Overview of two MATLAB-based methods for semi-automatic measurement of lateral and vertical fault offsets in topographic data

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Abstract

For many years, quantifying fault activity, such as how much a fault slipped, has been vital in understanding the processes driving when and how earthquakes along individual structures reoccur. A key component in assessing fault slips is cumulative offset, which is the disruption and displacement of a geologic or geomorphic unit. Particularly along strike-slip faults, sublinear geomorphic markers have been utilized to manually measure these fault offsets. However, offset measures and their uncertainty are only based on subjective visual interpretations, which may be debated. More recently, the advancement of high-resolution topographic data has prompted the development of automated methods for remotely measuring fault movement. This presentation will cover two of the most prominent MATLAB-based methods, LaDiCaoz and 3D_Fault_Offsets. These two methods have been developed to semi-automatically quantify fault offsets across ubiquitous linear geomorphic structures such as stream channels and terrace risers. While the LaDiCaoz computes horizontal offset by correlating two parallel fault profiles crossing an offset marker on either side of the fault trace, 3D_Fault_Offsets mathematically identifies and represents, in 3D, the most prominent geometric characteristics of ubiquitous geomorphic sublinear markers along faults to compute horizontal and vertical offset. The uncertainties in LaDiCaoz are determined from the range of possible back slipping reconstructions estimated by the user. Meanwhile, the uncertainties in 3D_Fault_Offset are evaluated using a Monte Carlo approach based on various sources of error. Both of these techniques eliminate the error resulting from the subjective interpretation of the visually identified geomorphic markers. In terms of error evaluation, 3D_Fault_Offset is more comprehensive and precise because it analyzes various error sources. The authors of these two methods all emphasize the significance of understanding tectonic geomorphology in order to make meaningful measurements.

Keywords: LaDiCaoz, 3D_Fault_Offset, Earthquake, Geomorphic markers, Offset