

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

Anonymous Referee #1

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The authors present an interesting study by which they analyse the trends in soil moisture characteristics under two climate change scenarios. This is important because soil moisture is a key variable for runoff partitioning. Also, it is a major control on agricultural production. Although I feel this work is of interest to HESS I have a number of issues, some of which quite major: 1) The first question that arises is why they authors used a single additional soil moisture model and not the soil moisture states from the GCM land models? Or are they not available from the CMP5 repository? They should state a reason for this is in the paper.

2) The question is also why the authors did not look at evaporation directly (probably also available from the repository). This is a more direct indicator for agricultural and ecosystem productivity. Please provide a reason why soil moisture was chosen here!

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3) The soil moisture model that is used assumes free drainage from the soil; i.e. the time-average soil moisture is such that it supports the unsaturated conductivity that allows the time-average recharge to pass through the soil under a 1:1 (is gravity) gradient. This is a realistic assumption when looking at larger time scales (which is what they do) and for unsaturated zones with deep water tables. This latter assumption does not hold for many basins they have chosen. For instance the Ob has large wetlands (peat bogs) and the lower Danube has a number of topographically flat areas (Pannonian Plain, Wallachian Plain) with shallow groundwater tables. The soil moisture dynamics in such areas may be much less sensitive to climate change due to groundwater convergence or impaired drainage. This is not accounted for. The question then is: what are the errors made by this assumption?

4) What is lacking is a proper validation of the model. GRACE is not particularly useful for validating soil moisture variations if a proper correction for especially groundwater volume changes is not done. This is difficult as there is limited info about this. The reverse has been done a lot: estimating groundwater variations by subtracting from the total storage change TWS soil moisture and surface water volume changes as obtained by land surface models. There are now close to 20 years of soil moisture data available from remote sensing (merging passive microwave and radar-based soil moisture retrievals – TU Vienna and VU University). I wonder why these were not used to validate the basin-scale soils moisture simulations? I think a validation with these data is in order.

5) The spatial variation within the basins (as big as the Danube) is neglected, assuming that the most dominant soil type forced with basin-average recharge will yield basin-average soil moisture or soil wetness. This is a pretty big assumption given that runoff generation and evaporation are non-linear processes and heterogeneity within basins (both in soil type, orography and climate – e.g. the Danube) can be very large. The author should at least show that the assumption is warranted that their approach produces the correct trends and tendencies. This can be done with a numerical experi-

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ment by choosing a heterogeneous catchment and do the analyses on subcatchments first (or grids of the GCM) average the results over the basin and compare these to their basin-average method.

6) The uncertainty is only marginally taken into account. The authors have an ensemble of GCMs to do the analyses on but only use the ensemble mean (except in the plots of Figure 2). If the ensemble was used as a whole, not only the percentage change could have been reported but also a t-test to signify if this change is significant. Alternatively, they could have made a percentage change map also indicating the number of the models showing the same tendency. Working with an ensemble but not using its potential to include uncertainty is an omission that should be corrected.

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