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Parameterized approximation of lacunarity functions derived from airborne laser scanning point clouds of forested areas

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Lacunarity, a measure of the spatial distribution of the empty space is found to be a useful descriptive quantity of the forest structure. Its calculation, based on laser-scanned point clouds, results in a four-dimensional data set. The evaluation of results needs sophisticated tools and visualization techniques. To simplify the evaluation, it is straightforward to use approximation functions fitted to the results. The lacunarity function $L(r)$, being a measure of scale-independent structural properties, has a power-law character. Previous studies showed that $\log(\log(L(r)))$ transformation is suitable for analysis of spatial patterns. Accordingly, transformed lacunarity functions can be approximated by appropriate functions either in the original or in the transformed domain.

As input data we have used a number of laser-scanned point clouds of various forests. The lacunarity distribution has been calculated along a regular horizontal grid at various (relative) elevations. The lacunarity data cube then has been logarithm-transformed and the resulting values became the input of parameter estimation at each point (point of interest, POI). This way at each POI a parameter set is generated that is suitable for spatial analysis.

The expectation is that the horizontal variation and vertical layering of the vegetation can be characterized by this procedure. The results show that the transformed $L(r)$ functions can be typically approximated by exponentials individually, and the residual values remain low in most cases. However, (1) in most cases the residuals may vary considerably, and (2) neighbouring POIs often give rather differing estimates both in horizontal and in vertical directions, of them the vertical variation seems to be more characteristic. In the vertical sense, the distribution of estimates shows abrupt changes at places, presumably related to the vertical structure of the forest. In low relief areas horizontal similarity is more typical, in higher relief areas horizontal similarity fades out in short distances.

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