Crustal Deformations Associated with the Sumatra Earthquake on December 26, 2004 derived from continuous GPS measurements

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We analyze continuous GPS data in and around Indonesia that are available through SOPAC's website (http://gsac.ucsd.edu/) in order to detect coseismic and postseismic deformations associated with the great Sumatra earthquake on December 26, 2004.

We use the following GPS Stations: COCO (IGS) on Cocos Island whose epicentral distance is ~1708km; NTUS (IGS) in Singapore (~905km); BAKO (IGS) in Cibinong, western Java (~1636km); SAMP (BAKO) in Medan, Sumatra (~328km). Observation period is from December 15, 2004 (DOY350) ~ January 23, 2005 (DOY023) so far. The Bernese ver.4.2 is adopted in the coordinate calculation and daily static solutions are obtained. We use IGS Rapid ephemeris and IGS Rapid earth rotation parameters since the final orbit and erp's are not available for the entire period. We set elevation mask to 10 deg and estimate zenith delay every 2 hrs. Integer ambiguities are also fixed. In this preliminary analysis ocean tide load is not taken into account.

Coseismic step of about 13cm can be seen in the EW component of SAMP in Sumatra on December 26. Coseismic step of ~1cm is also seen in the NS component. Postseismic movement began afterward and it amounts to ~3cm westward and ~1cm southward till Januray 23, 2005. Coseismic step is also recognized in the EW component of NTUS in Singapore on December 26. Noticeable disturbances can be seen in NTUS and BAKO during December 28 ~ 29. We regard this disturbance as common meteorological effect not true crustal deformation. If we neglect this disturbance, NTUS moved coseismically by 1cm to the west and by ~2cm afterward. However estimated postseismic movement is larger than coseismic one. Therefore it may be contaminated with seasonal variations. Although we can see a difference in the EW component of BAKO, in west Java, before and after the main shock, we will need data for the much longer period.

We simply calculate averages of horizontal coordinates of these stations before and the after the main shock and obtain coseismic displacement by taking differences of them. We use data till December 31, 2004, in this calculation. SAMP moved toward the epicenter (star in Figure 4) by ~13cm. NTUS also moved west by ~1.5cm. This pattern of horizontal displacements is consistent with the low-angled thrust faulting on the interface between the subducting Australian-Indian plate and overlying Sunda block.

We calculate theoretical displacements using Koshimura's (2004) fault model #6 (for detailed parameters see http://www.dri.ne.jp/koshimuras/sumatra/#m6). Predicted displacements are nearly twice as large as the observed near both SAMP and NTUS (~22cm at 99E, 3N; ~5cm at 101E, 1N). Koshimura's model consists of two segments with a uniform slip of 11m. We think displacement at SAMP can be fitted by moving faults a little bit northward, but significant changes may be necessary to fit displacement at NTUS. It suggests that width is much smaller or dip angle of fault, maybe deeper part, is much steeper.