On the origin of secondary microseism Love waves

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The interaction of ocean surface waves produces pressure fluctuations at the seafloor capable of generating seismic waves in the solid Earth. Secondary microseisms are the strongest terrestrial background seismic vibrations and account for the majority of the global seismographic data volume. They are generated by wind-driven ocean storms, whose energy couples with the solid Earth at the seafloor. Traditional generation theories for secondary microseisms satisfactorily explained secondary microseisms of the Rayleigh type but the accepted mechanism was unable to justify the presence of horizontally (transversely) polarized *Love* surface waves, which nevertheless have been observed in seismic data since the beginning of the twentieth century. Hence, an explanation for two-thirds of the worldwide ambient wavefield was wanting for over a century. Using unprecedented high-frequency numerical simulations of global seismic wave propagation, we have shed light on this hundred-year-old conundrum. These challenging numerical simulations help explain the origin of secondary microseism Love waves as being generated for a small fraction by boundary force-splitting at bathymetric inclines—but the majority is generated by the interaction of the seismic wavefield with wavespeed heterogeneity within the Earth. Secondary microseismic Love waves originate ergodically due to lateral heterogeneities in Earth structure. Our modeling quantitatively explains the observed seismic wave partitioning, accounts both for the effect of three-dimensional heterogeneity and for bathymetric force splitting, which is of minor importance but strongest in the steepest portions of midocean ridges and near ocean-continent boundaries. Small and well-focused Love-wave arrivals are observed at some seismographic stations, at great distances from storm sources, with strong seasonality observed in the shortest period bands (below 7 s). Our understanding of these processes is important to account for realistic source distributions in full-wavefield ambient-noise tomography.

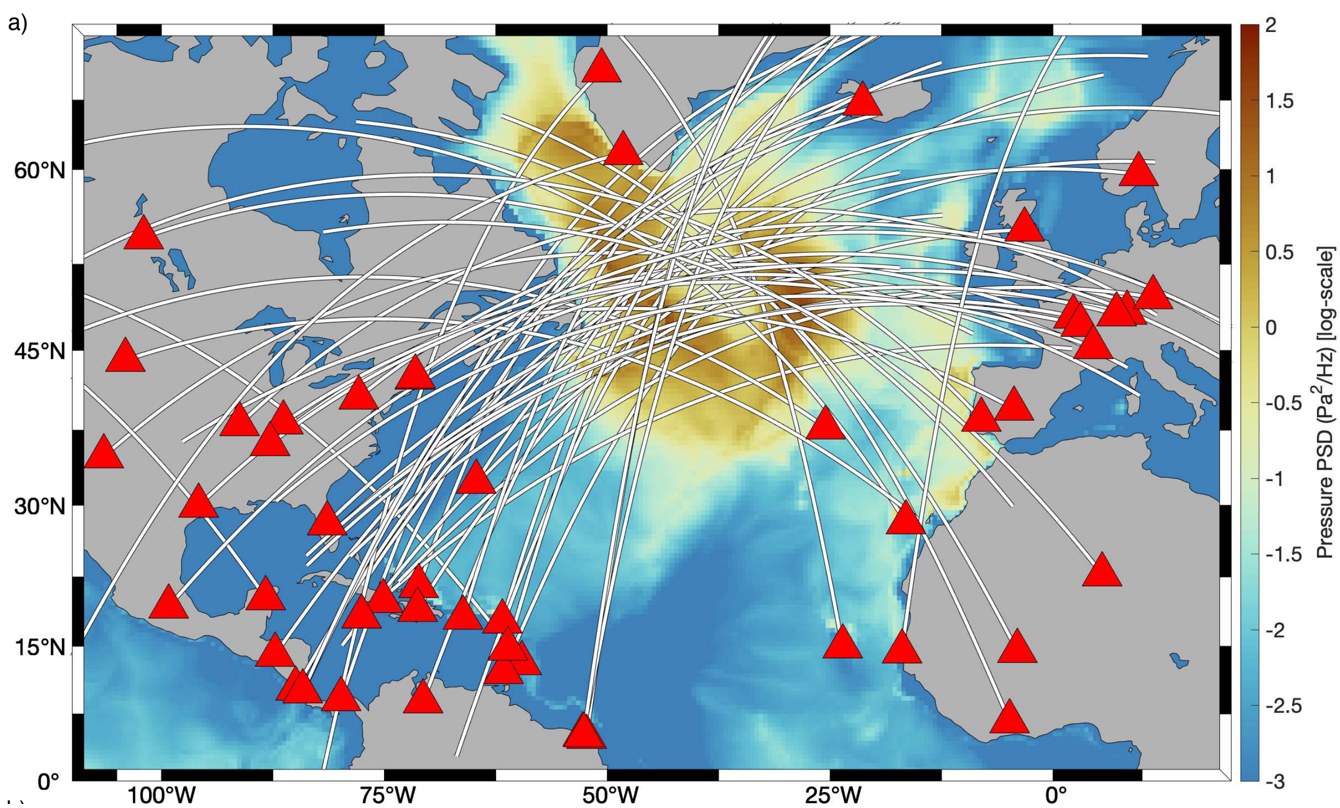

Figure 1: *Great-circle paths along the main direction of arrival for stations around the North Atlantic Ocean, as computed in 3-D Earth model S40RTS in the presence of bathymetry. The background color represents the median pressure power spectral density of the oceanic sources. Stations from the Global Seismographic Network were vital to conducting this study.* `http://doi.org/10.1073/pnas.2013806117` *and* `http://doi.org/10.1093/gji/ggab095`