3D forest model-assisted validation of the Sentinel-2 SNAP fAPAR product

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fAPAR is a radiometric quantity describing the fraction of photosynthetically active radiation (PAR) absorbed by a plant canopy. It is an important component of carbon cycle and energy balance models and has been named as one of the 50 Global Climate Observing System (GCOS) essential climate variables (ECVs). Space agencies such as the ESA and NASA produce satellite fAPAR products in order to address the need for spatially explicit global data to address environmental and climate change issues. Given the derived nature of satellite fAPAR products it is essential to independently verify the results they produce. In order to do this, validation sites (or networks of sites) are needed that directly correspond to the measurands. Further to this, in order to understand divergences between product and validation data, uncertainty information should be provided with all measurement results.

The canopy radiative transfer models which are used in satellite-derived fAPAR products implement simplistic assumptions about the state of the plant canopy and illumination conditions in order to retrieve an fAPAR estimate in a computationally feasible time. This contribution assesses the impact of the assumptions made by the Sentinel-2 SNAP-derived fAPAR and includes it in a validation of the product over a field site (Wytham Woods, UK), which also has concurrent fAPAR measurements. This is achieved using a 3D model of Wytham Woods which is used to simulate biases associated with specific assumption types. These are used to convert the in situ measurements to the same quantity assumed by the satellite product. The measurement network which provides the fAPAR data is also traceable to SI through sensor calibrations and has associated uncertainty estimates. To our knowledge, these latter points have not been implemented in the biophysical product validation literature, which may explain some of the large discrepancies seen between validation and satellite-derived fAPAR data.

The ultimate aim of this work is to demonstrate a validation framework for derived biophysical variables such as fAPAR which properly considers the quantity estimated by the satellite and that measured by the in situ sensors, whilst providing metrologically derived uncertainties on the in situ data. This will help to properly inform users as to the quality of the data and determine whether the GCOS requirements set for fAPAR are attainable, ultimately improving carbon cycle
and energy balance estimates.

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