

Interactive comment on “Data assimilation and uncertainty assessment in 3D geological modeling” by Daniel Schweizer et al.

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General comments:

In their paper "Data assimilation and uncertainty assessment in 3D geological modelling", the authors present an interesting, novel and well-structured analysis of uncertainties in the context of 3D geological modeling. This topic is in itself of high relevance, and the authors show this here specifically with an application to a case study where a 3D geological model is used as a basis for a subsequent analysis of ground heave damage in the city of Staufen, Germany. Specifically, the authors compare uncertainties in subsequent stages of detail in model construction - an aspect that has, to my knowledge, not been investigated systematically in an applied case study for 3D geological modeling before.

C1

Specific comments:

One important point that should be adapted in my opinion is the use of the term “data assimilation”. This term is typically used in a very different context (as an update of parameter and state space in the course of a dynamic simulation, but for the same model)! In order to avoid confusion (or wrong expectations by readers), I would suggest to remove any reference to “data assimilation” from the paper and replace it with a better fitting term. For example for the title: “Uncertainty assessment in 3D geological models of increasing complexity”.

Specific comments to location in text (identified by page/ line number):

- 1/17: I would claim that 3-D models are mostly preferable because our object of study is intrinsically 3-D. . .
- 6/5: Unclear what exactly “model complexity” refers to: the number of parameters or structural features?
- 6/5: What is meant with “data acquisition”? Do you mean “data integration”? Please clarify;
- 6/15: The listing of the steps already contains details about the specific model that is used later. A clearer separation from the general approach (here) to the specific application (in Sec. 4.2) would be better;
- 9/23: I would generally suggest to use “average entropy” instead of “total entropy” (even though I am probably to blame for the second term, but it may lead to confusion);
- 9/16-20: Other interesting aspects at this point could be the “geodiversity measures” of Lindsay et al., or the topological analyses of Thiele et al., 2016;

C2

- 9/23: Note that this definition is highly sensitive to outcomes with small probability! Could be more robust when using a threshold value of probability.
- 10/10: I am not sure that the term “city block distance” is correct here. Equation (10) seems to be simply the L1 norm over the cells for two combined sub-regions (as N is the number of cells). In the definition of Paul and Maji this is the number of features (“ m ” in their equation 1)! Interpreted in this context, each cell would be one “feature”. Is this what you intend to express here? Please check and/ or clarify;
- 12/19ff: Important points considering the specific implementation:
provide all parameters and the assigned probability distributions in table form; also, please describe the reason for the choice of these parameters (even if based on educated guess); two other choices are made: generating 30 realizations, and using a cell size of 5 m^3 . What is the reason for these choices? Especially concerning the number of realizations: is this based on an estimate of convergence (note that, for example, average entropy could be used here).
- 13/12: In my opinion, this is not a limitation of this specific approach, but the general statement of epistemic uncertainty and related to missing knowledge;
- 13/13: Model 4 not only may, but surely will, underrepresent true structural complexity by definition - because it is a model. In my opinion, the question is only if it represents complexity sufficiently for the specific purpose of the model. Please adjust or discuss this point (also in conclusion);
- 13/19: Please note that measures of information theory are not limited to point estimates (see e.g. Wellmann 2013 for exactly this context, please excuse self-citation);

C3

- 15/19: What exactly does “data specificity” refer to at this point? Please clarify;
- 17/15: Important aspect - how do they compare to the ones used here?

Figures: All figures are excellent throughout the manuscript and already of publication quality.

Technical corrections (identified by page/ line number):

- The names in the author list seem to be in the wrong (first name/ last name) order;
- 2/17: “we hypothesize”?
- 12/4: “in addition to”?
- 12/10: “ambiguous” instead of “equivocal”?
- 12/20: “includes minimal constraints”?

Interactive comment on Solid Earth Discuss., doi:10.5194/se-2016-174, 2017.

C4