



Microseism in the North Sea: Tidal forcing, H/V-variability and a future monitoring network

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Ocean generated microseism dominates the seismic background noise between 1 and 20 seconds. It consists of the so called primary (peak period about 14 seconds) and the more energetic secondary microseism with a peak at half that period. Sometimes it is complemented by local microseism with even shorter periods (2-5 seconds). While it is generally assumed that the majority of the microseismic wavefield consists of Rayleigh waves and the primary and secondary microseism is generated by waves breaking at shore and interaction of opposing waves with similar periods, respectively, detailed studies generally paint a more complicated picture. Microseism in the North Sea area has been studied for more than 100 years but many questions regarding the exact source region, the generation mechanism and the temporal variability are still not well understood.

We study 15 years of seismic broadband data recorded at Helgoland island in the German part of the North Sea to investigate questions regarding the temporal variability of the energy in the different microseism frequency bands and the ratio of the horizontal to vertical (H/V) component which serves as a proxy for the portion of non-Rayleigh wave energy. We calculate mean amplitudes of the three different frequency bands for consecutive two hour segments from Fourier transforms of the continuous data. The peaks of the corresponding amplitude spectra of the resulting time series with two hour resolution are identified and compared to peaks found in the amplitude spectra of tide gauge readings, air pressure and significant wave height. Furthermore, a correlation analysis between the local microseism amplitudes as well as the H/V ratios of the different frequency bands and the significant wave height in the area is performed.

Apart from the well known annual variability in all three frequency bands caused by higher wave activity in the winter, pronounced spectral peaks in the local microseism were found at periods of ocean tides. This might indicate a generation mechanism linked to tidal currents that possibly interact with bathymetric features. For the secondary microseism, we find a good correlation with the index of the North Atlantic oscillation, which indicates links to the air pressure differences in the North Atlantic. During the whole year the significant wave height at Helgoland correlates well with the local microseism. In addition, during the summer half-year (Mar-Sep) high correlation coefficients are found for the H/V ratio of the secondary microseism and the significant wave height recorded at Helgoland and along the coast of Germany and the Netherlands indicating possible non-Rayleigh wave generation in these regions.

These studies form the nucleation point for a wider initiative to gain a better understanding of the wave interactions between the atmosphere, ocean and solid earth. As preliminary work, a multi-parameter network consisting of seismic and infrasound arrays, gravimeters and tiltmeters was installed on Helgoland starting in 2017. The recordings which might be complemented by a similar network in the Baltic Sea region and additional modeling studies should further the process understanding of the microseism generation and propagation in the setting of marginal seas.