RADIATION MEASUREMENT QUALITY CONTROL AND TIME CORRECTION AT METEOROLOGICAL STATIONS

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Abstract

This paper proposes a methodology for quality control of solar radiation measurements including checking the recording time. It is currently believed that data recorded in meteorological stations do not show deviations because of the very advanced dataloggers used. However, many of the incidents in meteorological stations are caused by time delays. Thus, this paper proposes checking recording time as a necessary first step for quality control of solar radiation data, previous to the usual visual and BSRN checks. A method has been developed to detect and correct time errors automatically. This correction decreases the percentage of daily data that fail the BSRN checks, and the data accepted are for the right time for hourly analysis.

1. Introduction

The solar resource, the amount of solar energy available in a given location, is essential to designing and planning a solar energy system, and therefore, its accurate assessment is required. [1]

CENER is currently monitoring nearly 20 meteorological stations in real time to acquire valid series of measured radiation data to generate a typical meteorological year for on-site calculation of electricity by simulating the thermal plant. Data processing therefore consists in a first step of quality control of measured data to determine their validity.

To assess the quality of recorded data, the World Radiation Monitoring Center (WRMC) Baseline Surface Radiation Network (BSRN) [2] first recommends visual inspection of the data, and secondly, checking the consistency between the three components of radiation.

It is common for the measuring devices to be located in unattended places. The biggest problem is misconfiguration of dataloggers leading to valid irradiation data but with time shifts due to erroneous conversion from UTC to local time or vice versa, clock skews, etc.

This paper presents a method for automatic mitigation of this problem. In this methodology a complete day of measurement is considered valid if all the data recorded pass the quality check.

Fig. 1 shows two graphs made with data for the same day, before and after time correction. Shown are the extraterrestrial irradiance (black line) and the three radiation components.

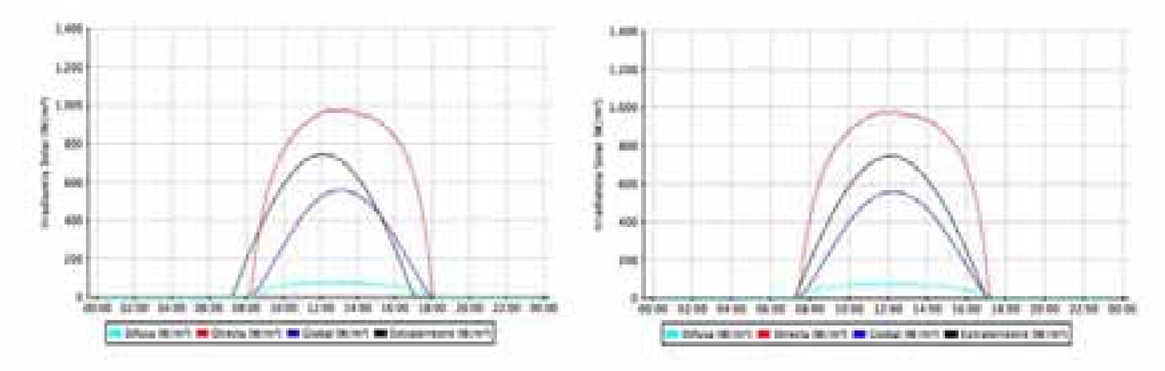

Fig. 1. Graphs for the same day, before and after correcting time.

2. Methods and Results

Two methods for correcting the delay that can be recorded at meteorological stations were tested using real data from stations monitored by CENER.

2.1. First method

We experimented with different delays in data, comparing the extraterrestrial irradiation with the measured data using the maximum clearness index for each delay. Results are best when the delay produces a minimum in this parameter. This method has proved to detect time delays in data for most of the day even with missing samples and varying sampling rate.

This method is of limited value on asymmetrical cloudy days when there are also missing data and the maximum clearness index is not at solar midday.

