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Identifying seismic noise sources and their amplitude from P wave microseisms.

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Understanding sources of seismic noise is important for a range of applications including seismic imagery, time-lapse, and climate studies. For locating sources from seismic data, body waves offer an advantage over surface waves because they can reveal the distance to the source as well as direction. Studies have found that body waves do originate from regions predicted by models (Obrebski et al., 2013), where wave interaction intensity and site effect combine to produce the source (Ardhuin & Herbers, 2013).

Here, we undertake a quantitative comparison between observed body wave microseisms and modelled sources- in terms of location, amplitude, and spectral shape- with the aim of understanding how well sources are observed and potentially what they reveal about the underlying ocean wavefield.

We used seismic stations from the Southern California Seismic Network, and computed beamformer output as a function of time, frequency, slowness and azimuth. During winter months (October – mid March) the dominant arrivals at frequencies 0.18-0.22 Hz were P waves that originated from the North Pacific, whilst arrivals from the North Atlantic dominated at slightly lower frequencies of 0.16-0.18 Hz. Based on this, we chose to focus on P waves during winter, and back-projected the beamformer energy onto a global grid using P wave travel timetables (following Gerstoft et al., 2008). We modelled the seismic sources using Wavewatch III and site effect coefficients calculated following Ardhuin and Herbers (2013).

We output the beamformer and the modelled sources on a 2° global grid averaged over 6 hour periods from September 2012 to September 2014, at seismic frequencies of 0.06 to 0.3 Hz. We then integrated the spectra over the full frequency range. Here we focus on results from the first winter in the North Pacific.

Preliminary results indicate that the logarithm of the modelled source and the logarithm of the beamformer output are well described by a two-term exponential model, with noticeable increase in beamformer output occurring after modelled sources reach amplitudes of $0.1 \mu m^2$.

Limiting the output to times when the signal to noise ratio was >1.5 (52% of the timeseries), we found that the maximum of the beamformer output and maximum of the modelled source were located within 10° (5 grid points) of eachother 80% of the time, within 6° 56% of the time, and on the same grid point 6% of the time. Calculated using the full spectra at these locations, the mean periods were almost identical for the beamformer and modelled sources (0.196s and 0.192s respectively) although the modelled sources had larger spread (standard deviations of 0.006s and 0.017s).

Next, we will estimate the locations and amplitudes of microseismic sources during the second winter, using the beamformer output and the relationship already identified. These estimated sources will then be compared with the modelled sources, considering errors in the modelled sources themselves due to choices of parameterisation and wind input. Finally we will assess to what extent parameters of the forcing ocean waves (e.g. mean wave period, significant wave height) can be interpreted from the observed microseisms.