Software correction of angular misalignments of tilted reference solar cells using clear-sky satellite open data

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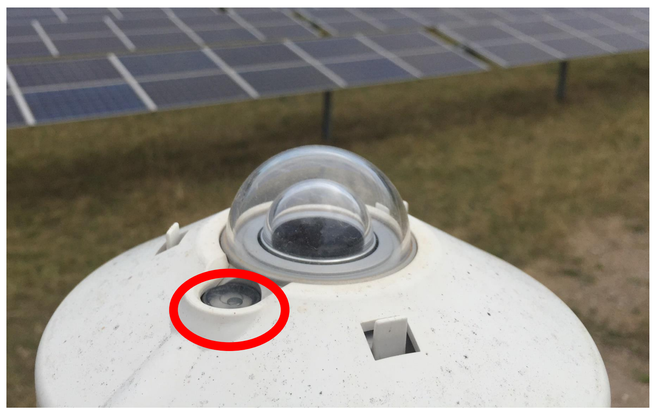
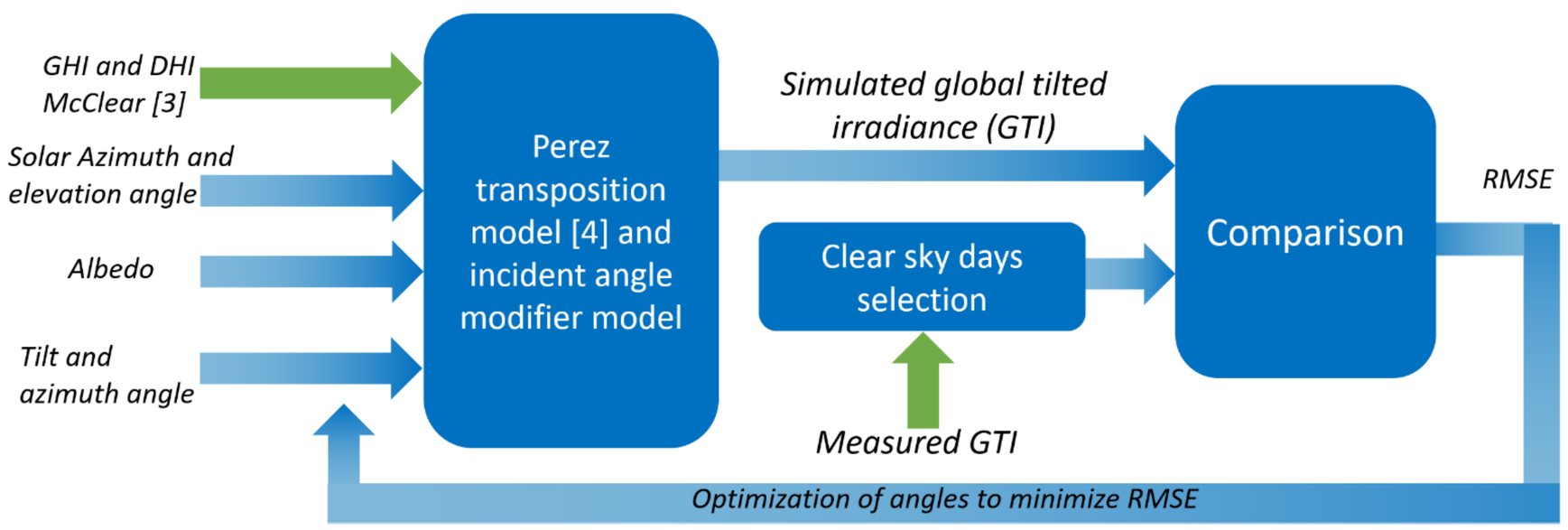
Context and objectives

- *In-situ* measurements for photovoltaic systems are very sensitive to angular misalignments :
  - ✓ They increase errors in solar resource estimation or nowcasting [1]
  - ✓ They reduce the accuracy of cloud tracking algorithms (*e.g.* in [2])
- Angular misalignment can occur e.g. during the installation or the operation, notably due to temperature gradients, wind efforts, birds, etc.
- We propose a method for estimating the angular misalignment of tilted reference solar cells or pyranometer using output of the clear-sky irradiance model McClear, a free Copernicus Atmospheric Monitoring Service.



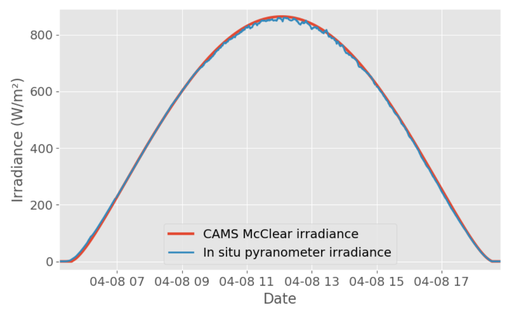
Example of misaligned horizontal pyranometer for PV plant monitoring

