Multi-resolution analysis of landscape characteristic length scales

Paola Passalacqua[1], Harish Sangireddy[1], *Colin Stark[2]

1.Department of Civil Architectural and Environmental Engineering and Center for Research in Water Resources, University of Texas at Austin, 2.Lamont-Doherty Earth Observatory, Columbia University

The wide availability of high resolution topography data has revolutionized the way we analyze landscapes. Information at fine scales allows the extraction of geomorphic features such as channel heads and the detection of geomorphic process transitions.
Here we present a technique called multi-resolution analysis (MRA) to analyze landscapes across scales, quantify how the probability density function of topographic attributes changes with scale, and identify characteristic length scales. The method consists of convolving high resolution data with Gaussian kernels of increasing standard deviation to obtain topography data at different scales. At each scale, we compute the probability density function of curvature and topograhic index, defined as the ratio of slope and contributing area in logarithmic scale. By analyzing the probability density function of each attribute across scales, we detect scaling breaks. Through the analysis of 1D and 2D synthetic signals as well as the analysis of numerically simulated landscapes under controlled initial and boundary conditions, we equate the detected scaling breaks to the scale of surface roughness and the median hillslope length scale. The MRA approach is then applied to various real landscapes to quantify their characteristic length scales.

Keywords: high resolution topography, roughness, hillslope

