Detection of Measurement Errors in the Time Series of the Coordinates of Surface Movement Monitoring Points with the Use of Satellite Navigation Systems

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SUMMARY

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Nowadays, we have a wide range of modern, very complicated internally, navigation satellite systems (GNSS) with the help of which we can conduct precise geodetic observations. However, it should be noted that these systems have some significant limitations, which are the main barrier to their widespread use. As shown by the current research in this area, time series of coordinate changes obtained on the basis of continuously operating GNSS stations, are affected by many effects, leading to large discrepancy of observations, also for stations operating in relatively small areas. Changes in the coordinates of such stations result from several main reasons: large-scale effects, such as tectonic effects, strictly local effects, such as the influence of the location of the observation antenna, or anthropogenic factors, and the effects of systematic errors of the GNSS system. Therefore, the time series of coordinates, in addition to the useful measurement signal, contain systematic effects ("color" noise) and random measurement noise ("white" noise). Appropriate modeling of these effects allows for precise and reliable determination of coordinate changes of observation points. This paper deals with the detection of outliers and random errors (white noise) in time series of coordinates generated on GNSS stations.

The results of continuous monitoring of ground surface movements carried out within the framework of the European research project are presented*. One of the aims of the project is to develop methods and plans for long-term monitoring of post-mining areas in order to reduce the seismic risk during and after the closure of coal mines. High-frequency (1 Hz) daily solutions, realized in real time, were analyzed in a continuous mode. The observations were made simultaneously at three control points, which are monitoring stations of an automatic system for

measuring and processing GNSS observations. On their basis, time series of coordinate changes were determined, for which systematic components, periodic components (fluctuations) and random components (noise) were calculated. Additionally, the mutual spatial-temporal correlation in the analyzed time series was examined. The results of the analyses presented in the paper were used to developing the results of long-term measurements, which are the subject of the mentioned project.

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