Note about the PHOTON simulation Software survey - 2011

André Mermoud - Institut of the Sciences of the Environment, University of Geneva
June 2011

The PHOTON laboratory has analysed and tested about 20 software available on the market for the study of PV systems yield. This analysis was published in several editions of PHOTON Magazine (German and Spanish of April 2011, Italian and French of May 2011).

For the comparison of the yield prediction of each program, PHOTON has chosen 3 monitored installations, which we will call Aachen-1, Aachen-2, and Wuppertal. Each installation is equipped with a measurement set of irradiance data in the horizontal plane and ambient temperature, as well as an horizon shading record using a Suneye equipment. The kind of irradiance sensor (pyranometer or reference cell) is not specified.

When trying to assess the accuracy of simulation software, it is essential to use very well assessed measurement, recorded with carefully calibrated instruments. Now with the concerned data, covering the year 2010 for the 3 installations, we observe a discrepancy of 5% between the measurements of Aachen-1 and Aachen-2, situated 10 km apart in similar suburb environments. This indicates that we can have some doubts about the calibration.

We have therefore performed a thorough analysis of the meteo data recorded in these 3 installations (Ineichen 2011-1). This work, based on advanced techniques about irradiance modelling and Satellite data, makes use of the clear conditions data for the evaluation of the absolute irradiance measurements (related to the sensor's calibration). This analysis is confronted to a well-known reference ground-measured station in Cabauw (NL, 180 km).

A comparison with SolarGIS data, the best satellite model (Ineichen 2011-2) for the year 2010 indicates that the measurements of PHOTON underestimate the SolarGIS values by a factor of 5 to 10%, as well for clear day conditions as for the complete hourly data.

	SolarGIS mbd			**Aachen-1** mbd	
	all hourly values [1]	hourly [2]	daily max. [3]	hourly	daily max.
		clear conditions: $K_t' > 0.65$			
Aachen-1	4.4%	5.2%	3.4%	n/a	n/a
Aachen-2	9.6%	10.9%	10.1%	5.1%	4.8%
Wuppertal	5.0%	4.6%	2.6%	-0.8%	0.4%
Cabauw	-2.5%	-0.2%	-1.3%	-2.0%	-1.5%

[1] no selection on hourly values
[2] clear conditions: hourly values with $K_t' > 0.65$
[3] highest hourly value for each day if $K_t' > 0.65$

Table 1. - Comparisons of PHOTON measured values by respect to SolarGIS satellite data, and coherence of the PHOTON data (given by respect to Aachen-1) for clear sky conditions
Top-left value should be read as "SolarGIS data evaluated at Aachen-1 is 4.4% higher than measurements".

These discrepancies will of course affect the results provided by all simulating tools, and therefore their differences by respect to the measured output of the systems as reported by PHOTON.

According to our experience, we can assume that the system output calculation (yearly result) behaves fairly linearly with the yearly irradiation level. Therefore we can apply this correction evaluated for the irradiance to the PHOTON analysis of the PV yields for the 3 installations. This shows that the ranking is deeply modified.

