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*Physical Simulation of Long-Range Infrasonic Propagation in the Atmosphere*

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**Physical Simulation of Long-Range Infrasonic Propagation  
in the Atmosphere**

Sergey Kulichkov, Igor Chunchuzov, Oleg Popov, Vitalii Perepelkin,  
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**Abstract**

*The results of experiments on the physical simulation of long-range infrasonic propagation in the atmosphere are given. The property of similarity between the profiles of effective sound speed stratification in the atmospheric boundary layer (between 0 and 600 m) and in the atmosphere as a whole (from the land surface up to thermospheric heights of about 150 km) was used in the modeling of long-range infrasonic propagation in the atmosphere. A detonation generator was used as a source of acoustic pulses. The experimental results show a structure similarity between the signals recorded in the atmospheric boundary layer and in the land surface—the lower thermosphere thickness.*

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## 1. Introduction

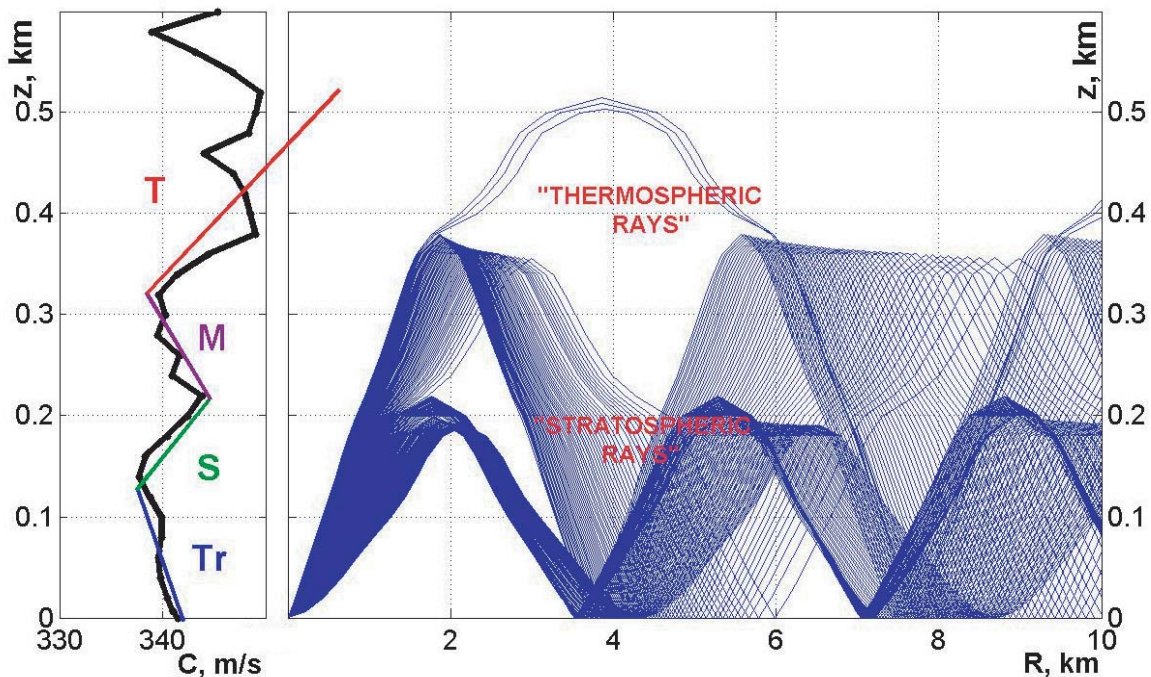
Infrasonic waves propagate throughout the atmosphere at distances of hundreds and thousands of kilometers from their sources. This property is widely used in developing the methods of nuclear test monitoring (CTBT), in solving the problems of atmospheric sounding, etc. [1-2]. In this connection, the following problems arise: (1) the problem of developing correct theoretical models of long-range infrasonic propagation; (2) the problem of determining the effect of a fine inhomogeneous structure of the atmosphere on the characteristics of infrasonic signals; (3) the problem of developing the reliable methods of recording infrasonic signals and their isolating against the background of natural noise; and a number of other problems. One of the methods of solving the above-mentioned problems is to carry out experiments on the physical simulation of long-range infrasonic propagation in the atmosphere.

## 2. Instrumentation

In this work, for this purpose, we use the property of similarity of the paths of sound

propagation in the atmospheric boundary layer (ABL) and in the atmosphere, as a whole, from the land surface up to the lower thermosphere. The corresponding sound velocity profile and ray trajectories are shown in Figure 1. It follows from Figure 1 that the form of the vertical profile of effective sound speed in the ABL is mainly similar to the corresponding profile up to heights of the lower thermosphere. In the form of this profile, one can conditionally isolate the regions corresponding to the “troposphere” (Tr), “stratosphere” (S), “mesosphere” (M), and “thermosphere” (T). The main advantage of the experiments on the physical simulation of long-range sound propagation in the atmosphere is that the vertical profiles of temperature and wind stratifications can directly be measured during these experiments. This allows one to make more correct comparisons between experimental data and the results of calculations according to different theoretical models, to find the most effective methods of signal recording, etc.

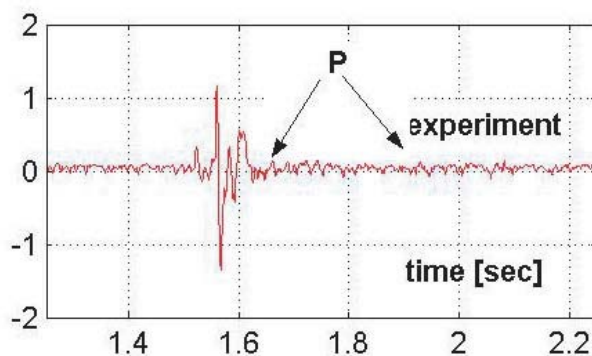
As a sound source, one can use different pulsed sources. In [3], a pulse acoustic oscillator was used as a sound source.



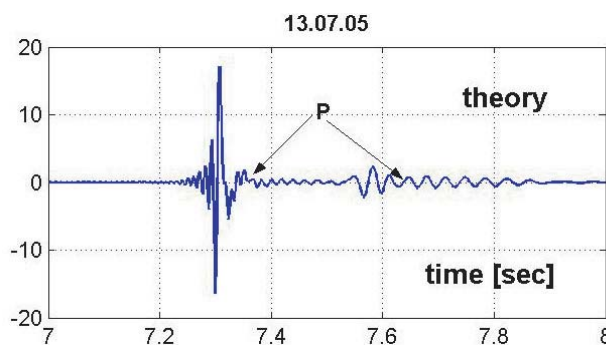
**Figure 1.** Profile of stratification of effective sound speed in the atmospheric boundary layer which may be used to model the atmosphere from the land surface up to thermospheric heights of about 150 km (Tr – “troposphere”, S – “stratosphere”, M- “mesosphere”, T – “thermosphere”) – on the left. Calculation of ray paths – on the right.

### 3. Results

Some experimental results are shown in Figures 2 and 3. The results of the parabolic equation code as applied to sound propagation in an inhomogeneous moving atmosphere yield a satisfactory agreement with experimental data even for calculation of the form of recorded signals. A satisfactory agreement between theoretical models and experimental data on the effect of anisotropic turbulence on fluctuations of acoustic signals propagating at long distances from their source is obtained in [4].



**Figure 2.** Acoustic signal at a distance of 2.5 km from its source.



**Figure 3.** Acoustic signal (calculated according to the parabolic equation code) at a distance of 2.5 km from its source for the stratification profile in Figure 1.

### Acknowledgements

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