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Assessing significance of trends using counts of signs of the trends as test statistic

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A common approach to assessing statistical significance of trends in climate elements is to conduct separate tests at individual sites. Trends that are not significantly different from zero are frequently not considered as relevant, a large amount of information being thus potentially lost. We argue that it is reasonable to assume that the prevalence of one sign of trends at individual sites is indicative of the significance of that trend (significance meaning here a high confidence in the trend not being zero), regardless of the (in)significance of individual local trends.

Our idea of significance testing builds on this premise: We propose to count sites (stations or gridpoints) with a trend of a given sign (positive or negative) and to quantify whether the number of sites with that trend sign may or may not have occurred due to chance under the given null hypothesis. In this contribution we examine the feasibility of the proposed way of significance testing on synthetic data, which are produced by a multi-site stochastic generator. More details on the generator are provided in another contribution by Dubrovský & Huth.

The synthetic dataset, mimicking an array of stations and/or gridpoints, is constructed assuming a given structure of the data time series and its length. This structure is characterized by (i) spatial separation (density of the station network), (ii) temporal and spatial autocorrelation structure, and (iii) a spatial pattern of the trend magnitude. The test statistic is defined as the number of sites with the trend of a given sign, and its probabilistic distribution is determined from multiple realizations of the synthetic dataset, in which no trend is imposed at each site (that is, any trend is a result of random fluctuations only). The procedure is then evaluated on the synthetic dataset in which a non-zero trend (which may but need not be spatially uniform) is imposed. A sensitivity analysis is conducted for various combinations of the trend magnitude, variance, and temporal and spatial autocorrelation.