Coulomb's static stress changes induced by the 2011 Tohoku-Oki earthquake: a case of spherical earth

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Some studies indicated that seismicity around a main shock is activated where the Coulomb's static stress changes (ΔCFF) are positive (e.g. King *et al.,* 1994; Stein, 1999). ΔCFF is defined as ΔCFF$=\Delta\tau+\mu\Delta\sigma$, where $\Delta\tau$ is the shear stress change on the fault (positive for the inferred slip direction), $\Delta\sigma$ is the normal stress change to the fault (positive for fault unclamping) and μ is the apparent friction coefficient. The failure is promoted if the ΔCFF is positive. Okada's (1992) theory on coseismic internal deformation in a homogeneous semi-infinite media has been widely used to calculate ΔCFF. Using this theory, Toda *et al.* (2011) estimated the ΔCFF induced by the 2011 Tohoku-Oki earthquake. Their results showed that the broad area over epicentral distance of several hundreds kilometers undergoes the stress changes larger than 0.1 bar. It should be considered whether Okada's (1992) theory can be directly applied to the calculation of such a broad deformation field. In other words, it is necessary to estimate the effect of the Earth's curvature and stratification on the deformation field. However, the method of theoretical calculation of coseismic internal deformation in a spherically stratified earth has not been entirely established because previous works assumed an incompressible earth (Piersanti *et al.,* 1995) or oversimplified the gravity (Pollitz, 1996). We have realized the theoretical calculation of coseismic internal deformation in a spherically stratified earth without such unrealistic approximation. We applied our method to the preliminary computation of the volumetric strains caused by the 2011 Tohoku-Oki earthquake and found that the discrepancies of the volumetric strains for the conventional half-space from those for a spherically stratified earth exceed 30 per cent at the epicentral distance of about 200 km. It is expected that there are discrepancies of the same order among the ΔCFF for the two earth models.

In this presentation, we apply our method to calculation of ΔCFF induced by the 2011 Tohoku-Oki earthquake and discuss the difference between those for a spherically stratified earth and for a half-space.

Keywords: Coulomb's static stress change, 2011 Tohoku-Oki earthquake, spherical earth, internal deformation