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Investigation of coseismic displacements and ionospheric disturbances in the Far East of Russia generated by the Great 2011 Tohoku earthquake

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The 2011 Great Tohoku earthquake struck and generated a huge tsunami along the Pacific coast of Honshu Island, Japan, almost two years ago. The near-field crustal displacements and deformations, propagation of surface waves and ionospheric disturbances were carefully investigated in a number of recent publications. However, the far-field coseismic displacements and ionospheric disturbances have not so far been completely investigated. In this study we determine and analyze the far-field coseismic crustal displacements, deformations and ionospheric disturbances induced by the 2011 Great Tohoku earthquake using different GPS data sources (IGS data, continuously and periodically observed regional geodynamic GNSS networks and other GNSS observations applicable for this study). We combined our coseismic offset estimates with the analogous results already published for the Korean Peninsula and China through the six-parameter transformation method using coseismic shifts at a set of common GPS sites. Our analysis shows that the most intense coseismic offsets exceeding 50 mm were localized in the south of the Russian Far East and propagated westward from the earthquake source. We modeled the observed far-field coseismic displacements using different source models developed based on our far-field GPS data and other sources. Quite good agreement between the calculated and observed offsets was found for a simple one-plane rectangular fault model of 200×100 km size with a homogeneous slip value of about 33 m. The total electron content (TEC) data extracted from the original GPS observations were used to study the ionospheric response to this seismic event in the far-field zone. The initial slant TEC series Io(t) were converted into the equivalent vertical values I(t) to normalize the amplitude of TEC disturbances. The I(t) series were smoothed with 2-min time window, to remove high-frequency oscillations, and detrended. The TEC disturbances with periods of 5-15 min propagated from the rupture were successfully detected by GPS methods at distances up to more than 2000 km away from the epicenter. Their intensities decreased away from the quake epicenter. It was found some irregularity of the TEC disturbance attenuation in different directions. A comparative analysis was carried out of the distribution of ionosphere disturbances and of the far-field coseismic displacements. This work was supported by Targeted Comprehensive Research Program of FEB RAS "Recent Geodynamics, Active Geostructures and Natural Hazards of the Far East of Russia (2009–2013)", by the grants of FEB RAS Nos. 12-III--08-017 and 12-I-P4-07; RFBR grants Nos. 12-05-00855a and 12-05-33032.