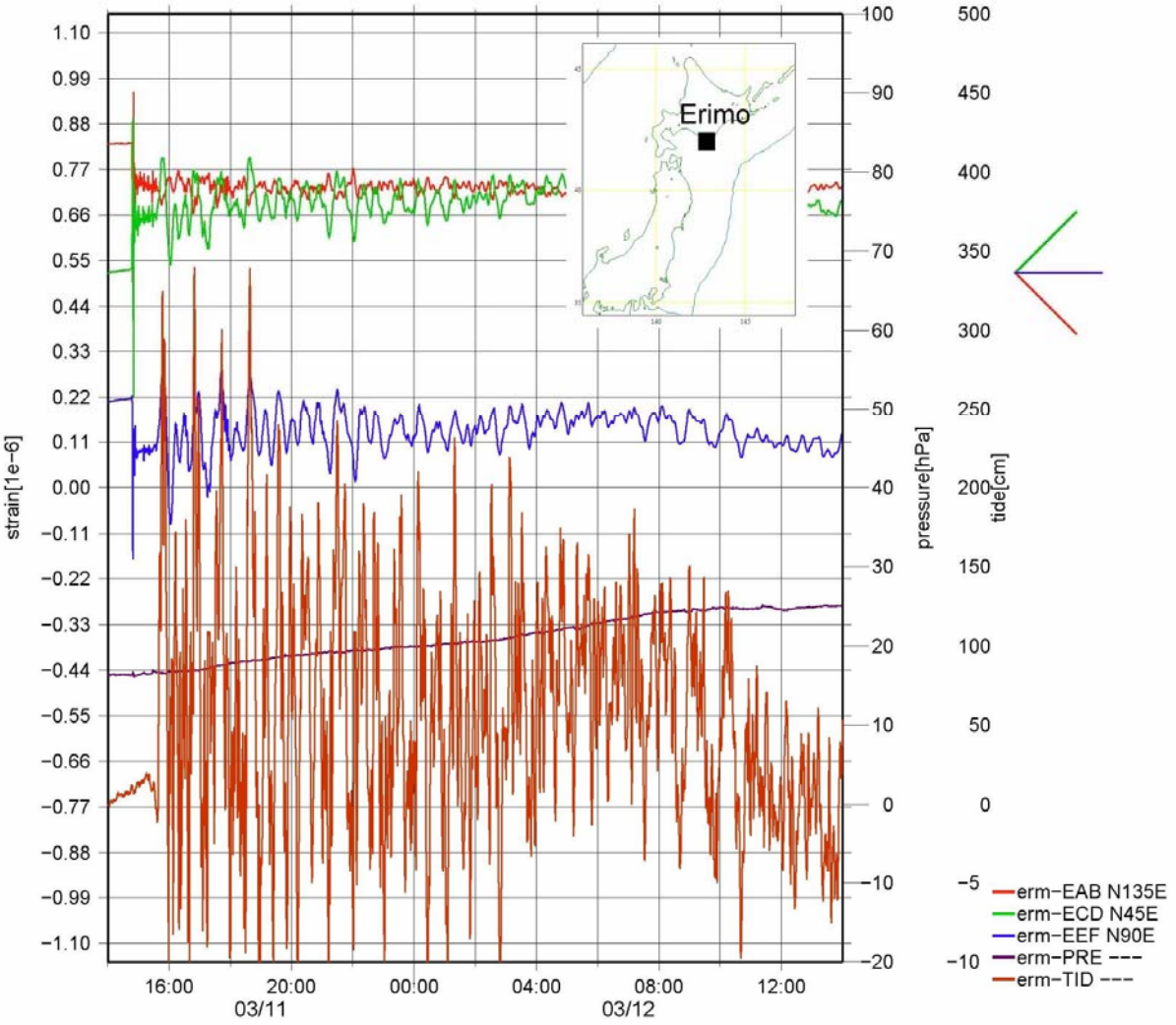
The 2011 Tohoku earthquake tsunami recorded by strain and tilt sensors at Erimo, Hokkaido, Japan

Akinari Shinjo and Hiroaki Takahashi
Institute of Seismology and Volcanology, Hokkaido University, Sapporo, Japan
a-shinjo0915@mail.sci.hokudai.ac.jp, hiroaki@mail.sci.hokudai.ac.jp

The 2011 M 9.0 Tohoku-oki earthquake generated catastrophic huge tsunami. Inhabitable areas along Pacific coast from Tohoku and Kanto regions were devastated by it. Real-time tsunami information from tide gauge stations should primary play important role for disaster operation. Unfortunately, functions of important tide stations were interrupted or destroyed by several severe troubles. Blackout due to strong ground motion was one of factors for failures. Backup battery system can solve this. Satellite communication also contributes to be keeping data transfer system.

Though tide gage or mareograph are the instruments to measure sea water level change, detector must be installed nearby sea. Sensors by bobber or ultrasonic technique have limit of maxim height itself, can not observe 30m height tsunami in principle. These conditions are not appropriate for hazardous tsunami observation. Destructive tsunami may destroy all functions of tidal stations, and in fact, we saw disappearing tide gage stations without traces by tsunami attack. Tsunami height information from Japan Meteorological Agency was devoid of data from most destroyed area. This data loss was crucial for disaster operation. This experience asks for another stable measurement system of gigantic tsunami. GPS-buoy system on sea is one of suitable techniques for hazardous tsunami observation.

Tsunami propagation generate loading on crust, hence, strain and tilt changes should be induced. We operate strain and tilt measurements with ultrasonic tsunami height sensor at Erimo, Hokkaido, Japan. Distance from mareograph to tunnel with crustal deformation sensors is 985m. Direct sea level measurement by ultrasonic sensor allows us to neglect effects of phase shift and nonlinear behavior due to sea-to-well conduit. Clear tilt and strain changes due to tsunami arriving were recorded. Maximum tsunami height by mareograph was 300cm. Observed coherent strain and tilt changes were 3*10-6 and 0.2*10-6, respectively. These values exceed minimum sensitivity considerably. Strain and tilt changes due to possible 60m height tsunami are much lesser than mechanical threshold of sensors. Tilt was more sensitive than strain, may reflect one-half loading. These facts clearly indicate strain and tiltmeters are available as tsunami sensor without height limitation.

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