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Detection of discontinuities in GPS coordinates time series through the Sequential t-Test Analysis of regime Shifts (STARS)

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The time series of GPS coordinates, in general, are affected by the superposition of different long- and short-period signals which shall be identified and their physical nature needs to be understood. Examples are long-period tectonic variations, effects of climatic origin and short-period seasonal fluctuations. In addition to these variations, discontinuities are commonly observed that impair the estimate of trends. These abrupt shifts can be originated by changes of the station equipment and/or the reference system, by the occurrence of earthquakes and, likely, by a number of unforeseen events. The magnitude of these jumps shall be estimated and the series corrected accordingly. There exists several methods allowing to detect discontinuities in the time series and to estimate their relevant magnitude. Typically, these adopt hypothesis-driven analyses, meaning, for example, that the detection of a jump resulting from a documented event (e.g. instrumentation change, earthquakes etc.) is accomplished through the a priori knowledge of the event timing. We have studied time series of GPS coordinates characterized by several jumps due to different reasons by means of a method known as Sequential t-Test Analysis of Regime Shift (STARS) developed by Rodionov (Geophys. Res. Lett., 31, L09204, 2004). This technique does not make any a priori assumption on the time series. A discontinuity or jump is detected, and its magnitude is estimated, when the time series mean value exhibits a significant change. Since the approach belongs to the sequential/exploratory type of statistical methods, jumps are detected as soon as they appear in the series. Two parameters are required, namely a cut-off length, which allows selecting the fluctuations time scales, and a significance level, used in the statistical t-test upon which the STARS algorithm is based. We have investigated the coordinates time series of several stations located in northeastern Italy, including those of the BOLG and MSEL Euref stations.