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Prediction of leaf functional traits of lianas and trees of the Neotropical Dry Forest using mid- and long-wave infrared reflectance

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As of today, many studies have been conducted using spectral properties of plants in the visible to short-wave infrared spectrum with the aim to predict leaf functional traits; however, few of these have been performed using the mid- and long-wave infrared (MLWIR) region. Most of these studies attempt to create models to predict leaf traits from a wide range of species without considering differences between groups of plants. This miss representation of the identity of groups could be crucial for life forms that coexist together and present contrasting anatomical, physiological, and biochemical traits such as lianas and trees. Here, we explore how the mid and long-wave infrared reflectance can be used to predict the specific leaf area (SLA), water content (WC), and equivalent water thickness (EWT) of lianas and tree leaves from the Neotropical Dry Forest. Likewise, we evaluate how the prediction of these models can be affected when those do not consider different life forms (lianas and trees). For this, sun canopy leaves for 14 species of lianas and 21 species of trees (n = 700) were collected in Santa Rosa National Park in the wet season of 2017. On each leaf sample, we measured the MLWIR reflectance (2.5- 14 μm) with a portable calibrated Fourier Transform Infrared Spectrometer (Agilent ExoScan 4100) and the three leaf functional traits using segments of these leaves. We applied continuum wavelet transformation on the reflectance measurements to highlight absorption features for future analysis. For each leaf trait, Partial Least Square Regressions (PLSR) models were performed on separated training-datasets for lianas and trees and were evaluated on separated testing-datasets of these same life forms. Then, the PLSR models developed for lianas and trees were also evaluated on testing-datasets for different life forms to know how the identity of life forms may affect the predictions. The latter was assessed comparing the errors of predictions (Errors = predicted-observed/predicted) for each algorithm, life forms, and the leaf traits. The overall results suggest that our models developed can predict with success the leaf traits showing R2 values on testing-datasets of lianas and trees close to 0.81 and 0.80 for SLA, 0.76 and 0.81 for WC, and 0.58 and 0.51 for EWT, respectively. These models developed and applied on datasets of the same life forms tend to have errors values homogenously distributed close to 0 $\pm$ 0.04 for SLA, 0.01 $\pm$ 0.04 for WC, and 0.01 $\pm$ 0.11 regardless the life form. However, the models developed and applied to datasets for different life forms tend to have errors values close 0.01 $\pm$ 0.08 for SLA, 0.02 $\pm$ 0.08 for WC, and 0.05 $\pm$ 0.18 for EWT. These results highlight the potential of MLWIR reflectance to predict leaf functional traits, but also suggest that models that do not contemplate the identity of groups of species may introduce bias to predictions of leaf traits. Therefore, the identity of groups of plants should be considered for future studies that attempt to up-scale leaf traits information to large-scales.