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Surface solar irradiance temporal variability as derived from geostationary satellite-based cloud observations

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Variability of solar surface irradiances in the 1 minute range is of interest especially for solar energy applications. Eight variability classes were previously defined for the 1 minute resolved direct normal irradiance (DNI) variability inside an hour. They combine high, medium, and low irradiance conditions with small, medium, and large scale variations from one minute to the next minute. A reference data base of ground-based 1 minute observations was created from one year of observations at the BSRN station in Carpentras, France.

In this study spatial structural parameters of satellite based cloud observations are used as classifiers to detect the variability class which can be expected in ground-based 1 min resolved irradiance observations. These spatial structure parameters include the cloud fraction within a window surrounding the location of interest, the number of gradients in a binary cloud mask, the number of clouds, and the fractal box dimension of the cloud mask, all within the same window. Furthermore, cloud physical parameters as cloud optical depth, cloud phase and vertical extension, and the cloud coverage in the satellite pixel are used as classifiers. A supervised classification scheme is set up searching for a best fitted irradiance variability class according to these spatial structures.

Such a variability classification method allows the comparison of different project sites in a statistical and automatic manner in order to quantify short-term variability impacts on solar power production. This presented analysis is based on cloud observations from satellite only and does not require any ground-based irradiance observations at the specific geolocation. Furthermore, the approach offers the opportunity to estimate variability information also for historical years at any point within the Meteosat Second Generation field of view.