Micro-density variation in alpine forests of central México mirrors the normalized difference vegetation index (NDVI)

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Abstract: Ongoing climate variability strongly affects high-elevation forests, influencing the wood formation process. Furthermore, spatio-temporal studies to establish links of wood properties and tree performance are needed. Using linear mixed-effects models, empirical cumulative distribution functions, and spatial analysis, we explore time trends and space connections of wood density of Pinus hartwegii Lindl. to remotely sensed variables (Moderate Resolution Imaging Spectroradiometer MODIS-derived) in two high-elevation forests in México, Tláloc (TLA) and Jocotitlán (JOC) Mountains. Results indicated that elevation and cambial age effects are important factors explaining wood density variation. Minimum earlywood—MID, average—AVE, and maximum latewood density—MXD were statistically similar between mountains (p > 0.05), but TLA showed a significant increase in MID over time with higher values after 1950. Wood density values and spatial correlations were site-dependent with TLA exhibiting the highest correlations between MXD and the Normalized Difference Vegetation Index (NDVI) of the spring season (r = 0.59, p < 0.05). Overall, correlations to remotely sensed information were positive with MXD, negative for MID and divergent for AVE. Historical temperature defines MID along the elevation gradient, while MXD was related to soil moisture only at low-elevation sites where soils are deeper. We found that two high-elevation forests, 115 km away from each other, with similar climate, soil, and vegetation, behaved differently regarding their wood formation process, indicating the potential of using the link between wood micro-density and remotely sensed information to understand forest response to climate change effects.