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PAR@METER: a wireless system for fAPAR and LAI continuous monitoring

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Integration of in situ ('SensorWeb') and remotely sensed data
Validation of remote sensing products

Ground measurements of photosynthetically active radiation (PAR) balance and leaf area index (LAI) are required for validating, and sometimes calibrating biophysical products derived from satellite observations. Non destructive methods are either based on instantaneous observations of the directional gap fraction from which the fraction of PAR absorbed by the canopy (fAPAR) is approximated by the PAR interception efficiency (fIPAR). LAI can also be derived from gap fraction measurements, leading to estimates of the effective LAI, or to an approximation of the actual LAI under a number of assumptions on leaf clumping and presence of woody elements. Current devices dedicated to gap fraction (and LAI) measurements are generally 'instantaneous': hemispherical photos or light transmittance (LAI2000, TRAC, ACUPAR…) systems operate within one 'shot'. Such systems allow easy replications over several places to account for spatial variability and get better representation of the average value of areas corresponding to a single or few high spatial resolution (5-50m) satellite pixels, However, they are very tedious to operate when describing the seasonality of fAPAR and LAI, which is mandatory for a number of studies. Alternatively, classical PAR balance could be installed at the site level by distributing individual PAR sensors on the ground, which are connected to a data logger. However, this system is relatively tedious to install because of the wires, has limited autonomy (both memory and energy wise) and is relatively costly, limiting thus a large spatial coverage.

The PAR@METER system was developed with the objective to get continuous PAR transmittance measurements with autonomous light sensors communicating with the data logger via a wireless-USB connection. The autonomy of the system is about 6 months, both energy and memory wise. The range of the system is in between 50 to 300 m depending on vegetation density and up to 1000m without obstacles. Individual sensors and data logger are cheap enough to allow larger spatial coverage. The system measures instantaneous PAR transmission every 5 minutes. PAR diffuse fraction is computed from incident PAR measurements. Effective LAI is derived from PAR transmission under several irradiance conditions.
This paper describes the system and its use with more details. Emphasis is put on calibration issues, derivation of the diffuse fraction, uncertainties in fAPAR measurements and LAI estimates. Few experiments are finally presented to illustrate the interest of the PAR@METER system and its connection to remote sensing observations.