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Stochastic investigation of the uncertainty of atmospheric processes related to renewable energy resources

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Renewable energy resources, e.g., wind and solar energy, are characterized by great degree of uncertainty and in general, limited predictability, because of the irregular variability of the related geophysical processes. A simple and robust measure of the inherent uncertainty of a process is the Hurst parameter. Specifically, the more complex a process is, the larger the introduced uncertainty (unpredictability) and the larger the Hurst parameter. This behaviour (called Hurst-Kolmogorov, HK) has been identified in numerous geophysical processes. Although there are several methods for estimating the Hurst parameter, the climacogram (i.e. variance of the averaged process vs. scale of averaging) is one of the most powerful ones, with a lower statistical estimation uncertainty compared to the autocovariance and power spectrum. We apply the climacogram method to timeseries from processes related to renewable energy systems (wind, solar, ocean etc.) with the aim to characterize their degree of uncertainty and predictability across different timescales. We compare results among the different processes and we provide real-world examples of renewable energy systems management to illustrate the technical relevance of our findings.
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