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Climatic controls on stream network geometry

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Channel networks disect most of the Earth‘s surface, draining the rain falling onto the ground. Yet the understanding how these networks form and how they evolve in time remains unclear. The influence of the climatic environment on the formation of stream networks has long been debated, but hard evidence of climatic controls remain rare.

By analyzing over one million digitally mapped rivers in the continental United States, we find that the branching angles of stream junctions strongly correlate with the recharge of the ground water given by the ratio between evapotranspiration and precipitation.

Theory predicts that bifurcating channels incised by re-emerging groundwater flow split at a characteristic angle of $\alpha = 2\pi/5 = 72^\circ$ [Devauchelle et al. PNAS 2012]. This case clearly emerges as a limiting case for high recharge while in dry areas dominated by surface runoff the branching angle is much lower. Our analysis shows that, contrary to most current theories, groundwater flow plays an important role in the formation and evolution of channel networks on a continental scale. This result also provides a tool to identify climatic controls in places where the climatic conditions are unclear, like on Mars.