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Hydrology and Earth System Sciences
Discussions

Interactive comment on "On inclusion of water resource management in Earth System models – Part 1: Problem definition and representation of water demand" *by* A. Nazemi and H. S. Wheater

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We greatly appreciate Anonymous Reviewer #1 for their positive, constructive and thoughtful comments, which led to substantial improvements in the revised version of our manuscript. In the following, the issues raised are addressed point-by-point in the order they are asked. The reviewers comments are numbered; our reply to each comment is shown immediately below the comment.

1- Title and models: Your definition of Earth System Models is unclear. On the one hand you talk about GHMs and on the other hand about LSSs, while DGVMs also

come into play. Please consider a thorough definition of model types (and a change of the title if applicable).

Many thanks for your comment. We tried to thoroughly define the model types and their distinctions (please see Section 1.1 in the draft revisions attached). Please note that now we refer to land-surface schemes (LSSs) as land-surface models (LSMs) according to comments we received from other reviewers of this paper and the companion paper. Please see the modified text in the draft revision file attached related to definition of Earth System models (lines 47 to 50), LSMs (lines 50 to 58), GHMs (lines 74 to 76) and difference in their applications throughout our review (lines 223 to 235). Please note that we do not specifically discuss DGVMs in our paper; however, many LSMs are equipped with algorithms for represent dynamic vegetation. In the revised version, we limit the large-scale models in this survey to GHMs and LSMs only (please see Section 1.1 in the draft revisions attached).

2- The title mentions "water resource management" while your focus is rather water demand (indeed, how models do water management is explicitly left out as stated on p. 8249 lines 2f – or do you mean effects on climate here?).

Indeed, the focus of our paper is on including water resource management in large-scale hydrologic and land-surface models that can be considered as sub-models within the broader definition of Earth System models (see Section 1.1 in the draft revisions attacached). However, for the purpose of our presentation, we divided the water resource management into water demand and water supply and allocation and in this paper we only focus on water demand (please see Section 1.3 in the draft revisions attached). We tried to elaborate this in Section 1 (please see lines 213 to 215 in the draft revision attached). Please note that from Section 2 onward, we only focus on the demand side of the water resource management and the discussion regarding the water supply and allocation is remained for the companion paper. Regarding your point in p. 8249 lines 2f, we meant agricultural land management strategies (e.g. no-till agriculture, double-cropping etc.) and declared that beyond the scope of this paper. We

deleted this sentence in the draft revisions to avoid any other confusion.

3- Section 3.2. and 3.3: I'm afraid I haven't understood the difference between "bottom-up" and "top-down" approaches. Are these appropriate terms? And aren't the problems discussed in 3.3 (e.g. the PET method) also inherent to approaches discussed in 3.2?

Many thanks for your comment. We should have clarified this. We named this way of calculation as "top-down"; since the information at the grid scale is estimated by downscaling data available at coarser scales. These data are coming from census information or socio-economic modelling products. Please note that socio-economic models do not directly calculate the agricultural water demand; but they estimate the agricultural productivity. The water use is then estimated indirectly using water required for producing each crop per unit of land. An example for such model is Global Change Assessment Model (GCAM; cited in the paper). Therefore, problems associated to PET are not in this kind of models (but of course, they are associated to other sources of uncertainty; please see p. 8255 line 15 in the original HESSD submission). We revised the text to elaborate this better. Please see the modified text in draft revisions attached for top-down (lines 341 to 344) and bottom-up approaches (lines 362 to 363) respectively.

4- P. 8251 first paragraph: Models with fully dynamic crop growth and dynamic irrigation may also misrepresent irrigation demands if they do not correctly represent the seasonality. In contrast, models with fixed crop calendars may not respond well to yearly weather conditions. I think Portmann et al. (2010) have a discussion on these effects, which should be considered here.

Many thanks for the heads-up on this. We include this discussion in the paper. Please see the modified text in the draft revisions attached (lines 317 to 327). We believe Portman et al. (2010) used the crop calendars reported in several inventories and/or national reports and gave more attention to the uncertainty associated to these sources; therefore, we used the reference for elaborating the revisions related to the top-down

algorithms. Please see the modified text in the draft revisions attached (lines 356 to 358).

5- Some further aspects could be briefly discussed, i.e. the following: How do models treat demand from groundwater (fossil, renewable)? How do water demand and its parameterization feed back to runoff/discharge and eventually sea level rise (could be part of section 5.1)? What can be said about how models treat tradeoffs among different demands (irrigation, industry, municipal) – which I think is a major topic? Do/can models rigorously consider water limitations in their demand calculations – which is another very important topic in my view? Whether models consider seawater desalination and "green" water demands could also be mentioned.

We completely agree with you and believe that these issues are extremely important. However, please note that we discussed issues related to the water supply and allocation in the companion paper. This has been clearly indicated in the paper. Please see the modified text in the draft revisions attached (lines 213 to 215). In the companion paper, we do discuss the allocation from fossil and renewable groundwater, runoff/reservoir discharge and desalination, and highlighted how models deal with water limitation and priorities (i.e. trade-offs) in water allocation.

6- The Abstract should mention a focus on how water limits energy, agriculture, etc., in case you'll consider this in your revision.

Please see the modified text in the draft revisions attached (lines 13 to 15).

7- The text on hydrologic improvements of models in terms of water supply (p. 8242 lines 17ff) is rather long given the focus of this paper; isn't this the focus of the companion paper?

Many thanks for your comment. Here the task is to discuss the importance of hydrological simulation capability in LSMs and the gradual improvement in representing the water cycle elements in these models over time. We did not tend to discuss the water

supply there, but aim at providing a brief overview on evolution of LSMs in describing terrestrial water cycle. According to your comment, we shortened the discussion and attempt to be more concise in our description. Please see the modified text in the draft revisions attached (lines 59 to 80).

8- P. 8243 lines 7-12 could also be left out.

Many thanks for your comment. After a careful consideration, we decided not to exclude this section in complete as it provides a context to explain why anthropogenic activities, and more specifically those related to water resource management, should be represented in Earth System models. Please note that in the revised version, we shortened and moved the discussion. Please see the modified text in the draft revisions attached (lines 85 to 92).

9- P. 8245 lines 8-19: This paragraph could be shortened and moved to the related discussion on the preceding page.

Many thanks for your comment. We did shorten and move the paragraph within the text, however, we kept it in the same order in relation to preceding paragraphs. Please note that the aim of this section is to provide some examples on why the human-water interactions can be relevant to hydrological and water security modelling and simulating land-atmospheric interactions, and therefore, justifies the inclusion of human-water interactions in large-scale models. Irrigation is an important component of water resource management and included here just as an example in which a human activity can affect the climatic surface boundary condition and perturb local climate. Please see the modified text in the draft revisions attached (lines 142 to 156).

10- Section 3 starts rather suddenly with irrigation, please introduce the section in a better way.

We revised the beginning of Section 3 based on your comment. Please see the modified text in the draft revisions attached (lines 293 to 306).

11- P. 8257 lines 19-22: I have the impression that non-irrigative demands are usually treated less interactively with other components than irrigation demands, can you say something about that?

This is due to the fact that the non-irrigative water demands are predominantly non-consumptive and therefore do not change the energy balance and/or perturb the atmospheric moisture condition. We highlighted this in the revised version. Please see the modified text in the draft revisions attached (lines 283 to 290).

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/11/C4865/2014/hessd-11-C4865-2014-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 8239, 2014.