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Test of TEDA, Tsunami Early Detection Algorithm

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Tsunami detection in real-time, both offshore and at the coastline, plays a key role in Tsunami Warning Systems since it provides so far the only reliable and timely proof of tsunami generation, and is used to confirm or cancel tsunami warnings previously issued on the basis of seismic data alone. Moreover, in case of submarine or coastal landslide generated tsunamis, which are not announced by clear seismic signals and are typically local, real-time detection at the coastline might be the fastest way to release a warning, even if the useful time for emergency operations might be limited.

TEDA is an algorithm for real-time detection of tsunami signal on sea-level records, developed by the Tsunami Research Team of the University of Bologna. The development and testing of the algorithm has been accomplished within the framework of the Italian national project DPC-INGV S3 and the European project TRANSFER. The algorithm is to be implemented at station level, and it is based therefore only on sea-level data of a single station, either a coastal tide-gauge or an offshore buoy. TEDA's principle is to discriminate the first tsunami wave from the previous background signal, which implies the assumption that the tsunami waves introduce a difference in the previous sea-level signal. Therefore, in TEDA the instantaneous (most recent) and the previous background sea-level elevation gradients are characterized and compared by proper functions (IS and BS) that are updated at every new data acquisition. Detection is triggered when the instantaneous signal function passes a set threshold and at the same time it is significantly bigger compared to the previous background signal. The functions IS and BS depend on temporal parameters that allow the algorithm to be adapted different situations: in general, coastal tide-gauges have a typical background spectrum depending on the location where the instrument is installed, due to local topography and bathymetry, while offshore buoys are mainly characterized by the astronomical tide and white noise.

TEDA has been tested on specific events recorded by Adak Island tide-gauge, in Alaska, and by DART buoys, located offshore Alaska, thanks to the collaboration with NCTR of PMEL/NOAA (NOAA Centre for Tsunami Research of Pacific and Marine Environmental Laboratory/National Oceanic and Atmospheric Administration). Three methods for the characterization of the background signal have been tested and compared with different characterization settings, in order to find the most appropriate calibration.

To evaluate the algorithm performance, different indicators have been taken into account, such as the number of false detections, the number of events detected, the delay of detection and the duration of the tsunami alert state. Particular attention has been reserved to the number of false detections, which compromise heavily the reliability of a detection algorithm and undermine the usefulness of the algorithm itself. The method to test TEDA is presented here and is proposed as an example of procedure to evaluate the performance of the tsunami detection algorithms used in the Tsunami Early Warning Systems practice.