TSUNAMI DETECTION FROM SPACE USING GNSS REFLECTIONS: RESULTS AND ACTIVITIES FROM GFZ

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The Sumatra tsunami of 2004 has shown dramatically that tsunami early warning is essential to protect people in coastal areas. Within the GITEWS (German-Indonesian Tsunami Early Warning System) project [1] therefore a tsunami early warning system for the Indian Ocean has been developed and installed at the coastline of Indonesia. It is operational since 2008. The GITEWS project is carried out through a large group of scientists and engineers from GFZ and its partners from German Aerospace Center (DLR), Alfred-Wegener-Institute for Polar and Marine Research (AWI), GKSS Research Centre, Leibniz-Institute for Marine Sciences (IFM-GEOMAR), United Nations University (UNU), Federal Institute for Geosciences and Natural Resources (BGR), German Agency for Technical Cooperation (GTZ), as well as from Indonesian and other international partners. Funding is provided by the German Federal Ministry for Education and Research (BMBF). The system consists of ground based and maritime sensors like seismometers, buoys, tide gauges and GPS stations [Fig. 1]. All of them are connected via satellite communication with a warning centre at Jakarta where the incoming signals are compared to previously calculated tsunami wave propagation simulations and the warning is mitigated.

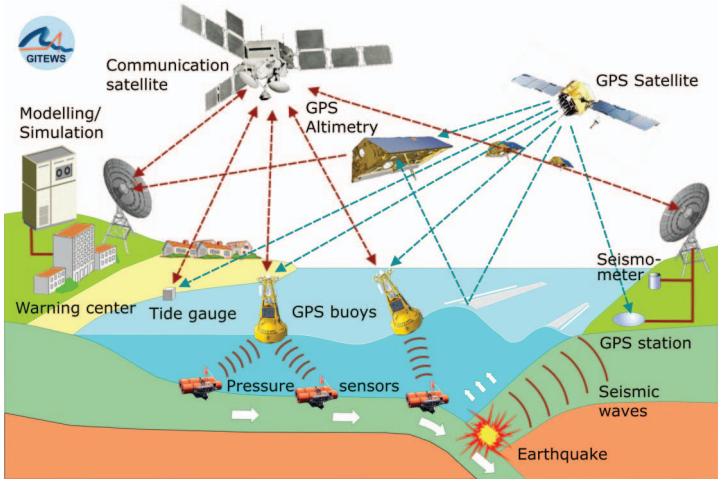

Figure 1: GITEWS sensor system overview.

There are endangered regions, as, e.g., the Mediterranean, where no tsunami early warning system exists yet. Since tsunamis are a global phenomenon, satellite based techniques are predestined as major components of future generation early warning systems. GNSS-Reflectometry (GNSS-R) is a potential remote sensing technique that can be applied at such systems [Fig. 2]. GNSS-R altimetry from space is expected to determine sea surface height anomalies at centimeter to decimeter level and should therefore be applicable for tsunami detection [2]. GNSS-R receivers are small compared to other payloads and appropriate for the installation aboard micro or mini satellites. With a cost-effective constellation of such small satellites ocean surfaces could be monitored with high temporal and spatial coverage, which is essential for effective tsunami detection.

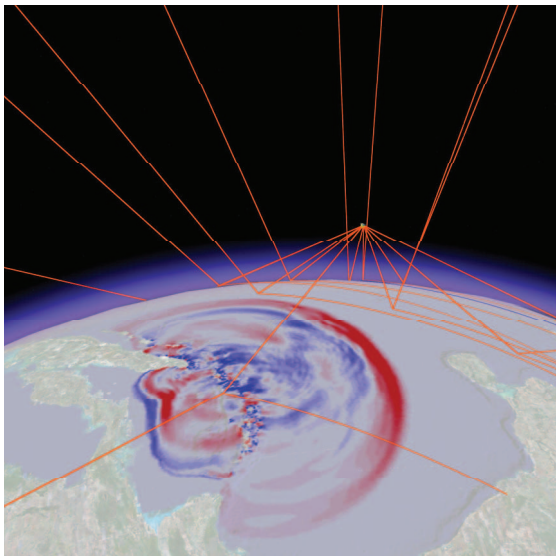

Figure 2: Google Earth animation of space-borne GNSS-R measurements applied to a representation of the Sumatra tsunami

We review GFZ activities regarding the potential application of GNSS-R as a main component of future generation space based early warning systems. These activities were funded as part of the GITEWS project. Key components of such satellite based GNSS-R constellations are appropriate GNSS receivers. Therefore GFZ started activities related to the development of such receivers in cooperation with industry [3]. Their performance was already successfully tested during several ground based campaigns (Bavarian Alps, Greenland). We review these measurements and introduce recent activities for airborne applications of GNSS-R. In addition we introduce results of a simulation study [4], where the detection performance of various multi-satellite GNSS-R constellations was investigated for tsunamis detection at the Indian Ocean and the Mediterranean.

References

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