Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC2
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Reply on RC1

Luca Guillaumot et al.

Author 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-AC2, 2022

Dear reviewer,

Thanks a lot for your time and your constructive comments. Please find below, some answers to your main comments. We will revise the manuscript accordingly:

- . Indeed, the area of the landuse category "groundwater-supported grasslands" need to be defined within each mesh of CWatM. The spatio-temporal extent of groundwater capillary rise (and the resulting contribution of groundwater to evapotranspiration) is an uncertain component of hydrology and there is no observed datasets providing "groundwater-supported lands" maps. Only hydrogeological models can provide an estimate of this process occurring where groundwater levels are shallow. The calibration has been done without including this specific land cover to avoid what the reviewer mentioned in the comment. Thus, we assume that adding this land cover does not impact the calibration (only locally). This landuse category was added to study more accurately the impact of irrigation. To clarify the manuscript, we will complete and we will move the description of the "groundwater-supported grasslands" (section 2.2.2) inside section 5 "Experiments to infer the impact of irrigation".
- We bring several improvments to the model regarding water management: the implementation of groundwater pumping (mentionned previously) and canals. Water allocation was not problematic as we simply prioritized non-irrigation requests while water withdrawal sources were more challenging. The revised manuscript will provide more details in section '2.2.3 Groundwater pumping'.
- We will clarify the parameter optimization in the revised manuscript following theses comments. Note the number of boreholes is given in section 4.1 « Available observed data ». In the new version, we also mention it in section 4.2 « Comparison between observed and simulated water table » dealing with parameter optimization. Aquifer thickness is not optimized and was determined in consultation with groundwater experts. For given pumping and recharge timeseries provided by CWatM, transmissivity (hydraulic conductivity times saturated thickness) first constrains Cmean. Then, once transmissivity is defined, porosity can be constrained by the nRMSE criterion focusing on water table fluctuations. Thus, we further calibrated hydraulic conductivity and porosity by trial-errors. Only groundwater parameters are calibrated in this study. Our approach consists in simulating hydrologic systems at large scale with a physically-based representation of groundwater. In this context, we tried to find equivalent homogeneous properties to model the system based on water table observations, our

results suggest that we can ignore heterogeneity at the aquifer scale even if it would lead to inaccurate results locally such as under/over-estimated water table depth locally. We agree in part with the comment regarding the comparison with the GLHYMPS database. This is a reference for hydraulic conductivity and porosity at global scale. However, the database itself contains a lot of uncertainty as it extends to the globe a correlation between hydraulic conductivity and geology based on existing calibrated hydrogeological models in several regions. The aim of section 6.1 was to compare our parameters with reference local data and also to compare them with large-scale datasets usually used.

- Our goal is to infer equivalent hydraulic conductivity and porosity from sparse water table observations so that the overall behavior of the aquifer is well reproduced. Thus, quality assessment requires to pre-process observed data to exclude the least representative boreholes (or boreholes where the model will never reproduce water table anyway). Time fluctuations can not be compared properly if we do not have enough time data, several boreholes are excluded for this reason. If not, some wells would be calibrated only during one or two seasons, or worst, only during humid or dry periods. We acknowledge that water table depths at the edges of the basin are surely less realistic because the 'no flow' boundary condition considers that the topographic limit of the basin is similar with the hydrogeological limit. This effect is important only for meshes at the edges of the basin and does not impact the simulation because the basin is huge. So, we think it makes sense to not consider these boreholes. Removing 5% "bad" boreholes is more critical but we can not exclude manually, one by one, boreholes presenting bad quality data, and investigating why they have a different behavior or measurement errors. Finally, even if criteria are slightly biased (as we keep 76 and 94 % of monitoring boreholes), we think this approach is suitable to infer parameters.

Sincerely,

Luca Guillaumot