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Characterizing insect outbreaks signal in forest reflectance using SENTINEL-2 in Northwestern USA

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In the past decades, forests have been experiencing unprecedented climate conditions that impair tree health and increase their vulnerability to disturbances such as droughts or insect attacks. Insect outbreaks are thought to affect a much larger extent than wildfires, particularly in Northern Hemisphere forests and expected to increase under future warming, possibly increasing tree mortality and long-term ecosystem degradation.
Systematic data on insect outbreak occurrence is only available in a few countries though [1]. Therefore, the large-scale patterns of insect outbreak occurrence and their impacts on forests are mostly unknown. Forest inventories are expensive and time-consuming, and therefore unfeasible in many countries. Satellite imagery is a cost-effective means of monitoring disturbances at the global scale. An innovative application of remote sensing data to map large insect outbreaks can thus fill this knowledge gap.

Insect outbreak detection requires monitoring of visible and near infra-red surface reflectance at moderate to high-resolution (to detect small patches) and frequent overpass (to accurately detect the timing and duration of outbreaks). Until recently, available satellite imagery could only provide a trade-off between these three aspects: early LANDSAT records (since 1972) with high spatial resolution (30m) and spectral coverage, but few images per growing-season [2]; and MODIS (since 2001) with daily to 8-day resolution, but moderate spatial resolution (250m to 1km, [3]).

Here we want to evaluate the potential of new, more powerful SENTINEL-2 imagery to develop a more finely tuned detection algorithm to track the evolution of insect outbreaks over forested lands in the Northern Hemisphere. We present preliminary results for a test region in Northwestern USA, which is covered by aerial detection survey data ([4]). This region is highly prone to both bark beetle and defoliator attacks and annual insect-affected areas derived from aerial detection surveys are publicly available. Here we analyze the characteristic spatio-temporal patterns of surface reflectance measured from SENTINEL-2 and vegetation indices in insect-affected areas, with particular focus on the differences between defoliator- and beetle-affected areas.

[1] Kautz et al. Glob. Ecol. And Biog. 2017
[2] Towsend et al. Ecol. App., 2004
[3] De Beurs, K. & Townsend, P., Rem. Sens. Env., 2008.
[4] https://foresthealth.fs.usda.gov/portal