Trail camera networks provide insights into satellite-derived phenology for ecological studies

Nanfeng Liu*, Matthew Garcia, Aditya Singh, John D.J. Clare, Jennifer L. Stenglein, Benjamin Zuckerberg, Eric L. Kruger, and Philip A. Townsend

*corresponding author: nliu58@wisc.edu

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ABSTRACT

Repeat digital photography at or near ground-level is a proven and efficient approach for tracking plant phenology. Here, we explored the potential to monitor phenology using the Snapshot Wisconsin (SW) trail camera network, a citizen science program. Using three curve-fitting methods for characterizing phenological transition dates, we assessed the phenological offset between understory vegetation and the overstory canopy in the trailcam observations and compared variations in derived phenology over the different spatial scales represented by trailcams (~20-50m), Harmonized Landsat and Sentinel-2 (HLS, 30m), and Moderate Resolution Imaging Spectroradiometer (MODIS, 500m). Our results showed that the apparent phenological offset between understory and overstory vegetation differed among forest types: in broadleaf deciduous forests, understory vegetation had an earlier start-of-spring (SOS) and later end-of-autumn (EOA) than the overstory canopy; in mixed forests, the understory showed an earlier SOS than the overstory, but no significant difference in EOA; in evergreen conifer forests, neither SOS nor EOA differed significantly between the understory and overstory. We found moderate correlations ($0.25 \leq r \leq 0.57$) between trailcam- and satellite-derived phenological dates. Moreover, those derived dates varied significantly among the applied curve-fitting methods: total growing season length (from SOS to EOA) could be 19 days longer for a threshold-based method than for a logistic curve-fitting method (our reference model), but 17 days shorter than the logistic method when using a piecewise-continuous method based on fitted sine curves. Despite the spatial limitations of trailcams for characterizing phenology on landscape and regional scales, trailcam networks have considerable potential for informing local phenological studies and disentangling the many drivers of phenology that can remain undetected from the satellite perspective.