Gravity Changes Associated with the 2004 Sumatra-Andaman Earthquake - Comparison of SNRNI Models with GRACE data

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Gravity changes associated with the 2004 Sumatra-Andaman Earthquake were detected by GRACE for the first time. Han et al., (2006) reported first detection of +/- 15-microgalileo gravity changes before and after the earthquake using GRACE level-1 data and compared the result with a theoretical value calculated by an elastic half-space model. Ogawa and Heki (2007) presented coseismic geoid depression and postseismic geoid recovery from GRACE level-2 data and theoretical calculation using elastic half-space model.

While coseismic and postseismic gravity changes are widely studied using GRACE data, there were few study which calculated coseismic gravity changes considering sphericity and stratification of the earth. Sun et al., (ex. 2006) gave the formulae of the global gravity changes induced by coseismic dislocation in a spherically symmetric, self-gravitating, compressive and layered earth. In this study, we investigated the effects of earth's curvature and stratification on the coseismic gravity changes with the same spatial resolution as GRACE and discussed GRACE sensibility to the coseismic gravity changes. We calculated the coseismic gravity changes induced by the 2004 Sumatra Earthquake using the formulations presented by Sun and smoothed the results using Gaussian averaging kernel for the comparison with GRACE data.

We, first, compared the coseismic gravity changes calculated by half-space earth model and spherical earth model under the same subsurface structure in order to estimate the effects of the earth's sphericity. The discrepancies between the results were very small and we can conclude earth's curvature does not make a big difference to coseismic gravity changes.

To investigate the effects of earth's stratification, we compared the gravity changes calculated by homogeneous spherical earth model and layered spherical earth model - PREM. We can found great difference between the gravity changes computed by the two earth models. Positive gravity changes were dominant in the calculation by PREM, though negative gravity changes were dominant in the results computed by homogeneous earth, which indicated the importance of earth's layer structure to the coseismic gravity changes.

We compare the computed coseismic gravity changes by homogeneous earth model and PREM with GRACE data. Gravity changes computed using homogeneous earth were well agreed with GRACE data. On the other hand, the results by PREM showed great difference. We also computed gravity changes using different earth model - 1066A, the results were not so different from PREM, which means gravity changes calculated by realistic earth model does not agree with GRACE data.

Our results indicated the earth's sphericity greatly affects the coseismic gravity changes and theoretical calculation by elastic half-space model and following interpretation of GRACE data must be reevaluated. In order to make an improving interpretation of coseismic gravity changes observed by GRACE, we try to confirm the computation algorism based on Sun et al., (2006) and validate PREM and 1066A considering the lateral inhomogeneous structure of the earth.