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Landscape heterogeneity modulates forest sensitivity to climate

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Elevation dependent snowmelt magnitude and timing strongly influences net ecosystem productivity in forested mountain watersheds. However, previous work has provided little insight into how internal watershed topography and organization may modulate plant available water and forest growth across elevation gradients. We collected 800 tree cores from four coniferous tree species across a range of elevation, topographic positions and aspects in the Lubrecht Experimental Forest, Montana, USA. We compared the annual basal area increment growth rate to precipitation and temperature from a 60-year SNOTEL data record, groundwater and soil moisture data in sideslope and hollow positions, and topographic indices derived from a LiDAR digital elevation model. At the watershed scale, we evaluated the relationships between topographic indices, LiDAR derived estimates of basal area and seasonal patterns of the Landsat derived Enhanced Vegetation Index. Preliminary results indicate strong relationships between the rates of annual basal growth and the topographic wetness index (TWI), with differing slopes dependent on tree species (P. menziesii $R2 = 0.66$-0.71, P. ponderosa $R2 = 0.87$, L. occidentalis $R2 = 0.71$) and elevation. Generally, trees located in wetter landscape positions (higher TWI) exhibited greater annual growth per unit of precipitation relative to trees located in drier landscape positions (lower TWI). Similarly, watershed scale analysis of LiDAR derived biomass and seasonal greenness indicates differential growth response due to local convergence and divergence across elevation and insolation gradients. These observations suggest that topographically driven water redistribution patterns may modulate the effects of large scale gradients in precipitation and temperature, thereby creating hotspots for conifer productivity in semiarid watersheds.