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Coseismic fault models for the March 9 2011 event (M7.3) and April 7 2011 event (M7.1) based on the geodetic data

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We propose coseismic fault models based on the geodetic data for the March 9 2011 earthquake (M7.3) and April 7 2011 (M7.1) one.

A large earthquake of M 7.3 occurred at the subducting Pacific plate interface on March 9, 2011, 51 hours before the M 9 huge off the Pacific coast of Tohoku Earthquake. We propose a simple rectangular fault model of the March 9 event based on a dense GPS network and one OBP (Ocean Bottom Pressure gauge) site. The coseismic displacements are estimated by baseline analyses. The rectangular fault was estimated by non-linear inversion approach. The simple rectangular fault model can explain observations including the vertical displacement based on tha OBP data. The amount of moment release is equivalent to Mw 7.17. The spatio-temporal aftershock distribution of the March 9 earthquake shows the clear migration to the southward of the estimated our coseismic fault plane. We suggest that the possibility of afterslip occurrence after the March 9 earthquake until the occurrence of the March 11 Mw 9 earthquake. The aftershocks may be triggered by afterslip. The afterslip generates strain concentrated in particularly edge areas of the afterslip region. It is important results for the understanding of the nucleation process of the M 9 huge off the Pacific coast of Tohoku Earthquake.

We also propose a source fault model for the 2011 April 7 earthquake (M7.1) deduced from a dense Tohoku University GPS network and GEONET data. The coseismic displacements estimated by GPS data clearly show the intraslab earthquake characteristics of not only horizontal components but also vertical ones. The rectangular fault was estimated by non-linear inversion approach. The results indicate that a simple rectangular fault model can explain the observations. The amount of moment magnitude was estimated to be Mw 7.16. The Japan Meteorological Agency hypocenter depth of the main shock is slightly deeper than the neutral plane between down-dip compression (DC) and down-dip extension (DE) stress zone of the double-planed deep seismic zone. This suggests that the depth of the neutral plane was deepened by the large slip of the 2011 M9.0 Tohoku earthquake, enabling to initiate the rupture of the thrust fault type M7.1 April 7 earthquake, although more investigations are required to confirm. The estimated fault plane has an angle of 50-60 degree from the surface of subducting Pacific plate. It is consistent with the hypothesis that intraslab earthquakes are thought to be reactivation of the preexisting hydrated weak zones made in bending process of oceanic plates at outer-rise regions.

Keywords: GPS, fore shock, intraslab earthquake