**Seasonal variations in Arctic Ocean wave action and sea ice conditions recorded by deep-water broadband ocean bottom seismometers**

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Studies of ambient seismic noise have proved a powerful tool to monitor the sea state in oceans, track large storms or even to conclude on the state of the sea ice covering the polar oceans. However, most studies of ambient noise use coastal seismic stations far from the source areas of seismic noise. Seasonal records of ambient seismic noise from the bottom of the polar oceans do not yet exist. In a pilot experiment from September 2018 to September 2019, we deployed four broadband ocean bottom seismometers at eastern Gakkel Ridge, Arctic Ocean, at water depths of about 4000 m underneath perennial sea ice. Only in August and September, the marginal ice zone of the Laptev Sea extended to the OBS position.

Spectrograms show the seasonal variations of the ambient seismic noise. Long-period double-frequency microseisms are slightly stronger in winter time. Their source is outside the Arctic Ocean. Short-period double-frequency microseisms are seasonally modulated and appear when the Laptev Shelf area becomes ice-free, suggesting that deep water conditions are not necessary to produce mid-ocean microseism. The longest periods of this noise band increase as the fetch area for swell generation increases. At high frequencies (6-50Hz), considerable noise is present, mostly as short, distinct noise bands in winter time. We associate these signals to noise generated by the sea ice. To analyze the seasonality of the noise sources, we extracted the spectral power in various frequency bands for the entire year and compared it with variations of the significant wave height from Wave Watch III hindcast models and of ice concentration and drift from satellite data. This comparison revealed that sea ice-related noise decays suddenly in late May while sea ice concentration is still 100%, suggesting that the physical properties of the sea ice change at this time prior to break-up. Likewise, sea ice only gradually develops its noise-generating capabilities after the freezing period, when compression of ice floes contributes to their thickening. During autumn, several swell events cause large-amplitude short-period double-frequency microseisms and simultaneously high-frequency noise although ice-noise is otherwise not present in this season. Ice concentration decreases following the swell events, showing the impact of swell on the state of the sea ice during the freezing season.