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The GNSS-based Ground Tracking System (GTS) of GFZ; from GITEWS to PROTECTS and beyond

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Introduction

An automatic system for the near real-time determination and visualization of ground motions, respectively co-seismic deformations of the Earth's surface, was developed by GFZ (German Research Centre for Geosciences) within the project GITEWS (German Indonesian Tsunami Early Warning System). The system is capable to deliver 3D-displacement vectors for locations with appropriate GPS-equipment in the vicinity of an earthquake's epicenter with a delay of only a few minutes. These vectors can help to assess the earthquake causing tectonic movements, which must be known to make reliable early warning predictions, e.g., concerning the generation of tsunami waves. The GTS (Ground Tracking System) has been integrated into InaTEWS (Indonesian Tsunami Early Warning System) and is in operation at the national warning center in Jakarta since November 2008.

After the end of the project GITEWS GFZ continues to support the GTS in Indonesia within the frame of PROTECTS (Project for Training, Education and Consulting for Tsunami Early Warning Systems) and recently some new developments have been introduced. We now aim to make further use of the achievements made, e.g., by developing a license model for the GTS software package.

Motivation

After the Tsunami of 26th December 2004 the German government initiated the GITEWS project to develop the main components for a tsunami early warning system in Indonesia. The GFZ, as the consortial leader of GITEWS, had several work packages, most of them related to sensor systems. The geodetic branch (Department 1) of GFZ was assigned to develop a GNSS-based component, which since then is known as the GTS (Ground Tracking System).

System benefit

The ground motion information delivered by the GTS is a valuable source for a fast understanding of an earthquake's mechanism with a high relevance to assess the probability and magnitude of a potentially following tsunami. The system may detect highest displacement vector values, where seismic systems may tend to have problems with the determination of earthquake magnitudes, e.g. close to an earthquake epicenter. By considering displacement vectors the GTS may significantly support the decision finding process whether a tsunami has been generated.

Brief system description

The GTS may be divided into three main components:

1) The data acquisition component receives and manages data from GNSS-stations being transferred either in real-time, file based or both in parallel, including, e.g., format conversions and real-time spreading to other services. It also acquires the most actual auxiliary data needed for data processing, e.g., GNSS-satellite orbit data or, in case of internet problems, generates them from ephemeris broadcast transmissions, received by the connected GNSS-network stations.

2) The automatic GNSS-data processing unit calculates coordinate time series for all GNSS-stations providing data. The processing kernel is the robust working and well supported »Bernese GPS Software«, but

wrapped into adaptations for a fully automatic near real-time processing. The final products of this unit are 3D-displacement vectors, which are calculated as differences to the mean coordinates of the latest timespan prior to an earthquake.

3) The graphical user interface (GUI) of the GTS supports both, a quick view for all staff members at the warning centre (24h/7d shifts) and deeper analysis by experts. The states of the connected GNSS-networks and of the automatic data processing system are displayed. Other views are available, e.g., to check intermediate processing steps or historic data. The GTS final products, the 3D-displacement vectors, are displayed as arrows and bars on a map view. The GUI system is implemented as a web-based application and allows all views to be displayed on many screens at the same time, even at remote locations.

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