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Extraction of crustal deformations and oceanic fluctuations from ocean bottom pressures

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It has been well known that megathrust earthquakes such as the 2004 Sumatra-Andaman Earthquake (Mw 9.1) and the 2011 the Pacific Coast of Tohoku Earthquake (Mw 9.0) had devastated the coastal areas in the western of Indonesia and in the north-eastern of Japan, respectively. To mitigate the disaster of those forthcoming megathrust earthquakes along Nankai Trough, the Japanese government has established seafloor networks of cable-linked observatories around Japan: DONET (Dense Oceanfloor Network system for Earthquakes and Tsunamis along the Nankai Trough) and S-net (Seafloor Observation Network for Earthquakes and Tsunamis along the Japan Trench). The advantage of the cable-linked network is to monitor the propagation process of tsunami and seismic waves as well as seismic activity in real time.

DONET contains pressure gauges as well as seismometers, which are expected to detect crustal deformations driven by peeling off subduction plate coupling process. From our simulation results, leveling changes are different sense among the DONET points even in the same science node. On the other hand, oceanic fluctuations such as melting ice masses through the global warming have so large scale as to cause ocean bottom pressure change coherently for all of DONET points especially in the same node. This difference suggests the possibility of extracting crustal deformations component from ocean bottom pressure data by differential of stacking data. However, this operation cannot be applied to local-scale fluctuations related to ocean mesoscale eddies and current fluctuations, which affect ocean bottom pressure through water density changes in the water column (from the sea surface to the bottom). Therefore, we need integral analysis by combining seismology, ocean physics and tsunami engineering so as to decompose into crustal deformation, oceanic fluctuations and instrumental drift, which will bring about high precision data enough to find geophysical phenomena.

In this study, we propose a new interpretation of seismic plate coupling around the Tonankai region along the Nankai Trough, and discuss how to detect it by using the DONET data effectively. In the future, we have to extract the crustal deformation component by separating other components such as instrumental drift and oceanic changes as an integral study collaborated by seismology, geodesy, physical oceanography, and mechanical engineering.