RC2: 'Comment on egusphere-2025-3989', Michele Cooke, 12 Oct 2025

The manuscript presents a new tool, FatBox for delineating faults networks either from the expression of normal faults scarps on topography or from strain maps. The paper describes the modules within FatBox and applies this tool to three different types of normal faults systems to highlight the different types insights that can arise from fault data extracted using Fatbox. As presented, the tool has great potential for normal faults systems. The figures are nicely constructed but the writing can benefit from greater clarity.

1. The paper has a strong focus on normal faults within extensional regimes. The paper could either 1) focus only on normal faults and accurately reflect this in the title and throughout the manuscript or 2) broaden the scope to strike-slip and reverse faults by adding examples of these faults and citations to fault detection approaches for those systems.
    1. For example, lines 45-47 talk about normal fault growth by linkage. Thes same could be said for strike slip and reverse faults.
    2. Strike-slip faults can have geomorphic expression. For example, can FatBox analyze detect strike-slip faulting along pressure ridges? Should present on this around lines 60.
    3. Figure 1 only presents normal fault scarp analysis, but FatBox could be applied to dilatational/longitudinal strain maps of reverse faulting or to vorticity/shear strain maps of strike-slip faulting.

This paper investigates in detail the case of extensional systems throughout several applications, but we fully agree that Fatbox can be applied to any type of faults. Other scientists have already begun using the toolbox in different tectonic settings, and their feedback and contributions will help expand the library and demonstrate its versatility. Hence, we prefer to keep the name of the paper identical to the name of the toolbox. Additional details have been added to the Introduction and Methods sections to clarify the range of possible applications.

2. The introduction explains how field mapping and numerical models investigation fault network development. The two sentences on physical experiments in the introduction do not adequately explain how these experiments are used to provide insight on fault networks. For example, the paper can explain that within the table-top experiments the material are often scaled so that stress states within the experiment represent the crust. The manuscript has been modified according to the reviewer suggestion to clarify this part.
3. Fault connectivity is a tricky element that the process of skeletonization process may or may not do in the same way as a human mapper. Fo example, the faults of Figure 3b maybe be under-connected. How is the correct degree of connectivity assessed? The connectivity is based on the distance between features. This connection detection is

performed between the skeletonization and the graph creation stage.
Once the network is built as a graph it can be modified easily in the filtering stage (between the extraction and the structural analysis). There, the user can decide to link or unlink structure based on distance, curvature, dip direction, etc. to increase the precision of the network. The final assessment can be made by importing a subset of manually mapped faults, extracting it as a network (tutorial available on Github) and comparing the two datasets. In the end, the user assesses the quality of the fault network extraction. Nevertheless, the idea of “correct degree of connectivity” is a tricky and debatable question, even between experts mapping manually the same area.

4. For the reason of c and other issues, the paper would greatly benefit from at least some validation exercise.
   Some validations are available in La Rosa et al. 2025. Fatbox was used to extract faults from the DEM of the Afar region and then used to perform an extended structural analysis to compute strain maps. A manually mapped subset was then processed using the automated structural analysis. The strain data from these two datasets were compared and shown to have similar strain values and spatial distribution (see figure S6 from La Rosa et al. 2025). The residuals between the manual and automatic datasets range from ± 0.1, with just an outlier pixel giving a residual of 0.15. Assuming the manual dataset is representative of 100% of the faults, we calculated that the automatic approach successfully retrieved 93.4% of the total number of faults.
   The manuscript has been modified to clarify this point, and detail has been added about the validation.

5.
   1. Can FatBox map as well as human? Probably not but it certainly creates maps faster than a human. Can FatBox save time my providing a map that a human can revise more quickly than if they built from scratch?
      Manually mapped datasets can be imported in the workflow and compared to semi-automatically extracted networks by Fatbox. Vice versa, networks can be exported as shp for example, to be compared with other datasets in GIS software or indeed to provide a basis for manual revision. The mention of this possibility has been added to the manuscript.
   2. It is possible that FatBox reduces biases introduced to fault map by human interpretation. The rigorous assessment of that is probably beyond the scope of this study but human mapping bias is well documented in the literature and could be mentioned.
      We added some details to clarify the biases.

6. Can the analysis work equally well for incremental strain maps and cumulative strain maps?
The analysis can be performed for both data sets. It has to be kept in mind though that each approach extracts different entities (all faults for the former case and active faults in the latter case). The availability of these data depends on the kind of model that is analyzed. In this manuscript, incremental strain maps are used in analogue model analysis, while cumulative strain (ie. plastic strain) was used in the numerical model application.

7. Some of the fault detection approaches within FatBox (absolute and relative strain threshold and adaptive threshold) have been used before and are not new to this study. Some discussion of the benefits and drawbacks of the different approaches along with citation to previous studies will help the reader make best use of Fatbox.
We added details to the discussions and references to the other approaches.

Specific comments:

- I recommend changing the term 'analog models' to either 'physical experiments' or 'experiments with crustal analog materials'. This change in wording better distinguishes numerical models from laboratory experiments.
Done.

- The paper uses a lot of passive voice which is not very interesting to read. Try adjusting passive voice (e.g. 'fault networks are investigated') to active voice ("structural geologists investigate faults networks') and you will find that the text is a lot more engaging and direct.
We have changed the manuscript accordingly. Thank you for that suggestion.

