Interactive comment on "Framework for assessing lateral flows and fluxes during floods in a conduit-flow dominated karst system using an inverse diffusive model" *by* C. Cholet et al.

Anonymous Referee #3

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Review of "Framework for assessing lateral flows and fluxes during floods in a conduit-flow dominated karst system using an inverse diffusive model" by Cholet et al.

This paper describes the hydrological behaviour of karstic systems that encompass both gravity-driven free-surface flows and pressure-drive conduit flows. A semi-explicit geometry is used to describe the interplay between main reaches (with known curvilinear distances in the streamwise direction) and lateral tributaries (represented by their average "non-point" contributions over selected sections of the main reaches). The chosen methodology is generic enough to explore saturated and non-saturated conditions, base flow and floods, water and suspended particulate matter or any other tracer concerned by the advection-dispersion equation, whose analogy with the diffu-

sive wave model is explored in a quite convincing way, in my opinion. The numerical resolution opted for leans on the analytical resolution of the diffusive wave proposed in former papers by Moussa (1996), Moussa and Bocquillon (1996) and Hayami (1951) which in turn forces the several simplifications in system geometry mentioned in the above. However, it seems to me that the gain in understanding the complexity of the studied karstic systems is worth the relative loss of "lateral" precision, that is, soon as the tributaries are not the key concern, i.e. the main reaches can be properly identified. I am not sure this point has been explicitly addressed but this is certainly a minor concern. I indeed have no major issues with this work and had a good time reading the paper. I therefore recommend it for publication provided the series of questions and remarks listed below receive appropriate answers.

Title

The word "fluxes" is a bit vague, as it is in some places of the manuscript. In this title, "fluxes" could be anything from suspended particulate matter to radioactive or chemical tracers. It sounds like you rather meant mass fluxes here and there in the paper, while strictly speaking any quantity whose movement is described by the advection-dispersion equation may fit in the word "fluxes". Please address this point.

Introduction

P2L1 "rapid transitions" P2L2 "Hauns et al. (2001)" P2L3 "but vanishes at the benefit of an increase in dispersivity with increased distances" P2L4 Does "concentration" mean sediment concentration ? P2L11 "storage exchange fluxes" maybe deserves an explanation for non-specialist readers P2L13 And the same for "gaining and losing reaches" to prevent any misinterpretation P2L17 "the difficulty to model and quantify the spatial patterns of tracer concentrations and..." P2L19 "zones" P2L20 "parameterization" P2L20 I think it is rather "had to account for" than "was strongly impacted by" P2L23 "large-magnitude quick flows" and quick is a bit naive, "flash" may be better here P2L24 "The SVE may be used to assess hydrodynamic processes as they describe..." P2L31

"information" P2L31 "is required" P2L32 degraded mode should write "degraded mode" P2L35 "be considered a valuable simplification" or maybe "relevant" instead of "valuable" P3L1 "SVE while staying a higher order" P3L1 This is interesting and relevant but deserves more indications on the comparative merits and drawbacks of the SVE, the DW, the Kinematic Wave and the uniform formulae. The same question comes a bit later in the paper in situations in which the diffusivity term loses significance and strength before the celerity term. P3L13 By "predetermination" you mean "first guess" or "starting values" to be fitted later? Then this should be made explicit. Even if the convergence to the correct pair of values seems easy to achieve, could we have a few words on the necessity (or not) to provide "good enough" starting values? P3L15 "are part of the hydrological" P3L16 "that was described by Moussa et al." P3L17 "the exchanges with" P3L23 Unwanted line break? P3L24 "Singh (2002)" P3L25 And there this assumption on what "flux" means. If you wish to keep the diversity of meanings possibly covered by "flux" you could make it clear in the abstract, the introduction and the M&M section. P3L26 "Moussa (1996)" P3L28 "coupling water flow"

