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Detecting tree species-specific forest vitality anomalies using Sentinel-2 time series

Abstract

The Forest Condition Monitor project of the Helmholtz-Centre for Environmental Research - UFZ aims at making information about national scale forest condition accessible to stakeholders, policy makers and scientists. One of its main components is an area-wide estimation of forest condition anomalies from satellite-based land-surface reflectance measurements. Reflectance patterns differ between healthy and damaged or dying vegetation and are widely used to depict vegetation vitality or anomalies. New satellite generations, such as Copernicus Sentinel-2, enable a spatially comprehensive detection of these mainly subtle reflectance deviations by their fine spatial and temporal resolution. Further, they enable the differentiation of the main tree species across Germany in high spatial resolution. Here, we used a tree species map with 20 m x 20 m spatial resolution to extract species-specific reflectance time series of tree stands all over Germany for 2016 to 2021. These time series represent the range of variation in reflectances - of nine spectral bands in the visible, near infrared and short-wave infrared part of the spectrum - of the main tree species in German forest. Subsequently, we calculated the dissimilarity between all reflectance observations of forest stands in Germany and the respective measurements within the reference time series to find spectral or temporal anomalies, also considering the natural temporal deviations caused by phenology. A seasonal aggregation of these dissimilarity values allows the generation of a spatially comprehensive forest condition map prototype with 20 m x 20 m spatial resolution, showing patterns potentially related to drought, fire and storm events as well as bark beetle outbreaks. Here, we present the prototype and its potential for monitoring and detecting vulnerable or damaged forest stands.