

Interactive comment on “Monte Carlo Simulations for Uncertainty Estimation in 3D Geological Modeling, A Guide for Disturbance Distribution Selection and Parameterization” by Evren Pakyuz-Charrier et al.

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An important study in developing uncertainty models for 3D geological modelling. The study focuses on a specific data perturbation method (MCUM) used in previous work but narrows in on how models can be calculated assuming that the constraining interface and orientation data has a predictable error (uncertainty) distribution. The work highlights the critical value in converting scalar orientation data to vector pole format (surface normals) for orientation measures. Some work on this topic, not in uncertainty modelling, has been done previously, as well as using quaternions (see De Paor 1995

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(Quaternions, raster shears, and the modeling of rotations in structural and tectonic studies (1995) Geol Soc. Amer. Abs. with Prog., 27 (6), p. A72.), Karney 2007) to spherically rotate (perturb) the observation set. Also, highlights the value in assessing and transforming heteroscedastic data. Only 2 case studies were used to make the point that using poles versus dip/direction scalar values enhances uncertainty reduction. Probably does for the most part but could have demonstrated this more systematically and dramatically with a sphere of orientation measures. A considerable mathematical expose was done making the case for Bayesian approach to developing priors for the distributions but this was hard to follow from a practical point of view. This section could use some more explanatory context such as when local or global priors are being estimated and how this is being done from the field point of view. Multi-observation sites to calculate local distributions? By regions? A major assumption sampling/disturbing ie. at $K=100$ the vMF distribution for orientation measures is that underlying natural variability is randomly concentrated on a spherical cluster. This is rarely the case in nature as there is generally a process dependant geometric bias such as deformation that controls rotation parameters. To capture this more work would need to be done. Perhaps part 2 but this will become important. Quaternions are potentially a way to do this as they are rotations about a vector which could be a population or local mean (E3 - eigenvector for example). At least moving from scalar orientation to poles is a great start. What about polarity? A near vertical stratigraphic interface needs to be managed with components for the pole to have direction to allow for overturning. Has this been considered when the disturbance is conducted?

Overall a good and important study but could be made clearer and appealing for a wider audience if some more context and practical implications could be given.

Please see specific comments in the attached PDF.

Please also note the supplement to this comment:
<https://www.solid-earth-discuss.net/se-2017-115/se-2017-115-RC1-supplement.pdf>

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