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Spatial and temporal similarity analysis: Linking landscape structure and climate to hydrologic response

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Climate and structure (topography, geology, vegetation) are frequently used to define similarities/dissimilarities between catchments. Despite widely available climate data and the growing availability of high-resolution digital elevation models, key drivers of hydrologic response remain poorly understood. Here, we examine differences in hydrologic response across 12 years and seven adjacent headwater catchments of the Tenderfoot Creek Experimental Forest (Little Belt Mountains, southwestern Montana). We used a simple transfer function rainfall-runoff modeling approach to estimate mean catchment response to snowmelt and rainfall. Mean hydrologic response time is the time required to discharge an amount of water equal to the effective precipitation input. Variations in catchment structure (e.g. slope, flowpath lengths, vegetation) were correlated to differences in the hydrologic response across the seven catchments. Climate, mainly maximum annual snow water equivalent, explained variability in the inter-annual response. Our analyses quantified catchment functional similarity and provide insight into the relative importance of climate and catchment structure in mediating hydrologic response.