Effects of ocean dynamics on ocean bottom pressure data inferred from the OBP observations in the off-Sanriku area

Takayuki Tamaki[1], # Hiromi Fujimoto[2], Ryota Hino[3], Tadahiro Sato[4], Koji Matsumoto[5], Toshihiko Kanazawa[6]

[1] Science Tohoku, [2] School of Sci., Tohoku Univ., [3] RCPEV, Tohoku Univ., [4] NAO, [5] Div. Earth Rotation, Natl. Astronomical Obs., [6] ERI, Tokyo Univ

Superconducting gravimeters and absolute gravimeters have enabled us to measure the gravity field with more than 1 micro-Gal accuracies on land. The satellite altimetry by such as TOPEX/POSEIDON (T/P) offers us precise distribution of the sea surface height (SSH) in global scale. With the launch of the satellite gravimeter GRACE, it is expected that the earth's gravitational field will be measured with a precision of 1 micro-Gal over the entire surface. At these accuracies, we should know not only the sea surface height (SSH) variations but also the redistribution of mass in the oceans accompanying with this variation. Recently, it has become possible to observe pressure variations precisely at the deep ocean bottom environment. Owing to such the rapid advances in geophysical observation technology, it is now becoming possible to evaluate how dynamic changes in the ocean and the atmosphere affect the solid earth.

In order to study influences of the ocean dynamics on the observed gravity, we have started a joint measurement of the gravity, the sea surface height and the ocean bottom pressure (OBP), by using the superconducting gravimeter, the satellite altimetry, and the OBP sensors. For example, SSH changes with mass transfer may cause load deformation of the seafloor observed as the OBP changes, and hence will also be observed as gravity changes.

In this study, we will show several relations between the ocean dynamics and the OBP changes clarified by our OBP observation made in the off-Sanriku region. In 2000, we deployed two OBP sensors; one (Sn1) is at an orbital cross-over point of the satellite altimeter and the other (Sn2) is 33 km to the west of Sn1. Sn1 is about 100 km off the eastern coast of the mainland of Japan. Water depths at Sn1 and Sn2 are 2115m and 1607m, respectively. We also used sea level data obtained at a coastal tide station (Kamaishi) operated by JHD as a reference of the sea level change during the OBP observation period. The observation was made from April 25 to October 16. Our pressure sensors have a full scale of 7,000 m in water depth and a resolution of 3 mm in water level scale.

We found that the observed OBP variations can be decomposed into three major components: (1) ocean tide, (2) annual and semi-annual variations, and (3) irregular variations due to other effects.

(1) Ocean tide:

Comparing the ocean tide components in the OBP records estimated by a program 'BAYTAP-G' (Tamura et al. 1991) with those calculated from an ocean tide model 'NAO.99b' (Matsumoto et al, 2001), we conclude that the observed tidal components can be predicted well by the global ocean tide model at an accuracy better than 1 cm.

(2) Annual and semiannual variations:

We estimate amplitudes and phases of the annual and semiannual variations in the coastal sea level data and compared those with the OBP data. The result indicates that the annual and semiannual variations observed from the OBP data are only 1/3 to 1/4 of those in the sea level variations.

(3) Irregular variations:

We compare the OBP records and the sea surface height (SSH) variations obtained from the T/P satellite altimeter. Correlations between the OBP and SSH are not high in long period (over 20 days) range except the annual and semiannual variations. The OBP data did not show an ocean dynamic phenomena with spatial scale on the order of 100 km and time scale on the order of one hundred days those which were identified from the SSH data. This may indicate that the OBP is not sensitive to sea level anomalies of such the local scale. The OBP variations with periods from a few days to a week show a little correlation with the coastal sea level and also with the atmospheric pressure data. This suggests that the oceans behave in a way of non-inverted barometer to the atmospheric pressure changes in this time scale.