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On the relationship of primary productivity and remotely sensed canopy biophysical variables

Roshanak Darvishzadeh[1], Elnaz Nienavaz[1], Margarita Huesca[1], Andrew Skidmore[1], Willem Nieuwenhuis[1], Nestor Fernandez[2], and David Wårlind[3]

[1]University of Twente, Faculty of ITC, NRS, Enschede, Netherlands (w.nieuwenhuis@utwente.nl)
[2]German Centre for Integrative Biodiversity Research (iDiv), Leipzig, Germany (nestor.fernandez@idiv.de)
[3]Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden (david.warlind@nateko.lu.se)

Canopy biophysical properties play an important role in understanding forest health and productivity. Among these parameters, forest leaf area index (LAI), canopy cover fraction, and canopy chlorophyll content describe the vegetation abundance, photosynthetic capacity and primary productivity of forest stands. The new generation of remote sensing satellites such as Sentinel-2 with high spatial and temporal resolutions has provided vast opportunities for monitoring these parameters and assessing their interrelationships over vast forest landscapes. In this research, temporal Sentinel-2 data between 2017-2019 in the temperate mixed forest ecosystem of the Bavarian Forest National Park, Germany, was used to retrieve forest canopy biophysical variables. INFORM radiative transfer model was used to retrieve LAI and canopy chlorophyll content while the fraction of vegetation functional types were calculated using phenological parameters and empirical approaches. A recent landcover map of the Bavarian Forest National Park was applied to retrieve considered variables pursuant to the different land cover classes. The retrieved variables were validated using in situ measurements of LAI and canopy chlorophyll content. Primary productivity was then calculated using (i) vegetation index universal pattern decomposition approach and (ii) the process-based dynamic vegetation-terrestrial ecosystem model LPJ-GUESS model. The relationships between calculated productivities and estimated biophysical variables were then studied. Our results showed that there is a good agreement between primary productivities calculated from LPG GUESS and the decomposition approach. Among studied parameters, canopy chlorophyll content, which represents pigments and vegetation abundance within the canopy, showed a strong direct relationship with both calculated primary productivities and hence may be used to explain plant functioning. Our results also revealed that remotely sensed vegetation biophysical parameters- that are becoming more and more readily available due to the availability of Earth observation data- can be used as proxies for estimation of the primary productivity calculated using either approach. Calculation of primary productivity usually needs information about canopy life-cycle and geometry, which are often not available at large scales. The results of our study support our findings in the myVARIABLE pilot of the EuroGEOSS Showcases initiative (e-shape) on developing primary productivity as a remotely sensed- essential biodiversity variable describing 'Ecosystem function.'