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Title: A robust Upwind Mixed Hybrid Finite Element method for transport in variably saturated porous media

RC2: 'Comment on hess-2022-153', Anonymous Referee #2, 14 Sep 2022 reply

I thank the authors for taking into account my previous comments.

I still have one point that I think needs clarification. In the new 3.2.1 section, I still do not understand the derivation of the method: why is it possible to use equation (26) (with (28) as a result), and later (31) ? The flow is obviously not steady, so if this is an approximation, why is the error expected to be small? I could not even make the connection with the way the method is presented in Younes et al (2006) Equation (28) there is the same as (32) in the current paper, but the derivation given there is different.

Additionally, the authors might want to move Section 3.2.1 to a new Section 3.1.2, as a review of existing methods, and keep the new hybrid, lumped, upwind method to section 3.2. This is merely a suggestion.

> **Answer:** As detailed in the section 3.2.1, the standard hybrid-MFE method is based on the transient equation (24) at the element level and the steady state equation (25) at the edge level. With the lumped formulation, we switch and write the steady state equation at the element level (equation (26) and the transient equation at the edge level (equation (29)). For triangular meshes, the obtained scheme is algebraically equivalent to the nonconforming Crouzeix-Raviart (Crouzeix and Raviart, 1973) finite element method (Younes et al., 2008).
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> We prefer to keep the sub-section 3.2.1 as a part of the section 3.2 since it explains the lumped formulation for the simple case of dispersion before introducing the new upwind scheme in 3.2.2.