Simulation Based Analysis Of MEMS Microphone Ports To Predict Wind Noise Spectra

Olivia Montana Canavan[1], Ken Dong, Ph.D.[1]

[1]Sonos, Inc.

Abstract

MEMS microphones have been widely adopted in a variety of consumer electronic systems. To ensure clear speech transmission and avoid degradation of important signals, careful tuning of microphone port geometry is essential to mitigate wind-induced airborne noise. This additional noise can cause the far-end listener, whether human or Voice Assistant, to have a diminished understanding of the conveyed signals.

In order to understand how acoustic hardware can support transmission of speech, physical prototypes and direct acoustic measurements are often used. Measuring wind can be cumbersome due to the necessity of a wind-generating machine, challenges in generating a laminar flow, and repeatability of tests. As an alternative, finite element method (FEM) simulation offers an efficient alternative for early design and mitigation analysis. It is therefore advantageous to model wind noise in COMSOL to study the improving effects of hardware mitigation techniques.

In this study, we sought to quantify the spectra of wind noise in microphone ports of varying geometries. The model uses the Aeroacoustic Flow Source Coupling MultiPhysics to combine Acoustics and Computational Fluid Dynamics studies. The model initially uses a transient study to quantify the velocity of the air over the microphone port. It then calculates the pressure across the system, and uses Transient Mapping from the Aeroacoustic Flow Source multiphysics. The time data is translated into the frequency domain, and the Acoustic analysis is then completed. The frequency response can be determined anywhere in the system, however it is most useful to view it at the MEMS microphone itself.

In our lab, we performed physical measurements to correlate the model results to actual data. Under conditions of laminar velocity, the measurement data was consistent with the model results. The simulation results provide meaningful insight into the way wind noise interacts with MEMS microphones, and how physical acoustics can address the unavoidable existence of wind. In conjunction with acoustical measurements, this can improve overall acoustical design and experience for users.

Reference

[1]E. Hagman and H. Sannar, “Mechanical Design Solutions for Wind Resistant Microphone Ports ,” PDF, Lund University , 2021. Accessed: Jul. 16, 2025. [Online]. Available: https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=9052862&fileOId=9052882

[2]Knowles, “Application Note AN-21 Microphone Wind Noise,” 2018. https://www.knowles.com/docs/default-source/default-document-library/an-21-microphone-wind-noise.pdf?sfvrsn=21ea4cb1_8 (accessed Jul. 16, 2025).

