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Light Models Intercomparison in AgriVoltaics Context

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Reduction of greenhouse gas emissions is one of the major issues facing our society when the population of the world is set to rise to 9.1 billion by 2050, 34 percent more than today.

In this context, research is being conducted to develop new efficient, resilient and sustainable agricultural production systems based on agroecology but also integrating agrivoltaism concept. If these Agrivoltaics systems (agri-PV) can be efficient for some productions in favorable soil and climatic contexts, solutions still need to be developed to guarantee synergy between energy production and agronomic yield for many markets gardening, cereal or arboriculture crops as well as for livestock.

Light is one of the major variables that needs to be characterised in order to analyse the conditions of synergy, as it is the main environmental factor involved in Photovoltaic (PV) system functioning and in the biophysical processes of crops, such as photosynthesis, evapotranspiration and photomorphogenesis, which are involved in plant growth and development. Because of climate variations from one year to the next [1], experiments should be conducted over several years in order to draw some conclusions. To address such problem, we propose to share the different datasets acquired during the various agri-PV experiments to allow robust statistical analysis. Moreover, analysis of light availability is not only based on measurements but also on the use of light models. These models are based on the same approach in both cases for the PV systems and the crops. Therefore, it exists different models (for instance based on raytracing or radiosity methods) that rely on similar assumptions regarding input data such as the characterisation of the concerned PV system and the physical modelling of incident irradiance (e.g., diffuse and direct radiation computation).

As part of a collaborative approach of data sharing to analyse the conditions for synergy between the two productions, it becomes determinant to evaluate the precision of the different models. This kind of intercomparison was done in the research topics of remote sensing with the RAMI project [2] or in plant ecophysiology [3]. In these examples, no measurements were used because one model was considered as a reference model.

In the present study, the objective is to quantify the precision of light models by simulating light below different configurations of agri-PV systems and compare them with actual measurements. The comparison will highlight the differences in physical modelling assumptions between the models and will include an estimate of biases and errors, as well as efficiency in terms of computational time.

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