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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Multi-model approach to quantify groundwater level prediction uncertainty using an ensemble of global climate models and multiple abstraction scenarios" *by* Syed M. Touhidul Mustafa et al.

Anonymous Referee #1

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General comments:

The aim of the paper is to make a prediction of a future groundwater level, and to quantify the uncertainty of multiple sources of the models. This is achieved by using multiple conceptual hydrogeological models, climate scenarios and abstraction scenarios. I think the authors conducted a challenging project and present worthwhile results. A relatively simple hydrogeological model is applied which makes that the results have to be judged to that background. The paper has a clear structure and is well written.

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Specific comments:

Line 273 The magnitude of the river bed conductance is given as 0.18 mˆ2/s (∼15500 mˆ2/d). It is unclear what this quantity means. Usually, in MODFLOW the river bed conductance depends on the river length (L) and width (L) within a grid cell, and the (vertical) hydraulic conductivity (L/T) and the thickness (L) of the river bed. This yields a value with dimension (Lˆ2/T). This is also the dimension of the given conductance, instead of the expected dimension (L/T).

I ask the authors to explain the interpretation of this quantity.

Line 304 The model is calibrated using PEST. The values of the calibrated parameters are given in the supplementary materials in Table SM-2. The calibrated values of the L1 models are 6.00E-3 m/s (518 m/d) and 4.45E-3 m/s (384 m/d) which seem to be unrealistic high values for the described subsurface. The same order of magnitude holds for the second layer of the L2 models, and for the third layer of the L3 models.

Many calibrated parameters are set to the upper boundary of the parameter range. This suggests that the calibrated values could not reach the real optimum, or that conceptual problems in the models prevent a good calibration.

From these observations it may be concluded that the calibration of the hydrogeological model needs more attention. The achieved results, as described in the paper, have to be judged with in relation to the quality of the hydrogeological models.

I ask the authors to add a discussion of the quality of the calibration, and to explain the magnitude of the conductivity values and their validity in the model.

I suggest the authors to add in the discussion an improvement of the calibration in a future study.

Line 480 The RMSE and the variance are both used to test the goodness of fit of the models. In table SM-5 and SM-6, however, all RMSE values are exactly equal to the square root of the variance. The description of the variance in line 319 also seems to be

the same as the calculation of the RMSE. This suggests that there is no added value to use both measures to judge the quality of the models. Are the authors convinced about the correctness of the implementation of these measures? Or are the calculations of both measures inherently equal?

Please make clear what the value of the variance is or, in the case of equality of both measures, I would suggest to remove the presentation of one of the measures (RMSE or variance) from the results.

Another presented performance measure is the PBIAS in Eq. 2. This equation is applied to the observed and calculated groundwater levels. Since groundwater levels are measured against an arbitrary reference level I think the PBIAS is not a suitable measure to apply on these values. The numerator of the formula of PBIAS is not affected by the choice of the reference level but the denominator is. The PBIAS measure seems more suitable for quantities without an arbitrary reference level, like fluxes.

I ask the authors to make clear why PBIAS is a good performance indicator in the current study and why it can be used, or to replace it by another indicator or, if they agree with my objections, to remove it from the article.

Line 496 The authors describe the cause of the outliers in Fig. 5. It is not explicitly mentioned which observations the authors call the outliers, but it seems to be the observations beyond the 95% interval. Obviously, about 5% of the observations will lie beyond the 95% interval. The presented graph does not have extreme outliers, relatively to the total data cloud. More important is to what extent a difference between observed and calculated values is accepted in this study.

I ask the authors to make clear what they consider the acceptable difference between observed and calculated values, or which acceptable interval.

Line 562 In Fig. 7c the temperature changes calculated in the different scenarios are presented. Herein, the Tmax is lower (instead of higher) depicted than the Tmean and

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Tmin, which is confusing.

Please explain what these values do represent?

Line 548 and Line 575 In these lines the period ‘dry season’ is mentioned. It would help the reader to repeat here which months are considered the dry season.

Technical corrections:

Line 65: first occurrence of CHMs should be singular

Line 74 increasing -> increasingly

Lines 86 abbreviation GHS is explained, Line 87 GHG is used

The words ‘groundwater level’ is often written as singular, where it should be plural.

I would suggest to add in long sentences commas (“,”) for readability.

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