Objective estimation of trend changing points in time series

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The linear trend constitutes the most straightforward assessment of the long-term behavior of a time series. However, real time series are generally not well fitted by a straight line and the use of other analytical functions always raises difficult interpretation problems. In practice, many data analysis start by a subjective inspection of the time series plot often revealing important features of the data, such as periodicities, trends, localized anomalies, localized changes in the trend or in other statistics that may contribute to an understanding of the underlying physics. Linear analysis, such as linear trend fitting or Fourier analysis, cannot deal with heterogeneity in the data, and are blind to many of the features that may be present. Here we present an objective method for fitting a finite number of continuous line segments to time series, where the number of segments, the location of the breakpoints between segments, and the slopes of the different segments are simultaneously optimized. This methods allows a different look at the slow evolution of time series, introduces new parameters, points of significant trend change, which can be relevant in the context of global warming studies, for instance. Several application are shown (mean Global temperature, NAO index and SOI index) and the sensitivity of the method is discussed. The use of this methodology as a natural long detrended tool is also explored. A cross-platform graphical user interface of the method was developed and is freely available at http://www.dfisica.ubi.pt/˜artome/linearstep.html.