



## **Comparison and quality assessment of five different methods for the estimation of PAR from satellite imagery – Application to the monitoring of raspberry harvest to maximize farmers' profit in Southern UK**

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This communication deals with the assessment of the Photosynthetically Active Radiation (PAR) from satellite images. Five different methods are applied onto Meteosat images over Europe and their results are compared to PAR measurements performed at terrestrial stations. This co-designed precursor of an operational application focuses on the delivery of time series and maps of PAR for the monitoring of raspberry cultures in plastic tunnels in the Southern United-Kingdom.

An accurate knowledge of PAR radiation is necessary as it represents the portion of the solar spectrum responsible for the growth of plants, algae, and of certain microorganisms. The scarcity of in-situ PAR measurements motivated scientists to find alternatives to derive PAR from measurements of the broadband solar radiation. As the broadband solar radiation can be accurately estimated at any place from satellite images, several empirical methods applying coefficients on broadband estimates have been proposed and validated. The advantage of such approaches is to meet the constraint of a real-time operational service. A few publications have also demonstrated the limitation of these approaches due to their dependence on the sky conditions and the atmospheric properties. To overcome this limitation, other approaches better describe the spectral content of the atmosphere in cloud-free conditions by using sophisticated Radiative Transfer Models (RTM), aiming at providing higher quality estimates of the spectral radiation. As RTMs are computationally expensive, a recent method has been built to reduce the amount of calculations by working on a reduced number of spectral bands. This method proposes a resampling technique of the outputs of the Copernicus Atmosphere Monitoring Service McClear service. The latter provides radiation components in cloud-free conditions in the thirty-two spectral bands described by Kato et al. (1999) using updates of ozone, aerosol and water vapour contents as inputs. A version of this service in all-sky conditions is obtained by extracting a cloud index from the satellite-derived database HelioClim-3 version 5 with the underlying assumption that the extinction of clouds is independent on the spectral range.

The validation results of three empirical methods together with two implementations of the proposed approach are presented, both in photosynthetic photon flux density (expressed in  $\mu\text{mol.m}^{-2}.\text{s}^{-1}$ ) and in irradiance (in  $\text{W.m}^{-2}$ ). The specifications, versions and performances, of the service are driven by a collaboration with an end-user requesting long-term archive and real-time PAR estimations for the monitoring of more than sixty farms producing raspberries in plastic tunnels. The use of plastic tunnels enable farmers to control and consequently postpone the raspberry harvest to maximize their profit.

This work belongs to a wider project which aims at providing irradiances in any spectral range to meet the numerous requirements from users in various applications for instance in solar energy, human health, agro-meteorology, e-cosmetic.