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Reply on RC1

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Author comment on "CliffDelineaTool v1.2.0: an algorithm for identifying coastal cliff base and top positions" by Zuzanna M. Swirad and Adam P. Young, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-269-AC1, 2021

Thank you for the thorough and constructive comments on our study considering previous models. We address all issues described above in reference to the specific comments listed below.

* Ln 49: What are the advantages to develop this new tool in MATLAB vs. an open-source software, when MATLAB is a proprietary software that necessitate a license? Can the algorithm be transferred in Python, R, or C++?

We originally developed the tool in MATLAB while working on a California coastal cliff erosion assessment (Swirad and Young, 2021). We agree that using open-source software has many advantages and have coded the tool in Python as suggested. The code is now available on GitHub (https://github.com/zswirad/CliffDelineaTool).

In the manuscript we updated the abstract (lines 8-9):

"Here we describe *CliffDelineaTool* (v1.2.0), a MATLAB/Python-based algorithm…"

We also modified the 'Code availability' section to (lines 271-273):

"See https://github.com/zswirad/CliffDelineaTool (last access: 2021-11-24) for the latest version of the source code, Python version of the tool (*CliffDelineaToolPy*, v1.0.0) and user instructions."

* Ln 75: In Figure 2, a, b, and c the vertical axis is approx. 4 to 5 times exaggerated in comparison with the horizontal axis. This makes the slope to appear steeper than it is. There is approx. 20 m elevation increase over ~ 100 m cross-shore distance, so the slope cannot be more than 10 - 12 degrees. In some instances that could be a sand dune in front of a cliff, like on the east shore of Lake Michigan. The authors are right that sometimes the definition of a cliff / bluff can change with location, so maybe a photograph from the location where this transect is, might help to prove that the whole profile is of a cliff, and not a cliff and a dune in front of it.

This is a very good comment. As suggested, we added airborne photographs of the eight AOIs in Figure 3 and in Figure 2 caption refer to the map and the photograph (lines 77-78):

“see Figure 3c for topography and airborne photograph”

The vertical exaggeration in Figure 2a-c was used for better visualization. We have added a note in the figure caption (line 83):

“Note the vertical exaggeration in a-c and horizontal exaggeration in d-f.”

* Ln 104: What are the parameters of the moving window? A 20 m vs. 50 m moving window will give different results, theoretically.

Correct. We discuss the moving window parameters in section 2.2.1 in lines 153-155:

“Optimal *SmoothWindow* was selected by comparing moving window ranging from 1 to 20 alongshore transects for each AOI to minimize RMS and number of skipped transects (Figure 5e-h; Table 1).”

Calibration of the *SmoothWindow* parameter is discussed in lines 241-244:

“*SmoothWindow* parameter depends on alongshore complexity of the coast, bay/headland sequence spacing, and their relation to transect spacing. Model results are sensitive to *TopSea*, *PropConvex* and *SmoothWindow,* and testing various values on short sections of the study area with visual inspection can help identify optimal values (Figure 6).”

* Ln 106: What means in this instance "re-examined"? Is the algorithm to be run again to get an alternative top? It is not clear from this context.

Yes, we now clarify this in lines 110-112:

“Transects with standardized residuals (residual divided by residual standard deviation) >2 are flagged as outliers (Figure 2e) and re-examined to identify new potential cliff top locations.”

* Ln 111: Are these coastal cliff sections relevant for other locations such as northern shore of Alaska or the bluffs around Lake Michigan? Or for each location with different geological context the calibration exercise needs to be repeated?

Good comment. We clarify this in line 230:

“For best performance, *CliffDelineaTool* should be calibrated to the user study section.”

* Ln 115: It seems that the transects are approx. 5 m apart for each AOI. The DEM is at 1 m resolution so theoretically you can have transects 1 m apart without repeating the cliff data profile. Was there any reason to decide to have transects 5 m apart and not 3 m or 1 m or 10 m apart? How where the transects generated? In Palaseanu-Lovejoy et al (2016)

and Payo et al (2018) the generation of transects is explained.

