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Global barotropic ocean modeling for detection of seafloor vertical deformation from ocean bottom pressure observation

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Seafloor vertical displacement can be detected from ocean bottom pressure (OBP) measurements. Large seafloor vertical displacement (O(10 cm)) related to volcanic eruptions and giant earthquakes (M>8) has been easily detected from tide-corrected OBP time series (Fox, 1990; Baba et al., 2006). On the other hand, it is expected that intermediate earthquakes of M7 induce vertical displacement with amplitude of several centimeters and duration less than a few months (Miura et al., 2006). In order to detect the vertical motion of the seafloor due to interplate slip events, we have started continuous observation using an array of OBP gauges with 10-km spatial separations in the landward slope area of the middle Japan Trench (Hino et al., 2009). Detection of such seafloor vertical displacement (O(cm)) requires correction to remove low frequency ocean variations in addition to tides from OBP time series. The low frequency ocean phenomena of periods ranging from days to months are mostly represented by barotropic motions driven by barometric pressure and wind (Ponte, 1993; Ponte and Gasper, 1999; Hirose et al., 2001). Carrere and Lyard (2003) applied a finite-element method for this barotropic ocean modeling which permits finer grids near coasts. This grid system may be insufficient to the ocean modeling with spatial resolution of several kilometers in open seas. We use a finite-difference method to address the high resolution (O(km)) ocean modeling even in open seas. In this presentation, we demonstrate global barotropic ocean modeling driven by barometric pressure and wind with a spatial resolution of 1/12 degrees. Bathymetry and coastlines are taken from ETOPO1. Surface air pressure and wind of JRA-25 reanalysis data drive the modeled ocean. Model accuracy is validated by the OBP data of Tohoku University (8 time series) and the DART (Deep-ocean Assessment and Reporting of Tsunamis) system of global coverage (54 time series). The model result shows agreement with the tide-corrected OBP time series with a mean correlation coefficient of 0.6. The residuals between the model and the observation averagely show 20% reduction in rms compared to the rms of the tide-corrected OBP time series. The model result shows especially good representation of variations of periods less than 10 days. It was found that the model accuracy strongly depends on the spatial resolution of the modeling, and we will perform simulations with a spatial resolution of 1/30 degrees. Model dependence on the boundary conditions of bathymetry and reanalysis data will be also examined.

Keywords: ocean bottom pressure, seafloor vertical deformation, ocean modeling