Warming does not delay the start of autumnal leaf coloration but slows its progress rate

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Aim Initiation of autumnal leaf senescence is crucial for plant overwintering and ecosystem dynamics. Previous studies have focused on the advanced stages of autumnal leaf senescence and reported that climatic warming delayed senescence, despite the fundamental differences among the stages of senescence. However, the timing of onset of leaf coloration (DLCO), the earliest visual sign of senescence, has rarely been studied. Here, we assessed the response of DLCO to temperature. Location 30–75ř N in the Northern Hemisphere. Time period 2000–2018. Major taxa studied Deciduous vegetation. Methods We retrieved DLCO from high-temporal-resolution satellite data, which were then validated by PhenoCam observations. We investigated the temporal changes in DLCO and the relationship between DLCO and temperature by using satellite and ground observations. Results DLCO was not significantly ($p > .05$) delayed between 2000 and 2018 in 94% of the area. DLCO was positively ($p < .05$) correlated with pre-DLCO mean daily minimum temperature (Tmin) in only 9% of the area, whereas the end of leaf coloration (DLCE) was positively correlated with pre-DLCE mean Tmin over a larger area (34%). Further analyses showed that warming slowed the progress of leaf coloration. Interestingly, DLCO was less responsive to pre-DLCO mean Tmin in areas where daylength was longer across the Northern Hemisphere, particularly for woody vegetation. Main conclusions The rate of progress of coloration is more sensitive to temperature than its start date, resulting in an extension of the duration of leaf senescence under warming. The dependence of DLCO response to temperature on daylength indicates stronger photoperiodic control on initiation of leaf senescence in areas with longer daylength (i.e., shorter nights), possibly because plants respond to the length of uninterrupted darkness rather than daylength. This study indicates that the onset of leaf coloration was not responsive to climate warming and provides observational evidence of photoperiod control of autumnal leaf senescence at biome and continental scales.
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