Monitoring sea ice thickness and properties with seismic noise: insights from a laboratory experiment

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The decline of Arctic sea ice extent is one of the most spectacular signatures of global warming, and studies converge to show that this decline has been accelerating over the last four decades, with a rate that is not reproduced by climate models. To improve these models, relying on comprehen- sive and accurate field data is essential. While sea ice extent and concentration are accurately moni- tored from microwave imagery, an accurate measure of its thickness is still lacking. Moreover, measuring observables related to the mechanical behavior of the ice (such as Young's modulus, Poisson's ratio, etc.) could provide better insights in the understanding of sea ice decline, by com- pleting current knowledge so far acquired mostly from radar and sonar data. This paper aims at demonstrating on the laboratory scale that these can all be estimated simultaneously by measuring seismic waves guided in the ice layer. The experiment consisted of leaving a water tank in a cold room in order to grow an ice layer at its surface. While its thickness was increasing, ultrasonic guided waves were generated with a piezoelectric source, and measurements were subsequently inverted to infer the thickness and mechanical properties of the ice with very good accuracy.