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Modeling secondary microseismic noise by normal mode summation

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Seismic noise is the continuous oscillation of the ground recorded by seismic stations in the period band 5-20s. In particular, secondary microseisms occur in the period band 5-12s and are generated in the ocean by the interaction of ocean gravity waves. We present the theory for modeling secondary microseismic noise by normal mode summation. We show that the noise sources can be modeled by vertical forces and how to derive them from a realistic ocean wave model. During the computation we take into account the bathymetry. We show how to compute bathymetry excitation effect in a realistic Earth model using normal modes and a comparison with Longuet-Higgins (1950) approach. The strongest excitation areas in the oceans depends on the bathymetry and period and are different for each seismic mode. We derive an attenuation model than enables to fit well the vertical component spectra whatever the station location. We show that the fundamental mode of Rayleigh wave is the dominant signal in seismic noise and it is sufficient to reproduce the main features of noise spectra amplitude. We also model horizontal components. There is a discrepancy between real and synthetic spectra on the horizontal components that enables to estimate the amount of Love waves for which a different source mechanism is needed. Finally, we investigate noise generated in all the oceans around Africa and show that most of noise recorded in Algeria (TAM station) is generated in the Northern Atlantic and that there is a seasonal variability of the contribution of each ocean and sea. Moreover, we also show that the Mediterranean Sea contributes significantly to the short period noise in winter.