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A stochastic weather generator to enrich existing climate change scenarios and quantify uncertainties in marine and coastal ecosystems*

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Available climate change projections, which can be used for quantifying future changes in marine and coastal ecosystems, usually consist of a few equally probable scenarios. For this reason, studies addressing climate change impacts on these ecosystems often make use of a low- (RCP2.6), moderate- (RCP4.5) or high climate scenario (RCP8.5), without taking into account further uncertainties in these scenarios. In this research a methodology is proposed to generate further synthetic climate scenarios, based on the available datasets, for a better representation of climate change induced uncertainties. The methodology builds on Regional Climate model (RCM) scenarios provided by the EURO-CORDEX experiment.

In order to generate new scenarios of the climate variables, such as radiation or temperature, a hierarchical model was developed. This parameterized time series model includes a linear trend component, a seasonal shape with varying amplitude and time shift, and a multiplicative residual term. The seasonal shape is derived with the non-parametric Locally Weighted Scatterplot Smoothing (LOWESS), and the multiplicative residual term includes the smoothed variance of residuals and independent and identically distributed noise. Consequently, the model parameters are the trend intercept (α), trend slope (β), amplitude of the seasonal shape (AS), amplitude of residual shape (AV), time shift in seasonality (τ), and the variance of the noise ($\sigma 2$). The distributions of the time series model parameters may be assumed or their posterior distributions can be estimated through Maximum Likelihood Estimation or Bayesian parameter estimation with Markov chain Monte Carlo sampling. By drawing samples from the model parameter distributions numerous new representative synthetic scenarios are generated including uncertainty estimates.

In the future, utilizing these generated synthetic climate scenarios and statistical models, that relate climate variables to ecosystem variables, a probabilistic simulation can be conducted to further propagate the climate changed induced uncertainties to marine and coastal ecosystem indicators.

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