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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Worldwide soil moisture changes driven by future hydro-climatic change scenarios" *by* L. Verrot and G. Destouni

Anonymous Referee #3

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This study presents a global analysis of hydro-climatic change. The authors performed a post processing of existing scenarios by computing a proxy of the soil moisture using a simplified model developed and published in previous studies.

My main concerns are linked to the model and the adding value it provides in comparison to more direct climatic indicators (P-ET, ET/ET0 Precipitation indexes) or simple water balance approaches, which for me would be more appropriate since all the water flow terms are available in CMIP 5 simulated data set. In the model presentation and in the discussion it would be important to better position the method and discuss its relevance with respect to other approaches.

1) The presentation of the model is not always easy to follow. A schematic diagram defining clearly the modelled system and the flows and how they can be related to

the CMIP 5 output variables would be very useful. The principal difficulty come with the definition of the Runoff Reff and R. To my understanding, Reff is the ground water recharge and R the sum of ground water recharge and surface runoff. This can be clearly defined in a figure.

2) The depth of the soil layer remains unclear. Does it correspond to the depth of the water table, which means that it could reach several hundreds of meters in the case of deep aquifer? What would be the value of the soil parameters, which described basically the top first meter?

3) What is the interest of showing equation 3, which is never used in the study? What is the difference between deltaS and the soil moisture?

4) The model use an equation describing local and instantaneous flows as analog of large scale and monthly integrated. It is audacious to use such a non linear equation considering that spatial integration (with very strong spatial heterogeneities) and temporal averaging tend to smooth non linear processes. In fact the resulting value can just be a crude proxy of the moisture content and it would be interesting to show how the adding value of such a proxy in comparison to that given by a simple soil water balance approaches since all the terms required to implement it are given by CMIP5 outputs. A discussion of this point would be very important in part 4, in particular to demonstrate the potential of the proposed approach to provide an original view for CMIP5 scenarios analysis. The relevance of the computed soil moisture is justified by a comparison with Grace. In the evaluation with Grace how the author estimate Reff, the soil depth (since soil moisture is given in term of Storage variations). Moreover, Grace measured the total amount of water. How the authors separate the variation in soil water content and those linked to the aquifer variations.

Specific comments

L126-132 : In the hydrological balance, DeltaS seems to be a second order quantity in comparison to P. Can the authors comment that statement and the consequence for

the study.

L170-180 : this paragraph is difficult to follow. What is the physical meaning of an upward flux (exfiltration? Contribution to river flow? lateral aquifer flow? Numerical artifact? . . .)

L197 I would say Equation 2 rather than Eq. 4

L198-209. This paragraph is difficult to follow. It seems that the rainfall threshold to distinguish wet and dry season is changing every year. This means that a given climate event, it can be classified as dry or wet according to the year (wet or dry). Can the authors comment that.

L201-202 : I don't understand what is done

L205-209 : I don't understand what is done

L210-L215 : This could be supported by a synthetic figure in the main text.

L219-220 : "and not . . ..landscape". I don't understand what is meant here

L233-240 :" inter-model differences are relatively small" looks contradictory to the subsequent statement "long term term average soil moisture may vary greatly". In general the paragraph is difficult to follow.

L248-250 : difficult to understand the agreement of results (which agreement? Which results?).

L324-L328 : very long sentence difficult to read.

L342-L346 : one of the interest of the approach is to bring some soil information in the analysis. It would be interesting to go above the simple non-linearity observation. How soil properties affect the impact hydroclimatic change on soil moisture variability

Results and discussion. Are the results consistent with previous analysis on hydroclimatic changes. What original conclusions can be highlighted by the use of the pro-

posed model?

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