

We thank Dr Long for his valuable review. We prepare to include the following changes on the manuscript according to his specific comments.

Opening paragraph of review: *This manuscript describes a first attempt to estimate groundwater recharge over a regional scale in Europe through the use of a simulation model. The approach presented is novel in that (1) it separates the study area into four karst landscapes by cluster analysis, and (2) the ranges of parameter values were determined by a step-wise process that used observation data and a priori information. Model uncertainty was assessed by evaluating the ranges of model outputs that resulted in the range of Monte Carlo parameter inputs. The manuscript is clearly written, except where noted, and rigorous and is suitable for publication in GMD after some moderate revisions.*

1. *The introduction states that a novel approach considers the sub-grid heterogeneity of karst using statistical distribution functions; however, this approach already was used in a previous version, called VarKarst, as described in Section 2.1. The novel parts of the manuscript are outlined in my opening paragraph above and are better described in the Conclusions of the manuscript.*

Answer Indeed, the novel parts of the VarKarst-R model compared to the VarKarst model are not elaborated adequately in the Introduction and the Data and Model section. The revised version of the manuscript will highlight the new functioning of the model in its introduction and it will clarify explicitly on the differences to the previous version of the model in subsection 2.1.

2. *Section 2.1 is a brief summary of equations previously published by the Author and appears to be shown here for the purpose of explaining the four parameters. This could be stated more clearly because it's not totally clear whether these are new equations or not. Also, the reader would need to read the previous papers to fully understand their meaning. One reason for the confusion is that this is described as being a new version (VarKarst-R), but the equations have not changed (unless I missed something). Therefore, please explain what was modified in the new version.*

Answer We agree that a better clarification on the novelties of the VarKarst-R is needed (see also our response to the comment just above). In addition, the set of equations that explains the numerical functioning of the model will be expanded to achieve better understanding without having to read through the previous papers.

3. *Section 2.5 states that VarKarst-R simulated recharge was compared to estimates previously published (Table 3); however, table 3 shows only the values estimated by the other studies and not VarKarst-R estimates. I can find no such comparison in this manuscript. It would be very informative to show the VarKarst-R estimated values for these same areas in table 3 for direct comparison.*

Answer The comparison the VarKarst-R simulation results (and the PCR-GLOBWB) results are provided in Figure 9. We apologize for not being clear enough on that. According to comment 2 of referee #2 Table 3 will be expanded. Figure 9 and the revised version of the manuscript will be updated accordingly. Doing so, we will also clarify the reference to Figure 9 when evaluating the model.

Other comments

1. *Section 2.3.1, 7894 lines 21-23 – “. . .we assume that differences among the karst landscapes are due to differences in relief and climate, and the consequent processes of landscape evolution including the weathering of carbonate rock.” This neglects several other factors, including depositional environments, tectonics (fracturing), and rain acidity, which could be stated here explicitly. It also could be pointed out that this simple categorization presented seems to be useful nonetheless, and it is also universally applicable and can be objectively applied.*

Answer This is true. We will improve the elaborations on the simplifying character of the descriptors used for cluster analysis as suggested by referee #1.

2. *p. 7896 line 5 – What is a reasonable number? Apparently 250 is reasonable because that is the number given later.*

Answer Yes, 250 was regarded to be large enough to provide a reliable measure of spread along with the desired reduction. The respective part will be clarified.

3. *p. 7896 lines 8-9 – At first look, a positive correlation seems like a very low threshold C2632criterion, but when we consider the large uncertainty of recharge estimates, it seems more reasonable. It would be useful to comment briefly on this.*

Answer This rather weak criterion was chosen because the observation data that is available for the parameter confinement strategy can be regarded as uncertain due to differences in scale and the not direct observation of recharge (but recharge related variables as actual evaporation and soil moisture). We will clarify on this point in the revised version of the manuscript.

4. *p. 7896 lines 19-20 – In the application of a priori information, it is stated that this assessment would indicate whether or not information applied in steps 1 and 2 is biased. But it does not state what is done if this is the case. Later we see that confinement step 3 is used to further narrow the parameter ranges. Please clarify.*

Answer Step 3 can be regarded as the other 2 previous steps. It is meant to confine the original sample of model parameters. The above-mentioned statement was added because usually a priori information is used first for parameter estimation, before applying observations of the output. But we chose to add the a priori information at the last step to evaluate the confinement procedure. If confinement steps 1 and 2 would provide completely different ranges than step 3, our procedure (or the data) could be considered flawed. The new version of the manuscript will provide more detail on that aspect.

5. *Fig 1a – This depiction is not clearly explained in the caption or in the manuscript body.*

Answer A more detailed caption of Figure 1a will be provided in the revised version of the manuscript.

6. *Fig 4 – Please explain AI, DS, and RA.*

Answer The indices AI (aridity index), DS (days of snow) and RA (range of altitudes) will be explained in the revised version of the manuscript (also in the caption of Table 4).

7. *Fig 5 – Parameter labels are missing to show the four different columns.*

Answer For each cluster the four columns show the reduction of the complete sample of parameter sets (25,000 x 4 parameters) from the initial sample (light grey) along the 3 confinement steps (moderate grey to black). Hence, the columns do not refer to the individual parameters but to the different step of the confinement procedure. We apologize for being not clear on that. The revised caption of Figure 5 will be more detailed on that.