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Dependence of multifractal analysis on image resolution and noise

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Multifractal models have been used to account for the scale-invariance of properties of various objects in very different contexts, ranging from soil thin sections to remote sensing images. Scale-invariance has been found to be of increasing importance in understanding the complexity of natural phenomena that are analyzed through images, although several authors have pointed out possible errors in the calculations due to the resolution chosen. In this study, two-dimensional geometrical multifractal gray fields were constructed using a generator based on averaging multiple homogeneous Sierpinski carpet generators resulting in variable mass fractions determined by the truncated binomial probability distribution. Repeated application of this generator onto itself results in a multiplicative cascade of mass fractions or multifractal. The generalized moments, Mi(q), of these structures scale as (1/b)ˆ[i(q-1)Dq], where b is the scale factor, i is the iteration level and Dq is the q-th order generalized dimension, with q being any integer between minus infinity and infinity. This theoretical approach was applied to simulate a gray level image with b=3 and a size of 729x729 pixels, obtained after 6 iterations. Gray level images produced by iterations < 6 were then used to simulate noise or low resolution. Each of the images obtained was analyzed by calculating the maximum configuration entropy (H(L)) and the characteristic length (L). The results indicate that H(L) and L are two useful descriptors that can provide an estimate of optimal scale of discrimination and the minimum spatial scale that should be considered for a multifractal analysis.