Figures used in the abstract

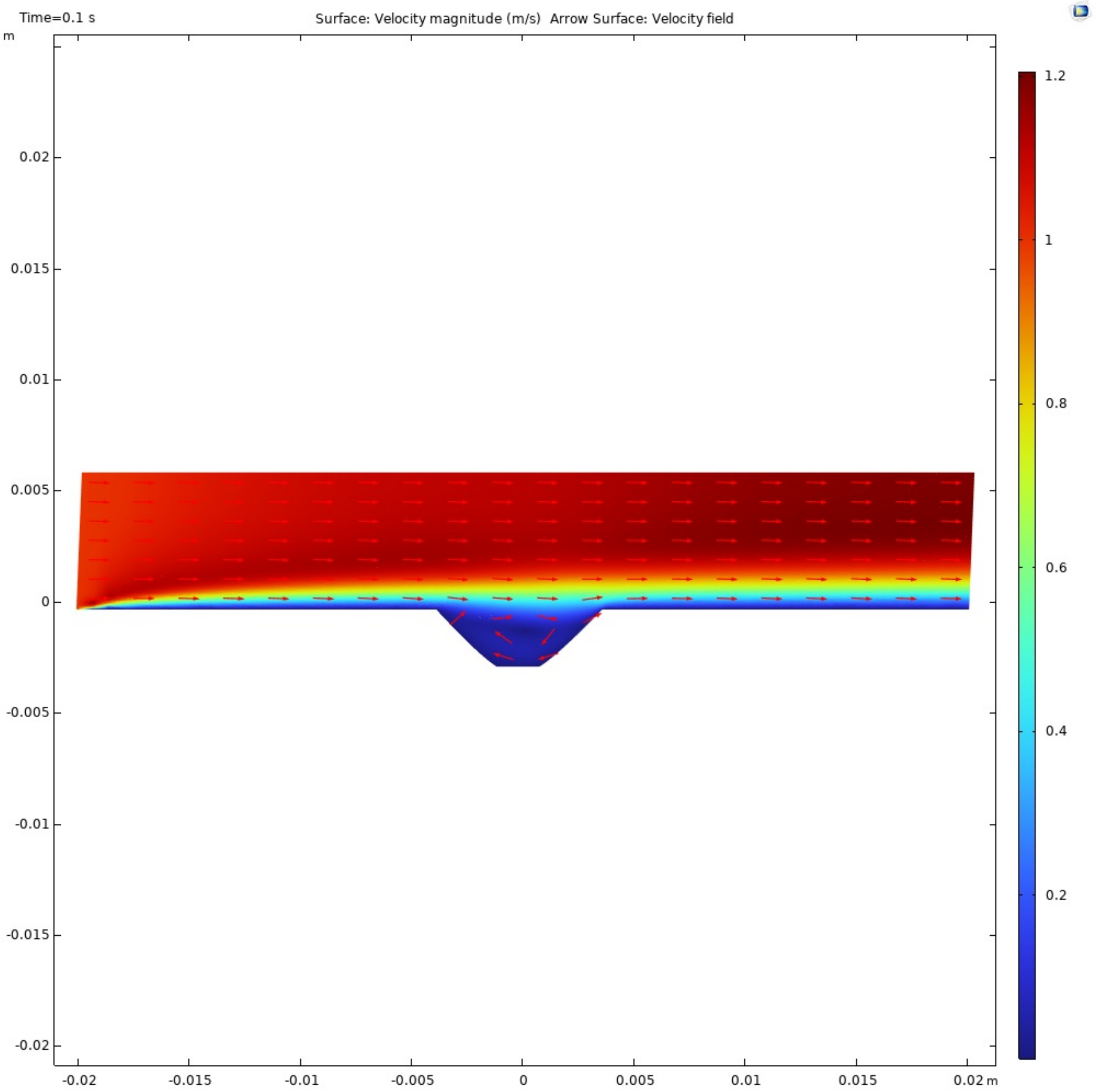

Figure 1 : This image shows the flow of the air velocity over the microphone port. The red arrows indicate the direction of the velocity field.

