Quality analysis of empirical Green's functions for Ocean Bottom Seismometers in Cascadia

Xiaotao Yang*[1], Haiying Gao[1], Sampath Rathnayaka[1], Cong Li[1]

1. Department of Geosciences, University of Massachusetts Amherst

The deployment of ocean bottom seismic arrays has facilitated significant date sets for the science community in imaging the seismic velocity structures and understanding the lithosphere/mantle dynamics. Surface wave tomographic methods, using data from ambient noise cross-correlations, have been commonly implemented to image the crust and upper mantle structure. The quality of the datasets is fundamental to ensure reliable velocity images. In this study, we conduct a comprehensive analysis of a few factors, including site conditions, types of instruments, and tectonic settings, that may influence the waveform quality of ocean bottom seismometers. We integrate all OBS data between 2011 to 2015 from Cascadia Initiative, the Gorda Deformation Zone experiment, the Blanco Transform Fault experiment, the Neptune Canada array, and land stations (Fig. 1a). We quantitatively analyze the signal-to-noise ratio of empirical Green's functions from ambient noise cross-correlations of vertical-component seismic waveforms. The average signal-to-noise ratio at each station is computed as the mean of signal-to-noise ratios from this virtual source to all receivers. In general, we observe the lowest signal-to-noise ratios for stations located between the trench and the coastlines. For most stations located within the Juan de Fuca plate, the average signal-to-noise ratio is on average greater than 8 (Fig. 1b). In contrast, stations in the Gorda Plate show extremely strong variations of signal-to-noise ratios (Fig. 1b). We find that water depth and sediment thickness are the two most important factors that influence the data quality. The average signal-to-noise ratio at each "virtual source" decreases from deep water to shallow water (Figs. 1b & 1c) and with increasing thickness of the ocean sediments (Fig. 1d). Another general trend we observe is that the LDEO stations, which are mainly HHZ component, on average have relatively lower signal-to-noise ratio compared to the WHOI and SIO stations, which are mostly BHZ components.

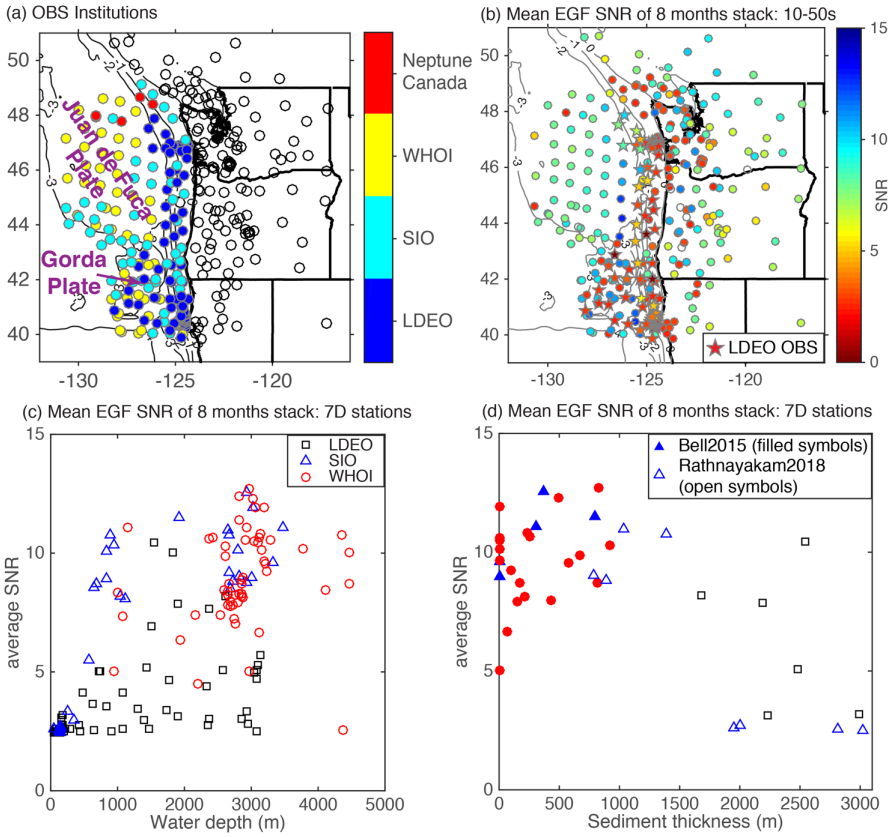

Figure 1. (a) Distribution of seismic stations used in this study, colored by institutions for offshore stations. LDEO: Lamont-Doherty Earth Observatory; SIO: Scripps Institution of Oceanography; WHOI: Woods Hole Oceanographic Institution. (b) Average signal-to-noise ratio of the empirical Green's functions at periods of 10 - 50s. LDEO stations, with relatively high noise level, are plotted separately as stars. (c) Relationship between SNR and water depth. (d) Relationship between SNR and sediment thickness at offshore stations. Bell2015 data is from Bell et al. (2015, SRL). Rathnayakam2018 data is from Rathnayakam and Gao (in review, SRL).