Nonlinear Processes in Geophysics Discussions

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Comment on npg-2021-4

Anonymous Referee #2

Referee comment on "Non-linear hydrologic organization" by Allen Hunt et al., Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2021-4-RC2, 2021

Reviewer Report Ms. "Non-linear Hydrologic Organization" By Hunt et al.

In this work, the Authors revisit the Stommel diagram variants to investigate the spatio-temporal scaling of the underlying hydrologic processes. The presented analysis is surely interesting, providing evidence of predictive scaling equations joining results from percolation theory and parameters related to the porous medium. Although some passages and the used terms sometimes make it not easy to be read by a wide audience, I found the manuscript well-organized and the argument intersting to deserve to be published in NPG. However, some points need to be clarified before considering the manuscript ready for publication. Thus, I would invite the Authors to consider the following points in revising their manuscript.

1) General comment: I have found some difficulties in reading some passages in section 2.2 due to the very specific terminology used. For instance, terms like "sill overlapping" may have a very specific meaning in hydrology studies. However, because of the interdisciplinary character of NPG I suggest, if possible, to explain some of the specific terminology in such a way to make it more readable to a wider audience.

2) Figure 1) is plotted using linear axes. In order to better appreciate the power-law relation between the two related quantities, it would be better to plot it in in a log-log diagram. Indeed, the Pearson coefficient R^2 suggests that the scaling index is obtained by a linear regression fit on a log-log diagram.

3) At page 2 the Authors introduce two different dimensionality indices (D_b and D_{opt}) without specifying how these dimension are estimated and/or the fact that these are related to the fractal dimension. I suggest the authors to spend some more words to explain the meaning of these dimensions and also to add some references to the percolation theory (perhaps the book by Stauffer and Aharony 2003, etc).

4) The terms in Eq. 2 are not clearly stated. I guess L is the stream length and A the drainage basin area. This should be clearly stated in the text so that the reader can immediately link the terms of Eq. 2).

5) The exponent in Eq. 2) should be related to a sort of fractal dimension relating the link between area and length, i.e, indicating the anomalous scaling of the area as a function of the length. Some words regarding this issue should be included in the text.

6) In the text the following unit measures are used: Ma and Myr (ka and kyr). I guess that both "a" and "yr" stand for years. If I am not wrong, and if there is not a specific reason to use "a" to indicate year I suggest to adopt a single notation. Otherwise, please explain the difference between "a" and "yr". (Furthermore, check yr in the text because there are some typos where yr is written as y).

7) All the estimated quantities, such as the fit parameters reported in Figures 4 and 5, should include the errors. R^2 is not a sufficient qualifier for the goodness of the fit. Also parameter errors provides correct estimation of the uncertainties in the fitting procedure.

8) The significance of R^2 when comparing different datasets, is not sufficient to estimate which one is the best. I suggest to make a significance test which takes into account the number of events in each set also.

9) In the text the Authors uses cm, m, km as length measurements. I suggest to adopt the standard SI (International System) notation and its scheme.

10) In the final section the Authors state that surface heterogeneities and non-linear dynamics. However, it is not clear what they exactly mean with the term non-linear dynamics or non-linear flow equations. The Authors should be more precise in defining the meaning and the equations they refer with the terms non-linear dynamics. What kind of dependence is it esxpectsd between the characteristic velocity and the increasing scale ? is it a linear or a non-linear dependence which may alter the expected scaling features ? Furthermore, they should better describe the interaction mechanism between surface and subsurface processes.