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Hilbert-Huang spectral analysis for the characterization of variability in satellite-derived time series of surface solar irradiance

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In the context of the ever increasing share of renewable energy in the global power mix, the thorough understanding of the variability of the solar resource is key to enable a smooth transition towards a carbon-free world energy scenario.

Recently, several studies of the surface solar irradiance (SSI) have addressed the characteristic time-scales of its temporal variability, by means of the Hilbert spectral analysis, with encouraging results. These works have focused primarily on high-quality measurements of the SSI from BSRN ground stations. Satellite-estimates of the SSI have become a popular alternative in supplementing ground measurements and offering a synoptic view of the SSI field.

The present study aims at extending the previous analyses by dealing with time-series of satellite estimates of SSI. The approach adopted here is of increasing complexity in physical modelling of the SSI. First, a "clean source" synthetic signal, the simulated top-of-the atmosphere extraterrestrial solar irradiance is investigated. Second, to emphasize the role of atmospheric effects (scattering, absorption) on the variability, clear-sky, i.e. cloud-free, estimates of the SSI come under scrutiny. Third, in order to also account for the effects of the clouds, satellite-derived estimates of the SSI are analysed. Finally, a comparison is done with the intrinsic time-scales of SSI variability found in ground measurements, which serve as "ground truth".

By conducting a complete analysis of the variability of the satellite-derived SSI at each step in the modelling chain, fresh insight is gained into the complex atmospheric interactions at play, which could lead to the improvement of the models and eventually to better forecast.