2.2. Second method

This method is based on finding sunrise and sunset, and from them, calculating solar noon as the midpoint between them. We propose the use of an improved method that involves several steps and is independent of the presence of nighttime data. Fig. 2 shows sunrise and sunset (diagonal arrows) and solar noon calculated from them (midpoint of the segment defined by the sunrise and sunset). This avoids problems arising from the appearance of peaks in the log (circled in green in the figure), which are more pronounced at higher sampling rates.

The proposed method has two limitations:

1. The presence of nighttime data, which can lead to errors in the estimation of sunrise and sunset.

2. The natural occurrence of global irradiation data before sunrise and after sunset makes the calculation of those moments more difficult.

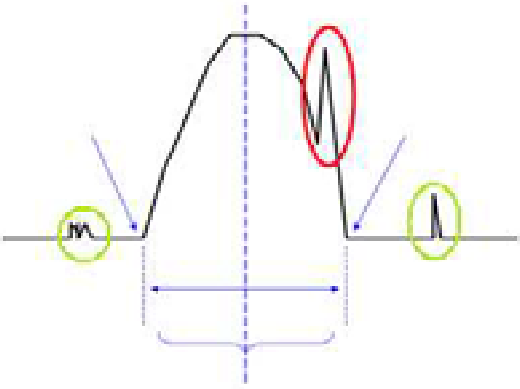

Fig. 2. Midpoint (solar midday) between sunrise and sunset.

For this calculation, , the instants of sunrise and sunset must be above a certain threshold, the curve may not drop below another threshold for a period of 2 hours, and is the average curve over another threshold. In principle, the method is carried out for complete recorded days.

Several thresholds have been tested. The best option found (for a one-minute data rate) is:

Threshold 1 = 5 Wh/m^2

Threshold 2 = 10 Wh/m^2

Fig. 3 shows a typical example of how sunrise and sunset is found. This method can also find some long delays as shown in Fig. 4.

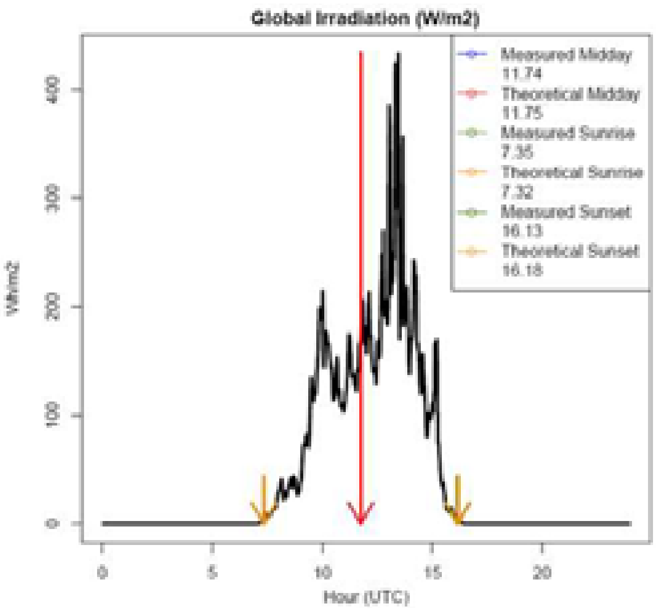

Fig. 3. Example of detection of sunrise and sunset.

