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The 2010 Chile earthquake tsunami observed by Hi-net tiltmeters

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The 2010 Central Chile earthquake exceited a tsunami in the Pacific Ocean. The tsunami reached Japan approximately 23 hr after the earthquake and the sea level vibrations were observed by ocean area stations such as tide stations and ocean-bottom pressure gauges. In the land area, National Research Institute for Earth Science and Disaster Prevention operates a nationwide high-sensitivity seismograph network (Hi-net) and about 700 Hi-net stations have a high-sensitivity accelerometer (Hi-net tiltmeter) These Hi-net tiltmeters observed ground tilt changes caused by the ocean loading due to the tsunami. The deformation in land area had been observed during massive tsunamis such as the 1960 Chile earthquake tsunami and the 2004 Indian Ocean tsunami [e.g. Tanaka and Tanaka, 1961; Nawa et al., 2007]. However, only a few stations had observed the deformation during those tsunamis and the 2010 Central Chile earthquake tsunami is the first case where wide area and dense network such as Hi-net could observe the deformation due to the ocean loading.

Hi-net tiltmeters in the Pacific coast area observed large tilt changes due to the tsunami. For example, the maximum amplitudes at stations IWEH and SMAH whose distance form the coast are bout 300 m and 500 m, respectively, were 0.3 and 0.1 micro rad, respectively. The maximum amplitude of the tilt changes decayed with the distance from the coast. The amplitudes at stations with the distance of 1 km or less from the nearest coast were approximately 0.1 micro rad and reached 0.02 micro rad at stations with the distance of 30 km. At KRYH station with the distance of 60 km from the coast slight change in ground tilt was observed.

The ground tilt changes oscillated linearly and their directions were generally perpendicular to the coastline near the station. At SZGH in Miyagi Prefecture, the ground tilted in the NE-SW direction which was not perpendicular to the general coastline in Tohoku area. The ground tilting at this station must be affected by the complicated coastline around the station. Moreover, an ellipsoidal vibration of the tilt change at this station may reflect the temporal migration of the ocean loading area along the coastline.

We also simulated the tsunami propagation of the 2010 Central Chile earthquake and the ground tilt changes caused by the ocean loading. We could reproduce the observed ground tilt time series at stations close to the coastline.