Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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# Comment on gmd-2022-83

Anonymous Referee #2

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Referee comment on "Mapping 3D Structure of Loose Quaternary Deposits Combining Deep Learning and Multiple-point Statistics: An example in Chencun, Northern Pearl River Delta" by Weisheng Hou et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-83-RC2, 2022

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The paper combines two methodologies, MPS and DL, to create realistic geological models in a very specific case study.

A number of claims are made regarding literature that are not correct, plus the literature review is significantly lacking in major recent contributions in this area

- "the MPS method difficult to reconstruct global spatial features with anisotropic and non-stationary characteristics". Many methods of non-stationary MPS exist, please consult the chapter "Non-stationary MPS" in the book of Mariethoz & Caers, 2015.
- "However, three-dimensional structure cannot be directly extracted from 2D cross-sections in the MPS-based simulation method". Many methods exist that use 2D cross sections to create: e.g. Comunian, A., Renard, P. and Straubhaar, J., 2012. 3D multiple-point statistics simulation using 2D training images. Computers & Geosciences, 40, pp.49-65. This problem (of stereology) is quite common in 3D imaging (e.g. X-ray; MRI) and many methods of DL exists to do this. CNNs are very popular for this.

There is also no mention of the recent contribution of GAN methods starting with Laloy

Laloy, E., Hérault, R., Jacques, D. and Linde, N., 2018. Trainingâ□□image based geostatistical inversion using a spatial generative adversarial neural network. Water Resources Research, 54(1), pp.381-406.

Song, S., Mukerji, T., Hou, J., Zhang, D. and Lyu, X., 2022. GANSimâ□□3D for conditional geomodelling: theory and field application. Water Resources Research,

p.e2021WR031865.

In addition, one would wonder if the case study specified would not be better solved with surface-based or implicit domain geological modeling. This literature is also missing:

Frank, T., Tertois, A.L. and Mallet, J.L., 2007. 3D-reconstruction of complex geological interfaces from irregularly distributed and noisy point data. Computers & Geosciences, 33(7), pp.932-943.

Consider an example with much larger complexity than presented in this manuscript:

Yang, L., Achtziger-ZupanÄ□iÄ□, P. and Caers, J., 2021. 3D modeling of large-scale geological structures by linear combinations of implicit functions: Application to a large banded iron formation. Natural Resources Research, 30(5), pp.3139-3163.

Also consider rule-based geological modeling methods: Pyrcz, M.J., Sech, R.P., Covault, J.A., Willis, B.J., Sylvester, Z., Sun, T. and Garner, D., 2015. Stratigraphic rule-based reservoir modeling. Bulletin of Canadian Petroleum Geology, 63(4), pp.287-303.

The question for me is: what is the new contribution of this paper? What has been achieved that is new and hence exportable to other cases, applications? My take on this question is that the contribution remains narrow

- The methodology seems tailored to their specific case study. As a result, it contains many, many ad-hoc choices and tuning parameters that I would not know how they extend to other cases.
- The methodology is directly applied to the case study, there is no other verification, for example, we do not learn about how it would apply to some simpler synthetic models.
- Because of the many ad-hoc tuning, the methodology is very complex for what may be easier solved with other geological modeling approaches. There is small likelihood that others would use this method for that reason. The paper does not contain any comparisons, except for broad methological comparison which (see above) are not always accurate.

The manuscript is a significant amount of work, and a lot of thinking went into modeling this specific case study. But then, my question for the editor is if this is sufficient for publication in GMD where the aim would be to share modeling approaches across many applications.