FDM Simulation of Trench Trapped Rayleigh Wave

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We studied a trench trapped surface wave which is observed occasionally associated with subduction zone earthquake occurring in Northern Japan by analyzing broadband record and FDM simulation of seismic wave propagation using heterogeneous subduction zone structure. In this study we examined the effect of sea water and oceanic sediments for developing such peculiar seismic phase in detail in order to improve the simulation model for subduction zone earthquakes. For analyzing observed records, it is considered that the effect of oceanic structure should be stronger for along the trench path than that across trench. In fact, a particular phase seems to be due to the thick cover of seawater over the trench has been found in such records. Nakanishi (1992) reported such phases recorded near the Kuril Trench. Yomogida et al. (2002) suggested by means of 2D ray tracing that the phase is a Rayleigh wave trapped in the Kuril Trench because of the low velocity zone along the trench with a thick seawater layer. We searched whole F-net broadband record catalog of Japanese stations for nearby, shallow event and find some other particular phases which are very similar to that by Nakanishi (1992). For example, one of them is found in the record observed at station of AOGF located at Izu islands during the outer-rise earthquakes occurred at off Sanriku. In the record, there is a large amplitude phase after 500 s of the S wave, far later form the arrival of surface waves. The dominant period of the later phases is about 15 sec dominating in three-component seismograms. From the particle motion, this phase is considered to be a retrograde Rayleigh wave. The similar phase was also found at station HJOF, the neighbor of AOGF, but the amplitude is smaller than that of AOGF. On the other hand, such phase did not appear on the waveforms recorded during earthquakes occurring at west side of Japan Trench. As considered the propagation path for these events, the peculiar phases we found are considered to be the trench trapped Rayleigh wave as firstly noted by Nakanishi (1992). In order to investigate the cause of such trench trapped Rayleigh wave, we conduct 2D and 3D simulation of seismic wave propagation based FDM with a heterogeneous subduction zone structure including seawater, oceanic sediments, and subducting plate. In this simulation we examined various structural models to see the roles of thick seawater, lateral variation in seafloor topography and heterogeneities in sedimentary layer on the development of observed feature of the trench trapped Rayleigh wave in detail. The results of simulation demonstrated that the trench trapped Rayleigh wave is developed by a converting from the oceanic acoustic wave propagating in the deep seawater along the Japan Trench. The acoustic wave is converted into the surface wave efficiently at a steep slope of onshore sea floor. It is also confirmed that the dominant period of the Rayleigh wave depends on the depth of seawater.