Under What Conditions Do Parallel Channel Networks Occur?

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Abstract. Geologists have long recognized that channel networks can deviate from typical dendritic networks when they develop under certain geologic or topographic constraints. One such deviation is the so-called parallel network, which develops on a sloping initial surface. The objective of this research is to determine the specific conditions under which parallel networks occur and the nature of the transition between dendritic and parallel networks. Both real and simulated channel networks were analyzed in this study. The real networks were obtained from the digital elevation models of basins that include large uneroded areas. The uneroded areas were identified as locations with small contributing areas and topographic curvatures that are close to zero. For each basin, the average slope of the uneroded areas was calculated by averaging the local slopes for all uneroded points. Each channel network was then classified using a recently published method that can distinguish five different network types (including dendritic and parallel) using three measures that are derived from scaling-invariance. These measures focus on the increments of drainage area along a channel, the irregularity of channel courses, and the angles formed by merging tributaries. Based on these classifications, it is observed that natural networks become abruptly parallel when the average slope of the uneroded area exceeds about 3%. Simulated channel networks were also generated using a detachment-limited model for fluvial erosion and a slope-dependent model for hillslope processes. The parameters of the model were selected to reproduce the conditions observed in the real networks. The average slope of the uneroded area is used to determine a constant slope for the initial surface. Based on these simulations, the model can also produce a transition between dendritic and parallel networks for an initial slope around 3%, but this threshold depends on the roughness of the initial surface.

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