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Does topography control the spatial organization of landscape hydrological connectivity?

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In this paper, we explore the extent to which topography controls the spatial structure of landscape hydrological connectivity in upland river catchments. We use a physically-based catchment hydrological model to produce time series of soil moisture status over a thirty year time period (1960-1990) for a large river catchment in the north of England. We use these time-series to characterize the space-time patterns of surface overland flow connectivity through to the drainage network. We then assess the extent to which these space-time patterns can be characterized by information derived from high resolution digital elevation models. We show that a significant proportion of the variability in connectivity statistics can be generalised by a topographically-defined measure of catchment wetness, based upon the minimum values of the topographic index found along a given flow path. The result implies that the spatial structure of landscape connection may be controlled by a relatively small number of topographically-defined critical locations and the space-time dynamics of hydrological response. It has the potential to be of huge significance for how we consider the generation of extreme flood events in rivers as well as for sediment and water quality transfer processes, notably if these critical locations lead to an effective disconnection between sediment or nutrient sources and the drainage network.