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DEM-based automatic characterization of volcano edifice morphometry

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Digital elevation models (DEMs) are increasingly available at accuracies and spatial resolutions that are adequate for precise geomorphometric analysis of landforms. We here present a DEM-based automatic method for the morphometric characterization of volcano edifice landforms. The method consists in two main steps that are carried out using two expressly written IDL-language algorithms, NETVOLC and MORVOLC. Firstly, the volcano landform must be in some way delimited by a closed boundary. Volcano edifices are generally distinguished from the surrounding landscape by their steeper slopes and can thus be delimited following slope-breaks around their bases. However, in practice, edifice boundaries are often obscured because of merging or complex relations with the neighboring landscape. NETVOLC automatically defines volcano edifice boundaries using DEM-derived profile convexity, slope and aspect values; profile convexity is a direct measure of slope-breaks, whereas a slope-derived mask favors lower slope values typical of edifice bases, and an aspect-derived mask constrains the search to slope-breaks facing away from the edifice center. The algorithm searches for the 'best' possible outline enclosing the edifice by minimizing a cost function that considers a combination of the DEM-derived data. Once the edifice outline is defined, MORVOLC uses elevation and slope layers to compute morphometric parameters that characterize edifice size and shape. Size parameters are basal and summit region areas and widths, height and volume. Plan shape is summarized with two independent elevation contour-derived indexes, ellipticity and irregularity. Profile shape is described with the height/basal width and summit width/basal width ratios. Slope statistics are also computed, as well as the number of secondary summit and flank peaks. The automated method produces objective and comparable sets of morphometric parameters that comprehensively quantify the size and shape of volcano edifices. The obtained parameters can be used for detailed analysis of single volcanoes or for regional comparisons, and to study the processes controlling volcano growth and morphology. Ultimately, the presented method can lead to a global database and classification of volcano edifice morphometry.