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Resolving canopy contribution to mixed satellite NDVI values in a sparse dry forest

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Remote sensing (RS) techniques have great potentials for land surface monitoring. Nevertheless, for most low to moderate resolution satellites, the problem of mixed pixels with information from the vegetation of interest and the background surfaces can cause significant biases in the signals and their interpretations. This is especially so in low-density forests and semi-arid ecosystems.

This work was motivated by the observed mismatch between satellite data (Landsat 8; nadir view) and tower-based Skye (90° angle of view) radiometer, in a low-density semi-arid pine forest (the Yatir forest in southern Israel) during 2013-2019. The two records showed opposite seasonal cycles in canopy NIR reflectance. We hypothesized that the different contributions of the surface components in the footprint areas of the two sensors could explain these observations and that accounting for this effect can help resolve the actual canopy NDVI values.

An image classification algorithm was derived from Unmanned Aerial Vehicle (UAV) multispectral images to estimate the fraction and reflectance of the three main surface components: canopy, shaded areas, and bare soil. The results showed 30% and 95% canopy fractions in the Landsat 8 and Skye footprints, respectively. Therefore, the Landsat 8 signal was strongly influenced by soil reflectance, which is, in turn, sensitive to soil moisture level. The Skye mainly reflected canopy properties, including pigment content and canopy structure.

Based on these results, we developed an approach to correct the sunlit and shaded soil contributions to the mixed Landsat 8-pixel NDVI, and retrieve the canopy NDVI. This approach relied on canopy fraction, sun elevation angle and the pre-determined NDVI values of the non-canopy components derived at the tower area. The retrieved canopy NDVI values were consistent with those of the high-resolution UAV-based canopy NDVI and independent of variations in the observed satellite NDVI values. These results demonstrated a new approach for improving the use of satellite NDVI to monitor the activities of forest canopies in sparse ecosystems, as well as the need for its application.