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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Testing the realism of a topography driven model (FLEX-Topo) in the nested catchments of the Upper Heihe, China" *by* H. Gao et al.

Anonymous Referee #1

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In this manuscript the authors test the model realism of conceptual bucket models with increasing complexity. The first (FLEXˆL) is a completely lumped model with 12 parameters; the second (FLEXˆD) is similar except that the climatic input and the lag time parameters are semi-lumped; and the third model (FLEXˆT) is semi-lumped with respect to topological indicators and land use, resulting in 3 parallel conceptual model structures which are coupled by a slow groundwater reservoir, where the contribution of each parallel model is determined by the areal fractions of the topological indicators. To test the model realism, the authors first calibrate and validate the model parameters in a split sample test and consequently testing their performance in two sub-catchments.

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They clearly show that the first two models perform well for calibration and much poorer for the sub-catchments, while the third model performs well on the sub-catchments as well. This is an interesting study and worth a publication, but I have a couple of issues that should be fixed/clarified first.

1) The title of the manuscript states that model realism is tested in this manuscript. I doubt if one can say that a conceptual bucket model is realistic anyway. To avoid this discussion I would advice to change the word ‘realism’ into ‘transferability’: not only in the title but throughout the manuscript.

2) I have some problems with the large amount of parameters of the FLEXˆT model; especially with respect to the other two models. Looking at it from a distance, one may argue that the better performance is simply due to the increased complexity. The authors have to make clear that the better transferability of FLEXˆT is not due to the increased complexity, but due to the explicit incorporation of the dominant runoff processes of each landscape attribute and, more important, due to the fact that the areal fractions of each sub model can be obtained a priori and thus adapted for different (sub) catchments. A proper way to show this is to compare FLEXˆT with a similarly complex model. One can think of the same model as FLEXˆT, but with the areal fractions treated as calibration parameters, or a similar model as FLEXˆD, but now with all parameters of the parallel model being calibrated independently. I still think that the FLEXˆT model will perform the best, but the comparison will be a fairer one.

More specific comments: (for page number, I only gave the last two digits)

Introduction: Keep in mind that at this stage of the manuscript, the fact that topography offers important information is still a hypothesis. Phrasings such as ‘but they fail to extract additional information from topography’ (P66, L4-5) or ‘it is important to investigate a more efficient use of topographic data’ (P66, L16-17) may be too strong

P67, L28: Make clear that you refer to transferability of both model structure AND model parameters.

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P71, L22: Why using percentages for C_p and not just a lapse rate in m^{-1}? Same for C_t. Then you lose the factor 10000 and 100 in Eq. (1) and (2).

P72: L2: the unit used for the precipitation lapse rate is not the same as for C_p: mm(100 m a)^-1 vs. %(100m)^-1

P72, L4-5: why are the lapse rates for the different stations different? Which data is used to derive these?

Section 4: add also the mass balance equation for all reservoirs: not only the flux equations

Section 4.1: Please clarify why this model structure is chosen. Is it linked to the perceptual model (and how) or is it a completely arbitrary model structure?

Eq. (4): Why is I_max introduced? To me it seems exactly the same as S_i/\Delta t?

P75, Eq. (9-10): This lag function means that the oldest day (t-T_lag) contributes the most, while there is no tail. This seems rather strange to me (unless my perception of the runoff processes is completely wrong).

P86, L5: The fact that the relative proportions of each landscape can be determined a priori is, in my opinion, a very important reason to successfully transfer the model to the sub catchment. I suggest emphasizing that.

Section 5.2: This section seems a bit suggestive to me. It is correct (and indeed intriguing) that the landscape classification correspond so well with the land cover map. But the statement that it clearly illustrates that topography is an integrated indicator of energy and water availability and redistribution of natural vegetation cover's growing and evolving environment is a bit too strong. For example: the fact that South facing slopes receive (in the Northern hemisphere) more solar radiation than the North facing slopes and thus have higher potential evaporation rates is also correct, but this thus not necessarily mean that the dominant runoff processes are different: it is merely a hypothesis that can be tested.

P90, L29: I agree that soft data (may) have added value, but the shown results do not demonstrate it. To do that, the results of the FLEXˆT model should be compared with the same model, but then calibrated without constraints.

Small comments

P64, L3: remove ‘poorly understood’

P64, L9: should be: spatially variable input

P66, L3: add potential before additional information

P66, L22: replace ‘(Savenije 2010)’ with ‘and the subject of this study’

P66, L25: remove comma after ‘is’

P66, L27: Remove reference to Gharari et al. 2011. This is already referred to in the line above.

P68, L7: The catchment is not controlled by the gauging station. At the gauging station, the cathment has an area of X m2.

P68, L22-23: List these references in chronological order? You may want to do that throughout the manuscript.

P69, L4-5: replace ‘and can help’ with ‘which we used’

P69, L6-7: did Beven (2012) and Tetzlaff et al. (2012) identify the different landscape classes used in this study? If yes, please rephrase to make this clear.

P69, L28: is SSF not a preferential flow?

P70, L7: remove reference to Savenije 2010.

P70, L9-12: Please rephrase this sentence.

P71, L14: Is there a reason why seven elevation zones are chosen?

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P71, L21: remove 'stationary', add unit for P, replace 'interpolated' with 'extrapolated'

P71, L23: add unit for temperature, replace 'distributed' with 'corrected'

P72, L15-16: replace with 'hydrological functions constructed with the modeling framework SUPERFLEX (Fenicia et al. 2011)

P72, L20-21: Add the notations S_u, S_s etc. after the mentioned reservoir.

P72, L24: Are the precipitation and temperature corrected for elevation as well?

P75, L7: give unit for R_f

P74, L3: change into '. . . core of the hydrological models used in this study, . . .'

P74, L14: add the before soil routine

P74, L14-15: give units for R_f and D

P74, L21: why is C_e not calibrated? Or are there good reasons to fix it at 0.5?

Section 4.3.2: Give the total number of parameters that has been calibrated.

P79, L10: add areal before proportions

P79, L23: add is before not

P84, L22-23: remove other than previous models

P84, L23-24: rephrase: which is, according to Westerberg et al. (2011), a more convincing than exact hydrograph simulation.

P84, L28: add semicolon after characteristics.

P91, L16: add an before eco-hydrlogical

P91, L16-17: replace 'on the other hand' with 'Also'

P93, L93: It may be better to say that this is outside the scope of this research.

Table 2: please add the elevation range as well

Table 4: indicate that T_lag is used in FLEXˆL and the other T_lag's in FLEXˆD

Figure 2: Explain what is seen in picture a-e

Figure 5: Indicate better that the numbers (5m, 0.1, 3600m etc) are the criteria for different landscape classes. One may do that by adding e.g. <5m for wetland and >5m for terrace and hillslope

Figure 7: Precipitation input does not equal the output. Is this change in storage caused by a real difference in the begin and end state or is it caused by a too short warming up period?

Figure 9 and 10: improve the y-axes: add numbers at the FLEXˆL and FLEXˆD graphs and add labels for precipitation and temperature.

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