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Retrieval of tsunami Green's function from the cross-correlation of continuous ocean waves

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Recently, a technique called seismic interferometry has drawn much attention of seismologists, by which seismic Green's function between two points is extracted from the cross-correlation of ambient seismic noise [e.g. Campillo and Paul 2003 Science]. Hence, seismologists can calculate the Green's function or estimate subsurface structure by analyzing ambient noise, without using any natural or artificial earthquakes. For tsunami researchers, it is necessary to use correct tsunami Green's function for tsunami source inversion analysis or simulating disastrous tsunami caused by anticipated huge earthquakes. Correct tsunami Green's functions are supposed to be obtained by numerical tsunami simulation with accurate and high-resolution bathymetry data. However, we cannot always estimate correct Green's function. For example, in the 2010 Maule, Chile earthquake tsunami, there was a significant discrepancy (~ 30 min) between observed and calculated tsunami arrival around Japan [Fujii and Satake 2010 SSJ Fall Meet.]. Therefore, it would be very useful if we can synthesize tsunami Green's function from the observation, in other words, if we can retrieve tsunami Green's function from the cross-correlation of observed continuous ocean waves. This study, hence, investigates a theoretical background for the retrieval of tsunami Green's function from the cross-correlation of long-period random ocean waves. Considering that tsunami has long wavelength and sea-bottom topography acts as point-like scatterers, we employ the first-order Born approximation. The framework of this study follows Sato [2009 GJI], who dealt with the case of 3-D scalar waves with isotropic scattering. For the application to the case of long-wavelength tsunami, this study extends his approach to a case of 2-D waves with a special non-isotropic scattering.

Keywords: Tsunami, Theory