Answer to R2

I believe that a new paper on KarstMod improvement will be justified when the snow and ET modules will be further improved. I think that they are over simplified in the present version.

KarstMod offers a user-friendly interface allowing to easily try various hydrological model structures. In this updated version we added the possibility of testing (i) various ET accounting (either using user-defined PET, Oudin's PET or real ET) and (ii) snow impacts on the spring discharge. We agree that at some point it is simplified, but this may be helpful for first analysis.

For the snow module the user must be able to define sub-catchments such as elevation bands as the snow cover varies a lot according to the elevation and possibly the location in the catchment. A purely lumped snow-pack in not usable in mountainous regions.

This point has been clarified in the manuscript. The influence of elevation bands is implemented as well as the temperature shift with the elevation. Also, the appendix A gives more details on the how the liquid water leaving the snow routine is computed.

For the ET module, a by-pass option must be included for making possible to assume that some recharge will take place if the rainfall intensity is higher than 7 or 10 mm over a few hours. Without this option we observe discharge peaks at the spring in summer, which are not simulated. Maybe you can manage it using surface runoff in KarstMod, but it's not clear in the present paper.

We agree with the fact that when rainfall intensity is higher than 7 or 10 mm over a few hours, this might induce discharge peaks at the spring, even in summer. This might be missed if the simulation is performed with a model setup to simulate discharge a daily basis (i.e. case studies in the paper) but the simulation of such processes may be possible if the user defines a model to simulate discharge at hourly time step (this option is available in KarstMod, i.e. Sivelle et al 2019). In this case, rainfall intensity higher than 7 or 10 mm over a few hours should sufficiently fill up the upper reservoir E and thus generate a direct flow bypass toward the spring if the structure of the model is properly setup and the flux Q ES is activated.

Sivelle, V., Labat, D., Mazzilli, N., Massei, N., Jourde, H., 2019. Dynamics of the Flow Exchanges between Matrix and Conduits in Karstified Watersheds at Multiple Temporal Scales. Water 11, 569. https://doi.org/10.3390/w11030569

Line 1: This first paragraph in the introduction is very, very general and could be shortened juste by telling tha karst in important in several regions of the World. You should rather say that the number of available tools dedicated to karst hydrology is limited and mostly very academic (i.e. not accessible or user-friendly) or inadequate.

Thanks for the suggestion. This paraph is rephrased according to this recommendation.

Line 30: What is this? You mean runoff?

In this manuscript, we use the term of "*surface water discharge*" as stated in Cousquer and Jourde (2022) "*In order to correctly describe and predict karst hydrosystem behavior at catchment scale, groundwater (GW) and surface water (SW) must be considered as a same entity, and thus as a unique water resource*". Then, we added some reference in the manuscript.

Bailly-Comte, V., Borrell-Estupina, V., Jourde, H., Pistre, S., 2012. A conceptual semidistributed model of the Coulazou River as a tool for assessing surface water–karst groundwater interactions during flood in Mediterranean ephemeral rivers. Water Resources Research 48. https://doi.org/10.1029/2010WR010072

Cousquer, Y., Jourde, H., 2022. Reducing Uncertainty of Karst Aquifer Modeling with Complementary Hydrological Observations for the Sustainable Management of Groundwater Resources. Journal of Hydrology 128130. https://doi.org/10.1016/j.jhydrol.2022.128130

Sophocleous, M., 2002. Interactions between groundwater and surface water: the state of the science. Hydrogeology Journal 10, 52–67. https://doi.org/10.1007/s10040-001-0170-8

Line 30: Disputable as the model is not really physics-based.

We rephrased, saying "analysis of the internal fluxes" instead of "hydrodynamic analysis…". The user can analyze the internal fluxes computed in the model, then the user is free to use this for interpretation on hydrodynamics or not. As it is lumped parameter modeling here it is clear that the hydrodynamics parameters cannot be captured but such model can be helpful to test some assumptions regarding the conceptualization of the flow behavior.

Line 34: What is this? Runoff? where?

