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Computer modeling of the Earth's atmosphere via reflectionless layers

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The Earth's atmosphere is highly inhomogeneous and nonisothermal, and waves in inhomogeneous media are known to be reflected and not able to propagate over a long distance generally. However, it is known that in an incompressible inhomogeneous fluid there exist surface and internal traveling waves, which are not reflected on inhomogeneities when the environment parameters satisfy specific conditions. In this paper we study the existence of such waves in a strongly inhomogeneous compressible atmosphere. The mathematical approach for obtaining of such solutions is connected with a transformational change of arguments and functions using the symmetry and the Lie algebra. For example, in this approach the wave equation with variable coefficients is reduced to an equation of hyperbolic type with constant coefficients, so that the existence of traveling waves becomes obvious. We have derived the ordinary differential equations for the vertical distribution of sound speed (temperature) at which the waves are not reflected. Their solutions are obtained analytically and numerically. It is shown that the Standard Earth Atmosphere is modeled by four piecewise reflectionless profiles. Approximation of the real profiles in geophysics will simplify the calculation of wave dynamics, reducing them to solving of algebraic equations in the "junction" of reflectionless profiles. These results can be used for interpretation of the dynamic processes in the Earth's atmosphere, particularly for the interpretation of abnormally large waves in the upper atmosphere, which could be called the "atmospheric rogue waves".