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In-situ calibration of NIED Hi-net tiltmeter data

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At every Hi-net observatory operated by National Research Institute for Earth Science and Disaster Prevention (NIED), a high-sensitivity accelerometer (tiltmeter) is installed in a borehole sensor capsule accompanied by a high-sensitivity velocity seismometer. Horizontal components of the sensor have been used as a tiltmeter and the recorded ground tilt data is useful to monitor crustal activities such as slow slip events in southwest Japan [e.g., Obara et al., 2004]. In this study, we present the results of in-situ calibration of the ground tilt data [Matsumoto et al., 2010].

For the in-situ calibration of the borehole tiltmeters, we compare observed amplitudes and phases of M2 and O1 tidal constituents with theoretical ones. From the observed tilt data, we extracted these tidal amplitudes and phases using the BAYTAP-G software [Tamura et al., 1991]. The parameters of theoretical tidal constituents are estimated by a modified version of the software GOTIC2 [Matsumoto et al, 2001]. In order to compute the precise ocean tidal loading effect on the borehole tiltmeters, we use Green's function applicable to arbitrary depths due to surface point loading [Kamigaichi, 1998] and the GOTIC2 program with this Green's function modified by Kamigaichi.

We calibrated ground tilt data at 31 Hi-net stations in Shikoku. The observed amplitudes and phases of M2 and O1 tidal constituents are obtained by averaging the estimated values for a 90-day time-window incremented at one day. Ratios of the observed amplitudes to the theoretical ones range from 0.7 to 1.5, and are consistent with the results of Matsumoto et al. [2010] where tiltmeters operated by Geological Survey of Japan, AIST, in Kii Peninsula were calibrated. Differences between observed and theoretical phases are smaller than 20 degrees, and we can confirm the validity of azimuths of borehole sensors estimated by Shiomi et al. [2003] based on teleseismic waves. However, the NS component at MISH station shows relatively large differences between observed and theoretical tidal constituents: amplitude ratio is 0.4 and phase difference of M2 constituent is 50 degrees. A possible cause of this discrepancy is that the accuracy of the calculated ocean tidal loading effect on this station is not sufficient because this station is located on the Sadamisaki peninsula, which has very complicated coastlines.

Keywords: ground tilt data, in-situ calibration, Hi-net