Geophysical Research Abstracts
Vol. 21, EGU2019-6557-1, 2019
EGU General Assembly 2019

Relationship between reflectance, morphological, and biochemical properties of beech leaves (Fagus sylvatica)

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Functional traits retrieved from remotely sensed data allow monitoring diversity at a variety of spatial and temporal scales. Most retrievals depend on specific light absorption mainly driven by pigment composition, leaf structure and water content across the solar reflective spectrum. Understanding of the seasonal dynamics of leaf biochemical properties is thus of utmost importance to validate measurements and identify associated uncertainties. In this study, we evaluate the potential of recent analytical advances in liquid chromatography technics to describe variations in pigment composition over the growing season.

We sampled sun exposed and shaded leaves of a mature beech tree (Fagus sylvatica) located on the University of Zürich campus on a weekly basis at different tree heights from 3 to 10 meters between May and November 2018. To investigate pigment content and composition, we selected three approaches based on spectral indices derived from: (i) leaf optical properties measured in–situ using a SPAD Chlorophyll Meter and a contact probe coupled with a spectroradiometer; (ii) optical properties of bulk extract, and (iii) individual pigments measured with both standard and newly developed high pressure liquid chromatography (HPLC) methods. Complementary traits including leaf per mass area, moisture, carbon and nitrogen content and isotopic composition were also measured with standard laboratory methods at leaf level.

Based on SPAD values, we first estimated variations in leaf chlorophyll and nitrogen contents within an individual tree. Both appear to depend on sun exposure, with respectively higher chlorophyll content and lower nitrogen content with increasing irradiance. However, no effect of sampling height was observed. Nevertheless, higher carbon isotopic ratios on the top of the tree in comparison to the bottom suggest photosynthetic effects on isotopic discrimination and thus metabolic processes depending on tree height. A more exhaustive description of pigment content and composition obtained with our HPLC method will allow us to better understand those processes. Preliminary results highlight that analytical methods and calibration strategy impact our plant traits retrieval. We will test if our method can improve the calibration and the sensitivity of spectral-band based devices, being used as a tool for assessing functional traits in forest ecosystems.