Geoscientific Model Development Discussions

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Comment on gmd-2021-269

Anonymous Referee #1

Referee 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-RC1, 2021

General comments

Thank you so much for the opportunity to review the manuscript entitled CliffDelineaTool v1.1.0: an algorithm for identifying coastal cliff base and top positions by Zuzanna M. Swirad and Adam P. Young. The manuscript is well written and organized.

The manuscript presents MATLAB-based algorithm that identifies cliff base and top positions on complex cliffs using cross-shore transects extracted from digital elevation models named CliffDelineaTool (v1.1.0). The advantages of having an automated method to extract cliff metrics is obvious and probably no more evident than when change analysis or erosion rates are to be computed from different lidar surveys.

The authors are basing their work on work previously published by Palaseanu-Lovejoy et al. (2016) and Payo et al. (2918) adding to the narrative few refinements in order to process complex cliff profiles and increase accuracy. While the previous authors algorithms were published in completely open-source software this work is presented in MATLAB, a proprietary software that necessitate a license. This unfortunately is a drawback of the present manuscript.

Both Palaseanu-Lovejoy et al. (2016) and Payo et al. (2018) present techniques to establish transects approximately perpendicular to the cliff face as well as ways to decide the length of these transects. Actually, in this, the two above mentioned papers differ the most, besides the programing language used. The present manuscript of Swirad and Young is not explicit on how the transects are generated although some indication on how their length is established is presented by discussing the user defined parameter NVert. Palaseanu-Lovejoy et al. (2016) has two main user defined parameters, the length of shoreline that is approximately parallel with the cliffs that have a comparable elevation range and one buffer distance for each individual shoreline segment in the effort to compensate against widely variable cliff elevation ranges to increase accuracy to top and toe delineation and decide on transect lengths. Payo et al. (2018) chose to forgo the necessity of buffers and use a constant transect length to speed up the time of processing considerably with some accuracy loss.

While both Palaseanu-Lovejoy et al. (2016) and Payo et al. (2018) have relatively few user-defined parameters, Swirad and Young method has 8 user-defined parameters that need to be established in accordance with different morphologies.

Swirad and Young method concentrates on evaluating other top candidates on very complex cliff profiles, and after using an outlier filter (Tukey ,1977) method to eliminate them. Although previous work does not necessarily look in details to other top candidates on complex profile, the work of Palaseanu-Lovejoy et al. (2016) does mention both secondary tops or toes, as well as using the same method of eliminating outliers from top / toe results as in this manuscript. The same work from 2016 has checks within the presented algorithm that does not permit on complex profiles to have toe positions that are either at higher elevation than the top of the cliff or more in-land on the transect than the position of the top of the cliff. This internal check is missing, it seems, from the CliffMetrics tool of Payo et al (2018) that was run on the present authors examples as demonstrated in manuscript Figure 7.

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 code has functions to eliminate outliers using Tukey (1977) method, generating secondary points of inflection (secondary top / secondary toe) on the cliff face, define all “positive tops” and “negative toes” on a transect (in the code called dunes crests and troughs), and get the relative convexity and concavity of the cliff / bluff profile.

In conclusion this work is interesting and tries to solve the problem that the method is relatively sensitive to cliff / bluff morphology in extreme complex cliff profiles. Also this work demonstrates that the definition of what constitute both cliff top and toe can differ from one analyst to another, from one location to an other and from one geomorophology to another.

Specific comments

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++?

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.

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

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.

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?

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.

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.

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

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

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.

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.

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.

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).

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.