Statistical characteristics of surrogate data based on geophysical measurements

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In this study, the statistical properties of a range of measurements are compared with those of their surrogate time series. Seven different records are studied, a synthetic multifractal time series (p-model), historical time series of mean daily temperature, daily rain sums and runoff from two rivers, and cloud measurements from Cumulus and Stratocumulus.

Seven different algorithms are used to generate the surrogate time series. The best-known method is the iterative amplitude adjusted Fourier transform (IAAFT) algorithm, which is able to reproduce the measured distribution as well as the power spectrum.

Using this setup, the measurements and their surrogates are compared with respect to their power spectra, increment distributions, structure functions, annual percentiles and return values.

It is found that the surrogates that reproduce the power spectrum and the distribution of the measurements are able to closely match the increment distributions and the structure functions of the measurements, but this often does not hold for surrogates that only mimic the power spectrum of the measurement. However, even the best performing surrogates do not have asymmetric increment distributions, i.e., they cannot reproduce nonlinear dynamical processes that are asymmetric in time. Furthermore, we have found deviations of the structure functions on small scales.

After obtaining these results we speculate that the algorithms that reproduce the power spectrum and the distribution will also be able to generate multi-fractal time series for

geoscience applications with reasonable accuracy and full control over the distribution.