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Comparison of Two Multifractal Analysis Methods: Generalized Structure Function and Multifractal Spectrum

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Soil variability has often been a constant expected factor to take in account in soil studies. This variability could be considered to be composed of "functional" variations plus random fluctuations or noise. Multifractal formalism, first proposed by Mandelbrot (1982), is suitable for variables with self-similar distribution on a spatial domain. Multifractal analysis can provide insight into spatial variability of crop or soil parameters. In soil science, it has been quite popular to characterize the scaling property of a variable measured along a transect as a mass distribution of a statistical measure on a length domain of the studied transect. To do this, it divides it into a number of self similar segments and estimate the partition function and mass function. Based on this, the multifractal spectra (MFS) is calculated. However, another technique can be applied focus its attention in the variations of a measure analyzing the moments of the absolute differences at different scales, the Generalized Structure Function (GSF), and extracting the Generalized Hurst exponents. The aim of this study is to compare both techniques in a transect data.

A common 1024 m transect across arable fields at Silsoe in Bedfordshire, east-central England were analyzed with these two multifractal methods. Properties studied were total porosity (Porosity), gravimetric water content (GWC) and nitrogen oxide flux (NO_2 flux). The results showed in both methods that NO_2 flux presents a clear multifractal character and a weak one in the GWC and Porosity cases. Several parameters were calculated from both methods and are discussed.

On the other hand, using the partition function all the scale ranges were used, meanwhile in the GSF a shorter range of scales showed linear behavior in the bilog plots used to estimate the parameters. GWC exhibits a linear pattern from increments of 4 till 256 meters, Porosity showed this behavior from 4 till 64 meters. In case of NO_2 flux only from 32 to 256 meters showed it. However, the relation between the mass exponent function and the GSF, found in the literature, was positively verified in the three variables.