Fire Season Precipitation Variability and Green-Up (1989-2005) Across a Vegetation Gradient in the Gila Wilderness, New Mexico, USA

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Abstract

We compared annual patterns of spring green-up from 1989-2005 inferred from 1-km^2 AVHRR Normalized Difference Vegetation Index (NDVI) data with spring precipitation metrics that are correlated with patterns of fire extent and severity in the Gila Wilderness, NM. For each of the 17 years, we extracted three different NDVI values (17 April, 29 May, and 9 July) corresponding to spring and early summer green-up for five sites that varied by vegetation type and 20th-century fire frequency. Annual NDVI values were significantly correlated with snow water equivalent (SWE), maximum consecutive days without rain from 1 April to 15 July (MNR) and total April-June precipitation (PCP) (canonical correlation = 0.80 – 0.88). In the three sites dominated by ponderosa pine, spring NDVI was strongly correlated with SWE, PCP and MNR, with most of the strength of that relationship driven by MNR. In spruce-fir forests, only SWE and MNR were significant model variables, with SWE strongly correlated with 17 April NDVI, likely reflecting delayed green-up due to persistent snow pack at higher elevations. Annual area burned by burn severity class inferred from Landsat-derived Relative differenced Normalized Burn Ratio (RdNBR) was also significantly correlated with these same NDVI variables (canonical correlation = 0.57). Principal components analysis reduced seasonal NDVI to two significant principal components that explain 89% of variability in NDVI. Principal component scores were well correlated with both SWE and MNR, supporting the canonical analysis results. The first principal component, which describes spring and early summer productivity was negatively correlated with both February and May maximum average temperatures, suggesting that warm spring temperatures could influence vegetation productivity by increasing evapotranspiration and soil water loss rates that would could intensify fire activity preceding the arrival of summer monsoon rains. Overall, these results support the conclusion that precipitation patterns drive vegetation productivity and drying, thus influencing burn severity, and thus support the results of our previous study suggesting that fire season precipitation patterns are an important driver of fire extent and severity in mid-elevation ponderosa pine forests in this study area.

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