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Investigation of the effects of ground surface and sound velocity profile on sound attenuation by employing parabolic equations method

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Abstract

The sound attenuation in atmospheric propagation depends on several factors, such as ground material, temperature, and geographical features. In this study, the propagation of sound in the atmosphere above ground has been studied. For the simulation of the ground surface, the four-parametric model of Attenborough has been employed to compute the specific impedance of the ground surface. At first, the governing equations of sound propagation and Parabolic Equations (PE) method were presented; then, by employing Finite Difference Method (FDM) discretization and Crank-Nicolson approximation, algebraic equations were obtained. The algebraic equations were solved by Three Diagonal Matrix Algorithm (TDMA) in order to evaluate the sound pressure and sound attenuation over the computational domain. After validation of the numerical simulation, the results of the linear and logarithmic sound velocity profiles were presented and compared in frequency range of 10-100 Hz. For the asid sound velocity profiles, two cases were considered; first, where shadow zone could not exist and the another, where the shadow zone was possible. The sound attenuation over 100 dB was achieved in range of frequency of 40-100 Hz in second studied case. In this situation, with increasing frequency, attenuation was increased but more oscillation was observed in the attenuation. Also, for the flat surface ground, sound attenuation was examined for different sound velocity profiles. Finally, the effects of ground surface roughness on the sound attenuation, by considering the logarithmic sound velocity profile, were investigated at different frequencies.

Keywords: Sound propagation, Ground surface simulation, Parabolic Equation (PE) method, Sound attenuation, Finite Difference Method (FDM).

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