EGU2020-11124
https://doi.org/10.5194/egusphere-egu2020-11124
EGU General Assembly 2020

In-situ microseism noise generation measured from distributed acoustic sensing on seafloor optical cable

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Measuring seismic and acoustic signals on seafloor telecom cables has proven recently its very high potential for earthquake monitoring but also for beter understanding the interaction between the oceans and the solid earth. A consequence of these interactions is the generation of the primary and secondary microseismic noise on coastal regions and in the deep ocean respectively. These seismic noises that propagate across continents are central to a large fraction of todays' seismic imagery and monitoring campaigns. Compared to previous studies and instrumentation setups, acoustic sensing over oceanic telecom cables offer the unique ability to measure in a very dense manner waves that are generated on the seafloor. We analyse a week long record of ambient noise measurements on the 41.5 km-long seafloor telecom cable offshore Toulon, south of France. At shallow depth, close to the coast, we measure the pressure changes caused by the oceanic gravity waves. The bottom pressure is then compared to an oceanographic buoy located a few kilometers away from the cable. The amplitude and frequency of the pressure are modulated by the gravity waves height and dominant periods. This observation opens the way for a distributed measurement of the oceanic waves characteristics over several kilometers. At depth larger than a 1km, we observe Scholte waves at the ocean-solid earth interface produced by the non-linear interaction of gravity waves. These waves have the double frequency of the gravity waves seen at the coast. We find that the amplitude and frequency change over time, as do the gravity waves observed near the coast. The frequency-wave number decomposition of the signal reveals that the apparent velocity of the Scholte waves does not depend of the azimuth of the fiber. These observations confirm that these deep Scholte waves are secondary microseismic noise, generated locally from the interaction of landward gravity waves with oceanward gravity wave reflected on the coast. Spatially distributed monitoring of the ambient noise wave field at the ocean-solid earth interface provides a better understanding of the noise generation and therefore will allow a better modeling of the ambient noise in the future.