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Assessing the temporal variability of the surface solar radiation with time-frequency-energy representations

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The share of solar photovoltaic (PV) energy in the global electricity mix is envisaged to rise in the coming decades. Yet, one major hurdle impeding its wide-spread penetration has been identified in the variability of the surface solar irradiance (SSI). Hence, a better understanding of the SSI variability can help lower costs for PV electricity producers, thus making solar power more economically attractive and speeding the addition of new production capacity. Here
we report on a preliminary assessment of the temporal variability of the SSI by scrutinising long-term time-series of high-quality ground measurements from the BSRN network. Owing to the non-linearity and
non-stationarity of the data, analysis is carried out with spectral methods that yield a time-frequency-energy representation of the signals. Two such techniques are employed and their ability in rendering an accurate picture of the temporal variability of the SSI is investigated. First, a scalogram is constructed by means of the continuous wavelet transform. Second, the empirical mode decomposition is used to elicit the embedded oscillatory modes of the signal, on which Hilbert spectral analysis is then applied. Results show that the adaptive nature of the second technique reduces spectral artefacts and yields a clearer image of the temporal variability of the SSI. In particular, the seasonal variability of the SSI is greatly emphasized, with two distinct spectral peaks showing.