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Nonparametric quantile regression for assessing the nonstationarity of extreme values in geoscientific time series

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Changing global climate conditions are known to affect not only mean values of meteorological quantities, but also the magnitude and, hence, potential impact of extreme events. Similar considerations apply to nonstationary dynamics in many other fields of geosciences. Whereas the proper trend assessment in terms of changing means has become a standard exercise of research, a reliable estimate of trends (or, more general, nonstationarities) in the extreme values often requires large data sets and is typically based on classical methods of extreme value theory. In situations where the overall state of the system under study changes relatively fast in comparison with the rate at which data can be obtained, this poses severe problems to statistical analysis.

In this work, we propose using quantile regression methods for deriving estimates of changing extremes. Since parametric models may not be sufficient for this purpose, the utilisation of modern nonparametric approaches is recommended. We review three recently derived methods from this class of approaches: quantile regression with spline models [1], kernel quantile regression [2], and quantile LOESS [3]. Based on some example time series from different fields of geosciences, the performance of these methods is systematically compared. Our results show that on the one hand, kernel quantile regression provides feasible and robust results, but does not allow for processing large data sets within reasonable time. On the other hand, quantile regression with spline models is fast, but requires particularly careful tuning of the method's inherent parameters. Quantile LOESS provides a reasonable compromise between the two other methods.

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