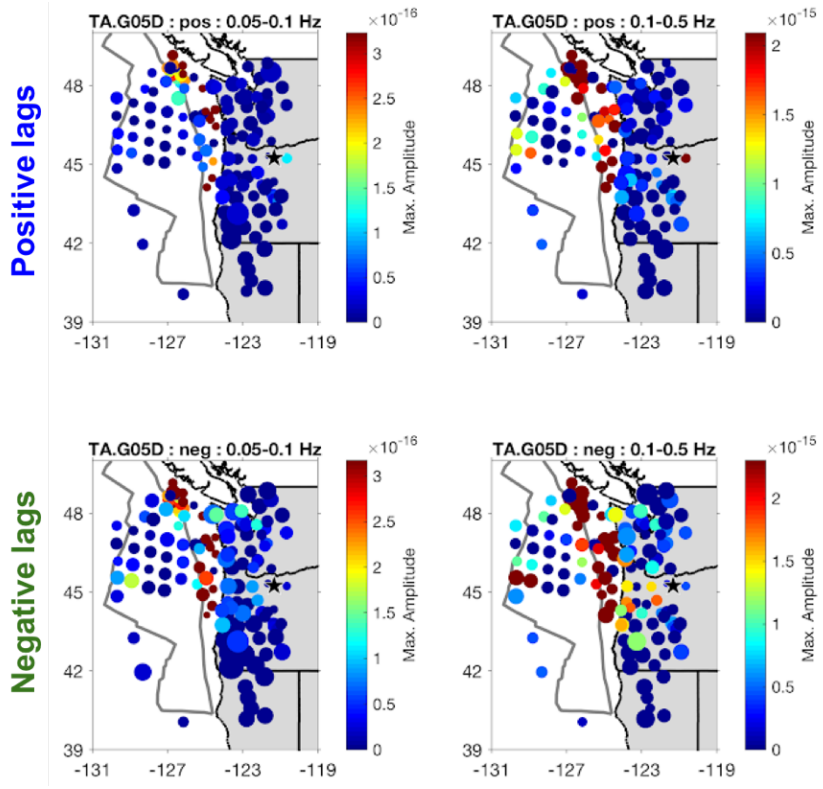
Characterize the Propagation of Seismic Waves along the Cascadia Subduction Zone through Seismic Interferometry

Xiaotao Yang[1], Zhitu Ma[2], Marine Denolle[1]
1. Department of Earth and Planetary Sciences, Harvard University. Cambridge, MA, USA
2. State Key Laboratory of Marine Geology, Tongji University. Shanghai, China

As one of the most active convergent margins on the Earth, the Cascadia subduction zone is the locality of potentially devastating earthquakes that could cause severe damages to large coastal cities. Additional hazards may come from the tsunami induced by megathrust earthquakes. It is, therefore, critical to estimate the ground shaking during large earthquakes and model the influence of sediments along the accretionary wedge on the ground shaking and on the dynamics of shallow earthquakes. Here we use seismic interferometry to characterize the propagation of surface waves along the Cascadia margin, particularly the accretionary wedge. We extracted 0.02-2.4 Hz daily empirical Green's functions from ambient seismic noises recorded by 227 Ocean Bottom Seismometers and 228 onshore stations from all available networks between 2010 and 2015. The surface waves from daily cross-correlations demonstrate strong temporal variations in terms of amplitudes and frequencies. For station pairs across the accretionary wedge, the estimated phase velocity at the frequency of > 0.5 Hz (most sensitive to the depth of < 10 km) is about 0.7-1 km/s, much lower than previous models. We are exploring denoising techniques with the help of machine learning and robust stacking to improve the quality of cross-correlations while preserving the relative amplitudes. We examine the characteristics of wavefield propagating along the margin and calibrate them with waveforms from local earthquakes. Results from this study will contribute to ground motion and dynamic rupture modeling for large earthquakes and, hence, the validation of earthquake early warning systems in the Cascadia region.



Peak amplitudes extracted from cross-correlation functions from the virtual source at TA.G05D (star) to all other receivers (color-coded dots). The cross-correlation functions are filtered at 0.05-0.1 Hz (left) and 0.1-0.5 Hz (right) for the results from positive lags (top panels) and negative lags (bottom panels).