Worldwide benchmark of 10 databases of modelled global and direct solar irradiance at 129 radiometric stations.

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Objective & Background

High-quality solar irradiance data are always required when planning new solar power plant installations and for monitoring their operation later on. Nowadays, various sources of such resource data do exist, either public-domain or commercial. Consequently, investors, power producers, and grid operators, might have difficulty selecting the most appropriate one, according to their application or specific location.

Within the framework of the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) Task 16, a group of experts has organized a benchmark exercise to give a wide overview of the performance of different modelled irradiance datasets, analysing them at 129 sites spread across all continents. This study considers both Global Horizontal Irradiance (GHI) and Direct Normal Irradiance (DNI).

Method

The study involves several different steps. First, many high-quality datasets of observed irradiance have been collected from various sources, such as research institutions or international networks, in an attempt to cover most regions of the globe. This effort resulted in a large observational database, consisting of measurements from 161 sites. In a second step, extensive work was carried out by the Task experts to ensure the quality of the reference dataset. Several automatic and manual/visual quality-control tests were applied (Forstinger et al, 2021). This resulted in a high-quality database of 1-minute irradiance data from 129 stations during 2015–2020.

In parallel, ten modelled irradiance databases have been obtained from various providers. Eight databases are derived using cloud information from geostationary satellites, one using data mostly from polar orbiters, and one from a numerical weather prediction model. Not all these datasets cover the entire globe, or are common to all reference stations.

By comparison between the modelled and measured irradiance data at hourly resolution, a comprehensive set of performance metrics and statistical distribution indicators are evaluated for different years at each station. The analysis also differentiates results at continental scale and using the main Köppen-Geiger climatic zones. Maps and color-coded tables are prepared for each station or region to summarize the results and provide guidance to stakeholders.

Principal Findings

This benchmarking work, still ongoing within the framework of IEA PVPS Task 16, highlights that the tested datasets of modelled irradiance differ significantly in terms of performance, depending on continent, climatic zone, or station. The dataset derived using cloud data from polar orbiters is found to underperform, mainly because of its coarse spatial resolution. In general, the performance decreases at cloudy, high-latitude, mountainous, or coastal sites, and there is a clear tendency of DNI predictions being generally worse than those of GHI.

Conclusion

The results of this benchmark can be used to properly select the most suitable dataset for the specific application and site. The work carried out, together with plots and tables of the results, is now in its final stage of publication as a Task report.

1. Reference: Forstinger et al., 2021. ”Expert quality control of solar radiation ground data sets”, SWC2021 Proceedings, DOI: 10.18086/swc.2021.38.02.