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Spatial and temporal simulation technique for geophysical variables

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In recent years, the availability of spatial observations from satellite and information provided by reanalysis models allows us to use gridded data records of different geophysical variables, such as sea level, sea surface temperature, significant wave height, etc., which require new methods capable of exploring both the global and local characteristics of data. This work provides a methodology to characterize the stochastic processes at different grid locations via Monte Carlo simulations, which can be integrated within risk assessment frameworks to study, for example, the effects of climate change. The method has the following characteristics: a) it manages long-term global trends through the Trend-EOF technique, b) the de-trended data local anomalies (residuals) are encoded using principal component analysis, obtaining the corresponding spatial patterns (Empirical Orthogonal Functions, EOFs) and the temporal modes (PC, principal components), c) the principal components accounting for a high percentage of the variance variability are fitted to time-series models (ARMA processes), and finally, d) an approximate technique for reproducing ARMA fitted residual correlations at different time lags is used. This allows the simulation of data within a defined time span over the whole grid, maintaining the spatial and temporal characteristics of the stochastic process involved.