

Change in the sea surface height observed by satellite altimetry before and after Sumatra earthquake

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1. Introduction

The aftershock region of the Sumatra earthquake of December 26, 2004 is 1300 km or more in length (by USGS). It is located along the northern Sunda trench and arcs from Simeulue to North Andaman Islands. This region may include the source region of the main shock. Several tracks of the polar orbit satellites used to measure the sea surface height by altimetry pass through the source region or its neighboring area. We compared the sea surface height anomaly in these tracks before and after the main shock.

2. Data and Methods

We used interim datasets obtained by altimetry from JASON1, which was operated in 10-day periodic orbits. Error factors of geoid, ocean tides, and atmospheric pressure were removed using fixed models and methods.

We only consider the case in which the sea surface height was obtained within the period from December 16 to January 5, both before and after the main shock, at the same sampling point on the satellite's orbit. In addition, data on December 26, which are considered to be influenced by the tsunami, were not used.

3. Results

The observations reveal that after the Sumatra earthquake, the sea surface height along satellite tracks between the arc islands and the trench axis in the zonal region, extending from Nicobar Islands to the west coast of northern Sumatra, is greater than that before the main shock by 0.2-0.3 m. On the other hand, that after the main shock is smaller than that before by 0.2-0.4 m in the zonal region between off east of northern Sumatra and Nicobar Islands. With the exception of Malacca Strait and off east of the Ayeyarwady River, the difference in the sea surface height is less than 0.2 m before and after the main shock.

After checking the difference in the sea surface height in several intervals without the date of occurrence of the main shock, we observed that typical oceanological changes of the sea surface height anomalies with measurement errors are less than 0.1-0.2 m at 10-day intervals, although these values tends to be larger in coastal areas than oceanic area.

4. Discussions

The observations show some changes of the sea surface height are larger than typical oceanological phenomena. Therefore, it is necessary to investigate this phenomenon.

First, it is difficult to consider meteorological or oceanological turbulence, except in extraordinary cases such as cyclone passages, with a horizontal scale of the order of 100km and the potential to generate a sea surface height anomaly of 0.2-0.4 m/10 days, since the source region of the Sumatra earthquake is near the equator.

Second, it is difficult to conclude coseismic gravity change is the principle factor. Crustal deformations caused by an earthquake change the gravity field; thus, the average sea surface height, which almost equals to the geoid height, increases or decreases. However, following the example of the 1964 Alaska Earthquake, estimation of the change in geoid height derived from M9 class earthquake is limited to the order of cm. Sun and Okubo (1998, *Geophy. J. Int.*) formulized gravity potential change due to a finite rectangular fault with a uniform slip and estimated that the geoid change due to the 1964 Alaska Earthquake was approximately 1.5 cm in its source region. Observed sea surface height anomaly change in the source region of the Sumatra earthquake (0.2-0.4 m) is more than 10 times larger than the estimated geoid change due to the Alaska Earthquake assumed Mw 9.4 with 10 m uniform slip.

We have not found yet the rationale for this observation. We will reveal updated results and are prepared to discuss this issue from various angles to explore the mechanism of the large change in the sea surface height by satellite altimetry before and after the Sumatra Earthquake.

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