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Providing intraday solar irradiance forecasts before the sunrise: satellite based night cloud index retrieval and forecast

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Photovoltaic power forecast are necessary to increase solar energy penetration in the electricity mix. Many actors require to obtain these forecasts early in the morning in order to schedule power delivery or to take trading decisions on the electricity market. Visible channel images of geostationary meteorological satellite are known to enable several hours' ahead forecasts more accurate than those provided using numerical weather prediction models. However, delivering irradiance forecast before the sunrise is not possible with visible image only as no cloud can be correctly observed if solar elevation angle over a given site is below 5-10°.

Recent works initiate the use of thermal and water vapour channels of Meteosat Second Generation to build a night cloud index. Daytime cloud index is computed using an algorithm like Heliosat by computing the difference between the reflectance of a given pixel and the one of the same pixel if the sky were clear. To build a night cloud index, the method consists in assuming that the proportion of cloudy pixels into a large area (e.g. European part of MSG high resolution channel) is constant between night and day time. Thus, using a several month time series, a relationship is set up between the value of day time cloud index and the difference between brightness temperatures at 10.8 and 3.9 μm. The continuous availability of a cloud index permits to launch, at any time, satellite-based forecast using our method extrapolating a current cloud pattern. Surface solar irradiance is then deduced from an extrapolate cloud index map.

In this current work we experimented several night cloud index building with different satellites. We modified the existing method by correcting the airmass influence on day cloud index when solar elevation is below 15°; thus we improved the time continuity of day and night cloud index. Then, we applied our forecast algorithm and assessed it with MSG Prime images over Carpentras (France), MSG IODC over Saint-Leu (Reunion Island) and Boulouparis (New Caledonia) using Himawari-8. Results of a 1-year time series for each sites are reported according to solar elevation angle. It permits to show the accuracy by day cloud index, night cloud index and combination of both for forecasts launched at dawn. For a 2-hour time horizon forecast, the RMSE is in average of 28 % for day time launch and 35 % for night time launch, beating a persistence algorithm in any case.