An extended approach for spatio-temporal gap filling: dealing with large and systematic gaps in geoscientific datasets

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Geo-scientific datasets often contain numerous and possibly systematically distributed gaps. This data fragmentation which may be due to instrument failures, sparse measurement protocols or unfavorable conditions (e.g. clouds or vegetation thickness in case of remote sensing data). It affects and often inhibits most statistical analysis which often require continuously sampled data points. Hence, gap filling is an undesired but often necessary task in geo-sciences. In cases where multivariate relationships are investigated they are often biased similar relationships which are used by the preceeding gap filling algorithm. In these cases univariate methods are needed.

Kondrashov and Ghil (2006) proposed a gap filling approach which exploits the temporal (possibly multidimensional) patterns as identified by Singular Spectrum Analysis (SSA). Here we propose an univariate extension of this method in order to additionally consider the spatial processes and patterns underlying most geo-scientific data sets. The latter has been made possible by including a novel 2D-SSA approach recently introduced by Golyandina and Usevich (2010).

Using both artificial and real-world test data we show that considering spatial and temporal patterns simultaneously improves the gapfilling substantially. We outperform the conventional approach particularly for large and systematically recurring gaps. Our method is fast, can be applied with a minimum of *a priori* assumptions on the data structure and is implemented *ready-to-use* in an open source software package.

N. E. Golyandina and K. D. Usevich. 2D-extension of singular spectrum analysis: algorithm and elements of theory. In Matrix Methods: Theory, Algorithms, Applications, pages 449–474. World Scientific, 2010.

D. Kondrashov and M. Ghil. Spatio-temporal filling of missing points in geophysical data sets. *Nonlinear Processes in Geophysics*, 13:151–159, 2006.