Data adaptive analysis of geodetic time series

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Résumé

The recent developpement of space geodesy has led to an significant increase in geodetic data sets. It is challenging, however, to extract signals of geophysical
origin from the background noise inherent the geodetic time series and, even more so, to separate the different kinds of signals such as the seasonal oscillations and the transient deformation. In addition, because of
the very large number of continuously data now available, it has become impossible
to systematically inspect each time series and visually compare them. Here we show
that Multichannel Singular Spectrum Analysis (M-SSA), a method derived from the analysis of dynamical
systems, can be used to extract transient deformations, seasonal oscillations, and background noise present
in GNSS time series. M-SSA is a multivariate, nonparametric, statistical method that simultaneously exploits
the spatial and temporal correlations of geophysical fields. The method allows for the extraction of common
modes of variability, such as trends with nonconstant slopes and oscillations shared across time series,
without a priori hypotheses about their spatiotemporal structure or their noise characteristics. We
illustrate this method using synthetic examples and show applications to actual GPS data from Alaska to
detect seasonal signals and microdeformation at the Akutan active volcano. The geophysically coherent
spatiotemporal patterns of uplift and subsidence thus detected are compared to the results of an idealized
model of such processes in the presence of a magma chamber source.

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