THE UNIVERSITY OF CHICAGO | DEPARTMENT OF STATISTICS

Master's Student Presentation

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"Simulating Acoustic Wave Propagation Using 3D-Printed Topographic Models"

Thursday July 20, 2023, at 9:00 AM
Zoom Meeting

Abstract

Propagation of acoustic waves generated by explosive sources can be complicated by reflections and diffractions from local topographic features. Quantifying such topographic effects is critical for estimating accurate source properties such as size and location. However, the quantification remains challenging due to limitations in observations and numerical simulations; observational data tend to have sparse spatial coverage, especially in the near field, and incorporating small-scale topography can be computationally expensive. To overcome these challenges, we propose a new experimental simulation method that utilizes 3D-printed topographic models.

In this study, we (1) print a 3D physical model with a sinusoidal topographic pattern and (2) simulate wave propagation on the 3D-printed model by generating laser blasts and measuring vibrations on the surface. We use pulsed lasers to reproduce the explosions and laser doppler vibrometers to record the motion of the air with dense spatial samplings. The experimental data exhibit clear air waves traveling above the model's surface at the speed of sound. To study topographic effects, we compare the data obtained using the topographic model against the ones obtained using a flat 3D-printed model without topography. We find that the observed topographic effects on the travel times and speeds of the air waves are compatible with the predicted travel paths for the given elevation changes around the source location. This new application of the 3D printing technology for lab-based experiments allows us to print any desired terrains for investigating topographic effects on acoustic wave propagation.
