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Interactive comment on "Short communication: A semi-automated method for rapid fault slip analysis from topographic scarp profiles" *by* Franklin D. Wolfe et al.

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The authors greatly appreciate Michael Hodge's thoughtful comments and have taken them into consideration in our revised manuscript. As suggested, we streamlined sections of the manuscript that are included in the User Manual and improved the code to include a simple option for users that are not working with geologic age data. This removes the tedious work-around that was previously incorporated into the workflow. Our changes are reflected in the revised manuscript and the User Manual. We also included rationale as to why the Taupo Volcanic Zone was chosen for the case study and made technical corrections throughout. We are very thankful for Michael Hodge's

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Discussion paper

review and believe that is has helped to focus the manuscript on the key conclusions that are novel to our study and new workflow.

- Franklin Wolfe

It is in my opinion that the paper spends much time talking about ArcGIS and QGIS, i.e. background and steps to pre-processing scarps and post-visualisation. However, the novelty of this work is the Python scripts and what they can do, which should the authors should highlight more. The selection of profiles across scarps, points along profiles et cetera has been covered in work previously, and whilst it is important and imperative for the pipeline of this work (and therefore rightly sits in the User Manual) too much space is used for this in this manuscript.

Some of this language is also covered in the User Manual; hence, it would be simple to streamline these sections into sharp sentences and then reference the User Manual for further inquiry. We very much appreciate the reviewer's suggestions on which sections can be removed from the manuscript and have chosen to do so. For example, the Define Fault Scarp Profiles in QGIS or ArcGIS and Extract Data for Profiles sections have been condensed into one section comprised of three sentences. We believe that this helps to focus the manuscript.

Here, the paper is about the code, and the case study is an short case study application more so. Therefore, my main recommendation is for the author and code developer to choose their battle: ArcGIS scripts or Jupyter Notebooks. It will be hard to update both during the rigours of academia. I propose the latter (Jupyter), because as the author mentions ArcGIS is commercial software (they give a great reason in point five C2 of 'section: Principles of Design for MCSST' as to why the focus should be on open source software), and also because I envisage a greater shift towards Python by Earth Scientists soon (whereby your users may not even use QGIS to select profiles, but use a pure Python approach instead). That is not to say you cannot mention that you have spent effort in creating ArcGIS plugins for those who want them, but this should be a

side-feature of your work.

We appreciate the concern that it will be more difficultÂăto maintain two parallelÂăcodes; however, a major focus of our research effort has been developing the ArcGIS codes, which utilizes a software many in the scientific community are using. Our goal with this project is to provide a means for all to enjoy our scripts with little barrier to entry. Providing a workflow that can utilize a selection of tools is a means of achieving this end goal. Thus, we do not wish to abandon the language devoted to the ArcGIS approach – though, we do share the author's sentiment that more researchers will use QGIS and python in the future. We hope that the User Manual will adequately support this approach.

Abstract (and throughout)

The use of the word 'rapid'. Rapid in this sense is relative to what you compare it against. The authors are right that it is rapid compared to traditional methods, but if someone built a machine learning neural net would it be as rapid as that once training had been successful? I recommend using a softer tone that 'rapid'.

We have chosen to focus on 'space' rather than time and replace some instances of 'rapid' with 'bulk fault slip analysis' to highlight to codes ability to permit analysis of multiple faults at once. This is exemplified in the updated title of the manuscript.

Introduction

Line 24 – This may be where my knowledge has faded. But here it looks like we are working with surface topography data. So, can we accurately calculate fault slip? Or can we only calculate surface displacements?

The 'Calculate slip statistics section' and Figure 1 explain how we arrive at estimates of near-surface fault slip from surface displacements. Thompson et al. (2002) includes a detailed explanation of this calculation.

Background

Lines 46 to 47 – Later you use the word component to talk about the hanging-wall, scarp and footwall. I like that, or feature, rather than 'variable' used in line 47.

Changed to 'component'

Principles of Design for MCSST

Lines 78 to 86 – as mentioned in my general comments I think this section can be removed, or at least shortened.

We appreciate this concern and have chosen to remove this section to streamline the manuscript.

Define Fault Scarp Profiles in QGIS or ArcGIS and Extract Data for Profiles

Both sections don't contain anything novel or imperative to the manuscript; perhaps this should just be covered in the manual and replaced here with a simple paragraph stating that 1) the user creates fault trend (perpendicular?) profiles across the scarp, 2) extracts elevation from the DEM (and optionally, geological age) at spaced intervals. Then more information can be found in the user manual.

This is great insight and we have chosen to combine these two sections into one section with just three sentences. The additional text is covered in the User Manual and thus not needed here in the manuscript. Thank you for helping to clarify where we could remove text that is not needed.

Line 89 – the authors don't address whether the profiles should be perpendicular to the scarp trend, or parallel to local/regional extension direction. I think this needs to be a little clearer and the reasons for it (changes to scarp dip etc). Also, the next sentences 'To do this' 'Within this layer', make little sense to me and probably don't need to be here (save for the User Manual).

We define that profiles should be drawn perpendicular to the scarp trend in this section. This is mentioned in the text of the manuscript. The confusing section has been

removed and is explained in the User Manual where it is more appropriate to discuss specific steps in the methodology.

Lines 95 to 96 - citation needed for “A spacing of 1-5 meters has proven to be adequate in defining meter-scale features”.