In this manuscript, we use the term of "surface water discharge" as stated in Cousquer and Jourde (2022) "*In order to correctly describe and predict karst hydrosystem behavior at catchment scale, groundwater (GW) and surface water (SW) must be considered as a same entity, and thus as a unique water resource*". Then, we added some reference in the manuscript.

Line 47: I would not use this word, which is not so well defined in English and often used for the "sensitivity of karst groundwater to pollution", which is not the purpose in the present paper. You could maybe use the word "sensitivity", but you should also make clear that the analysis is focused on the groundwater quantity and not on quality.

We agree that it may bring confusion to the reader. Therefore, we rephrased as "*the assessment of karst groundwater resources sensitivity, in terms of quantity, requires operational tools for estimating the sustainable yield of karst aquifers*". This states clearly that we focus only on quantitative aspects.

Line 85: From all challenges presented in this chapter, you only consider ETR and snow as improvement in KarstMOD. Why do you present the whole list? You should at least explain why you selected just two of this long list, and what you will do concerning the other ones.

Regarding the use of hydrochemical information for model calibration, we clearly state that application in karst area "*requires additional investigations before a suitable implementation in KarstMod*". Some work is ongoing on this topic, and we target new advancement in the future development, as mentioned in the conclusion.

In this part, we mention that using piezometric as well as surface water discharge can be of interest, based on former studies. This is now implemented in KarstMod.

Regarding snow and ET, we also provide some references showing the need for better considering snow and ET in lumped parameter modeling in karst. Some options are now implemented in KarstMod.

In the conclusion, we give some recommendation for future developments and also say that we want to go for an open access modeling software allowing connection with other numerical tools.

Line 110: You should make clear if the snow module is applied as a single value all over the catchment area or if subdivisions (e.g. elevation bands) can be considered.

The section "Snow routine" has been reworked to give clearer statements about how the elevations and temperature shift can be considered.

Fig2: This model seems oversimplified to me. But maybe I am misinterpreting what is really implemented in KarstMod. A classical problem with this simple model is that you can't have any recharge (out) as long as the reservoir level is below Emin. It means that storm event in summer usually do not produce any recharge although we observe discharge peaks at the spring. Therefore se usually introduce some by-pass for precipitations higher than 6 to 10 mm. You could possibly reproduce that using the runoff function, by I am not sure.

We agree with the fact that when rainfall intensity is higher than 7 or 10 mm over a few hours, this might induce discharge peaks at the spring, even in summer. This might be missed if the simulation is performed with a model setup to simulate discharge a daily basis (i.e. case studies in the paper) but the simulation of such processes may be possible if the user defines a model to simulate discharge at hourly time step (this option is available in KarstMod, i.e. Sivelle et al 2019). In this case, rainfall intensity higher than 7 or 10 mm over a few hours should sufficiently fill up the upper reservoir E and thus generate a direct flow bypass toward the spring if the structure of the model is properly setup and the flux Q ES is activated.

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Fig2.: Also I don't really understand why in case c) the actual ET is taken out of the reservoir, and in cases b) and d) this is the potential ET which is taken out. ETa and PET are quite different concepts and values.

We agree that ETa and PET are to different concepts. In KarstMod the user can work directly with Peff or using P and ET separately (ET can be either ETa or PET, the user can choose). This may offer the possibility to investigates how the modeling results can be sensitive to the consideration of ET. Figure 2 shows what is possible with KarstMod, then this is the user responsibility to apply good modeling practices. Case (c) in this figure can be useful to check the balance between ETa and the computed actual evapotranspiration, then the user can investigate if the ETa that he provides is suitable or not for his catchment. We agree that in some configuration it can be unsuitable for a modeling in a proper way, but we assume that this flexibility can helps the user to easily evaluate some aspects regarding on how to deal with ET (working with ETa or PET). This section we want to show what is possible with KarstMod, then the user is responsible for his modeling practices.

Line 308: do you mean here "real annual evapotranspiration"?

Correction done.

Fig6: Do you mean here surface runoff? Where does it flow to?

In this manuscript, we use the term of "surface water discharge" as stated in Cousquer and Jourde (2022) "*In order to correctly describe and predict karst hydrosystem behavior at catchment scale, groundwater (GW) and surface water (SW) must be considered as a same entity, and thus as a unique water resource*".

