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Discussions

Interactive comment on "Representation of water abstraction from a karst conduit with numerical discrete-continuum models" *by* T. Reimann et al.

Anonymous Referee #2

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The submitted manuscript presents two newly developed features for the Modflow CFP karst hydrological model, namely the introduction of a storage volume associated with conduits and a type of discharge-limited boundary condition that was not previously implemented in the code. The new model features are specifically applied to test cases where water is abstracted from a karst conduit. The manuscript is for the most part clear and well-written and approaches questions of relevance to the field of karst modeling. However, the manuscript also suffers from a few shortcomings. Areas of significant concern are enumerated below, followed by some additional minor comments:

Significant concerns:

1. The conceptual model for, and physical meaning of, the "Conduit-associated drain-

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able storage" (CADS) are unclear, particularly concerning how CADS relates to the common triple porosity conceptual model of karst. What are the volumes intended to physically represent? In the conclusion section, it is claimed that the current model is congruent with the triple-porosity model of karst. Dual porosity models (such as CFPM1) typically consider conduits and the porous matrix. Therefore, they are missing the fracture porosity of the triple porosity model. However, in the first panel of Figure 2, it is shown that CADS represents extensions of the conduit system toward the surface. This would be part of the conduit system, and not the missing fracture porosity. As a result, the description of the model is confusing. If CADS is meant to represent fracture porosity, then it is not clear why this would only be associated with the conduit and not more broadly distributed within the matrix. Along similar lines, the model is motivated by a need to damp the responses to pumping (or likely other forcing, such as recharge events). However, it's not clear to me that such damping observed in nature is not a result of fracture and matrix interactions. Perhaps this is discussed in Marechal et al. (2008), but it would be useful to briefly discuss it here as well. To what extent can similar damping be produced by conduit-matrix-fracture exchange? What features distinguish conduit-matrix interactions and this direct kind of storage? Another area of concern is that the mathematical nature of the model (whereby storage is immediately connected to the conduit) requires that the conduit be directly connected to a free surface (i.e. the water table). However, it's not clear how common or extensive this type of connection may be in phreatic systems. The mathematical model, at least as described, also allows extension of storage above the ground surface if conduit heads are sufficiently high. Since this occurs relatively frequently in karst systems, this limitation should at least be acknowledged.

2. The manuscript could be significantly strengthened by adding a discussion of how the CADS model relates to other previous models. For example, CADS is presented as an alternative to the more computationally intensive model for full pipes/open channels presented in Reimann et al. (2011). How successful is the new model at mimicking features of open channel drainage? Also, many previous workers have used linear and

non-linear types of reservoir models that seem related to the storage model presented here (e.g. Mangin, 1905; Halihan and Wicks, 1998; Geyer et al., 2008; Covington et al. 2009). However, the similarities and differences between the dynamics of the CADS model and these conduit/reservoir models are not discussed. This relates back to my confusion about the conceptual model, as it is not completely clear what CADS is meant to represent physically.

3. A new numerical feature of CFPM1 is introduced, and a few test cases are run, but no cases are run where results could be confirmed independently (i.e. by comparison to analytical solutions or other numerical models). Perhaps such tests were done, but it would be good if the results were at least briefly reported.

4. The extension of the model is relatively modest. While CADS is new, the new boundary condition has been implemented and/or discussed by other authors. The manuscript also presents relatively brief results from a few example cases. A more general discussion of the dynamics of the CADS model would be beneficial. One idea would be, instead of just presenting hydrographs, to plot some quantities representing hydrograph features (such as amount of damping) as a function of model parameters (such as storage volume width or matrix exchange coefficient).

Minor points:

1. Is the new code publicly available? 2. Equation 3 is not what I have normally seen referred to as the Colebrook-White equation, but rather a combination of the Colebrook-White equation for the Darcy-Weisbach friction factor and the Darcy-Weisbach equation. 3. final sentence, section 2.1, "whereas" should be "where" 4. page 4474. What is "constantly increasing drawdown?" confusing wording 5. next sentence. "Respectively" is used incorrectly. "Or" might work. 6. pg. 4475. confusing wording. "only little water" 7. Table 1. Would be good to explain what the arrows mean. 8. Fig 3. "respectively" used incorrectly

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