Geophysical Research Abstracts, Vol. 8, 06216, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06216

Exploration of multivariate hydrological time-series by a combined approach of singular system analysis and nonlinear dimensionality reduction

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Hydrological time-series are known to depict long-term structures, and pronounced nonlinearities. Singular System Analysis (SSA) is one way to extract long-term components of these data-sets. Classical SSA is a principal component analysis (PCA) in the time domain. We extended the SSA framework by using nonlinear dimensionality reduction (NLDR) techniques such as the manifold learning methods ISOMAP, LLE, HLLE, and compared it to the PCA-based SSA.

Facing the fact that many hydrological time-series are short and noisy, there is an interest in analysing regional patterns by performing multichannel SSA (M-SSA), a multivariate extension of SSA. In our case more than 100 runoff data-sets from South Germany were to be analysed simultaneously. Due to its high computational demand, M-SSA application was not possible.

In contrast, the NLDR-SSA approach overthrew the computational bottleneck of the M-SSA. Long term oscillations of ~ 4, ~ 7, ~ 11 years were identified. The separability of the extracted signals was much better compared to the linear SSA.