Surface Solar Irradiance retrieval from third-generation geostationary meteorological satellites using Machine Learning

02. Meteosat Third Generation: from products evaluation to operational value

Tuesday, October 1st 2024 12:15 - 12:30 Room 5 + 6

Mathieu Turpin[1] , Simon Duval[1] , Benjamin Adrien[1] , Sébastien Marchal[1] , Nicolas Schmutz[1]

[1] Reuniwatt

Surface Solar Irradiance (SSI) estimation by satellite in real-time is essential for monitoring photovoltaic (PV) power plants. It allows to detect a drop in PV performance ratio due to sudden system failure or soiling effects without relying on ground-based instruments. In this work, we develop a Machine Learning model, using the third-generation geostationary meteorological satellite GOES-16 satellite (operating for GOES-EAST) as a proxy to MTG-I1 FCI L1, to estimate SSI. This model is based on a Multi-Layer Perceptron (MLP) and utilize key input parameters such as Cloud Top Altitude and Cloud Optical Thickness, derived from the NWC/GEO (NWCSAF) software which will also support MTG from the beginning of its operational phase. A dataset of quality-checked 1-minute solar radiation measurements from several station networks across the USA over the period 2021-01-01 and 2023-12-31 is used. To assess the model's spatial and temporal generalization, the dataset is split into 80% of train stations (27 stations) and 20% test stations (7 stations), with 10 iterations over random train/test split. The model is trained using data from 2021 and 2023, with validation on 2022. The results are averaged over one hour and expressed in terms of Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Bias Error (MBE), normalized by the average of measurements. Our analysis shows that this approach improves the accuracy of SSI estimates compared to the performance of the NSRDB model, a physical model based on radiative transfer developed by NREL, with an average nRMSE of 9.0% and 11.4% respectively, and an average nMBE of -1.0% and 2.2% respectively. This work is co-financed by the European Union and Région Réunion. Europe is committed to Réunion through the ERDF Fund.