This was referring to the spacing density adequate for our case study. It has been removed from the manuscript since it is no longer needed (see previous comments).

Lines 98 to 99 – “If geologic ages are not defined within the GIS environment, the user can manually generate these features with a few simple steps outlined in the user manual.” I’ve only have a brief look at the code, but can you not add something to the code to skip this if it’s not included in the input variables. Rather than get the user to time-consumingly add this to GIS before they start calculating scarp information?

This is a great suggestion and we appreciate this criticism! We have added additional functionality to the code that allows the user to specify whether this data is available. Applying this new functionality of the code will limit the users from having to do the tedious workaround and further improve the ease-of-use. It is reflected in the updated user manual and manuscript as well. Thanks!

Monte Carlo Slip Statistics Toolkit (MCSST)

Line 117 – ‘previous method’ are these methods published? If so, needs a citation. If not, would be interesting to compare how the functionality has improved (time spent?)

We agree that this would be a very interesting metric to provide. Unfortunately, we do not have a specific comparison of the time spent with different methods. One of the authors, Tim Stahl, hasn’t published that workflow, but has published results based on that workflow in Stahl et al. (2016) NZJGG; Stahl and Niemi (2017) Nature Sci. Rep.

Check Your Selections

Line 123 – ‘checked for accuracy’ – by whom? The user?

Yes, by the user. The workflow allows for a convenient display of the user's choices. The text now includes the reference to the 'user check' to make this clearer

Case Study

For me I'd like to see more of the rational as to why this area was chosen. Has it proven too large for previous methods? What are the limitations of this area compared to other dip-slip fault scarps in other areas? This can be resolved either by using the tool elsewhere or commenting on the limitations etc of the tool.

We appreciate the reviewer's interest for included additional rationale for choosing this study area and include additional language to this portion of the manuscript to reflect our thought-process. In regards to choosing the TVZ, it is an ideal local due to (i) heaps of fault scarps across relatively narrow tectonic province (so ideal method for characterising the region); (ii) clear offsets of (relatively) planar unit that is easily correlated and has been mapped across the area; (iii) studied in detail so can compare with past results; (iv) known fault kinematics and near-surface geometries from one of the best paleoseismic datasets in the world. We only provide one case study within this research project and thus do not choose to comment on or provide results from another area. Later in the Case study section, we address the reviewers concern to include limitations of the code by including this language: "We attempted to obtain data from as close to the transect line as possible because scarp heights appear to vary along strike of the fault traces due to the complex nature of faulting in the TVZ. This is one limitation of the MCSST. The user must define unique profiles along the fault scarp for each measurement and thus may not choose the position of maximum displacement, a location that can resolve the full 3D slip vector, or reveal the complex nature of displacement on the fault (Mackenzie and Elliot, 2017)."

Efficiency of the MCSST Toolkit

Lines 232 to 233 - "To confirm the results, the entire process was completed again by multiple users, which resulted in similar outcomes across the board." I'd love to see the

results from multiple users. This sort of thing really interests me as no matter how we develop code, or who uses it, there will always be a degree of bias. Limiting that bias is the aim, not creating perfect code for a single user.

I agree with the reviewer's comments that this would be very interesting to include. Unfortunately, this analysis was not saved and thus I do not have access to the results from other users. The analysis was completed during a mini workshop I conducted at GNS Science. Because of this, we decided to omit this sentence from the manuscript.

Technical corrections.

Introduction

Line 29 – Possibly rewrite this sentence. "When Light Detection and Ranging (LiDAR) data have adequate resolution, the images can be used to identify submeter scale geomorphic features from a workstation". The resolution of LiDAR is relative to the distance captured from the object. For me, it only needs "LiDAR can be used to identify submeter scale geomorphic features from a workstation", then give a citation.

Done

Line 33 – lower case 't' on The.

Done

Principles of Design for MCSST

Line 65 – add a : after 'to'.

Done

Define Fault Scarp Profiles in QGIS or ArcGIS

Line 92 – 'In this example' – which one?

This sentence was removed as it is confusing and not needed in the section.

Extract Data for Profiles

Line 95 – remove ‘user-defined’, unneeded.

Done

Monte Carlo Slip Statistics Toolkit (MCSST)

Line 109 – add ‘scarp’ after fault? If we are looking at scarp components that is.

Done

Lines 110 to 112 – Possibly rewrite as “’To make it easier for the user, a slider has been included to select the distance along the profile each scarp component exists at”.

Done

Lines 132 to 134 – I found the sentence “If the hanging wall and footwall strain marker surfaces are not parallel, as is commonly the case, the calculated vertical separation is a function of horizontal distance to the fault and the dip slip calculation requires a knowledge of the position or projection of the fault tip onto the scarp.” difficult to read.

The sentence was simplified to read: “If the hanging wall and footwall strain marker surfaces are not parallel, as is commonly the case, the dip slip calculation requires a knowledge of the position or projection of the fault tip onto the scarp.”

Calculate Slip Statistics

Line 146 – maybe ‘calculates’ rather than ‘conducts a calculation for’, simpler.

Done

Figures

All are difficult to read as font is too small.

The figures should be larger when high resolution images are uploaded for the final manuscript submission. Thank you for this comment. We will ensure all font is legible.

Other

Use of capitals in headers needs addressing

All headers have been updated. The first word of each title and proper nouns (e.g., locations and toolkit name) are capitalized.

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