Thank you for the comment. We have modified the manuscript for clarification. Generation of transects is not part of the tool. The transects are a tool input. Lines 62-63 read:

"A single input file includes multiple ordered transects representing an entire coastal section."

We explain why we selected 5 m alongshore spacing in lines 126-127:

"Parallel calibration transects generated with ArcGIS tools were spaced 5 m alongshore to capture meso-scale details of alongshore cliff geometry and sampled at 1 m cross-shore resolution."

We discuss generation of transects in lines 217-221:

"Unlike the models of Palaseanu-Lovejoy et al. (2016) and Payo et al. (2018), *CliffDelineaTool* does not generate transects. For this study, simple cross shore transects with 5 m alongshore spacing were defined manually for each AOI. The relatively short AOI alongshore sections permitted use of parallel transects (Swirad, 2021). However, for longer, more complex cliff sections varying transect orientation will improve results and could be generated with *CliffMetrics* (Payo et al., 2018)."

* Ln 120: This is a very informative figure and maybe it should be placed somewhere more towards the beginning of this section. Also for each profile graph you should label on the y axis the vertical exaggeration, since this impacts how we perceive the cliff slope.

Thank you. We have labeled the vertical exaggeration as suggested (Figure 3). Figure 3 is located after the first paragraph of the section and just after the first time it is referenced according to standard formatting.

* Ln 124: 3, 4 and 9 m are all for AOI #2 or AOI #2 to #4?

As suggested, we clarified lines 131-133:

'Maximum cliff base elevation (*MaxBaseElev*) was subjectively set to 5 m (NAVD88) for AOIs #1, #3, and #4, and 9 m (NAVD88) for AOI #2 based on DEM inspection (Figure 3, Table 2).'

* Ln 126: What this means? Do you mean eliminating outliers?

We are unsure which statement the reviewer refers to. We assume it is '[…] while not skipping too many transects.' Transects are skipped if no point fulfils the potential cliff base or top criteria. This is explained in lines 89-90 and 96-97 that read:

"If no points fulfill the [cliff base] criteria, the transect is skipped at this stage."

"If no points along the transect fulfill the [cliff top] criteria, the transect is skipped and has no explicitly modelled cliff top."

* Ln 129: This is the basic understanding of the box-and-whisker plots and outlier interpretation from Tukey, John W (1977). Exploratory Data Analysis. Addison-Wesley. Please add citation.

Citation added as suggested (line 139).

* Ln 132-133: This sentence implies that the black whisker ends are the outliers, when the outliers are the values beyond the black whisker ends that are represented by red crosses. Please re-phrase.

As suggested, we re-phrased lines 140-142:

"Threshold slope angles were picked as minimum or maximum values excluding outliers ($q_3 + 1.5 \times (q_3 - q_1)$ or $q_1 - 1.5 \times (q_3 - q_1)$; black whisker ends in Figure 4; Table 1)."

* Pg. 14, Table 5: These results are very interesting. For CliffMetrics did you run the Payo et al (2018) code? That code does not have a routine/function to eliminate outliers, while Palaseanu-Lovejoy et al (2016) has a function to eliminate outliers from both top and toe positions using Tukey (1977) method, same method that is used in this manuscript as well. Very recently Plalaseanu-Lovejoy published the R code that follows the 2016 publication: Palaseanu-Lovejoy, M., 2021, iBluff - Geomorphic analysis of coastal bluffs / cliffs. https://doi.org/10.5066/P9HJ7QHD This R code has a function to eliminate outliers. Also CliffMetrics from Payo et al (2018) uses a constant length transect for an area, does not matter how big or small that cliff elevation range is. If there is a cliff at a base of a hill or mountain and that transect is so long that reaches the top of the hill or mountain then the CliffMetrics algorithm could select that top instead of the cliff top. This was a decision made by the authors to speed up the process of deciding how long those transects should be from the original Palaseanu-Lovejoy et al (2016) method where the length of the transects were a user defined parameter for sections of relatively comparable cliff ranges. The algorithm presented in this manuscript eliminates outliers, so the comparison is between 2 methods that use the same logic to select an initial top / toe but one eliminates outliers and one does not. So it is logic to get better results for the method that eliminates outliers. What happens if you compare the CliffMetrics method with stage 1 of this manuscript method? Or compare stage 2 or 3 results from this manuscript with Palaseanu-Lovejoy et al (2016) and Palaseanu-Lovejoy (2021) code that eliminates outliers. In conclusion I do agree, you will always get better results when outliers are eliminated.

