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Location, size and shape of ocean sources for Rayleigh and compressional (P) waves contained in microseisms.

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The analysis of microseisms, also called seismic noise, has been used for long as an indirect method to describe ocean sea-states. More recently, it has also raised much interest for tomographic purpose. The dominant seismic noise, with periods 3 to 10s, is generated by non linear ocean wave-wave interactions (double frequency micro-seisms, or DFM) as described theoretically [Longuet-Higgins, 1950; Hasselmann, 1963] and modeled numerically [Kedar et al., 2008; Ardhuin et al., 2011; Stutzmann et al, 2012]. The magnitude of the noise source is conditioned by the directional spectra of the swells and wind seas and the bathymetry. Seismic noise has been continuously recorded by stations spread all over the Globe for decades, which offers great perspectives for climate studies and 4D seismic tomography. Nevertheless, the efficiency of noise analysis is still limited by the poor knowledge of the location and geometry of noise sources.

Here we use seismic records and numerical modeling to characterize the distribution of the DFM sources in time and space. Our numerical approach combines a numerical wave model based on the WAVEWATCH III® framework. We compute the second-order pressure fluctuation that generates Rayleigh and compressional (P) waves. The coastal reflection of ocean waves is accounted for. We inspect noise records to detect anomalously high levels of seismic noise (peaks up to a few micrometers for the standard deviation of the vertical ground displacement) recorded simultaneously at several broadband stations. For events (peaks) well modeled, we validate the source centroid position using an independent estimate from seismic data. Sources for Raleigh waves that dominate the DFM spectra are located by performing a polarization analysis of the three-axes ground displacement recorded at a set of three or more seismic stations [Schimmel et al., G3. 2011]. When P waves are also detected, the source location is estimated using beam-forming analysis at dense seismic arrays. Once validated, the computed sources are described and discussed.

Our preliminary results show that the strongest sources are not localized only close to the coasts where they are promoted by incoming- and reflected-swell interactions, but rather in deep water where reflection is absent. Our analysis also suggests that most sources span large areas, with a gaussian width at half maximum around 1000 km. Only a few sources, in particular at the lowest frequencies, are more localized (500 km wide).