Review of AMC-D-14-03790 Partition of unity methods for approximation of pointwater sources in porous media

This article examines the use of several XFEM/PUM varients to model point source leakage/injection for steady state porous media flow problems using logarithmic enrichment functions, building on earlier works by Gracie and Craig 2010, 2012. This problem is a difficult problem for the standard FEM since the solution for pressure (head) is singular at the wells. The authors develop error estimates for quadrature and use this to provide an improved adaptive integration scheme. The authors use error estimates to the recommend optimimum value of the enrichment radius. The authors compare several XFEM variants with respect to convergence properties in the L2 norm, and the iteration count (conditiononing of the discrete system of equations) for solution by the conjugate gradient method.

In general the readability of this paper was quite good. It is the opionion of this reviewer that this article should be accepted for publication with the following minor revisions:

1. An image of the problem would be helpful to give the reader a better picture of the problem being solved.
2. The authors spend a great deal of effort to introduce the governing equations for a multi-aquifer system, but all results presented are for a single aquifer system. the presentation of the governing equation in terms of a multi-aquifer system seems like an unnecesary complication to the presentation of the article. It is suggested that the readability of the article would be improved if the equations for a single aquifer system was presented.
3. The authors may wish to consider that the corrected XFEM was introduced a the same time as the weighted XFEM (Ventura et al. Fast integration and weight function blending in the XFEM, International Journal for Numerical Methods in Engineering. 2009. These two methodologies are quite similar.
4. In the results section, the authors don't discuss or make reference to the convergence rate reported by Craig and Gracie, which was 1.8 versus the 1.9 in the present article. It seems that a few sentences comparing the current results with the previous works is call for.
5. The authors should consider an additional related article; Ladubec, Gracie, Craig. An extended finite element method model for carbon sequestration, International Journal for Numerical Methods in Engineering, 2014.

6. pg 2 - "...in In Section 4...."
7. pg 3 - Integral between Eq (3) and Eq (4) is missing "dx"
8. pg 4 - second integral should be "∂B_w^m"
9. pg 7 - "...rule of and order n..." - wording is confusing
10. pg 7 - third equation from bottom missing "dx" on integral
11. pg 7 - Second equation folloing Eq (21), it is not clear how 1D quadrature error can be compared to the 2D projection error. Please expand discussion.
12. pg 7 - the meaning of symbol $f^{(2n)}$ is not clearl
13. pg 8 - first equation missing "dx" on integral
14. pg 8 - replace "G. and C" with "Gracie and Craig"
15. pg 16 - Figure 2a - replace "G. and C" with "Gracie and Craig"
16. pg 10 - eq (29) missing "dx"
17. pg 11 - "We denied any problems....." - It is unclear what is meant by this statement.
18. pg 13 - " This value roughly matches a breakpoint in the plots of the error as a function of R in Figure 7." - Figure 7 shows error as a function of log h. Figure 8 does not show data at log (9.2) 1. Also it is not clear wha is meant by the breakingpoint.
19. pg 13 - Figure 8 does not seem to be reference in text.
20. Reference [4] and [5] author should be "Babuška" instead of "Babuka"