Monitoring and understanding the green-leaf phenology of tree species with Sentinel-2

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Abstract

Characterizing green-leaf phenology from satellite imagery is crucial for many ecological applications. This information can also help to better discriminate tree species in forests taking into account the variations of leaf flush and coloring among species. Substantial advances in the assessment of phenological traits from satellite data have been made recently. However, a large part of the previous works was based on products of moderate spatial resolution (such as MODIS) or with, possibly cloudy, images with a limited temporal resolution (such as Landsat). The new optical Sentinel-2 (S2) image time series providing data every 5 days with a high spatial resolution offer new opportunities to address phenological studies. Dense observations increase the probability to get cloud-free images which can help to better classify tree species and to derive more accurate phenological metrics.
In this study, we investigate the potentialities of dense S2 time series to (i) discriminate tree species in temperate forests and (ii) determine if the seasonal variations of spectral bands in the time series is related to phenological events observed in situ. To address this analysis, we conducted field observations of phenology every 10 days during the senescence and green-up periods (autumn 2017 and spring 2018 respectively). Field observations, based on a standard protocol, were carried out on a study site of 20 km x 25 km located in the southwest of Toulouse (France). Phenological events were collected in two distinct plots of 100 m^2 for 7 deciduous tree species (Oak, Red oak, Silver birch, Black locust, European ash, Aspen and Willow). Canopy closure and chlorophyll content were also measured, and in addition we noted the presence of understory vegetation which may influence the seasonal reflectance.
The first analysis of the spectro-temporal profiles show consistent patterns with the in situ observations (phenological stages, canopy closure and chlorophyll content). Additional works are in progress to compute phenological metrics from the S2 time series. In terms of classification, mapping tree species is a challenging task. Our last results show among broadleaf, red oak and willow are the two species the best identified. On the contrary, European Ash and Eucalyptus are the hardest to discriminate from the others species.

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