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Development of an algorithm for the detection of seismic events based on GPS records: Case study Tohoku-Oki earthquake

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The occurrence of strong earthquakes in the last decade (Sumatra, 2004; Tohoku-Oki, 2011, etc.) and the availability of high-rate GPS records (up to 100 Hz) with a kinematic positioning accuracy of 1-5 cm, show the potential of using GPS networks for the detection of earthquake. At GGL, ETH Zurich, a first version of algorithm for the detection of seismic motions based on GPS network records has been developed.
The developed algorithm mainly consists of two parts. After removing the low-frequency signal from the GPS kinematic time series the noise level is estimated, for a time interval with no motion. This noise level is used to detect the seismic signal. To improve the reliability of the detection, the signal of neighbouring GPS stations are then checked for a similar consistent signal.
The algorithm has been developed within the framework of the Bernese GNSS Software 5.1 (modified) and was used for the detection of ground motions in the GPS time series previously derived for the Tohoku-Oki earthquake. The kinematic GPS time series (north, east, up) were generated for >800 stations based on GPS observations with a 1-sec sampling rate.
Using the developed method the earthquake was correctly detected in the GPS records throughout the entire network. The detected signal in the GPS time series seems to correspond to different seismic waves (e.g. P-wave, S-wave, etc.) depending among others on the distance of each GPS station from the epicentre.