Thank you for this comment. We have now clarified which models we compare *CliffDelineaTool* to in lines 128-130:

"The *CliffDelineaTool* results were compared with the distance-to-trendline method (Palaseanu-Lovejoy et al., 2016) and *CliffMetrics* (SAGA GIS version; Payo, 2020) using input parameters (seaward transect end points, transect length, and no transect smoothing) to match the same cross shore transects used for *CliffDelineaTool* and the default vertical tolerance of 0.5."

Furthermore, we discuss the differences in the basic 'distance-to-trendline' method and the models of Palaseanu-Lovejoy (2021) and Payo et al. (2018) in lines 222-229:

"We compared *CliffDelineaTool* to the distance-to-trendline method which forms basis of *iBluff* (Palaseanu-Lovejoy, 2021) and *CliffMetrics* (Payo et al., 2018). However, *iBluff* and *CliffMetrics* both include additional steps to improve results and correct erroneous cliff base and top positions. *iBluff* uses manual transect shortening during pre-processing, and outlier removal using smoothing window, similar to *CliffDelineaTool*. *CliffMetrics* uses manual quality control and iterative parameter selection (Payo et al., 2018). The *CliffMetrics* results presented here used default parameters and predefined transects to provide a direct comparison to *CliffDelineaTool.* However, one of the strengths of *CliffMetrics* includes the ability to quickly iterate parameter set up. Therefore, the results could be improved using iterative parameter selection and varying transect length and orientation."

We have added the reference to Palaseanu-Lovejoy (2021) in lines 44-45:

"Palaseanu-Lovejoy (2021) updated the model (*iBluff*, coded in R) to include automatic outlier removal using a moving window (Tukey, 1977)."

* Ln 190: Figure 7. A very nice and informative figure. The length of the transects were the same for both the CliffMetrics and the CliffDelineaTool? For example, in figure e and f there is a cliff face that has a vertical range about 4 to 5 times bigger that the cliff faces on both left and right of it. It seems that a very long transect was used with the CliffMetrics algorithm from Payo et al (2018). Palaseanu-Lovejoy et al (2016) algorithm would have used different transect lengths and would check that the toe elevation and position is not higher and more in-land than the top elevation and position on the same transect, and if it is a new one is either selected or the toe is rejected completely for that transect. From the figure f it seems that the CliffMetrics selected a toe that is more in-land than the top of the cliff in that instance (same for figure d, the B situation).

Thank you for this comment. We have now clarified lines 223-226 to state:

"However, *iBluff* and *CliffMetrics* both include additional steps to improve results and correct erroneous cliff base and top positions. *iBluff* uses manual transect shortening during pre-processing, and outlier removal using smoothing window, similar to *CliffDelineaTool*. *CliffMetrics* uses manual quality control and iterative parameter selection (Payo et al., 2018)."

* Ln 204 – 205: I don't consider this a shortcoming of the method. The method requires a bare-earth DEM, if some vegetation is still present in the DEM it is obvious that the top of a tree close to the top of the cliff might be identified as the cliff top. This is a shortcoming of the DEM input data and not of the method per se.

We have added the note in lines 213-214:

"Other model application issues include occasional treetop selection for cliff top positions (Figure 6c-d) when using non-bare-earth DEMs."