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Propagation and source effects on the ratio of Love to Rayleigh energy in the ocean-generated microseismic wavefield

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The observed secondary microseismic wave-field is composed by Rayleigh and Love waves. While the presence and amount of Rayleigh waves can be explained well, the generation of Love waves is still under debate. We investigate both internal multiple scattering of surface waves and interaction with strong seafloor topography as possible mechanisms that could be responsible for the generation of Love waves in the secondary microseism.

In a first study, we assume that the secondary microseism source generates mainly vertically polarized waves, and that the Love waves are produced during the propagation of the wavefield. To study this hypothesis, we model the wavefield in a strongly random von Karman type medium with a free surface. To understand more about the relationship between the surface wave types and the parameters of the random medium, we start with a parameter study. We alter the model fluctuation strength, the correlation length and the layering structure of the medium. We find that the fluctuation strength has a major influence on the Love to Rayleigh ratio. We observe that the Love to Rayleigh ratio reaches a maximum value of 0.4 after approximately 4 scattering mean free paths. This value does not explain the observed Love to Rayleigh ratios in the secondary microseism, which lies between 0.6 and 1.2. Moreover, we would need an unrealistically strongly scattering medium to reach this value. Considering scattering properties similar to those encountered in oceanic crust for wavefields around 0.2Hz, we obtain a Love to Rayleigh ratio of 0.1, which significantly below the typically observed ratio of 0.6-1.2.

In a second study, we consider the case of a Longuet-Higgins type source in the water column moving over a set of sea mounts with different maximum heights and values for slope steepness. Furthermore, we model the effect of a ocean microseism noise source moving over a rough patch of realistic seafloor topography. We quantify the ratio of Love to Rayleigh wave energy in the fundamental and higher modes around the sea mounts and around the bathymetry structure. For frequency ranges around the secondary microseism, topography contrasts of the order of 500m generate Love-to-Rayleigh ratios in the range commonly observed in the field.