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Testing the potential to evaluate vegetation optical depth with ecosystem water dynamics in a temperate forest

Warming trends have been associated with drought which induces and heightens agents and factors that cause tree mortality. Remotely sensed observations are increasingly being used in vegetation studies and is obtained from Earth observation satellites.
Vegetation optical depth (VOD) is one such product and is obtained from the microwave domain, both passive and active. It measures the degree of attenuation of microwave waves within the canopy and relates to its above-ground biomass and relative water content. Despite the advancement in terrestrial and ecosystem modelling, models are unable to accurately represent or forecast mortality events. However, with more tree mortality being anticipated with climate change, model development is key to better understanding and forecasting.
Thus, the dynamic vegetation model, LPJ-GUESS has been updated with a plant hydraulics formulation to simulate leaf water potential, to improve simulations of drought-induced tree mortality. This research seeks to explain variations in the VOD of two deciduous broadleaf forests in North America, as a function of temperature, precipitation, vapor pressure deficit and LPJ-GUESS simulation of evapotranspiration and leaf water potential. Correlation results show that temperature has a strong influence on VOD and mostly combines with precipitation effects. Model simulation of evapotranspiration and leaf water potential failed to provide a better correlation to VOD than climatic variables. This research reinforces the importance of temperature and precipitation in monitoring tree mortality while highlighting the complexity of the processes that lead to tree mortality. Thus, the need for more information on factors such tree size, basal area, genotype, slope, terrain, amongst others and a deep understanding of how they interact with each other is key in dissecting VOD signals, understanding mortality and parameterizing ecosystem models for better model simulation of mortality scenarios.

Keywords: Physical geography; Ecosystem analysis; Vegetation optical depth; Temperate Forest; Climate; LPJ-GUESS; Evapotranspiration; Leaf water potential; Isohydricity; Hydraulic failure; Carbon starvation

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