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# Monitoring species specific phenology with conventional RGB cameras

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The use of conventional RGB cameras as a tool to monitor landscape wide phenology has gained a lot of attention over the last few years. Mostly a measure of canopy greenness for a region of interest (ROI) is used to produce yearly time series, reflecting canopy phenology. A multitude of methods ranging from logistic curve fits to fixed threshold values are used to extract phenological indicator dates. However, the ROI within these studies are often predefined and do not necessarily account for canopy heterogeneity. Consequently, spatial variability within the field of view (FOV) of a camera and within a predefined ROI has a significant influence on the retrieved canopy phenology.

Five years of data collected at Bartlett Experimental Forest (New Hampshire, USA) was used to dynamically assign ROI to different species (American beech, Fagus grandifolia; sugar maple, Acer saccharum; yellow birch, Betula alleghaniensis; red maple, Acer rubrum; paper birch, Betula papyrifera and eastern white pine, Pinus strobus) using a k-means clustering approach across the FOV of the camera. Time series for the corresponding ROIs were extracted and phenological indicator dates (onset of greenness, greenness maximum, greenness decrease and greenness minimum) estimated using a non-linear least square logistic fit.

The results of the analysis suggest that: (1) conventional RGB cameras are able to capture species specific phenological dynamics; (2) a clustering approach provides a powerful way to dynamically assign a ROI in an ever varying canopy and it allows for discrimination between elements within the FOV that do not display any phenological dynamics as such providing a way to automatically extract vegetation from image time series; (3) A comparison of the estimated phenological indicator dates for the different ROI show that different species display different growth strategies. Although, with the exception of eastern white pine, the onset of greenness is similar, leaf unfolding and growth is not. Paper birch displays an opportunistic growth strategy with fast leaf unfolding and early greenness maximum values. Although greenness maximum is reached at later dates compared to paper birch, maple species display a fairly rapid growth compared to the slow development of beech. Consequently, sensitivity to early spring frost events is higher for both birch and maples; (5) the warm spring of 2010 showed clear differences in the species specific responses with a very early greenness increase values for all species, but in particular for white pine, and a very fast leaf unfolding for all deciduous species.