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Interactive comment on "State-space representation of a bucket-type rainfall-runoff model: a case study with State-Space GR4 (version 1.0)" *by* Léonard Santos et al.

Anonymous Referee #2

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The paper implements a state-space representation of the popular rainfall-runoff model GR4. The state-space representation allows solving the model using robust numerical techniques as opposed to adhoc operator splitting techniques used in the old version of the model. A novel finding in this paper is that the new model version results in more robust parameter estimates that are less sensitive to the temporal resolution (hourly vs daily) of the model simulations. The paper is well written and the results are interesting. I hope my comments below help the authors to further improve their paper:

1. In developing the state-space representation of their model, the authors introduce two changes. First, a different routing model is used (Nash cascade vs unit hydro-

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graph). And second, the model is solved with a different numerical technique (implicit Euler with adaptive time stepping vs operator splitting approach with fixed time step). It would be preferable to introduce these two changes separately rather than together, so as to separate the effects of these two changes.

2. Run times are longer with the new model compared to the original implementation due to the use of implicit Euler with adaptive time stepping. Have you considered using a single-step implicit Euler integration? This may be faster without losing the benefits of the new implementation.

3. Please provide some details/examples of the actual time steps and number of non-linear iterations in your model, for example for one specific basin.

4. Questions about the state-space formulation, Eq. 1:

- why not include water balance of the interception store as an additional differential equation?

- Simulated discharge Q in Eq.2 is defined as an instantaneous flow I assume? Observed discharge is however an integrated quantity (total over an hour or a day). Wouldn't it be better to define simulated Q also as an integrated quantity? You could in fact add Eq.2 to the ODE system in Eq. 1: dQ/dt = Qr + Qd. Note that you then would have to reset Q = 0 at the start of each forcing time interval.

- it would be good to explicitly point out in table 1 that the instantaneous flux equations are the same for the two models.

5. Section 2: The discrete form is contrasted with the state-space form of the model. Note that a state-space representation can be either discrete or continuous, so it may be better to explicitly call it continuous state-space formulation.

6. Section 4.3: this section describes the relation between the unit hydrograph approach for routing in the old model and the Nash cascade representation in the new model; in my view this section really fits better in the methods section, for example

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following the text at the bottom of page 6. My suggestion is to move it there.

7. Abstract: what do you mean by "resolution"?

8. Typos:

p4 line 20: symetric -> symmetric

caption fig.1: discret -> discrete

p9 line 2: adaptative -> adaptive

p11 line 6: tose -> those

p14 line 16: unconsistencies -> inconsistencies

p18 line 20: grounwater -> groundwater

caption fig.11: comparaison -> comparison

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