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Local Short-Term Variability in Solar Irradiance: Modelling Spatial Correlations

Characterizing spatio-temporal irradiance variability is important for the successful grid integration of increasing numbers of photovoltaic (PV) power systems. Using 1 Hz data recorded by as many as 99 pyranometers during the HD(CP)^2 Observational Prototype Experiment HOPE, we analyze field variability of clearsky index k* (i.e. irradiance normalized to clearsky conditions) and sub-minute k* increments (i.e. changes over specified intervals of time) for distances between tens of meters and about ten kilometers. By means of a simple classification scheme based on k* statistics, we identify overcast, clear and mixed sky conditions, and demonstrate that the last of these is the most potentially problematic in terms of short-term PV power fluctuations. Under mixed conditions, the probability of relatively strong k* increments of ± 0.5 is approximately twice as high compared to increment statistics computed without conditioning by sky type. As well, spatial autocorrelation structures of k* increment fields differ considerably between sky types. While the profiles for overcast and clear skies mostly resemble the predictions of a simple model published by Hoff and Perez (2012), this is not the case for mixed conditions. Thus, we are about to analyze the suitability of a fractal cloud edge model (based on a diamond-square-algorithm) to reproduce the observed spatial autocorrelation structures.

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