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Euler Rotation of Focal Mechanism to determine the main shock of the East Japan Super Earthquake, March 2011

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Focal mechanism is most important information on the stress field. The focal mechanism is presented by the azimuth and dip of the princepal axes, P, T and N. The changes in the focal mechanism with the 6 parameters can be described by Euler pole and rotation, because the angular distances between pricepal axes are constantly 90^o (http://www.niitsuma-geolab.net/ Special Report 4).

CMT focal mechanism by Japan Meteorological Agency for the earthquakes in the main shock area of 2011 East Japan Super Earthquake are using for this analysis.

The Euler pole and rotation angle can be calculated for the three pairs of princepal axes, PT, TN and NP, on two earthquakes under the adjustment of the hand system. The calculated three Euler poles and rotation angles do not completely agree, because the azimuth and dip of princepal axes are presented with degree unit. Because the rotation angles around the Euler pole should same for the used pair of the princepal axes, the Euler pole is selected with the minimum difference in the rotation angles for the used pair of the princepal axes. The selected minimum differences are generally within 0.1^o.

The Euler rotation analysis is calculated from the main shock of East Japan Super Earthquake to the other earthquakes in this study. In the case of the position of the Euler pole locates on the southern side of the perpendicular line to the trench axis, the top of coordination system for princepal axes rotates toward island arc, and locates on the northern side, rotates toward trench. The rotation angle around Euler pole is defined with sign, positive toward island arc and negative toward trench.

All of 18 fore shocks, started by 16 February 2011, have positive rotation angles within 25^o. All of 35 after shocks have negative rotation angles smaller than -25^o. The complete separation of the sign of Euler rotations demonstrates that the Euler rotation of focal mechanism can be used for determination of main shock.

The positive rotation of fore shocks and the negative rotion of after shocks can be explained as follow. The stress field on the plate boundary along the Japan Trench is controlled by a resultant of shear stress and normal stress along the plate boundary and the compressional principal P axis dips toward trench. Fore shocks occurs by less fracture stress with less normal stress which has shallower dip of P axis than the main shock (36^o). After shocks occurs in the stess field controlled by mainly lithostatic stress with vertical P axis without shear stress which is released by the main shock.

The maximum fore shock M7.3 of 9 March 2011 with $+2.0^o$ of Euler rotation angle induced disorder by misjudgement as main shock, but the Euler rotation quantitically indicate to be fore shock and 7 earthquakes M5.2-6.8 in the next day 10 March 2011 had also positive rotation within $+25^o$.

Keywords: Euler pole, rotation angle, focal mechanism, hand system, determination of main shock, East Japan Super Earthquake