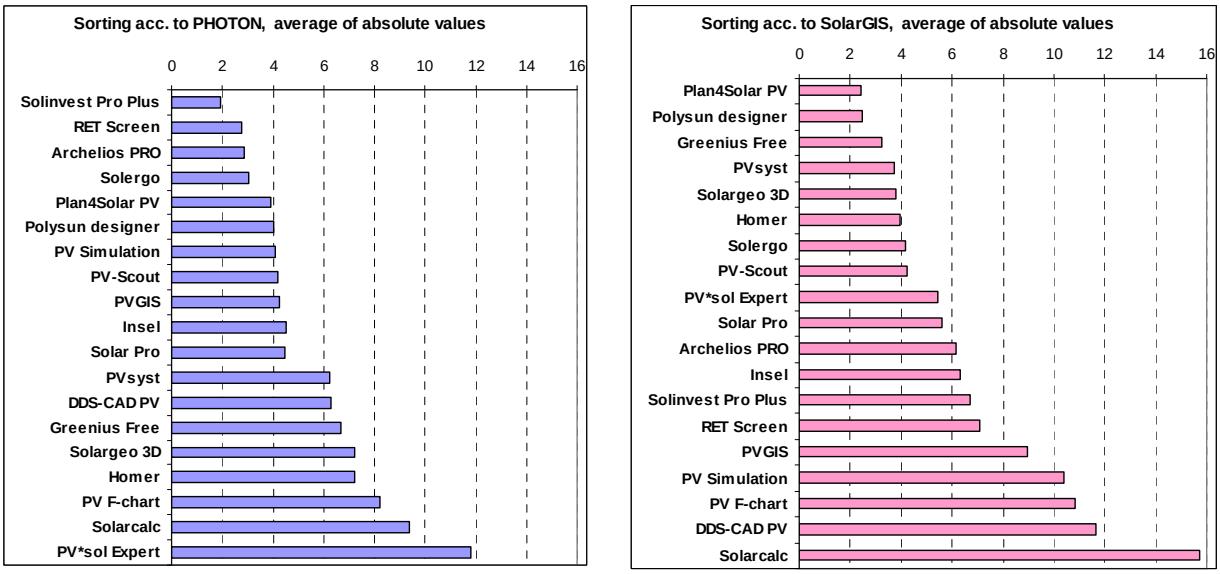

Fig 1 - Sorting according to average of absolute differences
a. - from Photon original data **b.** - with corrected meteo according to SolarGIS

Furthermore the indicator chosen by PHOTON, i.e. the average of the **absolute** differences between measurements and simulations for different runs, seems to be not very well suited to the evaluation of the performance of simulating software.

We would prefer a presentation of the average of the signed differences (MBD, Mean Bias Difference) as shown on fig. 2. This seems more pertinent as it indicates if the simulation is under-evaluating or over-evaluating the measurements.

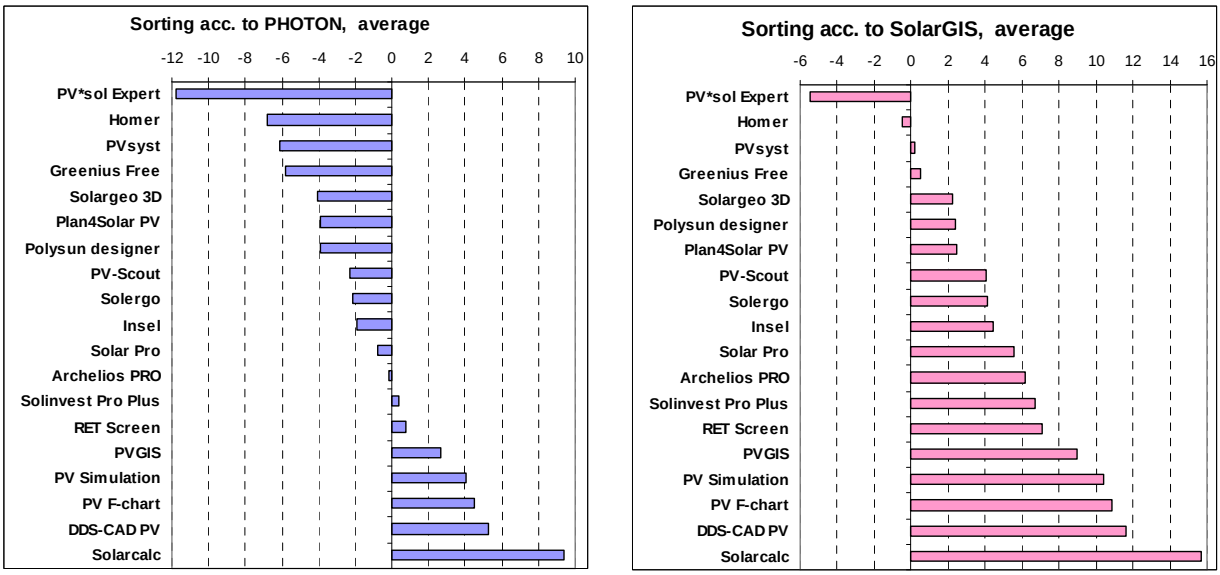

Fig 2 - Sorting according to average differences (MBD)
a. - from Photon original data **b.** - with corrected meteo according to SolarGIS

This indicates that the rather simple software - which don't take all losses into account - have the tendency of over-estimating the measured performances of the real systems.

This is often masked by the fact that most of theses software are referring their predictions to historical data before years 2000, when the real Insolation values have often significantly increased during these last years.

References:

1 - Note on the sensor's calibration at three sites in Northern Germany used for PHOTON magazin's comparison of photovoltaic simulation softwares.
Pierre Ineichen, ISE, University of Geneva, May 2011 (available on www.pvsyst.com).

2 - *Five satellite products deriving beam and global irradiance validation on data from 23 ground stations*
Pierre Ineichen, ISE, University of Geneva, February 2011 (available on www.pvsyst.com).