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Hydrology and Earth System Sciences Discussions

Interactive comment on "Value of river discharge data for global-scale hydrological modeling" *by* M. Hunger and P. Döll

M. Hunger and P. Döll

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Anonymous Referee 1

(1) *A diagram illustrating the model flowchart (input data and its frequency, main parameterizations, output and its frequency) can be helpful to summarize what is described in section 2.1.*

Response: A figure has been added to section 2.1 (Model description) that schematically represents the model s vertical water balance and lateral routing as well as the application of the tuning parameter and correction factors. We tried to keep the figure as concise as possible. As the most important information on input data and parameterization is given in the text, we decided not to include those aspects in detail.

(2) *Please clarify if the technical constraint in paragraph 2.2.3 is really unavoidable and why.*

Response: Section 2.2.3 (Technical constraints to tuning) has been supplemented according to your suggestion:

Constraint 1: During the tuning process, each sub-basin is treated separately, i.e. no information about water availability in neighboring basins is available and demand can only be fulfilled within the sub-basin. Avoiding this constraint would require iterative tuning of all basins at a time which would lead to unacceptable computing times.

Constraint 2: This restriction is accepted, as a perfect fit of station-specific initialization would require separate model runs for each sub-basin. This would impede water transfer across basin boundaries as described above.

(3) *Geographical plots could be improved by adding colors legends (Fig 2 and 4).*

Response: Color legends are included in figures 2 and 4 (see discussion paper: http://www.hydrol-earth-syst-sci-discuss.net/4/4125/2007/hessd-4-4125-2007.pdf)

(4) *The authors could consider to had a table at the end of section 3, summarizing conclusions per basin (at least for the major catchments, avoiding small ones) to list pertinence for modelling verification and main difficulties (e.g snow-dominant, ephemeral ponding) that have required/justified CFA, CFS tuning. This would ease the goal (mentioned in the conclusions) of using this study to guide the global-hydrological model cal/val. I acknowledge the fact that Table 3 partially contains this information although the nature of processes is mixed since basins are clustered by extension.*

Response: A table has been added to section 3.2.1 (To what extent does tuning against more discharge observation improve the representation of long-term average river discharge?) showing results for seven exemplary basins with regard to long-term average discharge. Benefits and drawbacks of adding more discharge information to these basins are discussed in detail at the end of this section.

(5) *Guidelines for the gauging strategy are embedded in the conclusions. A clear statement can be introduced (e.g. gauging un-gauged or too large basins can be valuable especially in humid climate).*

Response: It is hardly possible to formulate general guidelines on gauging strategy. As described in the conclusions an optimal distribution of tuning stations strongly depends on modeling purpose. We tried to clarify this by supplementing section 4 by the following text:

It remains a question of modeling purpose whether to accept potential model inconsistencies in order to gain a more realistic pattern of simulated discharge, or not. Certainly, a future priority should be to make available measured river discharge in ungauged basins and inside the 88 V2 basins larger than 100,000 km^2, as this would allow an improved representation of the impact of sub-basin specific characteristics on runoff generation.

Anonymous Referee 2

(1) *Although it is inherently included in the manuscript, it should be emphasized especially in the abstract and the conclusions section that the described effects of more observations available for model tuning strongly depend on the hydrological model formulation. For example, it is written in Sect. 3.1 on page 4145: V2 basins which require CFS are mainly located in snow dominated (e.g. Alaska, northern Canada and northern Siberia) and very dry areas (e.g. northern Africa, Central Asia), where the model can not account for all essential processes of the water cycle. I would expect different effect in these areas if a hydrological model is used that has a more sophisticated representation of cold region and dry region hydrological processes. Thus, some effects are clearly model dependent. In addition, it might be useful (if possible) to point out a) effects that are likely to be model independent, and b) effects that are strongly model dependent.*

Response: Your suggestion is certainly justified. We clarified the distinction between

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input data errors and errors that depend on model formulation in the abstract, section 2.2.1 and the conclusions:

Abstract: The value tends to be higher in semi-arid and snow-dominated regions where specific processes of the water cycle cannot be represented yet by WGHM, uncertainties with regard to climate input data are higher and the model is thus less reliable than in humid areas.

Section 2.2.1 (Tuning factors): However, for many basins, observed long-term discharge cannot be simulated with a deviation of less than 1% by adjusting gamma. This is due to a number of reasons, among them errors in input data and limitations in model formulation, both affecting notably semiarid and arid regions as well as snow-dominated regions. In dry regions the high spatial variability of convective rainfall is not captured well by observations. In high latitudes and mountainous areas undercatch of snow precipitation remains a major problem. WGHM cannot yet represent several specific processes that are assumed to be essential in the respective regions. These include river water losses to the subsurface, evaporation of runoff in small ephemeral ponds, capillary rise of groundwater as well as glacier and permafrost dynamics. Estimation of human water consumption is also uncertain. At this stage it is hardly possible to distinguish the effects of data errors and model limitations on discharge simulation, as they may affect simulated river discharge at gauges in similar ways.

Conclusions: The value of the additional discharge information tends to be higher in semi-arid and snow-dominated regions where results of WGHM, and of hydrological models in general, are typically less reliable. Tuning mainly compensates for precipitation undercatch in snow-dominated regions and for the incomplete integration of important processes in semi-arid regions.

(2) *Sect. 3.2.1.and Fig. 4: I don t understand how the SDF of V1 describes the value of additional discharge information. As SDF is defined, it just describes the goodness of fit for V1. It is written on page 4148: In variant V2, all SDFs should be zero. This*

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contradicts to the definition in Sect. 2.3 Eq. 6. This is rather confusing. Therefore, I probably do not understand the whole first paragraph in Sect. 3.2.1. Please correct and rewrite!

Response: Apart from a few sub-basins that could not be tuned properly due to the constraints described in section 2.2.3, SDF of V2 equals one (not zero - our mistake) at all V2 stations. This implies a perfect fit between simulated and observed long-term average discharge as a result of tuning. SDFs of V1 at the same locations may differ from one (at stations that are only used for tuning V2) and thus represent the error that would occur without the additional discharge information. We clarified this in section 3.2.1 and revised the caption of Figure 4.

(3) *Minor Remarks:*

Abstract, par. 1, p. 2 - line 4: The choice of;

Sect.2.1, par. 1, p. 4131 - line 6: Döll (2002) does not exist in the reference list

Sect. 3.2.5, par. 1, p. 4153 - line 22: the Murray-Darling basin

Sect. 3.3, par. 1, p. 4154 - line 10: introduction, basin size

Sect. 3.3, par. 1, p. 4154 - line 15: impact of basin size

Sect. 4, par. 1, p. 4157 - line 5/6 and abstract - line 4: of aquatic ecosystems.

Response: Corrected according to your suggestions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 4125, 2007.