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Stereonets for geomorphometrical analysis

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Surface change detection analysis is a widespread technique for various tasks in the Earth sciences. Besides basic illustration by coloured maps of the actual surface studied, it would be a very beneficial option to more explicitly exploit the information that is present in the data and e.g. to draw conclusions on the acting processes.

We present a new idea on how to analyse spatial change detection based on consecutive surface point clouds. The method is inspired by the stereonet visualization common in geology to display the spatial orientation of joint distributions etc. Here, we first calculate at-a-point change in direction of the local surface normals (e.g., by applying the M3C2 algorithm for surface change detection; Lague et al., 2013 ISPRS). If all these surface normals of the data set then are to start from one point, they penetrate a unit sphere around them. At last, sectorial means of change on that unit sphere are calculated based on the change values of the inherent point normals per sector.

This procedure delivers a 3D visualization of the general dependency of surface change at a certain point in the study area on the spatial orientation of the local surface around this point. For easier presentation, the data of one hemisphere can be projected onto a plane crossing the sphere through its origin. This corresponds to the area of the sphere that is visible by an observer and gives a circle plot. We demonstrate the concept by means of high-resolved (mm) bedrock erosion data from a gorge in Switzerland indicating the erosive effect of sediments (tools effect) by streamflow impacting at upstream-facing surfaces. Diverse applications with other Earth science data are possible, aiming at multiple objectives and also applying other statistics.