Response to the reviewers

I would like to thank the Editor for handling the paper and the reviewers for their positive review and to apologize for the delay in submitting the revised version, I am on maternity leave.

We made all suggested changes that are:

Reviewer 1

Title: the case for eco-hydrologic applications is not made clear in the paper.

Answer: The conclusion starts now with "This paper presents a precipitation--runoff model that computes spatially-explicit water fluxes at the ecosystem level and that can, thus, be used as a simulation tool for ecohydrologic applications requiring distributed discharge information. The model formulates the hydrologic response …"

P1867,L18: the Clark et al model has a separate parameterisation of subcatchment

Answer: the corresponding sentence has been updated to "For an example including subcatchment routing parameterization see, e.g., the work of Clark et al., 2008"

P1868, L3: It is not clear how this term "spatially explicit hydrological response model" is different from the standard term "distributed model".

We have termed our model spatially-explicit because the terms distributed or semi-distributed generally imply that the model parameters are fully distributed in space (each spatial unit has its own parameter set), whereas semi-lumped is commonly used to describe models that compute the state variables separately for each spatial unit but with the same parameter set for all units. We believe that the term spatially-explicit is more generic since it implies that the state variables and the model output are computed separately for different spatial units without specifying a priori whether the parameters are distributed or not (in the presented model, some parameters are, others not). This more general term is also more intuitive to understand for other geoscientists (we believe that the distinction between semi-distributed and semi-lumped is very specific to rainfall-runoff modeling).

We included at p. 1868: „We believe that the term spatially-explicit is more generic than the often used terms semi-lumped, semi-distributed or distributed model, which refer to specific set-ups in terms of spatial variability of state variables and of parameters."

P1869,L 14: Are wind, radiation etc also used in the energy balance?

We rephrased to "The precipitation--runoff module solves the mass balance equations at the source area scale. This component is driven by precipitation, temperature and potential evaporation input time series, which need to be properly provided at the source area scale."

Figure 1: It could also be useful to add the flux/state symbols.

We agree that a distinction between flux and state could be useful; however, for conciseness, the scheme shows only one state variable (snowpack height), which is required to decide whether there is ice melt or not. All other state variables are hidden.

P1870, L 6: Does "important vegetation cover" mean trees?

Yes, modified to "a simplification which is not advisable for applications to catchments with considerable forest cover".

P1870: What happens to the non-evaporated water Ic? It may be better to reformulate this store as dIc/dt as with the other stores

We do not model interception – re-evaporation as a storage – emptying process but as an instantaneous process. We added: “It is noteworthy that the above formulation assumes that interception is an instantaneous process, which takes place at time scales smaller than the simulation time step (i.e. subhourly). Only the evaporated water is subtracted from the incoming precipitation, which corresponds to a return of non-evaporated water as throughfall.”

P 1874, L19: Should be "slow" in the subscript

Corrected.

P1875: How do you account for the fact that water flows more quickly at higher stage (i.e. the kinematic assumption)?

We assume constant flow velocity (in space and in time), which we consider a sufficiently good assumption for the range of flow conditions that might be encountered in similar catchments. This will need to be relaxed for larger systems. We added in the text: “This assumption only holds for systems where flow velocity can be assumed to be relatively constant in time (independent of discharge) and space.”

P1876, L 17: Is explicit time stepping good enough for the fast component?

Explicit time stepping is used for the “fast” subsurface flow component, which is slow compared to the surface runoff component and still has a residence time of several days. Explicit time stepping is thus good enough here.

P 1879, L 24: What are the units or values of rD?

The formulation was erroneous and should read “rD is the surface runoff coefficient of the dominant land use class.” rD is thus unit-free.

P1881, L 22: Please state how many individual parameters were you estimating, given that many were jointly estimated using scalings between subcatchments.

The beginning of the results section reads now: “For the Dischma catchment, a total of 12 model parameters have to be calibrated, seven for the water input-runoff transform and five for the glacier- and snowmelt simulation. Here, these calibration parameters have been estimated through simple Monte Carlo simulation to illustrate the main features of the SEHR-ECHO model”

P1882, L1: The splitting between different speed processes was partly imposed by setting minimum residence times.

The new formulation is: “The splitting between the three hillslope scale runoff generation processes corresponds to the expected pattern: Fig. 5 illustrates that the slow subsurface component contributes essentially to base flow and that the direct surface runoff is activated only occasionally. It is noteworthy, however, that this pattern results partially from the imposed subsurface residence time scaling.”

P 1884, L 27: The "unique transferability across timescales" was not shown – I expect other models can also achieve this.

Based on our experience, many similar models require re-calibration if applied at a different time step, especially those that do not resolve the spatial origin of flow at the subcatchment scale. We toned down by removing “unique”. Furthermore, we added a sentence in the results section: “As comparable assessment of model performance at different time scales without re-calibration is rarely reported in the literature. For an example, see the work of Schaake et al., 1996.

P1885, L5: "the presented model can easily be extended to transport processes" – this is rather a bold statement, especially since the area-based scaling may no longer be valid when considering the transport of water/contaminant particles

Our intention was to state that the general modeling framework (albeit not the exact parameterization) can be extended to transport processes. We changed to "Including appropriate formulations of subcatchment-scale mass transformation processes, the general modelling framework can be extended to transport processes"

Reviewer 2

1. The Abstract does not mention calibration and validation of the model, which seem to be important and useful components of the paper - please expand the Abstract accordingly.

Answer: The new end of the abstract reads as "We present here the basic model set-up for precipitation--runoff simulation and a detailed discussion of its parameter estimation and of its performance for the Dischma river (Switzerland), a~snow-dominated catchment with a~small glacier cover."

2. Availability of the model code is briefly mentioned in a closing sentence - GMD model description papers are now required to include a brief "Code Availability" section, located between Conclusions and Acknowledgments. Please develop this section, make sure that the code is indeed available at the advertised website, and provide brief details (under "Code Availability") of what the code comprises and how to practically install/use it.

Answer: New section "Code availability: A fully annotated Matlab version of the model is available on \url{http://www.mathworks.ch/matlabcentral/fileexchange/}, together with example data and a corresponding model set-up file to illustrate the model use. The model code is thus readily useable within the Matlab coding environment or with compatible open source software."

Technical Corrections
1. p.1873, l.22: do you mean "timescales" (rather than "times")?
Correct to "reaction time scales"

2. p.1879, l.18: do you mean "data-base" (rather than "data-based")?
Corrected

3. p.1883, l.3: "clear identification" sounds better than "good identifiability"
Identifiability is a technical term and thus kept here.

4. p.1898, Fig. 4, middle two panels: Please be more specific than "Data" in labeling the y axes
Corrected

5. p.1902, Fig. 8: Please label y axes (or explain them in the caption) - I presume the quantity ranging 0 to 0.3 is fractional proportion of the population per parameter value bin (0-1)
Added in caption. „The y-axis shows the relative frequency of parameter values in each bin.