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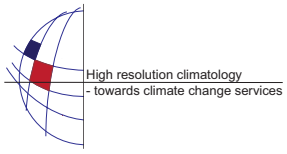

On the intraday resampling of time-integrated values of solar radiation

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Measurements of solar downwelling radiation are made at ground level by integrating the received energy during an integration time, e.g., 1 h. The sampling time, is usually equal to the integration time. In this way, one constructs time series of integrated values. Further processing of such measurements often requires the oversampling of the data in order to obtain radiation values at a higher temporal sampling. For example, the assessment of the direct irradiation in normal incidence from hourly values of beam irradiation on a horizontal surface requires a resampling of the time series to a higher temporal resolution, e.g., one minute, to account precisely of the solar position dynamics during an hour. Many interpolation techniques are found in literature for this oversampling processing. They are mainly based on standard signal processing techniques such as nearest neighbours, linear, cubic or spline interpolation.

This communication deals with beam irradiation on horizontal surface and focuses on the resampling of 1-h values or 15-min to 1-min values. Several techniques are used and their merits are discussed. Resampling can be performed on irradiation values; we show that better results are attained by resampling transformed values, such the clearness or clear-sky indices, then reversing the resampled indices into irradiation. Furthermore, we express the consistency property: the average of the oversampled temporal series should be equal to that of the original time series. We show that this consistency property is not respected by the usual resampling techniques. The error is small as an average but it is concentrated mainly in the high frequencies and therefore has an impact on the computation of the direct irradiation in normal incidence. This impact may be noticeable at different time-scales: intraday, day, month, and year.

Our theoretical expectations are confirmed by an experimentation made with high-quality time series of 1-min irradiation measured by the BSRN station in Payerne, Switzerland. This original time series serves as a reference. We average these values every 15 min and 1 h, in order to obtain time series of 15-min and 1-h irradiation. Linear and spline cubic interpolations are applied on either irradiation or clearness index. Results are compared to the reference. The respect of the consistency property is assessed. The time series of differences are summarized in terms of root mean square error, correlation and Kolmogorov-Smirnov test applied to the discrepancies in cumulative distribution functions. Fourier analyses are made to assess the power spectral density and, therefore, the temporal correlation of the estimation errors with respect to the different interpolation approaches. Unsurprisingly, we found that 1) resampling clearness index is more accurate than resampling irradiation, and 2) results are better in clear and overcast skies than in intermediate skies. The relative error in the consistency property on the hourly sum of beam horizontal irradiation in term of root mean square error ranges between 3 % and 6 % with a subsequent error on the estimation of the direct normal incidence between 9 % and 15 %.