

**Manuscript Number: hess-2022-153**

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

### **Editor Comments**

I am sorry, but the referee's comment has not been carefully considered. I double checked the version of the manuscript which should contain tracked changes, but I could not find any change. I also compared the file with the previous version of the manuscript, but I was not able to identify any differences. So, it seems that no changes have been done. If this is the case, please, state it explicitly in your answer.

I have not fast, direct access to Younes et al. (2006) to check the differences, that were mentioned by the referee, between the derivation given in this manuscript and that in the 2006 paper. Nevertheless, if I remain stucked to the submitted manuscript, it is not clear how the steady-state dispersive flux is defined and how it is related to the "real" transient quantities. I think I "grasp" the idea, but I am not fully sure that I correctly understood the derivation. So, I think that it is fundamental to **slightly reformulate section 3.2.1, in order to clarify the mathematical arguments.**

Moreover, even if the referee stressed that the modification of the structure of section 3 was a suggestion, I think that **a simple reorganization could significantly improve the manuscript.** For instance, the new structure could be something like this:

3.1 Existing approaches to upwind-MFE

3.1.1. The upwind-hybrid MFE of Radu et al. (2011)

3.1.2 The lumped hybrid-MFE scheme for dispersion transport by Younes et al. (2006)

3.2 The new upwind lumped hybrid-MFE scheme for advection-dispersion transport

**Answer:** We thank the reviewer and the editor for their suggestions to improve the quality of our manuscript. All the suggestions are accounted for in the new version.

More explanations are added in the revised version for the new upwind lumped hybrid-MFE scheme. Further, the structure of the paper has been modified. The lumped scheme of Younes et al. (2006), developed for dispersion, does not contain any upwinding procedure and, as such, cannot be included in the upwinding section. Instead, in the revised version, the upwind-hybrid MFE of Radu et al. (2011) and the

lumped hybrid-MFE scheme of Younes et al. (2006) form a new section devoted to these two approaches which have been developed to improve the stability of the MFE solution of the transport equation.

The new structure of the paper is as following:

## **1. Introduction**

## **2. The hybrid-MFE method for the advection-dispersion equation**

## **3. The upwind and lumped MFE approaches**

3.1 The upwind-hybrid MFE of Radu et al. (2011)

3.2 The lumped hybrid-MFE scheme for dispersion transport

## **4. The new upwind-hybrid MFE scheme for advection-dispersion transport**

## **5. Numerical Experiments**

5.1 Transport in saturated porous media: comparison against a 2D analytical solution

5.2 Transport in a variably-saturated porous medium

## **6. Conclusion**