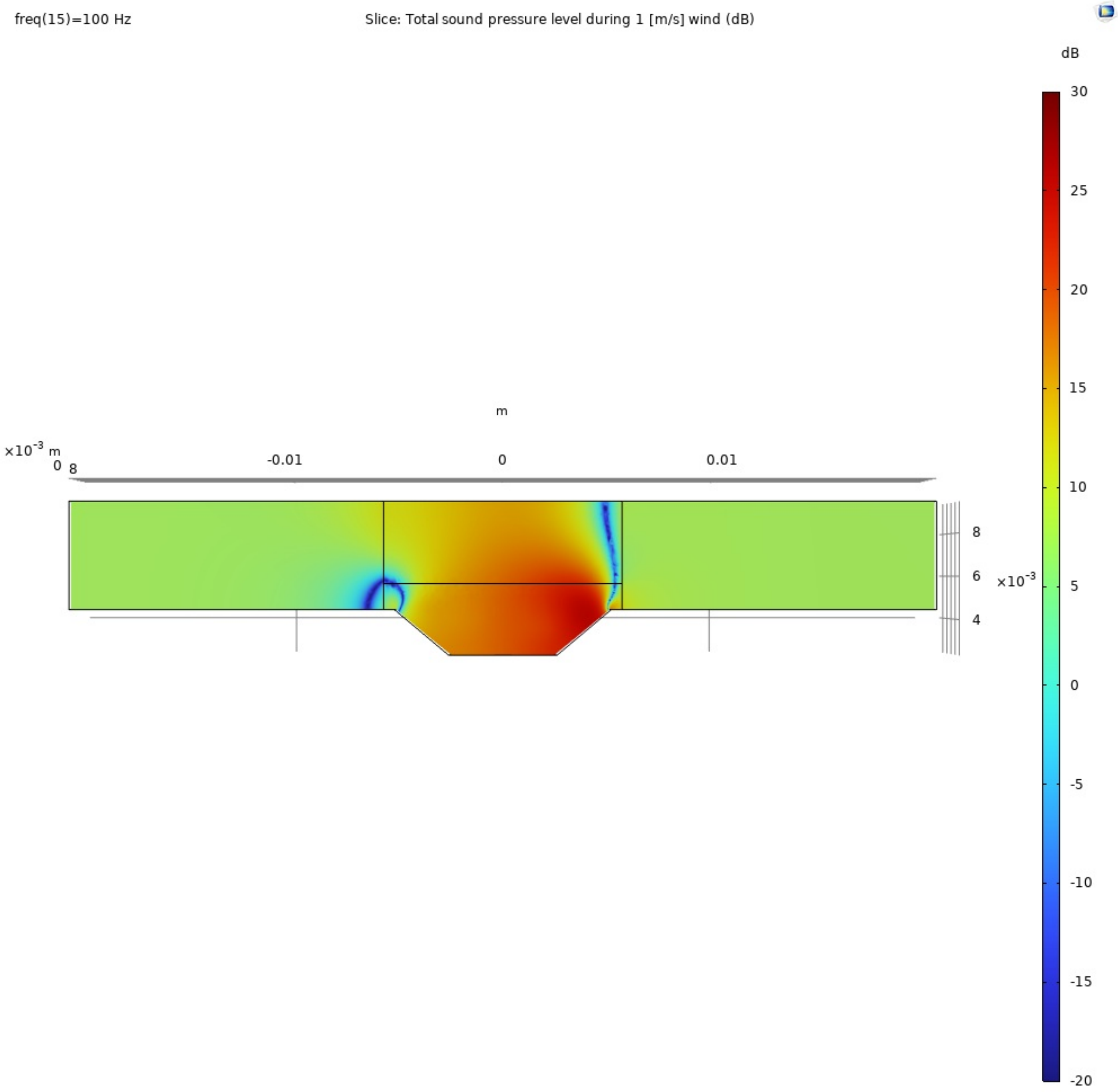

Figure 2 : This image shows the total sound pressure level in the microphone port with 1 [m/s] of wind. This plot is for 100 Hz. The most intense wind noise in this model happens between 100 - 200 Hz. Experientially, this is aligned with what many people hear.

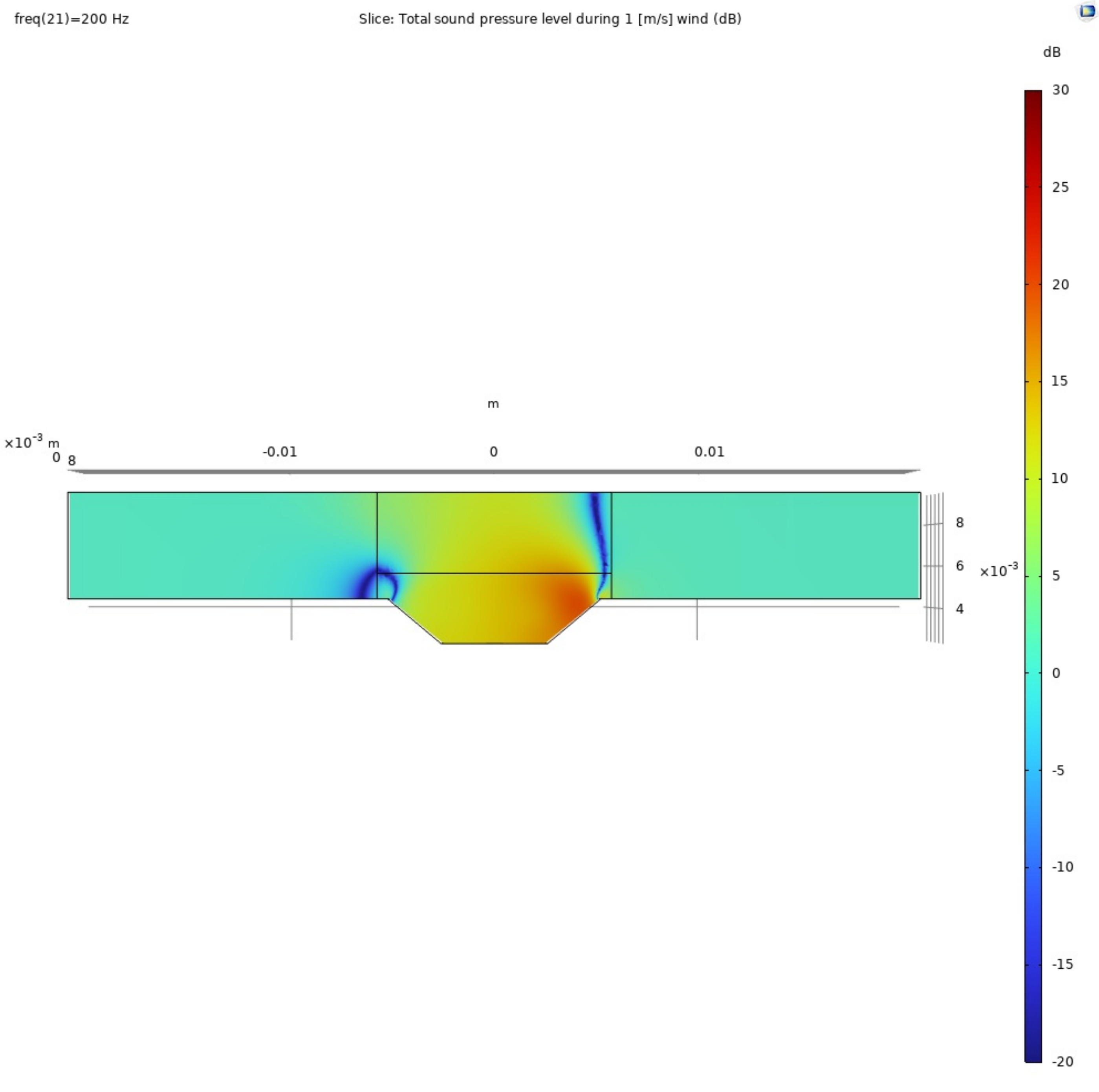

Figure 3 : This image shows the total sound pressure level at 200 Hz during 1[m/s] of wind.

