Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05634, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05634
EGU General Assembly 2008
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On detectability of nonstationarity from data using statistical tools

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It has been a common practice in geophysical research to characterize observed time series as nonstationary and to apply statistical tools to detect nonstationarity. However, in many cases the logic of such detections is flawed, principally because stationarity and nonstationarity are not properties of the time series (phenomena) but of the mathematical processes (noumena) devised to model the phenomena, and also depend on our current knowledge of the system state. One of the most common flaws is the rejection of a stationarity hypothesis based on a classical statistical test which assumes that the process is independent in time, whilst it is well understandable that time independence is not an appropriate assumption for geophysical processes. In the case that a scaling behaviour is verified or assumed, one of the most common misuses of statistics is the characterization of a time series as nonstationary based on an estimation of a Hurst exponent greater than 1. Among the tools used for such estimations is the spectral representation of the time series. To demonstrate common flaws, several examples are synthesized, using data generated from hypothesized models, known a priori to be stationary or nonstationary. The examples aim to demonstrate that erroneous conclusions are very probable and to locate the origin of flawed results.