Variability in Seafloor Pressure from Ocean Circulation at the Mexico Subduction Zone offshore Guerrero from Simulations and In Situ Data

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1. Introduction

Absolute pressure gauge measurements at instruments deployed on the ocean bottom have been shown by recent studies in marine geodesy to contain signals from the vertical component of crustal deformation. However, obtaining estimates for the uplift or subsidence at a site locally requires isolating the pressure change due to motion of the seafloor from the variability within the overlying water column. The removal of such "oceanographic noise" has previously been accomplished for array of seafloor pressure recorders by assuming that the ocean circulation is sufficiently well-correlated across the area covered by the array regardless of the time scale. Thus, by selecting one or several reference sites in an area with no expected crustal deformation (for example, on the incoming plate) and then taking the residuals of the pressure records with respect to a single or combined reference signal, the signals from oceanic variability may be eliminated. Another approach is to take the predicted ocean bottom pressure from a numerical ocean circulation model and remove that from the instrumental records instead to obtain the residual signal.

1. Data and Methods

In this work, we aimed to examine this assumption further by analyzing simulated ocean bottom pressure at subduction zone margins. For our work, we used the Estimating the Circulation & Climate of the Ocean (ECCO) model distributed by NASA-JPL, which assimilates satellite and in-situ data in its numerical solutions for the global ocean circulation. The ECCO2 version of the model assimilates satellite observations as well as in-situ data for sea surface height, temperature, salinity, and wind stress to constrain numerical solutions for the global ocean circulation The model output is provided at 1-day intervals on a ¼-degree grid spacing. We extracted ocean bottom pressure and sea surface height for a selected area at the Middle America Trench offshore Guerrero, Mexico. By performing a cross-spectral analysis of the simulated sea surface height (SSH) and ocean bottom pressure (OBP) from 1992 to 2018, we estimated how well these two variables correspond to each other up to periods of 64 days. Meanwhile, for the ocean bottom pressure records, we first processed the raw data by applying a low-pass filter with a cut-off period of 40 hours to remove the contribution from tides. For the spectral analysis, we downsampled the data to 1-day intervals and then used a multitaper estimation method. This allowed for testing the significance of periodic components in the signal.

3. Results and Discussion

Guided by the results from the computed sea surface height-ocean bottom pressure transfer functions, we then filtered the records from selected instrument sites to calculate the variability at period bands which overlap with the typical durations of previously observed slow slip events at those subduction zones. For the ECCO model results, OBP/SSH coherency is generally low but it is highest at periods of a few days, suggesting that depth-dependent circulation such as baroclinic phenomena may be more important there.

For some OBPR stations at Hikurangi and Guerrero, a peak in the calculated power spectral density is observed at around 14 days. This could be related to M_f, or the fortnightly tidal constituent which has a period of 13.8 days. However, investigating the contribution of M_f and other long-period tides thoroughly would require the construction of a longer time series spanning multiple years, perhaps by assembling the records from subsequent instrument deployments.