Modelling approach

P4L7 "is time and the celerity... and diffusivity" P4L11 Please briefly indicate here how the separation is made (I think it is mentioned later) P4L20 What is the origin of t? Does it start at t=0, what is the domain of values for t and what is the associated physical meaning? Think of non-specialists readers here. P4L25 Notation: there should be no "." between units. Are the notations homogeneous throughout the paper? P5L6 "uniform lateral distribution" P5L19 "The classical" P5L21 "lateral fluxes occur" P5L22 "straightforward" for "obvious" P5L24 This phrase on volume conservation seems a bit strange here. Isn't it guaranteed by the assumption that flow is incompressible? P6L1 "mass flux rate" P6L3 Explain what "mass-chemograph" is! P6L11 "By analogy with (5) the kernel function" P6L22 "the required data" P6L23 "includes" P6L24 I suggest another formulation. "Figure 2 gives a graphical representation of this framework whose 7 stages are listed below" P7L1 "from the hydrograph" P7L7 "using two steps." P7L8

"First" P7L11 "results as an automatic optimization with a quick convergence" P7L12 "needs" but why mentioning other cases without additional indications on what theses cases may be? P7L17 "The determination (if possible)... (t) follows then" P7L20 "events" P7L23 "will increase with more pronounced flood peaks"

Study site

P8L17 "15-minute" P9L3 What makes you think the selected event is representative? More generally, how do you define a representative event? The question may seem tricky but the answer depends on what you aim to show with the sensitivity analysis you propose. In fact, I do not think you need to assume there are any representative events as soon as the aim of your sensitivity analysis is to prove your methods are "discriminating" enough, meaning your model is able to identify the key factors in the description of the system. P9L7 I think you should rather state that "CM and DM play similar roles as CQ and DQ" P9L20 "the lower the peak flow intensity" P9L23 "could be reversed"

Results

P10L6 "but that it was due lateral" P10L9 "were half these of" P10L12 "dynamics" P10L13 "were simulated" P10L24 "2.6 times higher" P10L28 You mention a lower slope but is the difference between 0.3 and 0.4 really striking? P11L7 Delete "show"? P11L14 "towards" does not seem appropriate here P11L16 "the distribution of values for the model parameters" P11L17 "intensities, with the aim to retrieve information on flow dynamics" instead of the existing phrasing? P11L18 "contain" rather than "furnish" P11L20 "which span both the unsaturated and the saturated zones" P11L21 You indirectly mention the role of antecedent/initial conditions. I think this point should be better and more explicitly addressed as soon as you intend to provide a rather generic of the hydrological behaviour of the system. In particular, do you think you have enough events to draw general conclusions regarding the sensitivity of the model to its initial conditions. This would be a step towards more genericity and a possible way to endow

the model with increased predictive capabilities. P11L24 "did not find" P11L28 "again with high values only for events" P12L2 "trends" rather than "patterns" P12L3 "for the hydrological" P12L8 "therefore deliver" P12L11 Does this hypothesize no effect exist on DQ and/or does this assumes DQ is definitely a second-order term in such cases? If so, this could be voiced here. P12L16 Where does this approximation come from?

Discussion and conclusion

This section should be separated into "discussion" and "conclusion". Moreover, I tend to disagree with the rather atypical names of the sections in this paper. According to me, "Study site" should be the 2.2 part of a Section 2 named "Material and methods", following the 2.1 part entitled "Modelling approach".

I found the discussion repetitive in some parts, which I suggest to remove. This would facilitate the reader's task and make the additional indications (i.e. the real discussion elements) more punchy.

Delete most of P12L20 to P13L2 P13L4 "variability" is repeated The discussion P13L7-16 is very instructive P13L18-19 What would be the effect of a smaller spatial discretization in the streamwise direction? Could the model handle a smaller dx and could this be part of the discussion? P13L29 Alternatively what are the requirements for boundary conditions not to be poor? What are the required BC to ensure the model performs well (or to make sure the BC are not the weak point of the description)? Delete P13L31-34 and start the next phrase with "The functional scheme..." P14L3 "Fig" not "fig" and in other occurrences too P14L6 "had lateral inflows" P14L7 "these mineralized inputs" P14L11 "mineralized" P14L19 Delete "derived" P14L31 "R1" P15L1-7 Make it shorter or delete P15L8+ The last part of the document is convincing and well-written. Should be the conclusion and the message for future research leads.