21) P14, L23: "time series": where is this shown?

(22) P14, L39-45: The authors could discuss the appropriateness of different performance measures by referring some recent studies that have used a wide range of such performance measures (Veldkamp et al. 2018; Zaherpour et al. 2018). This comment is relevant to P12, L5-15 as well.

(23) P15, L23: "groundwater dynamics and human influences": Is the HRU-based representation a suitable choice for the representation of these missing factors? Would a fully distributed be required? Please also see a related comment earlier.

(24) Finally, the authors should provide caveats in the current framework and the challenges in upscaling the framework to continental and possibly to global scales. The discussion regarding advancements compared to the existing models/ongoing efforts (e.g., the National Water Model) also becomes relevant here. A note on the use on the use HRUs, and not distributed grids, should also be made.

Minor/editorial issues: (25) P2, L2: impact on "what"?

(26) P2, L8: some refs contain first names/initials

(27) P11, L8: PET is abbreviated here but already used before.

(28) P12, L32: the catchment details are redundant with the information in Section 3.

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