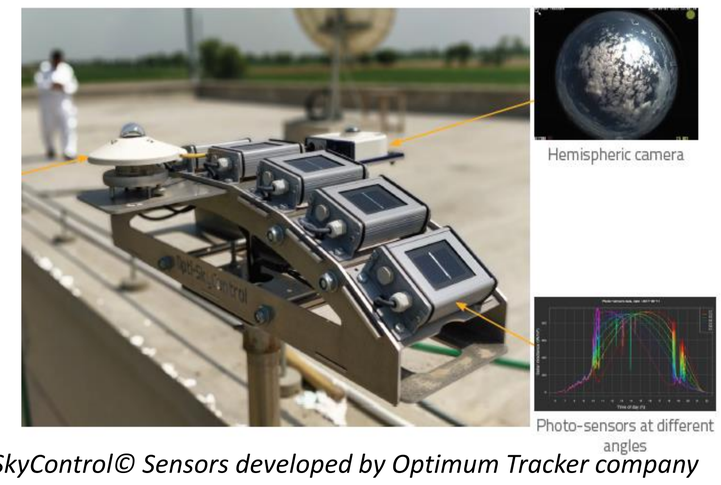
Description of the method



Case study

- Seven reference cells at different angles from the sensors of the Opti-SkyControl
  (-35°, -20°, -10°, 0°, 10°, 20°, 35° tilted in N/S axis)
- GTI measured at 1 min time step in a site located in the South West of France, over the year 2017
- Optimal angle correction found in the 6 first months (9 clear sky days)
- RMSE test in the 6 following months
  (8 clear sky days)

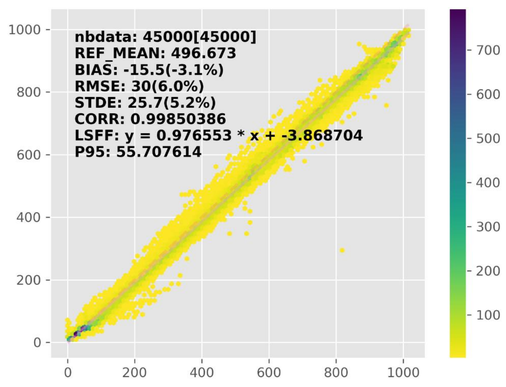




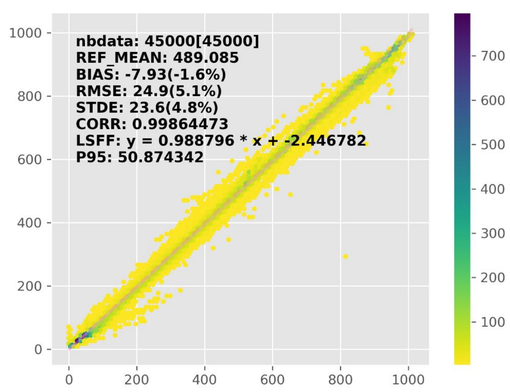
Opti-SkyControl© Sensors developed by Optimum Tracker company

Results

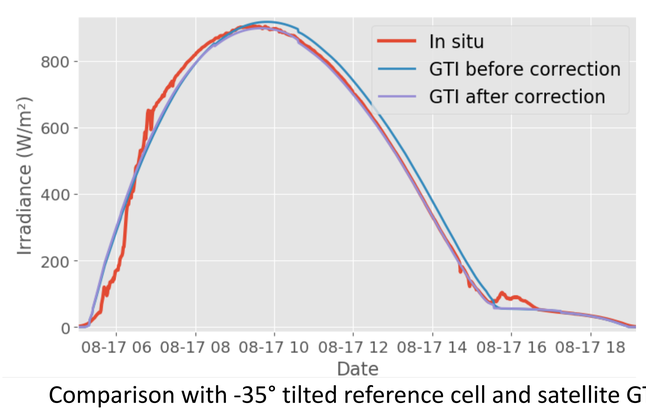
- Bias (-7,6 W/m²) and RMSE (-5,1 W/m²) improved, all sensor included, in the 6 following months after angle correction



All sensors vs satellite GTI before correction



All sensors vs satellite GTI after correction



Comparison with -35° tilted reference cell and satellite GTI

Conclusions and perspectives

- We propose a robust and efficient algorithm to correct *a posteriori* angle misalignment of pyranometric sensors
- Angular correction improves satellite-based estimation of GTI for the 6 following months for clear sky days
- Next possible step: dynamic correction to detect misalignment variations

Références

[1] Killinger, S., Braam, F., Müller, B., Wille-Haussmann, B., & McKenna, R. (2016). Projection of power generation between differently-oriented PV systems. Solar Energy, 136, 153-165.

[2] Arliaud,J., Crucifix, A., Blanc, P. (2015). Procédé de pilotage de l'orientation d'un suiveur solaire basé sur des modèles cartographiques. Patent n° WO2017001791A1

[3] http://www.soda-pro.com/fr/web-services/radiation/cams-mcclear/info

[4] Perez, R., Seals, R., Michalsky, J., 1993. All-weather model for sky luminance distribution—preliminary configuration and validation. Sol. Energy 50 (3), 235–245.

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