- When citing a paper that is just one of many examples that you could use, preface the citation with 'e.g.' this signifies that there are many other papers on this topic. Throughout the manuscript many citations listings need this e.g. because they do not list all of the papers on that topic.
Absolutely. We corrected this issue.

- Rewrite the application sub heading include the type of data set analyzed. 3.2 application 1: topography from Magadi Natron basin; Application 2: strain rate maps from numerical models; Application 3: topographic and incremental strain maps from experiments
Done.

Line: 15: “Understanding complex fault networks” is a very vague and your contribution could be more effectively community by being specific.
We changed the vocabulary to use more precise words.

Line 25 (and else where): the word ‘graph’ is not effectively used here and elsewhere. What do you mean? How is a fault network represented as a ‘graph’.
A graph is an ensemble of components mapped at a given time which together compose a network. We updated the manuscript to define the vocabulary early.

Line 31-32: The definition of faults here could equally apply to opening mode joints, veins and dikes, which are certainly not faults. You are missing the key element to faults that is dip or strike slip.
The manuscript has been modified to be more specific.

Line 59: awkward working: Maybe try “…unlike thrust faults within contractional settings where the hanging wall collapses and obscures the fault scarp”.
Done.

Lines 95-98: This listing is vague and confusing. Can be clarified by using similar set up for each example 1) uses a topography dataset from Magdi Natron basin, 2) uses a strain rate data set from a numerical model and 3) uses topography and increment strain data sets from experiments. “Fault geometry tracking within an analogue model’ doesn’t mean anything.
Done.

Line 124: This is only for normal fault systems so the text should be revised to state this.
Caption modified according to the reviewer suggestion.

Line 128: Throw and heave are displacements. By displacement do you mean net slip?
In the paper “displacement” means slip along scarp.
The manuscript has been modified to clarify this point.

Line 150: Incorrect. Particle image velocimetry (PIV) is a process and not a product. What you are extracting the faults from is the strain map. This can be longitudinal strain, shear strain, dilatational strain or vorticity. Thos strains are calculated from the displacement fields generated by PIV. But the fault maps are not extracted from PIV.
We changed this misleading sentence.

Line 153: Only in regions with low erosion and deposition rates
The manuscript has been modified to clarify this point.

Line 163: Largest continental rift. The mid ocean ridges are larger.
We clarified this point.

Line 189: What does ‘dedicated functions’ mean? Are these bespoke scripts for the particular data set that the user develops?
This sentence refers to functions developed by the authors and already available in the toolbox. Manuscript updated.

Lines 211-212: What does this mean?
This sentence refers to the process of field survey when the geologist walks along the fault and measures the fault structural parameters at regularly spaced distances. We clarified the sentence.

Lines 217: ‘Fault displacement and extension’ ⇓ doesn’t make sense. I think you mean net slip on the faults? By the way this is one (of many) sentences with passive voice.
This sentence refers to the motion parallel to the fault plane and the associated horizontal displacement (i.e., the amount of extension accommodated by the fault motion).
The manuscript has been modified to clarify this point.

Line 219: “accessible though dedicated attributes” This needs more explanation.
Absolutely. We added some examples.

Line 320: incorrect PIV is a type of Digital Image Correlation. They are not synonymous. PIV calculates incremental displacement fields. It doesn’t calculate velocity because the time step does not emerge from the PIV analysis. The analysis doesn’t consider the timing between successive photos.
We corrected the vocabulary.

Line 329: Fault extraction has been performed from experimental strain maps and that literature should be presented because it is not new to this study. The work that I’m most familiar with are for experiments of strike-slip faults. Some studies use a globally set incremental strain threshold (e.g. Hatem et al., 2017 JSG, Visage et al., 2023 Tectonophysics). Some recent papers use a adaptive threshold for fault detection from strain maps (e.g. Chaipornkaew et al., 2022 GRL; Gabriel et al., 2025 Tektonika). In a paper from my research group that is currently under review (under review since July!) we test the sensitivity of the detect strike-slip fault network to adaptive threshold parameters. Seems like this could interest the authors and I am happy to follow up to share the paper.
References to these papers have been added to the manuscript.

Line 371: Extension of the faults? Unclear. Do you mean dip slip along normal faults that accommodate extension? Once again here faults do not have displacement, they have slip as one side of the fault displaces relative to the other.
The manuscript has been modified to clarify the vocabulary.

Line 441: post-extraction validation of the fault network. This paper would be greatly strengthened with a demonstration of validation (see point d). We don’t know if the tool is useful if it is not validated. At minimum, this part of the discussion can outline how such a

validation could be performed and the network assessed.
Some detail about the validation performed in La Rosa et al. 2025 has been added to the manuscript. See also details above, in the major comment 4.

Line 470-: The first statement of the conclusions implies that Fatbox provides tools for fault analysis. The tools provided are very helpful for extracting faults, fault tracking and slip information but the analysis itself is done after that data is collected by Fatbox. For example, if someone wanted to analyze the evolution of displacement-length data along a set of faults, Fatbox could extract the data, but the researcher would need to do the analysis of the data. Rewording the text here and in the abstract (lines 27-29) could more accurately convey the value of the tools.
This statement refers to the automated structural analysis tool provided by the toolbox. The kinematic fault parameters, such as extension, displacement (slip along fault) etc, can be computed automatically. Of course, the interpretation and scientific analysis of the resulting plots and data remain the responsibility of the expert user.
The manuscript has been modified to clarify this point.