

Geosci. Model Dev. Discuss., referee comment RC3  
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## Comment on gmd-2021-45

Anonymous Referee #3

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Referee comment on "RHEA v1.0: Enabling fully coupled simulations with hydro-geomechanical heterogeneity" by José M. Bastías Espejo et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-45-RC3>, 2021

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### General comments

The manuscript describes a new contribution to the modelling of hydro-mechanical problems in form of a MOOSE-based simulator. While I think that it deserves publication in GMD, it needs substantial improvements as outlined below. This particularly concerns Section 3 which should be made much more detailed and explicit to be of any value. Moreover, the literature review on existing implementation efforts should be considerably improved. So far, it arbitrarily picks three open-source packages and discredits them with oversimplifying statements.

### Specific comments

- l.44ff: I don't agree with this statement. The mentioned references indicate that more sophisticated sequential schemes like iterated fixed-stress perform quite well. It's the "naive" or "straightforward" approaches like drained-split or non-iterated fixed-stress which might perform poorly. Please rephrase.

- l.55ff: There's a more recent "official" paper on PorePy which is better to cite than the 2017 one: <https://link.springer.com/article/10.1007/s10596-020-10002-5>. I think that the statement "these codes are in an immature stage" doesn't properly reflect the apparently rather big efforts behind, at least, PorePy. I'm also not sure about the argument with the "point and line sinks", maybe they have already been integrated or maybe it's very easy to integrate them as a user of the framework. To me, the intention of these codes is just very different from company efforts like COMSOL or coupling frameworks such as MOOSE and probably not what the authors need or aim for.

- l.60f: I also don't like the negative statements here or at least the general way in which they are formulated. I'm sure that the developers of OpenGeoSys would disagree. It's open source, anyone can adapt the "fundamental governing equations" to her needs. In principle. Please relate things with something like "from our experience, it's rather difficult to..."

- The list of other mentioned packages is very short and subjective. There are many other efforts for hydro-mechanical modelling based on other frameworks, such as

\* <https://doi.org/10.1016/j.cam.2016.10.022> or

<https://doi.org/10.1142/S1793962321500033> based on deal.II

\* <https://doi.org/10.1007/s10596-020-09987-w> based on Dumux

\* <https://doi.org/10.1029/2019JB017298> based on MRST

\* PFLOTRAN can do geomechanics:

[https://www.pflotran.org/documentation/theory\\_guide/mode\\_geomechanics.html](https://www.pflotran.org/documentation/theory_guide/mode_geomechanics.html)

All of these frameworks can deal with heterogeneous material parameters.

- l.67: What are "gold-standard numerical solvers"?

- l.70f: "for example an experienced user can easily modify the source code to add desired features such as..." I'm convinced that this also holds for the open-source codes which are mentioned above and which have been put in a negative light.

- Section 3 does a very poor job in describing the implementation of the model, as it doesn't connect enough to Section 2. There's only a few lines 135ff which make an explicit connection, the rest is generic blabla. I consider this the most important section of the manuscript. Please be much more precise here. How are the two modules integrated? How are they coupled? What finite elements are used? What time integration scheme? What about local mass conservation?...

- l.349: I saw that you are required to link to Zenodo. That's ok, but please keep also the link to GitHub, that's where your code is developed further, hopefully.

### **Technical corrections**

- l.32, 92, 102, ...: a single "porous mediUM", many porous media

- l.161: "designED"

- l.189: "undraiNed"

- (19): "L" instead of "H"

- l.336: "play" without "s"