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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Horton laws for Hydraulic-Geometric variables and their scaling exponents in self-similar river networks" *by* V. K. Gupta and O. J. Mesa

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We appreciate that both the referees made very helpful suggestions so we can make our paper more understandable than before for a typical reader of NPG and geophysics. All of their comments and suggestions are incorporated in the revised version attached here, mainly through a major reorganization of the paper and improvements in the writing. In particular the following is a list of our answers to both the referees' specific comments and suggestions: 1. We changed the title to "Horton laws for Hydraulic-Geometric variables and their scaling exponents in self-similar Tokunaga river networks", in response to comment 11 of referee #2. 2. The Abstract was

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modified to be self-explanatory, taking into account a comment of referee #1. 3. The introduction was modified to state the problem and its significance. It also includes a brief description of the organization of the paper. It Addresses the general comments of referee #1 and comment 1 of referee #2. 4. The Background section 2 was reorganized to include a brief review of the literature that includes all the material that was scattered in different sections of the paper they reviewed. In addition, we added two new 'methods' subsections in Section 2. The first on the Horton laws for network topology and geometry as asymptotic relations in self-similar Tokunaga networks and the second on the principles of similarity, dimensional analysis and the Buckingham-Pi theorem, asymptotic self-similarity of type-1 (SS-1) and asymptotic self-similarity of type-2 (SS-2). These revisions Address comments 2, 3 and 4 of referee #2; and comments of referee #1 on lines 23, 25. 5. Subsection 3.3 on "Dimensionless River-Basin Numbers" is now section 3. It incorporates comment 5 of referee #2. 6. Section 4 on "Mass conservation in self similar Tokunaga networks" was condensed according to comment 6 of referee #2. But suggestions 7 and 8 of referee #2 were not incorporated because Eq (11), which it is now Eq (14), is necessary. Also, comment 9 of referee #2 regarding Eq. (16) [now 18], questioning whether it is valid in the limit of large network order is clarified in Section 2.1. The result holds for small values of w. 7. We redrew the Figures according to referee #1 suggestions. 8. Referee #1 in his first comment asks the authors to improve their explanation of the underlying physical reasoning for their result as many different processes can lead to the same scaling behavior. We attended this important suggestion in the following way: Our theory is developed for self-similar Tokunaga networks given in method section 2.1 using dimensional analysis method given in section 2.2 with examples. Where dimensional analysis does not hold and requires a generalization is also given in section 2.2 with examples. It is feasible that the theory holds in more general self-similar networks like Random Self-similar Networks, but that is an open question at the moment. Also the theory, at its present state of development, does not predict depth and velocity scaling exponents via prediction of the two anomalous scaling exponents from physical processes. So our paper takes a first step to develop an analytical theory of H-G in networks but needs further work as mentioned in the conclusion section. 9. Referee #1 in his second comment asks to elaborate in more details the "advantages/disadvantages" of the presented theory compared to the OCN theory. e.g. compare the different assumptions in the different models and discuss their significance. This question is addressed in Section 6. 10. The third comment of referee#1 suggests to elaborate on the fact that slope defines a critical point and the possible interpretation in the context of scaling and critical phenomena. In particular he asks if there is a phase transition at the critical point. Barenblatt (1996) makes a brief passing remark on the last pages (364-365) that SS-2 (renormalization group) is analogous to the situation familiar in critical phenomena in the context of particle physics and thermodynamics. We cannot say more except to note that critical phenomena are not used in the theory. It could be an area of future research in the present physical context. 11. Referee #1 suggest to justify assumption of constant length: Tokunga model is deterministic and does not include any statistical variability that is observed in real networks. Therefore, the link lengths are assumed to be a constant throughout the paper. This comment is in the same line as his comment about the need for a length scale definition and his suggestion for an explanation of how geometric properties are obtained from RSN. We introduce geometry for Tokunaga networks via drainage area in section 2.1 (eq. 5), but RSN model Is not used in this paper. 12 Comment 10 of Referee #2 (10) asks for more discussion on the self-similarity assumption of the H-G variables. We have done this in section 5

Please also note the supplement to this comment:
http://www.nonlin-processes-geophys-discuss.net/1/C264/2014/npgd-1-C264-2014-supplement.pdf

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