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Classifying 1 minute temporal variability in global and direct normal irradiances within each hour from ground-based measurements

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Time series of surface solar irradiance are characterized by a high variability on various scales. Obviously, there is a seasonal cycle and a daily cycle due to sun geometry. These variations are well known and can be described in a deterministic manner. Additional variability is introduced by atmospheric extinction caused mainly by aerosols, water vapor, and other atmospheric trace gases as ozone as described in clear sky models. Nevertheless, in general, the variability induced by aerosols or water vapor is assumed to be small on the temporal scale below one hour. On the other hand, a strong temporal variability below one hour is found due to the extinction in clouds. It may reach even the scale from second to second. Nevertheless, there is only a small number of ground measurements in the second resolution available. Therefore, we concentrate of the 1 min resolved time series as a database. A number of various indices for the quantification of variability of irradiances from second to second, from minute to minute or from hour to hour have been suggested by other authors and will be discussed. Especially, for the day ahead forecasting or the assessment of solar resources the variability inside an hour or even a day has to be quantified.

This study aims at classifying the 1 min resolved variability in an hour in generic variability classes. It couples existing variability indices and adds new indicators to quantify aspects of the time series not being quantified so far. Additionally, the focus is laid on an automatic detection scheme. Eight classes are differentiated and described with respect to several aspects of variability.

Based on the variability indices and the generic variability classes, the typical values of indices and their distribution in each class are derived for the Baseline Surface Radiation Network (BSRN) station Carpentras and the year 2012. These index distributions are used in the automatic classification scheme as ‘reference distributions’ describing each generic variability class. It is assumed that these generic classes are typical for any location in the world, only their frequency differs from station to station. This automatic scheme is applied to all cases in the reference database from Carpentras. Overall, 71% of all cases are placed into the same class in the automatic and the visual classification.