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Combining in situ observations and high resolution VENμS data to monitor temperate deciduous shrub and tree phenology

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Direct in situ phenological observations of co-located trees and shrubs help characterize the phenological profile of ecosystems, such as, temperate deciduous forests. Accurate determination of the start and end of the growing season is necessary to define the active carbon uptake period for use in reliable carbon budget calculations. However, due to the resource intensive nature of recording in situ phenology the spatial coverage of sampling is often limited. In recent decades, the use of freely available satellite-derived phenology products to monitor 'green-up' at the landscape scale have become commonplace. Although these data sets are widely available they either have (i) high temporal resolution but low spatial resolution, such as, MODIS (daily return time; 250m) or (ii) low temporal resolution but high spatial resolution, such as, Landsat (16-day return time; 30m). However, the recently (2017) launched VENμS (Vegetation and Environment monitoring on a New Micro-Satellite) satellite combines both high temporal (two-day return time) and spatial (5-10m) resolution at a local scale thus providing an opportunity for small scale comparison of a range of phenometrics. The next challenge is to determine what in situ phenophase corresponds to the satellite-derived phenology. Our study site is a temperate deciduous woodlot on the campus of the University of Wisconsin-Milwaukee, USA, where we monitored in situ phenology on a range of (5) native (N) and (3) non-native invasive (NNI) shrub species, and (6) tree species for a 3-year period (2017-2019) to determine the timing and duration of key spring (bud-open, leaf-out, full-leaf unfolded) and autumn (leaf color, leaf fall) phenophases. The monitoring campaign coincided with the 2-day return time of VENμS to enable direct comparison with the satellite data. The shrubs leafed out before the trees and the NNIs, in particular, remained green well into the autumn season when the trees were leafless. The next step will be to determine what exact in situ phenophses correspond to NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index) derived start, peak and end of season from MODIS and VENμS data. In addition, we will determine if VENμS can detect differences in phenological profile between N and NNI shrubs at seasonal extremes. We anticipate that the high resolution VENμS data will increase the accuracy of phenological determination which could help improve carbon budget determination and inform forest management and conservation plans.