West African solar forecast errors and their link with meteorological conditions: case study of Zagtouli solar farm (Burkina-Faso)

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There is a double stake to develop renewable energy in West Africa to enhance access to electricity without compromising the states to fulfil their commitments in their Nationally Determined Contributions. Solar resource is well assessed in West Africa (e.g., Plain et al., 2018) which makes this energy a good candidate to support the energy transition. However, solar energy forecast, necessary for the solar plant and electrical network managements, remains poorly developed in this region, in particular because of the specificities of the West African climate. Indeed, clouds (Danso et al., 2020-a) and dust events (Haslett et al., 2019) affect Global Horizontal Irradiance (GHI). Current operational forecasting systems over West Africa are too coarse to properly capture these two main features.

This study aims at understanding which meteorological conditions are sources of solar radiation forecast errors. It is based on the comparison between the observed GHI and its associated probabilistic forecasts at the Zagtouli solar farm (Burkina-Faso). The forecasts are performed using a multi global forecast models (IFS-HRES and GFS, at the resolution of 0.125° and 0.5° respectively) and a multi neighboring mesh aggregation provided the French start-up Steadysun. Two main scores are used to evaluate the accuracy of the forecast: the Mean Absolute Error [MAE] and the Mean Quantile Difference [MQD]. Both MAE and MQD are integrated on different time scales (from 1h to 7days) to capture different meteorological processes (from low level clouds to dust events).

Results show that whatever the integration times, MAE and MQD present maximum value in August during the wet season. Then, the relationship between forecast errors and GHI cloud attenuation is studied. The latter is given by CAMS solar radiation retrieve model which integrates the Meteosat Second Generation [MSG] satellite observations. The GHI cloud attenuation also presents a pic in August. The forecast performances are also compared with dust indicators such as Dust Aerosol Optical Depth [DAOD] from IASI satellite observations and AOD measurements from two AERONET measurements sites (Cinzana (Mali) - and Banizoumbou (Niger)). Dust indicators present a different seasonal trend, and no significant correlation is found between forecast errors and dust.

Cloud effect seems to be the main contributor of the origin of the forecast errors even if there is a close link between aerosols and clouds. IFS-HRES and GFES both use prescript coarse dust climatology. The cloud forecast errors may thus be partly due to dust particles miss-representation in the models. To go further, we propose to test a nested model forecast chain with or without a dust life cycle diagnostic to compare the importance of model resolution and dust forecast.

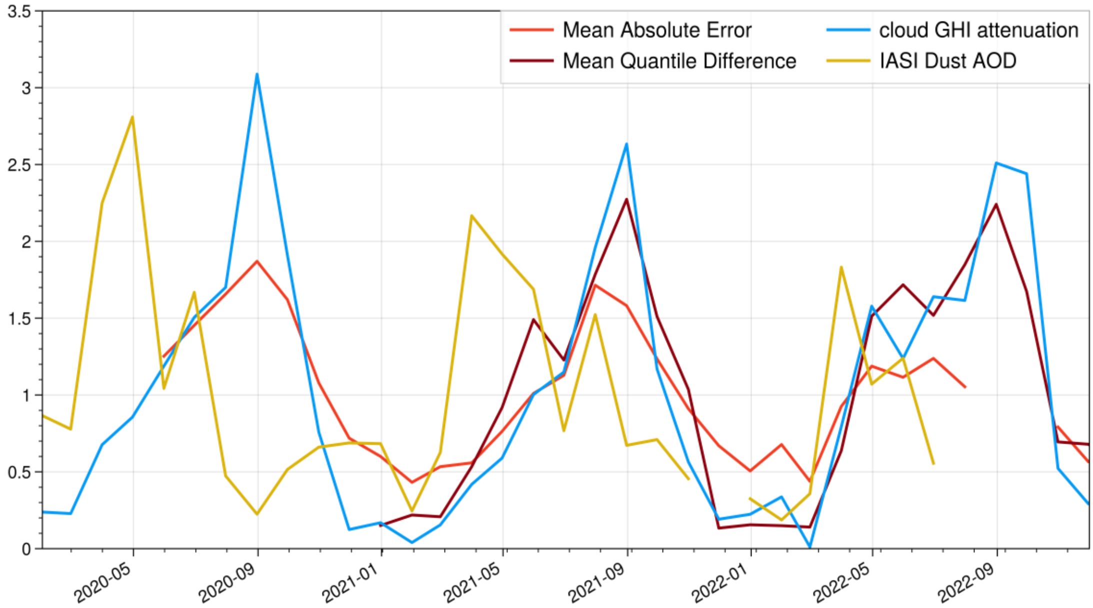

Figure 1: Normalized monthly mean of daily indicators from May 2020 to May 2022 at Zagtouli solar farm (Burkina-Faso). Mean Absolute Error is the daily absolute error between GHI forecasts and measurements; Mean Quantile Difference is the daily Q90-Q10 difference from GHI probabilistic forecasts; cloud GHI attenuation is derived from Meteosat Second Generation (MSG) satellite measurements; IASI Dust AOD is given by the LMD v2.2 algorithm from IASI satellite measurements.

1. Plain, N., B. Hingray, S. Mathy, Accounting for low solar resource days to size 100% solar microgrids power systems in Africa, Renewable Energy, doi.org/10.1016/j.renene.2018.07.036
2. Haslett, S. L., Taylor, J. W., Deetz, K., Vogel, B., Babić, K., Kalthoff, N., Wieser, A., Dione, C., Lohou, F., Brito, J., Dupuy, R., Schwarzenboeck, A., Zieger, P., and Coe, H.: The radiative impact of out-of-cloud aerosol hygroscopic growth during the summer monsoon in southern West frica, Atmos. Chem. Phys., 19, 1505–1520, https://doi.org/10.5194/acp-19-1505-2019, 2019
3. Danso, D. K., Anquetin, S., Diedhiou, Cloudiness information services for solar energy management in West Africa, Atmosphere 2020-a, 11, 857; doi:10.3390/atmos11080857