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Non-planar Fault Source Modeling of the 2008 Iwate-Miyagi Inland Earthquake (Mw6.9)

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Iwate-Miyagi Inland earthquake (Mw6.9) occurred on 14 June, 2008, in the northeastern Honshu, Japan. The epicenter is located along Ou mountain areas and the mechanism is reverse faulting. Geodetic observations such as GPS and SAR show the maximum of displacements greater than 2m, and their spatial distributions are quite complex. Especially, the Kurikoma2, one of the GEONET observation station, indicates localized large displacements that was difficult to reconcile with SAR-based observation data. Although fault models based either GPS or SAR have already been published (e.g., Ohta et al., 2008, Takada et al., 2009), no unifying models have yet to be proposed that can explain both GPS and SAR data We estimate a non-planar fault model that can explain both data. We reported the non-planar fault model based on GPS and SAR data in the meetings last year (JpGU, Seismological Society of Japan, The Geodetic Society of Japan). However, the model cannot explain the GPS data at Kurikoma2. As a result of trial and error, at last, we developed the fault model that can largely explain all data.

We first developed a non-planar fault model that explains the GPS data alone. The maximum dip slip is ˜5 m and that of strike slip is nearly 0.5 m. The slip components are localized under Kurikoma2. These slip distributions are consistent with a reverse fault motion and GCMT solution. The moment magnitude inferred from this model is ˜6.9. Thus, this model can well explain the displacements acquired by GPS, and it may suggest that east-dipping fault is unnecessary.

Using the geometry and the slip parameters, we performed an inversion analysis and confirmed whether or not the fault model could explain the SAR data. There are significant misfit residuals greater than 50 cm in radar LOS. Moreover, the calculated range-offset data reveal notable discontinuities in the misfit residuals. These results strongly suggest that the GPS-based co-seismic displacements do not capture what the SAR-based displacement data sets tell us. Besides the pixel-offset data around the epicenter, aftershock distribution data also support the existence of an east-dipping fault segment.

Adding the east-dipping segment, we finally developed the non-planar fault model that explains the GPS and SAR data. The differences from the model based on GPS data alone are slip distribution and its maximum magnitude. While the dip slip component distributed broadly in the west-dipping segment, it is rather localized in the southern part of the east-dipping segment, and few dip slips are derived in the northern part. The maximum dip-slip of east-dipping and west-dipping segment is ˜3.5m and ˜2.5m, respectively, and that of strike slip is ˜1.5m on both segments. These inferred slip distributions are quite consistent with the lack of east-dipping lineament in the aftershock distribution. The total moment magnitude including east and west-dipping segments is ˜6.9. Moreover, the location of top edge on the east-dipping fault matches to the steep gradient of Bouger gravity anomaly.