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Search for geoid height changes due to the Tohoku Oki earthquake (Mw9.0) by satellite altimeter Jason-2

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On March 11, 2011, The Tohoku Oki earthquake (Mw9.0) occurred, and the accompanying crustal deformations and gravity changes detected by SAR, GPS, and GRACE have been reported (e.g., Matsuo and Heki, 2011). While these results are very important to reveal the mechanism of the earthquake, if we detect coseismic changes of geoid height over the ocean, we can exploit the data to constrain the earthquake mechanisms immediately above the epicenter because the co-seismic geoid height changes would be one of the few near-field data for the earthquake offshore. However, no successful report of the detection of coseismic geoid height changes have been reported yet.

Geoid height changes link with mean sea surface height changes, and one of the most useful ways to calculate them is to use satellite altimeter. In this study, we used GDR (Geo Physical Record) SSHA (Sea Surface Height Anomaly) data of satellite altimeter Jason-2 and searched for geoid height changes due to the Tohoku Oki earthquake. Although we don't think about sea bottom changes, water load and so on, we estimated the geoid height changes by the fault model reported by Geospatial Information Authority of Japan before this research. Then, it is expected that coseismic geoid height was changed to 3.5cm at most at latitude 38 degrees north and longitude 144 degrees east. And the Jason-2 pass 238 is running around this point, so that it is possible to observe those changes by Jason-2 (measuring precision of 2 ~3cm). The biggest problem to search the geoid height changes is how to eliminate sea surface height changes due to ocean tide, oceanic currents and so on. In this study, we use SSH (Sea Surface Height) data from JCOPE2 (Japan Coastal Ocean Predictability Experiment) oceanic circulation model in order to correct those sea surface height changes, and this experiment is provided by JAMSTEC (Japan Agency for Marine-earth Science and Technology). Jason-2 GDR SSHA data and JCOPE2 SSH data have similar trends of these changes. We thought the differences between those two data suggest the geoid height changes and we compared these differences.

We stacked and compared these differences of each year (2009~2011) and there is the about 20 cm peak around latitude 38 degrees north in pass 238 data across the earthquake. But it is far from the theoretical value. And although we applied High Pass Filter on this result, we couldn't get any useful information about the geoid height changes.

This study has room for us to consider contributions for the geoid height changes by sea bottom changes, water load and so on. In point of fact, many kinds of changes which must not be ignored have been found: the local more-than-10m sea bottom changes by the fault model reported by Geospatial Information Authority of Japan, about 5m mean sea surface changes around latitude 38 degrees north in Jason-2 pass 238 obtained by Jason-2 observation, and so on. Our future works are to consider these things. Furthermore, to check the noise properties on other passes, we are going to use SSHA data of Jason-1, the conventional model of Jason-2.