Minimum Detectable Overall Trend Rate in GNSS Time-Series

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SUMMARY

The overall trend rate, i.e. one-dimensional velocity in a GNSS time-series of a local coordinate component is one of the most important parameters for investigating deformed bodies, such as tectonic regions, landslides, mining fields and engineering buildings. The standard deviation (sigmav) of this trend has been studied in many papers to figure out how precise trend rate can be determined. This standard deviation depends on four main conditions, namely the length of time-series (time-span), the observation frequency, the noise structure in the GNSS data, and the type of the regression model if the time-span is shorter than about 2.5 years. Most of these studies, however, consider that only the white noise exists in the data. It has been reported that a GNSS time-series includes also flicker noise of which amplitude is 1.5 and 4.0 times bigger than the white noise, random walk noise of which amplitude changes depending on the monument type and local effects, as well as some other power-law noises occuring due to the different geophysical processes. Existence of these colored noises means that the time-series is temporally correlated. Hence, omitting them in the analysis of the GNSS time-series leads to very optimistic standard deviation for the trend rate and so, wrong statistical decisions after realization or at the design stage of the GNSS measurement experiment. This contribution aims to discuss the minimum detectable overall trend rate (MDTR) with the 80% power of the test according to the sensitivity analysis for one coordinate component in GNSS time-series. While the time-span is longer than one year for daily GNSS data, the MDTR can be given as about 2.8(sigmav) from the power function of the noncentral chi-square distribution. This MDTR is studied in GNSS time-series consisting of trend+annual and semi-annual signals for different noise models (different flicker noise and random walk noise models as functions of observing session duration dependent-RMS repeatabilities), different time-spans between 1 year to 10 years as well as daily and monthly observation frequencies. According to the numerical results, the bigger flicker noise compared to the white noise may cause about 3-4 times bigger MDTR whereas random walk noise affects badly the trend

rate more than the flicker noise does. The MDTR for horizontal component becomes less than 1 mm/year when the time-span is longer than three years, the flicker noise is two times bigger than the white noise and the observing session duration is 24 hours. This trend rate increases if the colored noises increase as well. The longer observing session duration results in smaller MDTR in any noise models as expected. Interestingly, daily and monthly GNSS data provides similar MDTRs if the time-span is more than about 4 years.