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Development of rupture process analysis for great earthquakes using Direct Solution Method

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Conventional rupture process analysis methods using teleseismic body waves were based on ray theory. Therefore, these methods have the following problems in applying to great earthquakes such as 2004 Sumatra earthquake: (1) difficulty in computing all later phases such as the PP reflection phase, (2) impossibility of computing called "W phase", the long period phase arriving before S wave, (3) implausibility of hypothesis that the distance is far enough from the observation points to the hypocenter compared to the fault length. To solve above mentioned problems, we have developed a new method which uses the synthetic seismograms computed by the Direct Solution Method (DSM, e.g. Kawai et al. 2006) as Green's functions.
We used the DSM software developed by Nozomu Takeuchi (http://www.eri.u-tokyo.ac.jp/takeuchi/software/index.html) for computing the Green's functions up to 1 Hz for the IASP91 (Kennett and Engdahl, 1991) model, and determined the final slip distributions using the waveform inversion method (Kikuchi et al. 2003).
First we confirmed whether the Green's functions computed by DSM was accurate in higher frequencies up to 1 Hz. Next we performed the rupture process analysis of this new method for Mw8.0 (GCMT) large Solomon islands earthquake on April 1, 2007. We found that this earthquake consists of two asperities and the rupture propagated across the subducting Sinbo ridge which is consistent to the results shown by Taylor et al. (2008) that estimated vertical deformations using coral microatolls. The obtained slip distribution better correlates to the aftershock distributions than existing method. Furthermore, this new method keep same accuracy of existing method (which has the advantage of calculating) with respect to direct P-wave and reflection phases near the source, and also accurately calculate the later phases such a PP-wave.