

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2022-161

Anonymous Referee #1

Referee comment on "Coupling a large-scale hydrological model (CWatM v1.1) with a high-resolution groundwater flow model (MODFLOW 6) to assess the impact of irrigation at regional scale" by Luca Guillaumot et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-161-RC1>, 2022

General comments

The paper describes a combination of two hydrological models, CWatm and MODFLOW, nested into each other where MODFLOW has a comparatively high spatial resolution (100 m x 100 m gridcells), and CWatm has a resolution of 1 km. Focus is on the inclusion of human management (irrigation and pumping) into the calculation of water table depths and water table fluctuations. The authors claim that this is the first attempt of combining topography and precipitation-driven processes with these two human activities at these spatial scales. The test basins are two very different ones from Austria and India, which differ with a factor of 80 in size and are also very different in the intensity of management.

The paper is written in a somewhat lengthy and occasionally redundant style, but rather clearly structured and of high language quality (hard to find typos). There are a couple of issues which need to be corrected as outlined in the following. They accumulate to "minor revisions", and since the scope of the paper is clearly fitting to GMD, it could be publishable in this journal once the authors consider the points raised.

Specific comments

The landuse category "groundwater-supported grasslands" is problematic. It is defined through model runs and a sort of arbitrary threshold (4 out of 12 months), i.e, is not a property of "nature". The classification is obtained through initial model runs and then kept fixed – however, with optimal parameters, some of the cells could change their classification (the threshold crossed). Did you consider this feedback loop?

The description of the management implementation into the model is rather vague. Most prominently, (l. 218) "outfitted with daily-reservoir-specific operations" and then "are set to satisfy some agricultural demands" (l. 222) are so unclear that no other modeler could reproduce your results. You should provide more details or a different way of presenting the inclusion of irrigation and pumping.

The parameter optimization (to obtain values for aquifer thickness, permeability and porosity) is not described to any detail. It was done as an inverse-modelling approach "calibrated manually by comparing simulated and observed water table..." (l. 348). How many boreholes did you use for calibration, and how many were then used for validation? How certain are you that the simple values obtained for Theta and T are the optimal ones (in the sense of minimum C_mean? Or nRMSE? Or both?) In any case, the values obtained are model-internal, needed to obtain sufficient model performance, not properties of the basins; one aspect of this mismatch is that all three are local properties, spatially varying, whereas your model approach is ignoring this heterogeneity. It is therefore also not justified to claim that "the GLHYMPS database overestimates these values" – no, a valid statement would be that your optimal parameters obtained in the CWatm-MODFLOW approach are smaller than those from the database.

The quality assessment of the model is positively biased due to subjective choices of the modelers: first, boreholes at the edges are discarded since lateral flow is not properly implemented in the model; then, incomplete records (less than 50% values available) are discarded, without obvious reason; then, and worst, 5% "bad" boreholes (with particular poor model performance) are also excluded. The remaining time series have a higher performance by construction, but exactly how much better? Also, it is wrong that the locations where the model is performing particularly poor are "impacted by specific local conditions", you can't know that since there are no independent validation data? Please elaborate on this; the reported C_mean, nRMSE and KGE values are necessarily biased.

Technical corrections

l. 31: "subgrid resolution" is something else as "river incision", the parenthesis seems to indicate that the latter is an explanation of the former, which is not the case. Please correct.

l. 52: why should „unrealistic aquifer properties" always UNDERestimate water table depth? It could also be the other way round. Please correct or explain.

l. 91: Please expand on "environmental flow limit", at least provide a reference here.

l. 303: no, this information is not contained in Table 1. There is also no Table 2, so what do you refer to here?

l. 306: out from the deficit of previous reports for the Bhima basin (e.g. canal leakage is not included), it can't be concluded that your model is appropriately representing the region's annual water use. The "therefore" is a logical fallacy.

l. 327: how can topography "extend over several orders of magnitude" (and of what variable? Slope?)?

equation after l. 331: the summation index (typically i) is missing! It has to be $WTD_{obs,mean_i}$ and $WTD_{sim,mean_i}$. and the it also should read $i=1$ below the Sigma.

l. 334: the first sentence is trivial, the second questionably – a discrepancy of just below 50% is not an indication of a good model; presumably, both NSE and KGE would show quite poor values

equation after l. 341: the summation index is missing! This time it is t , it should read $WTF_{obs,t}$ etc.

Figure 4c) and all with a time axis: delete "[monthly]" in the legend of the x axis. This is just calendar years.

Figure 4b): it would be quite natural to include the r^2 value for this scatterplot. Similar in Fig. 5b)

Figure 5c): here, the temporal resolution seems to be 6 months, which is rather odd. The model operates at daily scales, if you don't want to show the resulting time series you might aggregate to monthly values, but not half-yearly.

l. 408: the uninitiated reader might wonder about "KGE" which is nowhere explained. Write out Kling-Gupta Efficiency and provide the reference.

l. 584: "hydrological modelers..never observed in river networks"? Doesn't make sense. Something went wrong here. Even replacing "modelers" by "models" doesn't help. What are you intending to say here?