We added more information about how Qloss is computed.

"Discharge is also measured downstream (Lavalette gauging station) where the measured discharge corresponds to the Lez spring discharge and the main tributaries (Lirou and Terrieu streams) which flow essentially after intense Mediterranean rainfall events. As suggested in Cousquer and Jourde (2022)}, the surface water discharge,

denoted Qloss, can be estimated as the difference between the total discharge in Lavalette and the Lez spring discharge.''

Line 341: Obviously QLoss is larger than QLez... What is the liability of QLoss measurements? Don't you use it as a calibration parameter?

We provide more information about the estimation of Qloss (see previous comment). In the area the contribution of tributaries (which are mainly surface flow coming from upstream secondary springs) can exceed the spring discharge during intense mediterranean rainfall event. More information is given in Cousquer and Jourde (2022) which is referenced several times in the manuscript. We decided to give only the basic information to shorten the manuscript.

Line 355: The paragraph is not really easy to understand as figure 8 is hardly readable.

Fig8 corresponds to the visualization in KarstMod interface, which fit with the screen of the user's computer. We would like to keep it as it is. If accepted by the editor the figure can be shown in 'landscape' layout.

Line 363: I am not so sure that this statement is really adequate. In fact, we can see in figure 7 that Z is quite poorly simulated by KarstMod. The reason is that in the real system the head (Z) is related to Q with a non-linear relationship, producing the plateau at about 65 m.a.s.l. The model does not reproduce this plateau very well because for doing so you should at least introduce an intermediate outlet to reservoir C and possibly M. Therefore, we can expect the flux predicted by the model between C and M being quite strongly biaised compared to the flux really taking place in the the Lez system.

The modeling result give NSE(piezo)>0.5 which is given as "fair" according to the literature. We assume that the results can be used for some analysis. Various hypothesis can be tested to better reproduce the piezometric such as (i) taking another reference piezometer in the area, (ii) considering changing porosity according to the depth (and the geological features over the area) but this not the purpose of our present manuscript. The general dynamics is pretty well constrained (e.g., there are no fake overflow) then analyzing the fluxes constancy compared with other karst studies show an acceptable agreement in terms of general flow behavior. Also, the analysis doesn't go into details like quantification of exchanged volumes. Finaly, we assume this case study as suitable to show how KarstMod can be useful to test some conceptual representation of the flow behavior. More effort are required to better take advantage of piezometric head measurement in hydrological modeling of karst aquifers, but this not the main purpose of the present manuscript.

Fig.8: I like this way to represent the "model evaluation". However for the figure in the paper, most texts are too small to be read. It is therefore difficult for the reader to understand and follow what is commented in the text.

Fig8 corresponds to the visualization in KarstMod interface, which fit with the screen of the user's computer. We would like to keep it as it is. If accepted by the editor the figure can be shown in 'landscape' layout.

Line 368: KarstMod is a really interesting tool for applying the reservoir approach to the simulation of karst hydrological response. To my opinion it should "just" be slightly improved concerning snow and ET calculations. I believe that these improvements would not be too difficult to implement. Even if improved, the conclusion should shortly present the limitations of this approach which is lumped and functional. It can hardly reproduce any aspect of the hydraulics of flow. It is also not applicable for any spatial characterization of the groundwater flow. This can already be seen in the Lez example where the piezometric value is poorly simulated (to my point of view).

KarstMod is a modeling tool developed in a collaborative way. This manuscript aims to show what KarstMod is able to do now and where the community of 'lumped parameter modeling in karst hydrology' should put effort in the next years. Then, the section "Challenges in karst groundwater resources" was made on that purpose. So

even if the present version of KarstMod cannot address all the mentioned challenges we assume relevant to mention them here as potential directions for the future development of hydrological modeling in karst areas.

Line 379: This is necessary when considering snow, as snowmelt usually does not take place at the same time all over the catchment area (as soon as the catchment is somehow mountainous).

We rephrased to add the mention of requirement for consideration of spatial heterogeneity in recharge processes in catchment with snowmelt.