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Application of a change-point detection and time series decomposition algorithm to the analysis of long-term interannual surface solar irradiation variations

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Understanding and characterizing long-term variability of surface solar irradiation (SSI) is essential for both climate studies and industrial applications. Recent studies on the long-term variability of SSI have shown that statistically significant trends -or more precisely long period waves- can be evidenced. These local "trends" vary spatially and temporally: coherent regions and periods with decrease (“dimming”) and increase (brightening”) in SSI have been revealed by the statistically analysis of worldwide observational networks [1]. The identification of brightening/dimming periods and the detection of the local trend is a difficult problem due to the entanglement of effects of the two unknowns (localization of the period and quantification of the trend) as well as the small order of magnitude of the trend with respect to the interannual SSI variability.

We propose to evaluate the potential of a change-point detection and time series decomposition algorithm called rBeast [2] to jointly isolate brightening/dimming periods and evaluate SSI local trends. The rBeast algorithm was selected because its formulation - assuming a decomposition of a time series in a trend, waves and seasonal and noise terms over different intervals - is particularly adapted to the long-term SSI analysis. In addition, its implementation which uses a Markov-Chain Monte-Carlo avoids any data preprocessing (e.g. application of Gaussian low-pass filter) and yields an uncertainty estimates of the local trends as well as of the transition instant between brightening and dimming periods.

The work presented is structured in two parts. A verification of the potential of the rBeast method to isolate brightening and dimming periods and to estimate trends has first been verified on synthetic but plausible data. The use of synthetic data allows to evaluate the sensitivity of the algorithm to different factors such as the data availability or the order of magnitude of the trends. Then, the algorithm has been applied to time series analyzed in previous papers on different locations equiped with long-term ground stations and the results are compared to the outputs of the rBeast algorithm. The results obtained for the Potsdam station agree with the periods highlighted in the literature and the uncertainty on the trends and change point given by the method represent a valuable information for the analysis of long-term variation of the SSI.

[1] Wild, M. (2009), Global dimming and brightening: A review,J. Geophys. Res.,114, D00D16, doi:10.1029/2008JD011470.

[2] Zhao, K., Wulder, M. A., Hu, T., Bright, R., Wu, Q., Qin, H., Li, Y., Toman, E., Mallick, B., Zhang, X., Brown, M. (2019) Detecting change-point, trend, and seasonality in satellite time series data to track abrupt changes and nonlinear dynamics: A Bayesian ensemble algorithm, Remote Sensing of Environment, Volume 232, 2019, 111181, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2019.04.034.