Precision of Surface Wave Displacement Seismograms From the 2011 M_W 9.0 Tohoku, Japan Earthquake Recorded by a Dense High-rate GPS Network in Taiwan

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Abstract

High-rate GPS positioning has been demonstrated by its capability in measuring seismic waves of large amplitudes over a wide range of temporal and spatial scales. In Taiwan, over 200 continuous GPS (CGPS) stations with high-rate (1-Hz) records are operated in real-time, and surface waves of the 2011 M_W 9.0 Tohoku, Japan Earthquake were well recorded by high-rate GPS stations and broadband seismometers in Taiwan out to epicentral distances of 2400 – 2800 km. We investigate the potentiality of high-rate GPS displacements for seismology by the GPS position precision analysis and the comparisons of the motions of co-located broadband seismometers data sets after velocity integral process. 1-Hz observations of 183 CGPS stations in Taiwan and neighboring islands were processed by precise point positioning (PPP) to estimate epoch-by-epoch positions for the Tohoku earthquake. Modified Sidereal Filtering (MSF) has been used to mitigate the near-daily periodical variations of high-rate position time series influenced by multipath effect, and the band-pass filter was used to remove noises in inconsequentially marginal frequency. The results show the precision are improved after MSF from 8.7 mm to 5.9 mm in the horizontal and from 28.6 mm to 21.4 mm in the vertical displacements. High consistency between the high-rate GPS and seismometer results of surface waves from the Tohoku earthquake are achieved, and the cross correlation coefficient are enhanced by the band-pass filter (0.008 – 0.1 Hz) from 0.85 to 0.95 in the horizontal and from 0.58 to 0.85 in the vertical displacements. About two-third (115/183) of CGPS displacements are estimated efficiently for reliably-derived surface waves, and the poor records are strongly related to the poor sky view environments (mountainous and urban areas) and some abnormal offsets in displacements are attributed to the cycle slip effect.