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Seasonal variation in plant traits of Douglas fir

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Monitoring biodiversity is of essential importance to characterize environmental sensitivity to droughts, climate change, and human activities. In that view, these investigations are increasingly using functional (bio)diversity to understand patterns, such as species competitive abilities and the influence on ecosystem functioning. Key in this functional diversity is the accurate estimation of plant functional traits and their seasonal trends.
Traditionally, plant traits were obtained using field measurements and lab work at plant to molecule level. Such methods have significant drawbacks as they are 1) highly time consuming, 2) limited to relatively small areas and 3) available only at a few points in time. In contrast, remote sensing is capable of consistently mapping plant traits over large spatial and temporal scales, using radiative transfer model inversion. However, the retrieval of tree and needle leaf trait for a whole growing season is rarely investigated; inverse modelling of radiative transfer models has been performed mostly spatially and focussed on broadleaf vegetation.
The goal of this research therefore is to map seasonal changes in plant traits of a conifer species using inverse modelling and traditional measurements. For this, the needle-leaf model LIBERTY was combined with the canopy model 4SAIL to retrieve plant and leaf traits from the canopy reflectance acquired using a RS-3500 spectroradiometer. The campaign focussed on Douglas fir (Pseudotsuga menziesii) in the Speulderbos, from April to September. In total 12 traits (plant height, leaf area index, leaf lignin, carbon, nitrogen, carotenoids, chlorophyll a/b, leaf dry matter (LDMC) and leaf water content (LWC), leaf mass per area (LMA), specific leaf area (SLA) and leaf thickness) were obtained using traditional measurements and retrieved using remote sensing. The analysis focussed on an inter-comparison of measured plant traits and a cross-comparison against the RTM retrieved traits. Additionally, the canopy reflectance spectra were inter-compared against each other over time.
Preliminary results show significant temporal dynamics of measured traits during the growth season. Most interestingly, we found that carotenoids content had a significant inverse peak in August. The retrieved and measured nitrogen and lignin showed a similar trend. However, LWC did not show similar results (RMSE=0.009 g/cm2, R2=0.23). In respect with the reflectances observed during this period, it was found that largest spectral variations were from 750 to 1350 nm (with a mean absolute deviation of 8.7). The results indicated that most traits followed a seasonal change as expected. Preliminary results of RS retrieved traits did not always correspond to the measured plant traits over a growing season, but did show the potential of the novel combination of LIBERTY and SAIL.