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Automated morphological analysis of volcanic landforms: new insights into the structure, evolution, and dissection of active continental volcanic arcs

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Morphological analysis of volcanic areas is an important tool when used as an approach to the characterization of volcanic and tectonic structures. This is particularly true in recently evolved volcanic regions, as active volcanic arcs, where exogenous processes have not had time to deeply erode and modify the original landforms. In this case, the morphologies and their spatial distribution mainly reflects the nature of erupted products, the volcanotectonics relationships, and the evolution and dissection of the volcanic edifices. The recently available global coverage of high resolution digital elevation models (DEMs) as the SRTM and GDEM-ASTER datasets, provides an unique opportunity to analyse the volcanic landforms at the regional and continental scales to get new insights into their structure, evolution, and dissection. Here we present an automated morphological analysis of selected regions of the Trans-Mexican Volcanic Belt and the Andes continental volcanic arcs. The objective of the work is to setup and validate a series of tools for the extraction and quantitative analysis of volcanic landforms, in areas where the geology and volcanic history are known. Our approach is based on the analysis of terrain shapes using statistical techniques and algorithms, such as the cross-correlation between adequately classified volcanic landforms and the available measurements of the landscape. For this purpose, the application of fuzzy approaches will also be considered and investigated.
The results of the morphological analysis are stored in a GIS database for further spatial and statistical analyses. The outcomes of our study consist of a processes-oriented classification of the volcanic landforms, an analysis of their spatial distribution in the frame of the geology and the tectonics setting of the area, and the identification of landforms dissection patterns related to the nature of the volcanic products, their age and climate. Our work is an effort to setup a suitable methodology for the automated analysis of DEMs of volcanic regions, and for the extraction of geological, tectonic and climatic information over large areas on the Earth and other terrestrial planets.