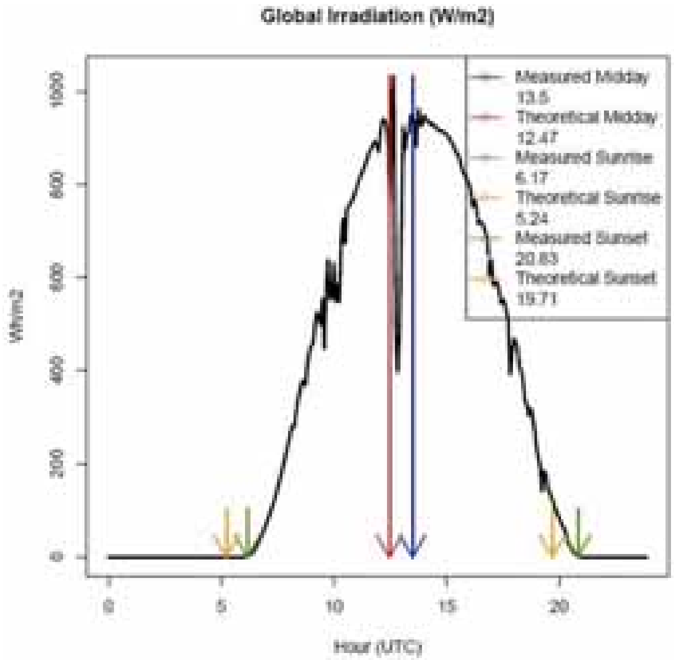

Fig. 4. Example of a long delay found.

In addition, if the theoretical length of the day differs by more than 15% of the expected, the correction must be rejected. The new detection method is shown in Fig. 5:

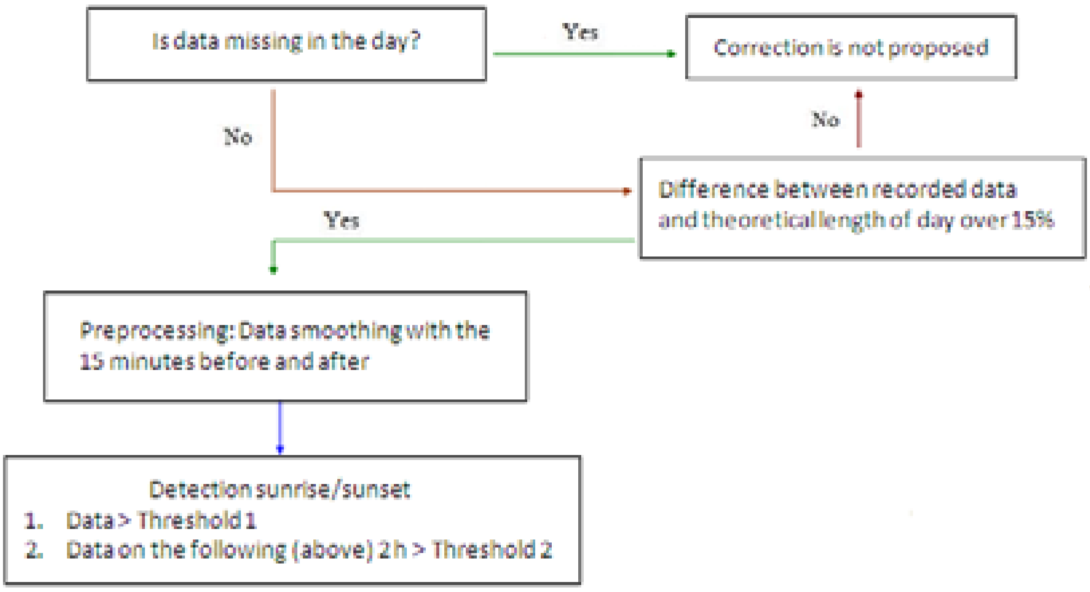

Fig. 5. New detection method.

This method has been tested with one year measurement data and simulated time gaps. This methodology has successfully identified most of the simulated time gaps and in the worst case, the difference between the real and detected delay was 10 minutes.

3. Conclusion

- A time delay causes a high percentage of failures in daily BSRN checks, although the radiation data recorded for that day are valid.
- A time correction methodology has been implemented. This methodology is not limited on symmetrical cloudy days.
- The proposed methodology improves the results, but does not allow accurate one-minute correction.

References

[1] McArthur L.J.B., (2004). Baseline Surface Radiation Network (BSRN). Operations Manual. WMO/TD-No. 879, WCRP/WMO

[2] H.Hegner, G.Müller, V.Nespor, A.Ohmura, R.Steigrad, H.Gilgen, (1998). Update of the Technical Plan for BSRN Data Management. World Radiation Monitoring Center (WRMC). Technical Report 2.Version 1.0.