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Controls on stream network branching angles, tested using landscape evolution models

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Stream networks are striking landscape features. The topology of stream networks has been extensively studied, but their geometry has received limited attention. Analyses of nearly 1 million stream junctions across the contiguous United States [1] have revealed that stream branching angles vary systematically with climate and topographic gradients at continental scale. Stream networks in areas with wet climates and gentle slopes tend to have wider branching angles than in areas with dry climates or steep slopes, but the mechanistic linkages underlying these empirical correlations remain unclear.

Under different climatic and topographic conditions different runoff generation mechanisms and, consequently, transport processes are dominant. Models [2] and experiments [3] have shown that the relative strength of channel incision versus diffusive hillslope transport controls the spacing between valleys, an important geometric property of stream networks. We used landscape evolution models (LEMs) to test whether similar factors control network branching angles as well.

We simulated stream networks using a wide range of hillslope diffusion and channel incision parameters. The resulting branching angles vary systematically with the parameters, but by much less than the regional variability in real-world stream networks. Our results suggest that the competition between hillslope and channeling processes influences branching angles, but that other mechanisms may also be needed to account for the variability in branching angles observed in the field.

References:

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