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Interactive comment on "Fractal metrology for biogeosystems analysis" *by* V. Torres-Argüelles et al.

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We are totally agreed with the main Referee observation about the obscure nature of steps followed by the algorithms of the main commercial software. Notwithstanding, each branch of Metrology is looking for the reference and easy to find techniques for each selected measurand measurements. In the case of Fractal Metrology, we chose the designed by scientific community and discussed in Science (Seffens, 1999) Software- Benoit (SCION Corp., 1999). For each Benoit technique, the corresponding home-made algorithm was written by Jean-Francois Parrot during the last 15 years (see references in our manuscript) and used in order to overpasses the black-box effect of the commercial software. However, these step by step algorithms, with all known parameters, are more recommendable for the scientific and not for applied purposes.

The calibration results of all these algorithms application were published previously by our research Group. From our point of view with these "home made" algorithms we overpass the main problem of digital images fractal analyses: the necessity to segregate the digital image in pore and solid sets. In spite of this division, we propose to quantify the whole pore-solid distribution in space and time, putting attention on the scale invariant gray-intensity roughness.

The standard deviation (SD) is accepted and recommended as the reference measure of realistic uncertainty by the Working Group 1 of the Joint Committee for Guides in Metrology (2008). Of course it is better to describe the whole *structure of uncertainty* (proposed by the same group and included in the *Guide to the expression of uncertainty in measurement* GUM). However, this description requires a lot of space. In order to answer to the Referee question, let us tell that all measurement technique are inherently imprecise and produce some errors. Notwithstanding, we are agreed with Vijay Srinivassan (Elements of Computational Metrology, DIMACS Workshop on CAD/CAM, Rutgers U., 2003) that "*no measurement can be absolutely accurate and with every measurement there is some finite uncertainty about the measured value or measured attribute*". The analysis of the uncertainty structure of selected for Fractal Metrology toolbox was out of the paper scope, because the error of each applied technique was the same for each of compared soils measurement. These comparison focused on the structure dynamic of three morphologically contrasting soils was realized by the mixture of commercial and home designed algorithms. The measurement of SD in each procedure was accomplished by classical procedure (Weisstein, E.W., "Standard Deviation.", from MathWorld Web Resource. http://mathworld.wolfran.com/StandardDeviation.html):

The standard deviation σ of a probability distribution (PDF) is defined as the square root of the variance σ^2,

$$\delta = \sqrt{\langle x^2 \rangle - \langle x \rangle^2},$$
$$= \sqrt{\mu_2^{\prime - \mu^2}},$$

where $\mu = \overline{x} = \langle x \rangle$is the mean, $\mu_{\prime 2}^{=} \langle x^2 \rangle$ is the second raw moment (Weisstein, 2010).

The next question is coincided with the degree of similarity between the discussed results. Due to the significant differences in the mean Hurst exponent values we prefer to use SD (the second central moment of gray distributions) for all comparisons, assuming the higher precision of SD. If we would to answer the more generic question: shouldn't the different methods provide similar results? The answer would be: yes, but only theoretically (Mandelbrot, 1983). In practice the compared methods have strongly different precision measured in terms of SD. If we answer in the Fractal Geometry way, we would compare the length measurement with steps of ant as with passes of elephant, which results will not be the same. Each used technique is based on its own theory (or power law in our case) and all of them resulted in different uncertainties which were compared by Person r and Student t procedures in order to discriminate between their usefulness.

The question about the information anisotropy is very important. Therefore the detailed description of sampling technique used in the present research was included in the corrected manuscript version. It seems important to measure in both direction. But in the case of the present research the undisturbed sampling was realised in parallel to the surface direction and it was important to relate the data to the direction of tillage implement passes.

We took into account each one of the Referee specific and technical comments, including them in the corrected manuscript version. The whole manuscript was re-ordered, some parts are re-written, following the Reviewer comments. We clarified the concept of Phase transition of soil structured patterns, exemplifying them with studied soils (Results and Discussion chapter).

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Best regards,

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