
MSTWeatherGen: a multivariate and space-time stochastic weather generator

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Abstract

Stochastic weather generators are probabilistic tools used to simulate synthetic weather data whose statistics resemble those observed. These tools face difficulties when it comes to accurately simulating multiple meteorological variables in space and time, because they necessitate models that can capture the complex inter-variable and space-time dependencies. We propose a new multivariate space-time weather generator designed for regional-scale applications at a daily resolution, called MSTWeatherGen. This stochastic weather generator takes advantage of the recent development of multivariate space-time covariance functions to model and simulate different weather variables, including temperature, precipitation, wind speed, humidity, and solar radiation, across space and time. Specifically, we employ an approach that involves a non-linear and non-stationary marginal transformation of a multivariate Gaussian random field, characterized by a stationary and non-separable spatio-temporal multivariate cross-covariance function. To further address the time-varying nature of the weather variables, we split the time domain into states called weather types. The method is assessed on the Provence-Alpes-Côte-d’Azur region in France, which is characterized by heterogeneous topography and meteorological conditions. Evaluation results demonstrate the effectiveness of this new stochastic weather generator in reproducing a wide range of weather statistics, including highly non-linear indicators such as heat wave or fire weather index.

Keywords: Multivariate covariance function, space, time covariance function, Fire Weather Index

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