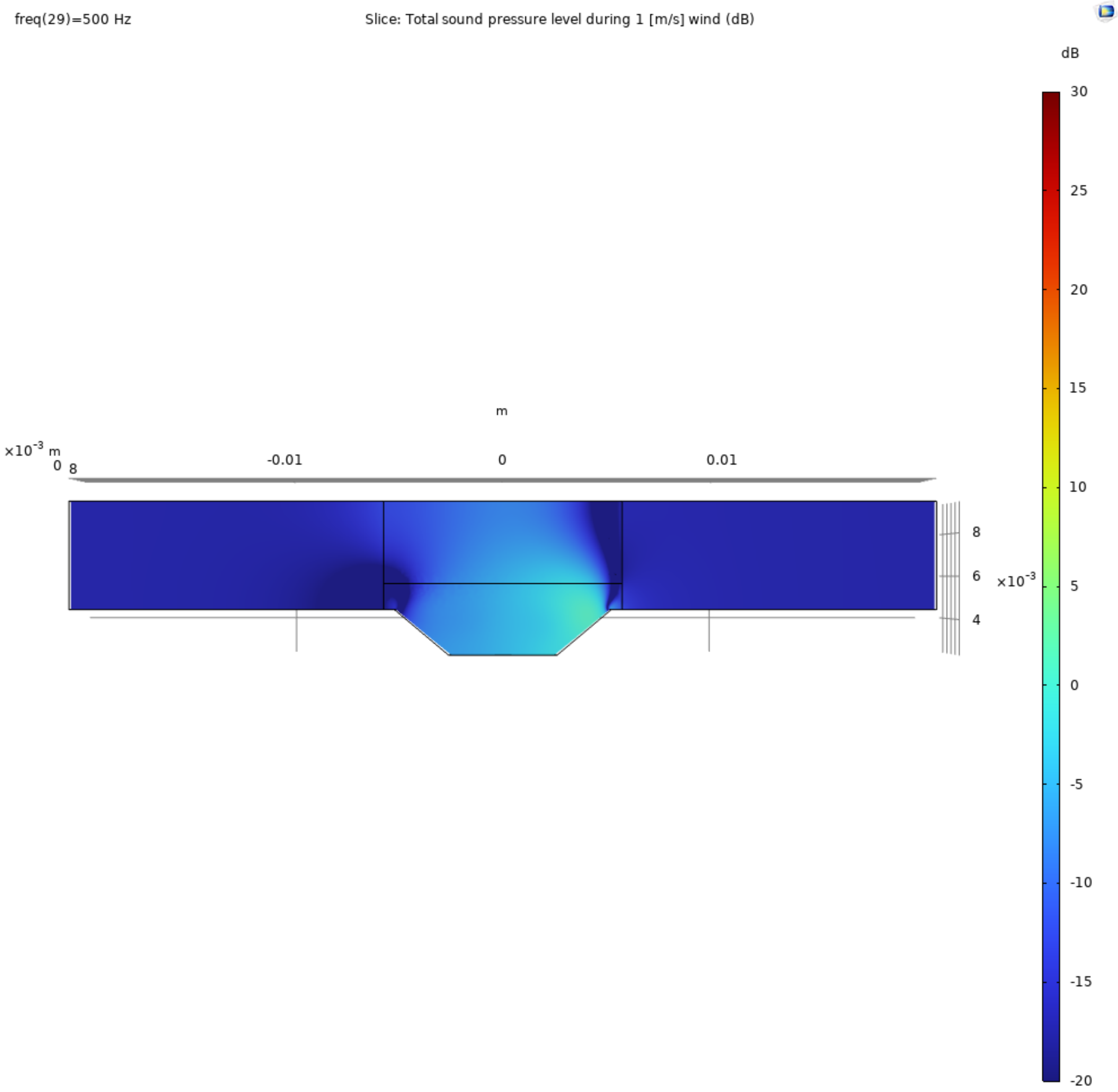

Figure 4 : This image shows the total sound pressure level at 500 Hz during 1 [m/s] of wind. By 500 Hz, the amount of wind noise present decreases significantly than what is present at lower frequencies.